2.8 Saint Lucia

2.8.1 Profile

The data collection survey conducted in Staint Lucia emphasized the confirmation of the present situation and implementation progress of the components recommended by the Jamaica and St. Lucia Data Collection Survey in 2014 as well as on the current efforts and activities of the government and other donors which is inquired and confirmed from the National Emergency Management Organization (NEMO).

The basic information have been confirmed and updated by referring to the report of the said survey.

(1) Basic data

The basic data of Saint Lucia are shown in Table 2.8.1.

Table 2.8.1 Basic Data of Saint Lucia

Profile	
Population	182,300 persons(2013, WB)
Land area	620 km^2 (WB)
Capital	Castries
Largest city	Castries
GDP	US$1.33 billion (2013, WB)
GDP per capita	US$7,328 (2013, WB)
GNI (Atlas method)	US$1.310 billion (2013, WB)
GNI per capita	US$7,060 (2013, WB)
GDP growth rate	-0.43% (2013, WB)
GFCF (%GDP)	26.2 (2015, UNISDR, GAR)
Current account	US$(-)183 million (2013, Balance of Payments Manual, IMF)
Assistance received total	US$27 million (2012, WB)
Income level	High/Middle Income Level
Independence	February 22, 1979
Currency	East Caribbean Dollar (EC$)
Climate	Tropical Rainforest Climate
Administrative division	11districts
Residents	African 85.3%, Mixed10.9%, East Indian 2.2%, Others (2010, CIA World Fact Book)
Language	Official Language: English
Religion	Christian 64.9% , Others
Principal industry	Agriculture, Tourism
Major Development Indices	
HDI index	0.725 (2012, UNDP)
Literacy rate (15-24 years old)	--
Primary school enrollment rate	93.0% (2007, WB)
Infant mortality rate (per 1,000 births)	11.75 persons (2014, CIA World Fact Book)
Mortality rate of pregnant women and nursing mothers (per 1,000 cases)	34 persons (2014, CIA World Fact Book)
HIV infection rate (15-49 years old)	--
Improved water service rate	93.8% (2012, WB)
Improved sanitation rate	65.2% (2011, WB)
GINI index	42.6 (2015, UNISDR, GAR)
Life expectancy at birth (years)	74.8 years (2013, WB)
Poverty gap at national poverty lines (%)	--
Social expenditure (% of GDP)	--

Governance Indicators	
Rule of law	0.75 (2015, UNISDR, GAR)
Government effectiveness	0.97 (2015, UNISDR, GAR)
Voice and accountability	1.18 (2015, UNISDR, GAR)
Control of corruption	1.17 (2015, UNISDR, GAR)
Environment	
Ecological footprint	--
Environmental performance index	--
Forest change	--
Freshwater withdrawals (% of internal resource)	0.0 % (2015, UNISDR, GAR)
Climate Change	
Electricity production from renewable energy	0.0% (2015, UNISDR, GAR)
CO_2 emissions	2.27 metric ton/capita (2015, UNISDR, GAR)

Source：World Bank (WB), UNDP, CIA World Fact Book, MOFA Japan (ODA Country Data Book), UNISDR

(2) Overview of Natural Situation

1) Topography and Geology

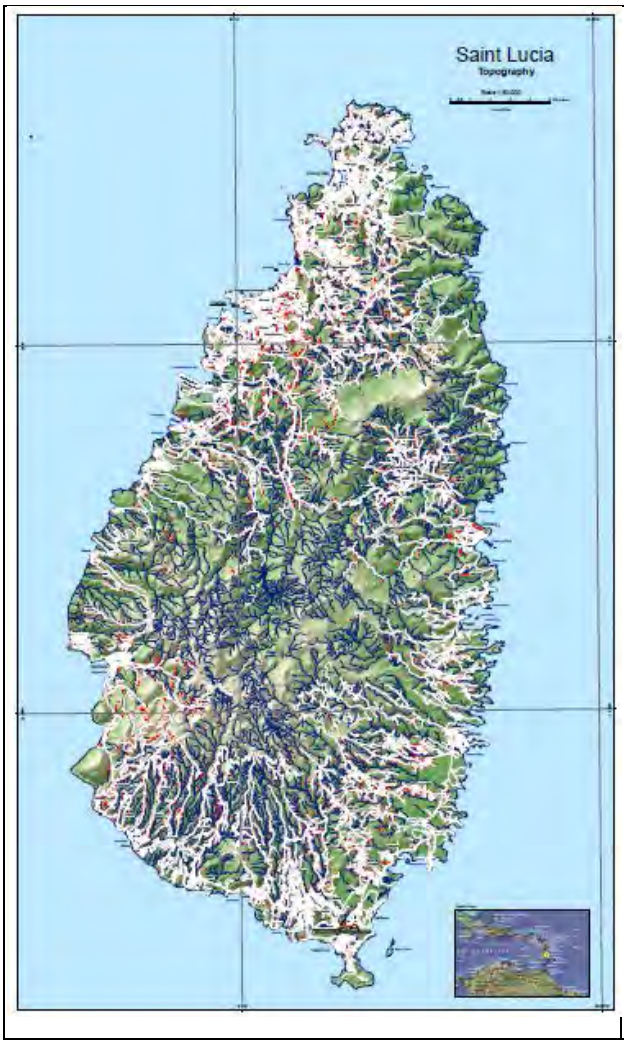
The island of Saint Lucia is located at around 13°59´N latitude and 61°W longitude, and is a small island situated in the Lesser Antilles. Saint Lucia is a volcanic island and characterized by mountainous and undulated topography, where the highest peak is Mt. Gimie (950 m). Active Soufriére Volcanic Centre in the southwest part of the island is alive. The Petit Piton Mountain (748 m) and Grotesque Piton Mountain (798 m) in the south of Soufriere Volcanic Centre were registered in 2004 as world heritage site as Piton Management Area.

Geology of Saint Lucia Island consists almost entirely of volcanic origin with the oldest rocks dating back to the Early Tertiary period. These are composed mainly of andesite, various basalts and pyroclastic flow/ash flow deposits. Rhyolite and Limestone deposits formed during the Lower Miocene period are sporadically observed in the island.

2) Climate

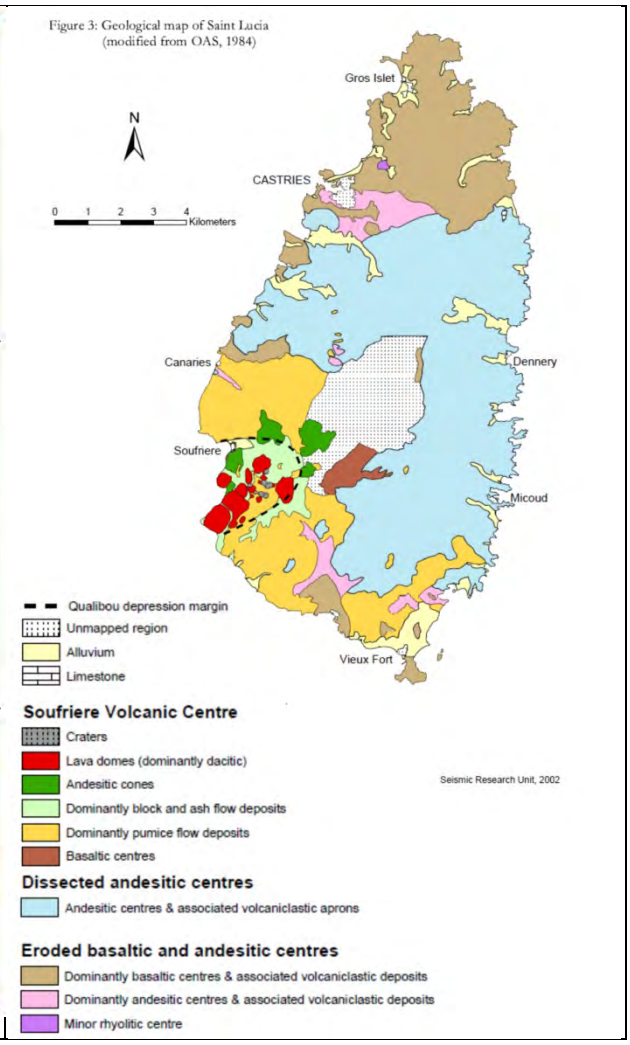
Saint Lucia has tropical maritime climate and is located in the trade wind climate zone where seasonal temperature fluctuation is small with annual mean temperature of 28°C. Climate is classified into two seasons including dry season between January and March and rainy season between June and November.

Annual rainfall amounts to 1,265 mm in the rather flat coastal area and 3,420 mm in the high altitude area. Monthly means of temperature and rainfall are respectively shown in Figure 2.8.3



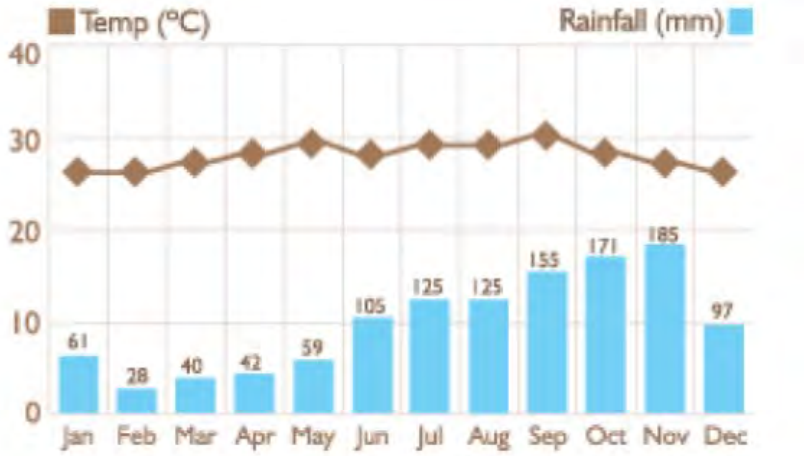
Source : Caribbean Handbook on Risk Information Management (CHARIM, 2015)

Figure 2.8.1 Topography of Saint Lucia



Source : Organization of American States, 1984

Figure 2.8.2 Geological Map of Saint Lucia



Source:presburyworldwiderresorts.co.hk

Figure 2.8.3 Monthly Mean Rainfall and Temperature in Saint Lucia

(3) Socioeconomic Condition

1) Political Situation

Saint Lucia became independent from Britain in 1979. It has a two-party system comprising the conservative United Workers Party (UWP) and the St. Lucia Labour Party (SLP) with a social democratic stand.

UWP yielded power to SLP after holding power for five years through the general election held in November 2011.

2) Population

According to the World Bank's survey, it is estimated that the total population of Saint Lucia was 180,000 as of 2012, 83% of which are living in the rural area with an increasing trend. Residents in the urban area have decreased from 28% in 1987 to 17% in 2012. Table 2.8.2 shows the change of population in Saint Lucia.

Table 2.8.2 Change in Population in Saint Lucia

Indicator	1988	1993	1998	2003	2008	2013
Total population (person)	133,532	143,592	153,066	161,766	172,734	182,273
Population growth rate (annual %)	1.89	1.16	1.36	0.96	1.51	0.77
Urban population (person)	38,422	41,881	43,116	40,791	34,773	33,646
Urban population (% of total)	28.77	29.17	28.17	25.22	20.13	18.46
Rural population (person)	95,110	101,711	109,950	120,975	137,961	148,627
Rural population (% of total)	71.23	70.83	71.83	74.78	79.87	81.54

Source: World Bank, World Data Bank

3) GNI and GDP

Nominal GNI per capita and nominal GDP per capita of Saint Lucia are over US$7,000 and US$7,300, respectively as shown in Table 2.8.3.

Table 2.8.3 Nominal GNI and GDP per Capita in Saint Lucia

Indicator	2009	2010	2011	2012	2013
GNI per capita, Atlas method (US$)	6,670	6,580	6,910	6,920	7,060
GDP per capita (US$)	6,716	7,014	7,193	7,202	7,328

Source: World Bank, World Data Bank

4) Government Agencies and Administrative Division

The ministries of the Government of Saint Lucia are enumerated in Table 2.8.4.

Table 2.8.4 Central Government Agencies of Saint Lucia

Central Government Agencies
Office of the Prime Minister (OPM)
Ministry of Agriculture, Food Production, Fisheries, Co-operatives and Rural Development
Ministry of Commerce, Business Development, Investment and Consumer Affairs
Ministry of Education, Human Resource Development and Labour
Ministry of External Affairs, International Trade and Civil Aviation
Ministry of Finance and Economic Affairs
Ministry of Health, Wellness, Human Services and Gender Relations
Ministry of Home Affairs and National Security
Ministry of Infrastructure, Port Services and Transport
Ministry of Legal Affairs
Ministry of Physical Development, Housing and Urban Renewal
Ministry of Public Service, Information and Broadcasting
Ministry of Social Transformation, Local Government and Community Empowerment
Ministry of Sustainable Development, Energy, Science and Technology

Central Government Agencies
Ministry of Tourism, Heritage and Creative Industries
Ministry of Youth Development and Sports

Source：Saint Lucia Gov. data arranged by the JICA Study Team

Local administrative regions are composed of 17 councils as shown in Table 2.8.5. Castries is divided into five councils.

Table 2.8.5 Administrative Regions in Saint Lucia

Regional Council	Area (km^2)	Population (2011)
1 Castries Central	79.5	66,262
2 Castries North		
3 Castries East		
4 Castries South		
5 Castries Southeast		
6 Anse La Raye/Canaries	46.9	8,368
7 Soufriere	50.5	8,550
8 Choiseul	31.3	6,154
9 Laborie	37.8	6,763
10 Vieux-Fort South	43.8	16,434
11 Vieux-Fort North		
12 Micoud South	77.7	16,434
13 Micoud North		
14 Dennery South	69.7	12,715
15 Dennery North		
16 Babanneau	101.5	25,443
17 Gros-Islet		
Total	539.0	167,123

Source：Saint Lucia Gov. data arranged by the JICA Study Team

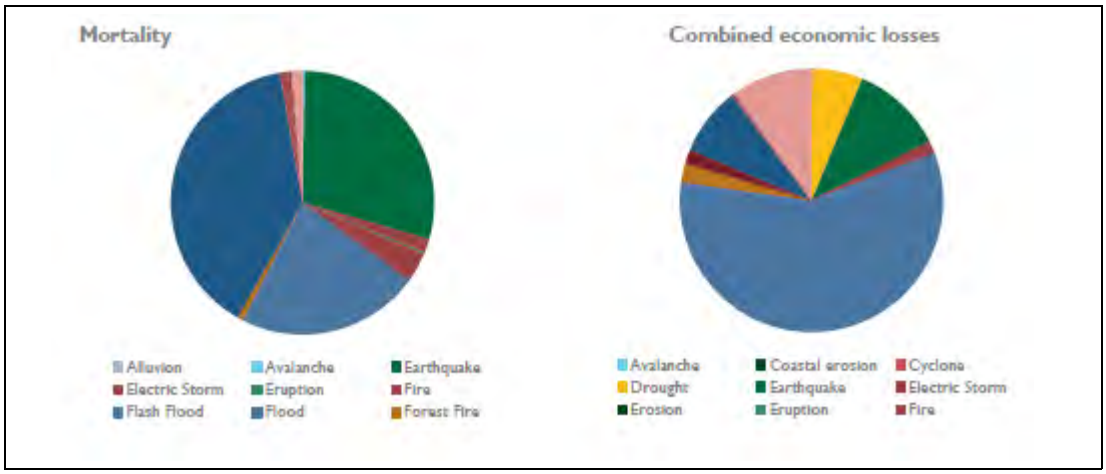
2.8.2 Disaster Situation

(1) General

The Global Assessment Report on Disaster Risk Reduction 2015(UNISDR) indicates disaster frequency and economic losses as shown in Figure 2.8.4. As shown in the figure, the most serious disaster in Saint Lucia from 1990 to 2014 is due to flood in terms of death toll and economic loss.

Referring to the record of disasters in the whole Saint Lucia from 1900 to 2012, the worst disaster is storm and then flood and sediment disaster in terms of the number of deaths and affected people, which show that the serious natural disasters in Saint Lucia are caused by hurricanes and storms.

Serious disasters in recent years include the landslide due to the earthquake in 2009, flood disaster in 2011, and landslide disaster in 2013. In addition, small-scale floods and sediment disasters occur every year everwhere in the country.



Source: Global Assessment Report on Disaster Risk Reduction

Note: The term "Cyclone" is used as in the source.

Figure 2.8.4 Proportion of Disaster in terms of Death Toll (left) andCause-specific Percentage of Economic Loss by Disasters (right)

(2) Flood

1) Feature of Floods

In Saint Lucia, the main disasters are flood and storm surge where flash flood and debris flow are the most frequent disasters according to the country's natural condition. There are 37 watersheds in the country and issues such as decline in the water retention potential, steep slope area, water resources conservation by land use control of steep slope area, and watershed conservation have been identified. The critical areas are Denny Quarter along the Atlantic Ocean as well as the Anse La Ray Quarter along the Caribbean Sea where floods and storm surges occur frequently.

2) Record of Floods

Saint Lucia is located within the hurricane belt and frequently suffers serious damages from floods. Table 2.8.6 shows the flood disasters that occured in recent years. Serious floods in recent years were due to Hurricane Tomas in 2010 and the Christmas heavy rain in 2013. Many bridges were damaged during the Christmas heavy rain in 2013; however, most of the bridges on the trunk road have been restored afterward and the remaining bridges are under rehabilitation.

Table 2.8.6 Severe Natural Disasters in Saint Lucia in the Past 100 Years

Disaster	Occurence Date	Death Toll	Damage Amount (Referrence) (US$1,000)
Storm	1988/09/11	45	1,000,000
Storm	1980/08/01	18	No data
Storm	1963/09/25	10	3,465
Storm	2010/10/30	10	500
Storm	1980/07/31	9	87,990
Flood	2013/12/23	6	No data
Storm	1994/09/10	4	No data
Storm	2007/08/17	1	40,000

Source: Data Collection Survey on Disaster Risk Management in Jamaica and Saint Lucia (JICA 2014)

3) Field Inspection and Confirmation of Site Condition

i) Inner Water Drainage Facilities in Castries City

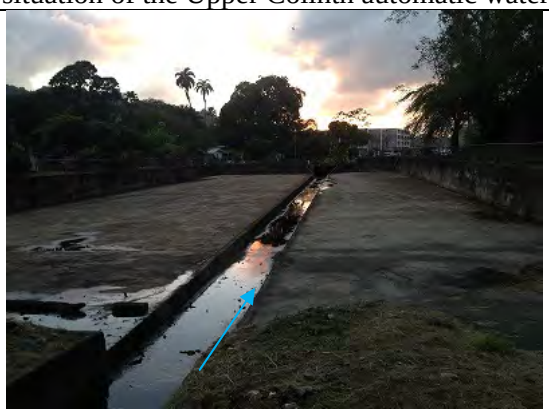
Runoff from the hilly terrain located in the upper part of Castries are drained through the drainage channel, drainage pump at the river mouth, and retarding ponds in the city area. Urban drainage condition in Castries has been much improved with the installation of the drainage facilities, which were constructed mainly with the support from China and have been operated and maintained by the

city government. The said retarding ponds are exclusively used for drainage and not for multi-purpose use. Figure 2.8.5 (left side) shows a present situation of the innner water drainage facility in Castries City..

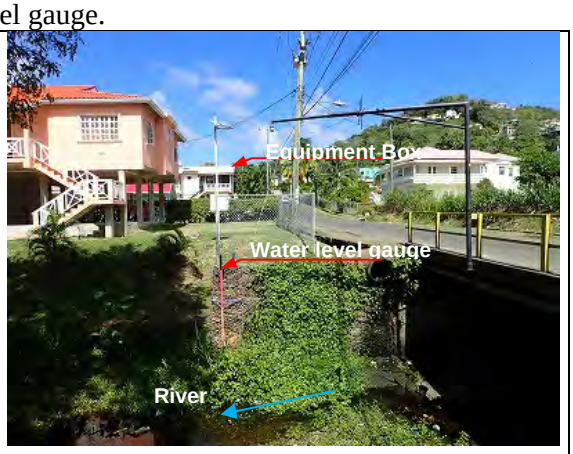
ii) Early Warning System in Upper Corinth

The early warning system for community disaster management in the Bois'd Orange River basin in the northwest area of Saint Lucia was established under the Caribbean Area Disaster Management Project, Phase II (CADM2: January 2009 to June 2012) as a pilot project. One rainfall station was installed at Pleateau in the most upper reach as well as water level gauge in Upper Corinth, in the upstream reach of the target area, and in Grand Riviere, which have been maintained by the Water Resources Management Agency (WARMA).

Currently, the observation and recording units are functioning but warning dissemination cannot be made due to communication equipment (modem) troubles at the three stations; these equipment have not been repaired due to the lack of manual and spare parts. Figure 2.8.5 (right side) shows a present situation of the Upper Colinth automatic waterlevel gauge.



Retention facility for inland water drainage in Castries City (February 19, 2015)



Upper Corinth Water Level Gauge (February 20, 2015)

Source：JICA Study Team

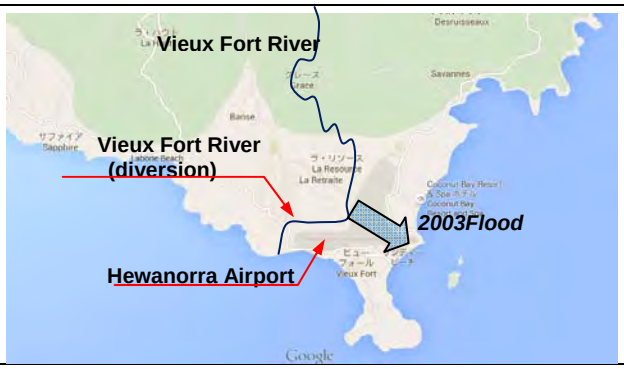
Figure 2.8.5 Site Situations (Flood)

iii) Flood Damage in the Hewanorra Airport

Flood damages were caused both in two airports respectively located in the northern and southern areas. Field inspection was conducted at the Hewanorra Airport in the southern area to confirm the damage to the road south of the airport and the neighboring culverts.

The Hewanorra Airport is located in the coastal plain around the river mouth of the Vieux Fort River, which is a main river in the southern area. The diversion channel was constructed from the Vieux Fort River when the airport was constucted so that the airport would not be directly hit by the flood flow.

The airport area was inundated by the flood due to the Chiristmas heavy rain in 2013, whose inundation was caused by the flood flow going into the airport directly from the diverson channel by overflowing the riverbanks at the diversion intake. A part of the coastal road in the south of the airport was washed away by flood current on the road as shown in Figure 2.8.6. No drastic measure of river improvement has been taken yet; however, damaged road sections were restored through the installation of three units of drainage culverts.



Location map around Hewanorra Airport

Coastal road washed away in the south of the Hewanorra Airport (December 26, 2013)

Source：JICA Study Team

Figure 2.8.6 Flood Damage Situation at the Hewanorra Airport

(3) Sediment Disasters

1) Distribution Characteristic of Sediment Disaster

Major sediment disasters that occurred in Saint Lucia Island are shown in Table 2.8.7. Sediment disasters occur in nearly the entire island because the geology of Saint Lucia Island consists of volcanic origin deposits. The disasters frequently occur in the Anse LaVerdure area in the west of Mt. Gimie and in the area at the southern foot of Mt. Ground Magazin.

Table 2.8.7 Major Sediment Disasters in Saint Lucia

Date	Event	Number of Deaths	Number of Homeless	Comment
November 21/22, 1938	Ravine Poisson Landslide	100		
July 10, 1960	Landslide	6		Hurricane Abby
1981	Landslide on West Coast Road between Castries and Soufriere			About 765 m^3 of debris from the cut slope blocked the road.
September 17, 1988	Landslide			
November 06, 1990	Landslide in Morne du Don		68	
November 29, 1992	Landslide in Bocage		10 families affected (36 persons)	
September 10, 1994	Mudslide	3		Tropical Storm Dabby
October 14, 1998	Landslide in Boguis		12 households (49 persons)	
September 01, 1999	Black Mallet /Maynard Hill Landslip		102 families relocated	Approximately 80,000 m^3 of colluvial material 'flowed' downslope toward the Marchand River
September 26, 2004	Landslide/Subsidence in Tapion			Approximately 1,800 m^3 of colluvial material 'flowed' down slope
July 01, 2005	Landslide Windjammer Landing Beach Resort			Heavy rainfall prior to the failure

Date	Event	Number of Deaths	Number of Homeless	Comment
October 30/31, 2010	Many landslides in Colombette, Fond St Jacques, along the Barre De L'ile, Millet and on the hills east and south of Castries			Hurricane Tomas
December 24, 2013	Several landslides along the roads			Christmas Eve Trough

Source：NEMO (2011), CHARIM (2015)

2) Field Inspection and Confirmation of Site Condition

West Coast Road Anse La Verdurearea (Stop 1, 2)

East Coast Road and West Coast Road are important highways that connect two international airports in the north and south. These highways, especially West Coast Road, pass through sediment disaster prone areas.

Fundamental countermeasures such as slope stabilization are not implemented yet but temporary countermeasures such as temporary road closure, sediment removal, and road reopening after sediment removal are repeatedly undertaken when sediment disasters occur. Field inspection was conducted around the Anse La Verdure area where landslides occur frequently and traces of the past disaster still remain. Figure 2.8.7 shows present situation of the Anse La Verdure Area.

Site of landslide caused by Christmas trough in 2013. Debris has been pushed out of the vicinity of the road.

Site of large-scale landslide caused by Hurricane Tomas in 2010.

Source：JICA Study Team

Figure 2.8.7 Site Inspection on the West Coast Road in Anse La Verdure Area (February 21, 2015)

(4) Storm Surge

Design scale assessment against strong wind, storm surge, and high wave was made under the Caribbean Disaster Mitigation Project (CDMP) by the recurrence interval. High surge and high wave levels in and around Castries for the 100-year probable flood are estimated to be 0.6 m and 6.1 m, respectively.

(5) Strong Wind

As shown in Table 2.8.6, storms brought by hurricanes are the most serious natural disasters in Saint Lucia in terms of human and economic losses according to the past disasters record.

(6) Earthquake

In Saint Lucia Island, there have been at least ten earthquakes in the last 200 years including volcanic earthquake swarms and their aftershocks as referred to Table 2.8.8. The earthquakes in 1906 and 1990 seem to have been triggered by a large tectonic one. The last tectonic earthquake of note was of Magnitude 7.3 in 1953.

Table 2.8.8 Major Earthquakes Observed in Saint Lucia

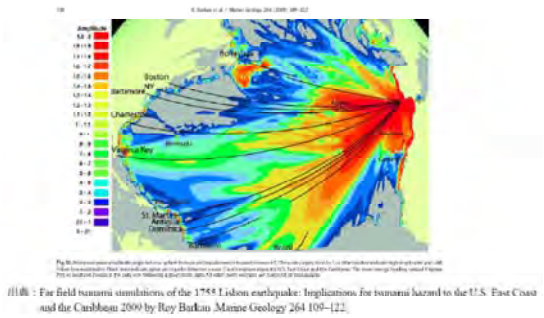
Date	Event (Magnitude)	Death Toll	Number of Homeless	Note
January 11, 1839	Earthquake (7.5)	1		Located east of Martinique - In Castries, all public buildings and masonry houses were severely damaged with partial collapse in some cases. In Soufriere, one person was killed.
February 02, 1906	Earthquake (7.0)			
May 21, 1946	Earthquake			Building damage
March 19, 1953	Earthquake (7.3)			In Castries, there was partial collapse of buildings previously damaged by the 1948 fire, and some damage to other buildings. New buildings designed to resist earthquakes were not damaged.
Early 1986	Series of Earthquakes			12 earthquakes happened in a single day, of which four were reported to be widely felt in southern Saint Lucia.
1990	Series of Earthquakes (3.0 to 4.5)			From February to November, ranging in strength from M3.0 to 4.5. 29 earthquakes occurred in a single day on May 19, 1990.
April to June 1999	Series of Earthquakes			105 volcanic earthquakes were recorded in southern Saint Lucia.
2000	Series of Earthquakes			The swarm began in July 2000 and culminated on November 24, 2000 with 27 earthquakes occurring in a single day. Activity was largely over by January 2001.
November 29, 2007	Earthquake (7.3)	None	None	
December 11, 2007	Earthquake (5.3)	None	None	Aftershock

Source：NEMO(2011), UWI-SRC

(7) Tsunami

Tsunami disaster record is scarcely available in Saint Lucia. However, many active plates are existing around Saint Lucia Island. The Lesser Antilles Trench, just east of the island, is highly probable to be a hypo-center so that it is a concern for the occurrence of tsunami.

In 1755, the tsunami caused by the earthquake which occured near Lisbon, Portugal reached the Caribbean Sea area. The wave height observed in Saint Lucia is higher than 10 m, which shows that tsunami to be caused in the Atlantic Ocean might reach the east coastal area of the Caribbean Sea. Figure 2.8.8 presents the numeric simulation result of tsunami in



出典：Far field tsunami simulations of the 1755 Lisbon earthquake: Implications for tsunami hazard to the U.S. East Coast and the Caribbean 2000 by Roy Barkan ,Marine Geology 264 109–122.

Figure 2.8.8 Numeric Simulation Result of Tsunamiin the Atlantic Ocean

the Atlantic Ocean.

(8) Drought

Saint Lucia have sometimes suffered damage from drought and occurence frequency is estimated at once in less than five years according to the meteolological service. The John Compton Dam Reservoir, which is the sole reservoir in the country was constructed in 1955 for water supply purpose with CIDA support. Currently, the reservoir storage volume has been decreased to one-seventh of its capacity in the beginning stage due to heavy sediment. Thus, countermeasures against sediment issues are formulated through the feasibility study supported by CIDA whose final report will be available in March 2015.

(9) Bridges

Table 2.8.9 shows the disaster-stricken bridges for which field inspections were conducted as indicated in Figure 2.8.9. All bridges were stricken by flash flood caused by the Christmas flood in 2014.

Table 2.8.9 Situation of Disaster-Stricken Bridges

No	Name	Road	Damage Situation	Present Situation
①	Canaries Bridge	WCR	Broken	Rebuilt with Bailey Bridge
②	Ravine Claire Bridge		Flowed down	Re-erected with Bailey Bridge
③	Mocha Bridge		Broken	Newly built
④	Piaye ValleyBridge	WCR	Broken	Newly built
⑤	Wannier,- Micoud Culvert	ECR	Culvert and road flushed away	Newly constructed with larger section box culvert
⑥	Cul de Sac Bridge	ECR	Overflowed	Used in a critical condition
⑦	Ferrands Bridge	ECR	Overflowed	Used in a critical condition
⑧	Ravine Poisson Bridge	ECR	Overflowed	Used in a critical condition
⑨	Alba Bridge	ECR	Broken	Newly built
⑩	Millennium Highway		Pavement deteriorated	Used as normally

Source：JICA Study Team

Source：JICA Study Team

Figure 2.8.9　Locations of Field Inspection (Bridge)

Canaries Bridge（Location①）

The old Bailey bridge was washed away during the Chiristmas flood and was reconstructed with a new Bailey truss with length of 33 m and width of 4.2 m as seen in Figure 2.8.10. It is probable that similar damage might be caused in case of a similar scale flood because the position and clearance of the new bridge seem same as the old one.

	
Date：February 21, 2015 Site： Right bank near the Canaries River mouth Outline：Bailey bridge with new steel floor slab.	Date：February 21, 2015 Site：View from downstream left bank Outline：Restored in the same manner as the previous bridge in terms of location as well as height

Source：JICA Study Team

Figure 2.8.10　Canaries Bridge

Cul de Sac Bridge（Location⑥）

The present Cul de Sac Bridge is a two-lane box culvert type. Many driftwoods, dead branches, and dry grasses are caught under the bridge in the upstream side even during the the dry season. Such driftwoods and others prevent the smooth flow of river water, which raises the water level and causes inundation in the upstream reaches. Therefore, it is required to modify the bridge design into a single span bridge (with no pier) in view of disaster mitigation.

Furthermore, some considerations shall be taken regarding countermeasures such as settlement consolidation at the abutment structure and approach road area in the design of a new bridge in another place because the proposed construction area is on the flood plain of the Cul de Sac River. Present situation of the Cul de Sac Bridge is seen in Figure 2.8.11.

	
Date：February 19, 2015 Site：From right bank towards left and downstream to right side. 21 m long and 5.5 m wide	Date：February 19, 2015 Site：Central partition wall

Source：JICA Study Team

Figure 2.8.11　Cul de Sac Bridge

Ferrands Bridge（Location ⑦）

The Ferrands Bridge located 1 km east from the starting point of the East Coast Road (ECR) has unusual three-lanes culvert type design which is liable to obstruct smooth river flow. Present situation of the Ferrands Bridge is seen in Figure 2.8.12.

	
Date：February 19, 2015 Site：1 km east from the starting point of ECR Outline： Panoramic view; deformed triple box culvert type	Date：February 19, 2015 Site： View from downstream (right) Outline：Suspended trees caught on the partition wall

Source：JICA Study Team

Figure 2.8.12　Ferrands Bridge

Ravine Poisson Bridge（Location ⑧）

This bridge has concrete slab placed on a steel girder which has no proper maintenance. The end of the girder is rather rusted. Present situation of the Ravine Poisson Bridge is seen in Figure 2.8.13.

	
Date：February 19, 2015 Site：8.5 km from the starting point of ECR Outline：View from upstream (left); Steel girders bridge with length of 15 m and width of 7.5 m	Date：Feb. 19, 2015 Site： View from downstream (left) Outline：Abutment of left bank sticks out to the river channel

Source：JICA Study Team

Figure 2.8.13　Ravine Poisson Bridge

Millennium Highway（Location⑩）

The JICA Study Team surveyed the Millennium Highway which is desired to be rehabilitated by the government. The Millennium Highway was constructed about 15 years ago with the Kuwait Fund and it connects Castries and the crossing point of the East Coastal Road (ECR) and the West Coastal Ropad (WCR).

It is generally observed that the pavement of the highway does not need urgent repair although there were locally deteriorated parts. Notwithstanding, the improvement of the pavement is one of the government's requirement for the rehabilitation. Present situation of the Millenium Highway is seen in Figure 2.8.14

	
Date : February 19, 2015 Site : Millennium Highway, about 300 m from the starting point Outline : Much traffic and road surface looks in good condition	Date : February 19, 2015 Site : Millennium Highway Outline : Deteriorated portion; no other section where pavement condition is particularly bad

Source : JICA Study Team

Figure 2.8.14 Millennium Highway

2.8.3 Present Disaster Management

(1) Present Disaster Management

The disaster management policy of Saint Lucia aims at long-term sustainable development and comprehensive disaster risk management by mainstreaming disaster management taking disaster cycle into consideration. Present disaster management system is based on "the Disaster Preparedness and Response Act" that is the act related to disaster management and established in 2000 in accordance with the CEDRA Model Disaster Management. According to the said act, the National Emergency Management Organization (NEMO) was estabilised as the national disaster management agency. The Disaster Management Act has been established in 2006, and NEMO takes responsibility as the coordinating agency for all stages of disaster risk management on the basis of the act.

(2) National Emergency Management Organization (NEMO)

The present main tasks and activities of the NEMO secretariat include disaster management training and enlightment activities during the preparatory stage as well as taking charge of the urgent operation center for urgent disaster corespondence. However, NEMO does not work proactively on other disaster management activities.

The NEMO secretariat comprises nine staffs and staff insufficiency is supplemented by the volunteers' assistance. Members of the national committee in case of emergency correspondence are mostly volunteers.

According to the NEMO Annual Report 2012, the secretariat has the following issues:

Insufficient information communication technology(ICT) management;

Insuffcient ICT for the disaster management agency secretariat;

Human resources are necessary in NEMO such as media, telecommunication and project continuity plan fields as well as mass-scale event coordinator;

Technical knowledge on hazard map risk information analysis;

Capital and human resources for updating risk map and hazard map.

2.8.4 Meteorological and Hydrologic Services

(1) Meteorological and Hydrologic Agencies and Duties

The meteorological service office is under the Ministry of Infrastructure, Port Service and Transport (MIPST). MIPST-Saint Lucia Meteorological Service (SLMS), Hewanorra Airport Satellite Office conducts the meteorological observation in the airport.

Water level observation is conducted by the Water Resource Management Agency (WRMA) under the Ministry of Sustainable Development, Energy, Science and Technology (MSDES), while the Water and Sewerage Company (WASCO) carries out reservoir water level observation.

(2) Outline of Meteorological and Hydrologic Agencies (Personnel and Budget)

The numbers of personnel of MIPST and WRMA are about 30 and nine, respectively. Both offices did not disclose their budget but said that the operation and maintenance works cannot be executed good enough due to budget constraint.

(3) Meteorological and Hydrologic Observations

1) Meteorological Observations（Surface and Upper Air）

Rainfall observation is conducted by MIPST. SLMS conducts manned meteorological observation and automatic rainfall observation in the meteorological observatory in the Hewanorra Airport.

Rainfall stations under WRMA exist at 35 locations nationwide; however, 12 stations are not functioning and without any restoration effort due to financial constraint.

2) Meteorological Radar Observation

No meteorological radar equipment exist in Saint Lucia but radar observation information from Martinique Island and Barbados are available. No installation plan is expected considering O&M cost and operating capacity constraints.

3) Hydrologic Observation (River)

River water level observations are made by both MIPST and WRMA.

Water level stations at two locations as well as one water level station were installed in Corinth under JICA CADM2, which has been managed by WRMA.

4) Tide and Surge Observations

Tide level and surge observation information is received from NOAA in Miami.

5) Observation Database System

Observation records by SLMS are kept in the observatory.

(4) Dissemination of Weather Information, Forecast, and Warning

MIPST disseminates hurricane warning based on the information received from the NHC in Miami. Regarding rainfall, the High Rainfall Warning System was established in 2004 which indicates rainfall intensity in four levels and warning levels with color classification.

MIPST regularly provides the aviation authority with meteorological information such as temperature and wind velocity. Information is received such as GCM weather forecast, hurricane forecast, and meteorological radar information through internet from the related organizations. In addition, tsunami warning is received upon its occurrence from the Pacific Tsunami Warning Center so that the tsunami warning is issued to NEMO and the headquarters of the meteorological service.

2.8.5 Support of the Japanese Government

There is no individual support by Japan in the disaster management field. Technical assistance for hazard mapping in the pilot project area and formulation of the community disaster management plan were carried out in the JICA Caribbean Disaster Management Project, Phase II (CDMA 2, from 2009 to 2012).

2.8.6 Support of Other Donors

Many donors including the World Bank, UNDP, IDB, CDEMA, CIDA, Department for International Development (DFID), Australian Agency for International Development (AusAID), and others have supported Saint Lucia in the disaster management area. No local office of any donors was set up in

Saint Lucia and the Ministry of Finance and Economic Affairs set up the World Bank Unit and EU Unit as donor contact service. The ministry undertakes management of donor-supported projects.

The recent donors' supporting performances are shown in Table 2.8.10.

Table 2.8.10 Recent Donor's Support in Disaster Management Field in Saint Lucia

Current Projects Supported by Donors	Donor	Budget (US$)	Period	HFA Priority Areas of Activity*
Additional Financing to the Saint Lucia Disaster Management Project II	WB	3.96 million	2008-2011	1, 2, 3, 4, 5
Disaster Management Project II (DMP II)	WB	8.9 million	2004-2011	1, 2, 3, 4, 5
Comprehensive Disaster Harmonized Implementation Program (CDM HIP)	CDEMA/CIDA /DFID			1
Caribbean Risk Management Initiative	UNDP	2.1 million	2004-2010	1, 2, 3
Enhancing Resilience Vulnerability in the Caribbean	Government of Italy	4.5 million	2009-2011	1, 2, 3, 4, 5
Mainstreaming DRM in the OECS Countries	IDB	0.4 million	2008-2011	
Regional DRM Strategy for the Caribbean Tourism Sector	IDB	0.8 million	2007-2009	
Regional Monitoring and Evaluation Framework for DRM in the Caribbean Tourism Sector	IDB	0.75 million	2009-2012	

Source：National Progress Report 2009-2011, St. Lucia

(1) World Bank

The World Bank has commenced the DVRP as a new project in the disaster management field in FY2014 for about three to five years. The said project will be executed as a joint project with the PPCR project, which is the climate change adaptation project to be supported by the World Bank.

Other than the above, the World Bank is supporting the disaster restoration project together with CDB as a result of the damages caused by Hurricane Tomas on October 30, 2010. As for the heavy rain disaster on December 24, 2013, identification of potential urgent works is ongoing after the disaster assessment survey.

(2) IDB

IDB is implementing support in the education, housing, and poverty reduction fields, as well as disaster restoration of Hurricane Tomas. Support by IDB, CIDA and DFID are undertaken through CDB.

(3) CDEMA

CIDA and DFID conduct the Comprehensive Disaster Harmonized Implementation Program through CDEMA and the maintenance services of machinery and equipment are introduced in CDMA2.

2.9 Dominica

2.9.1 Profile

(1) Basic Data

The basic data of Dominica are shown in Table 2.9.1.

Table 2.9.1 Basic Data of Dominica

Profile	
Population	72,003 persons (2013, WB)
Land area	750 km^2 (WB)
Capital	Roseau
Largest city	Roseau
GDP	US$517 million (2013, WB)
GDP per capita	US$7,176 (2013, WB)
GNI (Atlas method)	US$513 million (2013, WB)
GNI per capita	US$6,930 (2013, WB)
GDP growth rate	-0.91% (2013, WB)
GFCF (%GDP)	21.5 (2015, UNISDR, GAR)
Current account	US$(-)94 million (2013, Balance of Payments Manual, IMF)
Assistance received total	US$26 million (2012, WB)
Income level	High/Middle Income level
Independence	November 3, 1978
Currency	East Caribbean Dollar (EC$)
Climate	Tropical Rainforest Climate
Administrative division	10 districts
Residents	African 86.7%, Mixed 8.9%, Caribbean 2.9%, European 0.8% (2011, CIA World Fact Book)
Language	Official Language: English
Religion	Christian 82%, Others
Principal industry	Agriculture
Major Development Indices	
HDI index	0.745(2012, UNDP)
Literacy rate (15-24 years old)	--
Primary school enrollment rate	91.8%(2010, WB)
Infant mortality rate (per 1,000 births)	11.61persons(2014, CIA World Fact Book)
Mortality rate of pregnant women and nursing mothers (per 1,000 cases)	--
HIV infection rate (15-49 years old)	--
Improved water service rate	94.4% (2006, WB)
Improved sanitation rate	81.1% (2006, WB)
GINI index	0.0 (2015, UNISDR, GAR)
Life expectancy at birth (years)	76.6years (2006, WB)
Poverty gap at national poverty lines (%)	--
Social expenditure (% of GDP)	--
Governance Indicators	
Rule of law	0.63 (2015, UNISDR, GAR)
Government effectiveness	0.71 (2015, UNISDR, GAR)
Voice and accountability	0.99 (2015, UNISDR, GAR)
Control of corruption	0.69 (2015, UNISDR, GAR)

Environment	
Ecological footprint	-- (2015, UNISDR, GAR)
Environmental performance index	47.1 (2015, UNISDR, GAR)
Forest change	-- (2015, UNISDR, GAR)
Freshwater withdrawals (% of internal resource)	0.0 (2015, UNISDR, GAR)
Climate Change	
Electricity production from renewable energy	0.0% (2015, UNISDR, GAR)
CO_2 emissions	1.91metric ton/capita (2015, UNISDR, GAR)

Source：World Bank (WB), UNDP, CIA World Fact Book, MOFA Japan (ODA Country Data Book), UNISDR

(2) Overview of Natural Situation

1) Topography and Geology

Dominica is located in the area between 15°12'N-15°39'N latitudes and 61°14'W-61°29'W longitudes. It is a small island country included in the Lesser Antilles. The island is approximately 48 km north to south and 24 km wide on the east-west axis. Dominica is a mountainous volcanic island and the highest point on the island is Morne Diablotin at 1,447 m in the central part of the island. Morne Trois Piton, being registered as a UNESCO World Heritage Site, is the second highest at approximately 1,423 m located in the southern part of the island.

Geology of Dominica Island consists almost entirely of volcanic origin with the oldest rocks dating back to the Early Tertiary period. These are composed mainly of andesite, dacite, and basalt. Limestone deposits formed during the Lower Miocene period are sporadically observed in the island.

Topography and geology of Dominica are respectively shown in Figures 2.9.1 and 2.9.2.

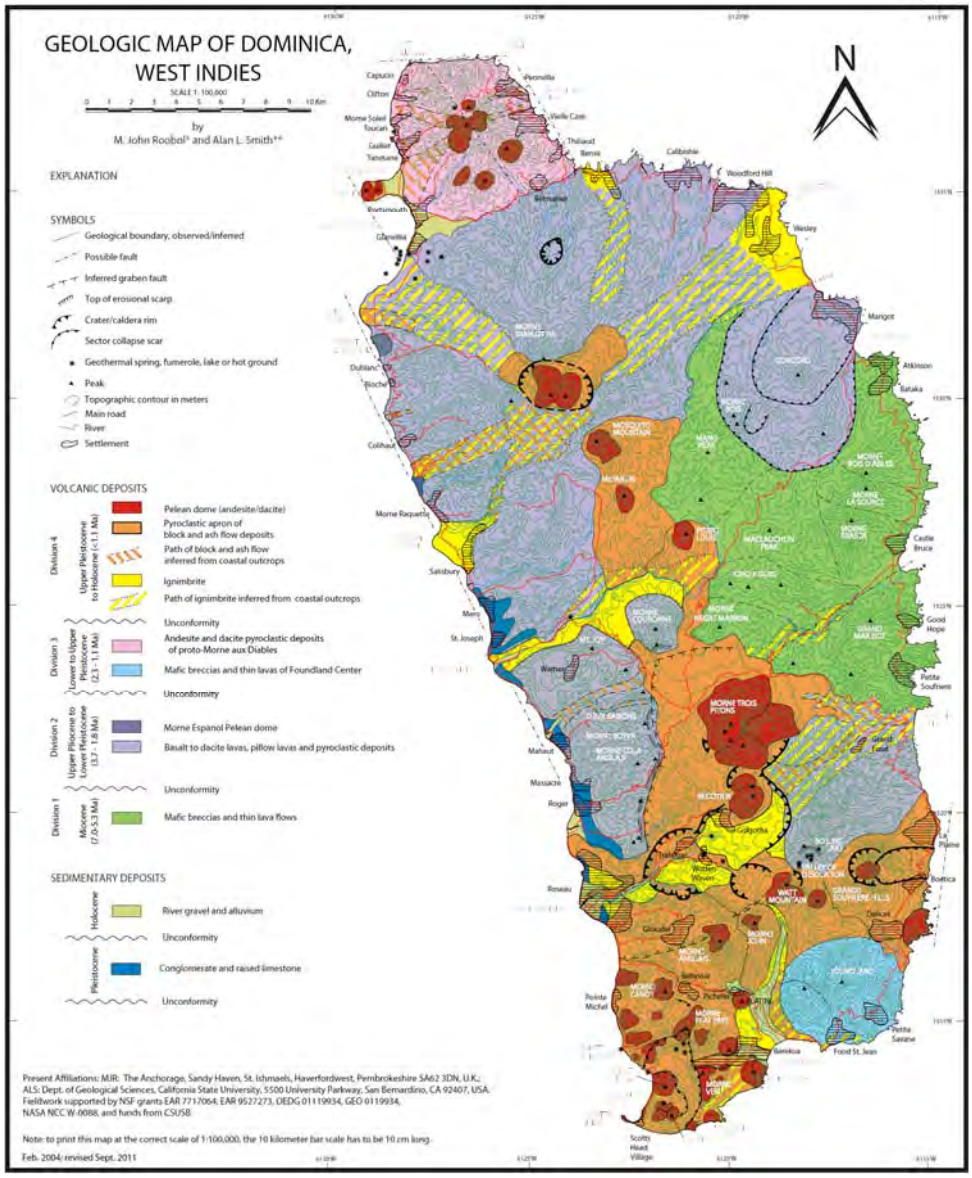
2) Climate

Dominica has tropical maritime climate and is located in the trade wind climate zone as well as within the hurricane belt that is why it is affected by hurricanes from June to November. It has mountain climate locally in the central mountainous area. Seasonal temperature variation is small and annual mean temperature is about 26°C to 27°C in the coastal area, while it is in the range from 19°C to 21°C in the mountainous area. Among the East Carribean islands, the rainfall volume is biggest in Dominica where annual rainfall amount is over 2,500 mm. There are rainy and dry seasons each year, in which the dry season is from February to June. Figure 2.9.3 shows the monthly mean rainfall and temperature at Canefield, Melville Hall in Dominica.

Source：http://www.glogster.com/globalisation/how-has-globalisation-shaped-trade-/g-6nj66am3nctrava6gn8cpa0

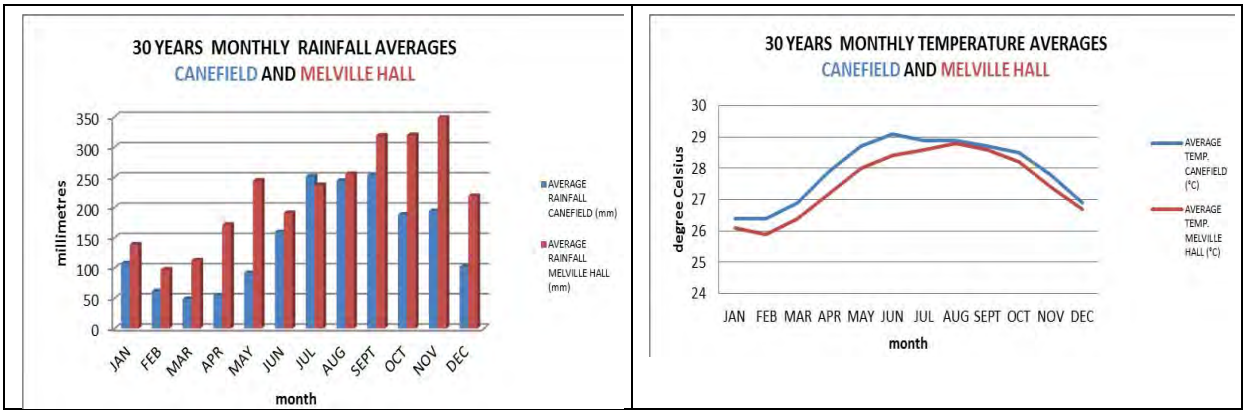
Figure 2.9.1　Topography of Dominica

Fig. 9



Source: ODM (2011)

Figure 2.9.2 Geology of Dominica



Source: Dominica Meteorological Service

Figure 2.9.3 Monthly Mean Rainfall and Temperature in Dominica (Canefield, Melville Hall)

(3) Socioeconomic Condition

1) Political Situation

Dominica became independent from Britain in November 1978, and it has been a constitutional republic with single chamber. Dominica Labour Party (DLP) won in the general election in December 2014, and has been taking power continuously for four terms.

2) Population

According to the World Bank's survey, it is estimated that the total population of Dominica was 72,000 as of 2013, 30% of which are living in the capital Roseau and 62% are in the coastal area. The change in population in Dominica is as shown in Table 2.9.2.

Table 2.9.2 Change in Population in Dominica

Indicator	1988	1993	1998	2003	2008	2013
Total population (person)	71,743	71,205	70,295	70,058	70,883	72,003
Population growth rate (annual %)	-0.87	0.32	-0.65	0.36	0.12	0.44
Urban population (person)	28,842	25,167	24,539	23,824	23,036	22,343
Urban population (% of total)	40.20	35.34	34.91	34.01	32.50	31.03
Rural population (person)	42,901	46,038	45,756	46,234	47,847	49,660
Rural population (% of total)	59.80	64.66	65.09	65.99	67.50	68.97

Source: World Bank, World Data Bank

3) GNI and GDP

Nominal GNI per capita and nominal GDP per capita of Dominica are about US$6,900 and US$7,200, respectively as shown in Table 2.9.3.

Table 2.9.3 Nominal GNI and GDP per Capita in Dominica

Indicator	2009	2010	2011	2012	2013
GNI per capita, Atlas method (US$)	6,620	6,810	6,970	6,820	6,860
GDP per capita (US$)	7,027	6,927	7,122	7,182	7,176

Source: World Bank, World Data Bank

4) Government Agencies and Administrative Division

The ministries of the Government of Dominica are enumerated in Table 2.9.4.

Table 2.9.4 Central Government Agencies of Dominica

Central Government Agencies
Ministry of Agriculture and Forestry
Ministry of Education and Human Resources Development
Ministry of Finance
Ministry of Foreign Affairs and CARICOM Affairs
Ministry of Health and Environment
Ministry of Housing, Lands and Water Resources Management
Ministry of Information, Science, Telecommunication and Technology
Ministry of Justice, Immigration and National Security
Ministry of Kalinago Affairs
Ministry of Public Works and Ports
Ministry of Social Services, Family Services and Gender Affairs
Ministry of Tourism and Urban Renewal
Ministry of Trade, Energy and Employment
Ministry of Youth, Sports, Culture and Constituency Empowerment
Ministry of Commerce, Enterprise and Small Business Development
Ministry of Planning, Economic Development and Investment

Source：Web Portal, the Government of Commonwealth of Dominica

Local administrative regions are composed of ten parishes as shown in Table 2.9.5.

Table 2.9.5 Administrative Parishes in Dominica

Parish	Area (km^2)	Population
St. George	53.5	21,241
St. John	58.5	6,561
St. Peter	27.7	1,430
St. Joseph	120.1	5,637
St. Luke	11.1	9,786
St. Paul	67.4	1,670
St. Mark	9.9	1,834
St. Patrick	84.4	7,622
St. David	126.8	6,043
St. Andrew	179.6	9,471

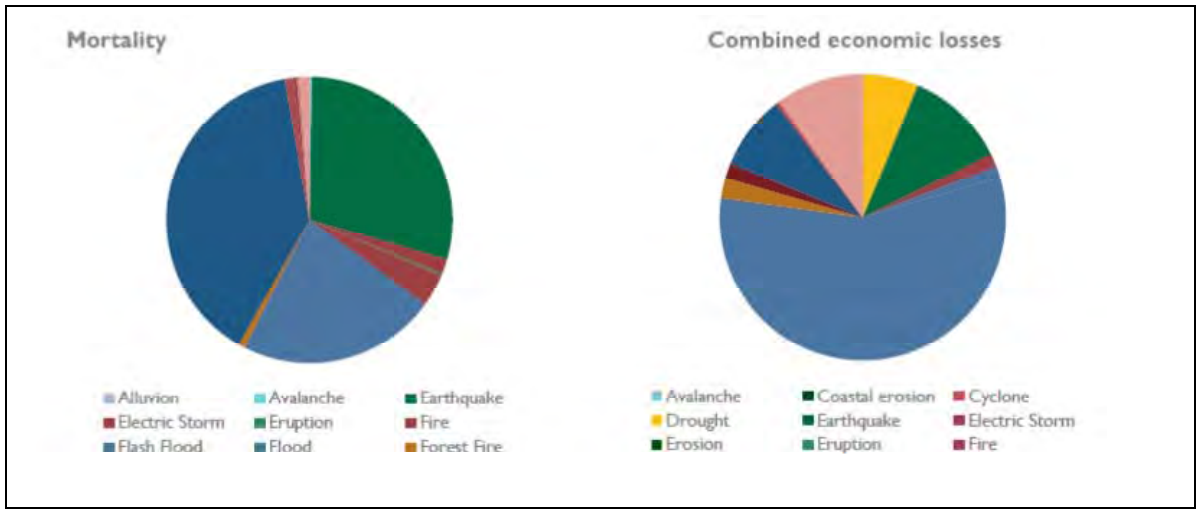
Source：http://www.citypopulation.de/Dominica.html

2.9.2 Disaster Situation

(1) General

Dominica frequently suffers from natural disasters such as floods. Recent serious disasters are the landslide due to the earthquake in 2009, and floods and landslide disasters in 2011 and 2013. Furthermore, Dominica suffers rather small-scale flood and sediment disasters every year all over the country.

According to the Global Assessment Report on Disaster Risk Reduction 2015 (UNISDR), the most frequent disaster hitting Dominica is that due to flood.



Source: Global Assessment Report on Disaster Risk Reduction, Note: The term “Cyclone” is used as in the source.

Figure 2.9.4 Proportion of Disaster in Terms of Death Toll (left) **and Cause-specific Percentage of Economic Loss by Disaster (right)**

(2) Flood

1) Records of Hurricanes and Flood

Flood disasters in Dominica are caused mainly by flash flood which is fast rainfall runoff within several hours after heavy rainfall due to hurricane or tropical storm. Table 2.9.6 shows the records of hurricanes and heavy rainfall as well as sediment disasters. Other than those shown in the table, there are disasters with death toll of more than 2,000 in the 1930 flood and death toll of 40 in the 1979 flood.

Table 2.9.6 Major Flood and Sediment Disasters in Dominica

Date	Event	Impact	Losses	Classification
December 23-25, 2013 (Christmas Flood)	Trough, flash flood and landslides	Damage to housing and infrastructure		Heavy rain caused by cold front
April 2013	Heavy rains, 30+ landslides across the country	Damage to roads and agriculture	2 deaths	
2011	-Storm Ophelia -Collapse of Matthieu Dam (natural dam formed during 1995 flood)	-Damage to housing and infrastructure -4 deaths, Huge economic loss including agriculture and livestocks in Layou Valley on downstream reaches		
July 2009	Flooding	Damage to infrastructure		
2008	Hurricane Omar	Damage to coast and fishing industry	No death	Sea surge, 20 to 30 feet
2007	Hurricane Dean (Category 2)	Damage to agriculture and housing		Flash flood
1999	Hurricane Lenny	Coastal damage	1 death	Sea surge, 30 to 40 feet
September 5, 1995	Hurricane Luis	Damage to housing, agriculture and infrastructure		
September 1995	Hurricane Dean (Category 2)	Damage to housing, agriculture and infrastructure		
August 26, 1995	Hurricane Lenny	Damage to housing, agriculture and infrastructure		
September 17, 1989	Hurricane Hugo （Category 4）			
September 10, 1988	Hurricane Gilbert (Tropical depression)			
1984	Hurricane Klaus			
1980	Hurricanes Frederick and Allen (Category 1)	Economy, Agriculture	No deaths	Disaster
August 29, 1979	Hurricane David (Category 5)	Total devastation	43 deaths, 60% homeless	Disaster
1920	Landslide and flooding in Roseau Valley		1 family died	

Source：Disaster Risk Reduction Country Profile 2014

2) Field Inspection and Confirmation of Site Condition

i) Roseau River

The Roseau River flows through the Roseau City area, which is like a mountain stream with rather high flow velocity. In the upper reaches of the urban area where there is no dyke system, flood

disasters frequently occur due to flash floods by heavy rainfall every year. In the downstream reach in the urban area, no severe flood damage has occured since river improvement with bank protection works have been well undertaken through steel sheet pile revetment, concrete wall, and gabion piling. Currently, river protection works with concrete walls are in progress at the downstream right bank using the national budget. Furthermore, sediment runoff is so remarkable that periodical dredging works are carried out at the river mouth area and downstream reaches. On the other hand, risky situation in the river course is identified by some squatters in the sandbar, which disturbs flood flow in the river. Figure 2.9.5 shows present situation of the affected area along the Roseau River downstream reach.

	
Date：March 2, 2015 Site：Roseau River	Date：March 2, 2015 Site： Roseau River

Source：JICA Study Team

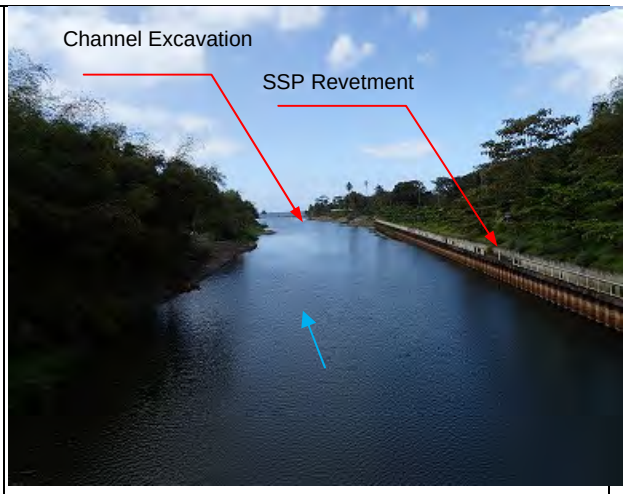
Figure 2.9.5 Situation of Affected Area along the Roseau River

ii) Layou River Mouth

The Layou River is one of the biggest river in Dominica. The alluvial cone is formed around the river mouth. River flow is rather gentle than other rivers because of gentle river bed slope.

In the 2011 flood, villages at the right side of the river mouth were inundated due to flooding around the bridge on the trunk road, while no inundation occured in the 2013 flood. During the flooding in 2011, lots of sediment were deposited in the downstream reaches where dredging works are ongoing.

Figure 2.9.6 shows the situation of flood in September 2009 as well as present situation around rivermouth area.



Date：September 28, 2011 Site： Layou River mouth Outline： A bus stuck in flood waters in Layou Source: News Article http://dominicanewsonline.com/news/homepage/news/accidents-tragedy/kelver-darroux-say-situation-in-layou-is-terrible/	Date：February 28, 2015 Site： Bridge at the Layou River mouth Source：JICA Study Team

Figure 2.9.6 River Mouth Area of the Layou River

iii) Small Streams in the Western Area

Both the Massacre River and the Mahault River are small-scale rivers with a width of 6 m which the west coastal road with the most traffic in Dominica crosses. The structures of the said rivers were damaged by the flood in 2010 and the retaining wall has been constructed as part of the rehabilitaion works in the downstream reach to the river mouth section. Bridges on the river create a bottleneck in the river course which cause backwater effect and inundation in the upper reach area. Present condition around Massacre River mouth area is shown in Figure 2.9.7.

Date：February 28, 2015 Site： Bridge near the Massacre River mouth	Date：February 28, 2015 Site： Revetment wall near the Massacre River mouth Outline：After the flood in 2011, masonry revetment was constructed, which is 3 m high and 1 m from the riverbed. There is dike road at the left side.

Source：JICA Study Team

Figure 2.9.7 River Mouth Area of the Massacre River

(2) Sediment Disasters

1) Distribution Characteristic of Sediment Disaster

Sediment disasters, mainly landslides, frequently occur around active volcanoes as well as in the southern region where late Pleistocene-Holocene pyroclastic flow and ash flow deposits are distributed. Major sediment disasters are shown in Table 2.9.7.

Table 2.9.7 Major Sediment Disaster that Occurred in Dominica (1806–2014)

Date	Area	Event Type/Scale	Inducement	Impact
December 24, 2013	Nationwide	Trough, flash flooding and landslides	Christmas Eve trough	Damage to housing and infrastructure
September 5, 2013	Morne Prosper	Landslide		Road blocked
April 2013	Across the country	30+ landslides	Heavy rains	Damage to roads and agriculture; 2 deaths
July 29, 2011	Soufriere	Landslide		Road blocked
May 24, 2010	San Sauver	Landslide	Heavy rains overnight	Disaster zone; 3 deaths
2007	Campbell	Landslide		2 deaths
2007	Bellevue Chopin	Landslide		2 deaths
November 4, 2004	-	Series of landslides		
2003	Carholm	Landslide		Damage to agriculture and tourism; No death
December 9, 2003	Bellevue Chopin	Landslide		
April 1999	Northern Area	100+ landslides	Hurricane Lenny	Damage to roads and housing
1997	Bagatelle	Landslide		
November 12, 1986	Castle Bruce	Landslide	Several days of heavy rainfall	
November 11, 1986	Good Hope	Landslide	Several days of heavy rainfall	1 death
1983	Bellevue Chopin	Landslide		1 death
1977	Bagatelle	Landslide		13 deaths
1970	Bellevue Chopin	Landslide	Hurricane Dorothy	
1960	Bellevue Chopin	Landslide		1 death
1920	Roseau Valley	Landslide and flooding	Hurricane	1 family died
August 28, 1916	-	Landslide and flooding	Hurricane	
September 20, 1934	-	Landslide and flooding	Hurricane	
September 9, 1806	-	Landslide and flooding	Hurricane	

Source: ODM (2014), CHARIM (2015)

2) Field Inspection and Confirmation of Site Condition

Location map of site inspection is shown in Figure 2.9.8.

a) Slope Failures at the Section between Pointe Michel and Soufriere（Stop 1）

Nearly vertical cliffs continue on the mountain side along the western coastal road towards the southernmost Scotts Head from Loubiere. Although the cliffs with relative height of about 20 m and consisting of pyroclastic debris covered with volcanic ash flow continue collapsing, fundamental countermeasures are not yet implemented. Only temporary countermeasures are taken such as temporary closure of road and sediment removal when sediment disasters occur. Road is reopened after the removal of sediments.

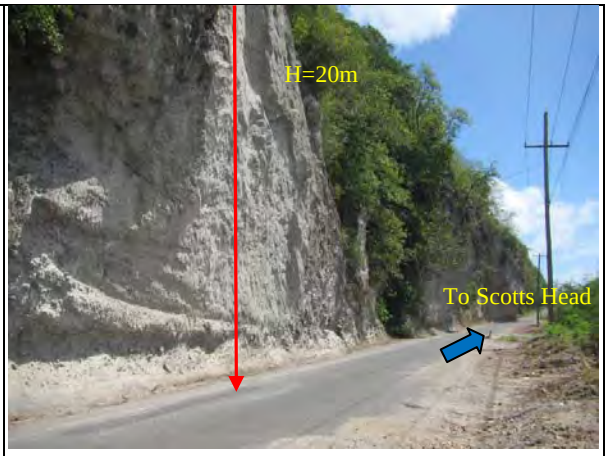
In particular, slope failures and rockfalls are frequent at the section between Soufriére and Pointe Michel.

Field inspection was conducted around the Anse La Verdure area where landslides occur frequently and traces of the past disaster still remain.

Source：JICA Survey Team

Figure 2.9.8 Locations of Field Inspection (Sediment Disaster)

Date：March 5, 2015



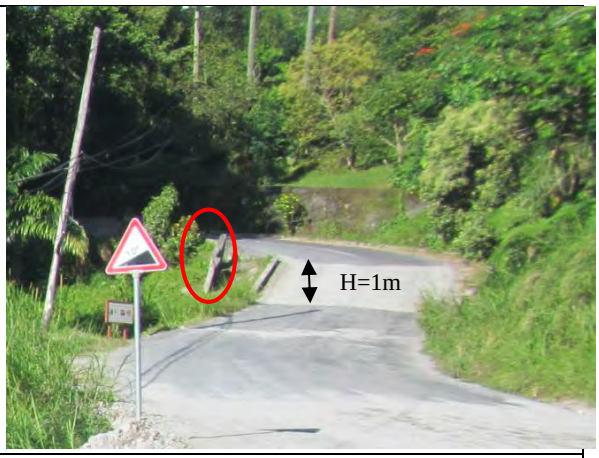
Date：March 5, 2015

Source：JICA Study Team

Figure 2.9.9 Steep Cut Slope between Pointe Michel and Soufriere

b) Antrim Landslide in Springfield Estate（Stop 2）

An avtive large-scale landslide is sliding on major primary road connecting capital and airport on Spring field area. Compared with the past satellite image with the current GPS coordinate, it appears that the ground has been pushed out to the downstream together with the road by about 20 m at the maximum. There is no plan so far to undertake a fundamental countermeasure against the landslide by the government or NGOs.

	
Date: March 4, 2015 The enlarged view of the red square part is shown in the right photo. There is a water pipeline over the landslide.	Date: March 4, 2015

Source：JICA Study Team

Figure 2.9.10 Antrim Landslide in Springfield Estate

(4) Storm Surge

It is noted that some parts of residential houses and public infrastructure such as roads are damaged by storm surge and coastal erosion. Paricularly in 1999 and 2008, coastal erosion was severe and the coastal lines near the airport was damaged by erosion caused by Hurricane Omar in 2008.

(5) Strong Wind

Damages in the agriculture sector are caused by strong winds due to hurricanes and tropical storm.

(6) Earthquake

The record of earthquakes including volcanic earthquakes observed in Dominica since the 18th century is summarized in Table 2.9.8. The earthquake that occurred in 2004, whose epicenter was 50 km submarine north-northwest from Roseau, damaged the church in Portsmouth in the north of the island although there is no victim.

Table 2.9.8 Major Earthquakes Observed in Dominica (18th Century to Date)

Date	Location	Problem Center	Comments
February to June 1765	S. Dominica	Southern centres	150 shocks felt
October 1841	N. Dominica	Diablotins/Aux Diables	Up to 20 earthquakes felt per day
January to April 1849	S. Dominica	Plat Pays volcanic complex	24 earthquakes felt in one night in Soufrière area
February to March 1893	N. Dominica	Diablotins/Aux Diables	Frequent shocks felt in mid-March
October 1937 to April 1938	S. Dominica	Southern centre(s)	13 shocks felt within a few hours on 1 April
September 1959 to May 1960	S. Dominica	Southern centre(s)	Not felt. Exact locations unknown, but within 5 km of Roseau
June 1967	S. Dominica	Southern centre(s)	Lasted 2 days, June 19-20; 65 events
January to June 1969	Detail unknown	Detail unknown	126 events between January 1–5; swarm until Jun.
January 1971	Detail unknown	Detail unknown	25 shocks felt on January 15
April to November 1974	S. Dominica	Plat Pays volcanic complex	Major belt of epicentres trending E-W through Boiling Lake and Wotten Waven. >190 earthquakes recorded on April 19
February to June	S. Dominica	Southern centre(s)	Epicentres in Roseau, extending offshore

Date	Location	Problem Center	Comments
1976			to SW
November 1985 to June 1986	S. Dominica	Plat Pays volcanic complex	Epicentres beneath Morne Plat Pays
December 1994 to January 1995	S. Dominica	Plat Pays volcanic complex	Epicentres beneath Morne Plat Pays
November to December 1997	S. Dominica	Plat Pays volcanic complex	Epicentres beneath Morne Plat Pays
October 1998 to July 2000	S. Dominica	Plat Pays volcanic complex and Anglais	More than180 earthquakes recorded on Oct. 23, 1998
January 20 to 25, 2000	N. Dominica	Single station–no locations possible	66 earthquakes recorded on January 20, 2000
February to June 2003	N. Dominica	Aux Diables/Diablotins	More than 50 earthquakes recorded from February 15 to 26, 2003; More than 500 times of earthquakes recorded from April 14 to 26, 2003
November 21, 2004	Leeward Islands	50 km NNW of Roseau, M6.3	Damage to churches and housing in the north; No deaths
November 29, 2007	Leeward Islands	40 km SSE of Roseau, M7.4	Damage to housing infrastructure; No deaths

Source：Prepared by the JICA Study Team based on the data from UWI-Seismic Research Centre

(6) Tsunami

Volcanic belt exists in the central area of the island. Potential risk of tsunami is recognized by people concerned with disaster management. Nevertheless, tsunami has been experienced in Dominica since 1955.

(7) Water shortage

In recent years, drought disaster occurred in 2010. According to the rainfall record at the Canefield Airport, the monthly rainfall in January, February, and March 2010 are 35%, 0.8%, and 81%, respectively of the last 5-year mean rainfall of each corresponding month. In the same year, forest fires occurred frequently due to unusual dry climate.

(8) Bridges

Bridges on several rivers were damaged mostly by flash flood. The JICA Study Team conducted field inspection of the bridge damages based on the information of the agencies concerned. The requests of the agencies concerning roads and bridges are as follows:

Request from the Ministry of Public Works:

Bridge rehabilitation in the Roseau River Valley

Coastal revetment and countermeasure against slope failure in the southwest area

Improvement of the Castel Comfort River

Dominica Water and Sewerage Company Limited (DOWASCO)

Restoration of bridge(s) and pipelines on the Roseau River

1) Field Inspection and Confirmation of Site Condition

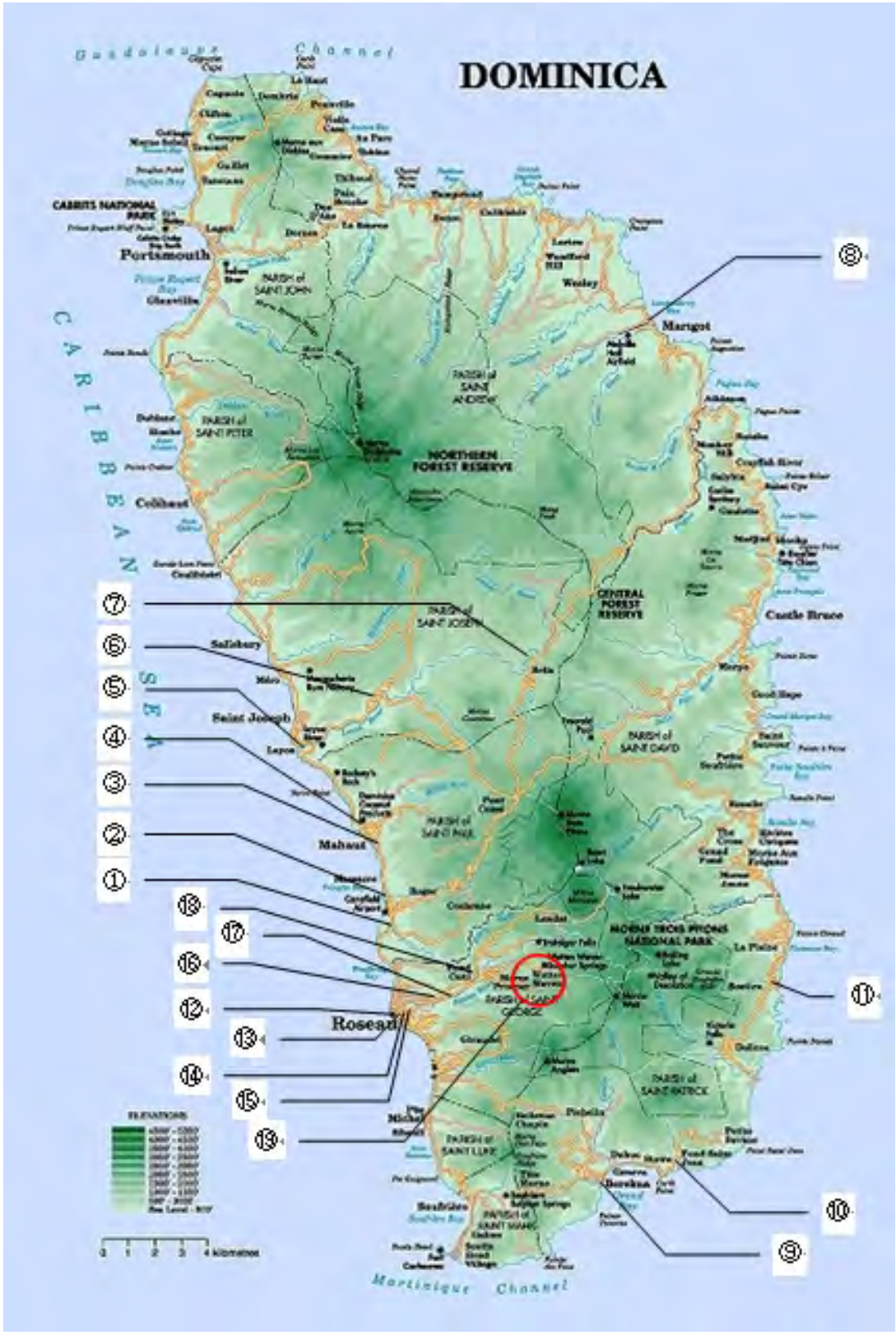
The present situation of the bridges that have been inspected is shown in Table 2.9.9. Among these bridges, most of the bridges in the southern area were damaged by the Christmas flood in 2013, while bridges in the western coastal area suffered damages from Tropical Depression Ophelia.

Table 2.9.9 Inspected Bridges in Dominica

No	Bridge Name	Road	Damage Situation	Present Situation
1.	Checkhall River Bridge	WCR	Overflowed	Used as before
2.	Massacre River Bridge	WCR	Overflowed	Concrete wall was built and used as before
3.	Mahault River Bridge	WCR	Overflowed	Concrete wall was built and used as before
4.	Belfast River Bridge			
5.	Layou River Mouth Bridge	WCR	Overflowed	Used as before
6.	Layou River, Midstream Bridge		Overflowed and one span broken	Repaired and used as before
7.	Layou River, Upper branch stream Bridge	EOLH	Overflowed and broken	Refurbished
8.	Channel River Bridge		Overflowed	Used as before
9.	Geneva River	DFSJ	Overflowed	Used as before
10.	White River	FJPS	Overflowed, Deteriorated by sea breeze	Plan of renovation through EU Fund
11.	Tabarie River	DMR	Overflowed	Used as before
12.	China Friendship Bridge	HS	No damage	
13.	Roseau Bridge	GGS	Overflowed	Used as before
14.	West Bridge	IndPS	Overflowed	Used as before
15.	Bath Road Bridge	BR	Overflowed	Used as before
16.	Bath Estate Bridge	Vale R.	Overflowed	Used as before
17.	Emshall Bridge		Overflowed	Used as before
18.	Pothal Bridge		Overflowed	Used as before
19.	Trafalgar Bridge group		Overflowed	Used as before

Note: WCR: West Coast Road (Official Name: The Edward Oliver Leblanc Highway), EOLH: The Edward Oliver Leblanc Highway, DFSJ: Dubuc Fond St Jean Road, FJPS: Fond St Jean Petitte Savanne Main Road. DMR: Delices Main Road, HS: Hanover Street, GGS: Great George Street, IndPS: Independence Street, BR: Barth Road

Source：JICA Study Team



Source：JICA Study Team

Figure 2.9.11　Locations of Field Inspection (Bridges)

Layou River Mouth Bridge（ ⑤ ）

This bridge is located on the main road of the West Coast Road and crosses the Layou River around the river mouth. It was submerged and inundated due to river overflow around the river mouth area during Tropical Depression Ophelia in 2011. The bridge has length of 50 m and width of 3.8 m, and it has two lanes of steel girders as seen in Figure 2.9.12.

	
Date：February 28, 2015 Site： Layou River Mouth Bridge Outline：Located on the trunk road and crossing the Layou River which is the largest river in Dominica. River mouth area was inundated during flood in 2011.	Date：February 28, 2015 Site： Layou River Mouth Bridge Outline：Two steel girders are installed in parallel; 50 m long, 3.8 m wide.

Source：JICA Study Team

Figure 2.9.12　Layou River Mouth Bridge

White River Bridge（ ⑩ ）

The old Bailey truss type bridge with length of 36 m and width of 3.6 m shown in Figure 2.9.13 is located on the Fond St Jean-Petite Savanne Main Road crossing the White River around its river mouth. This bridge is not in use.

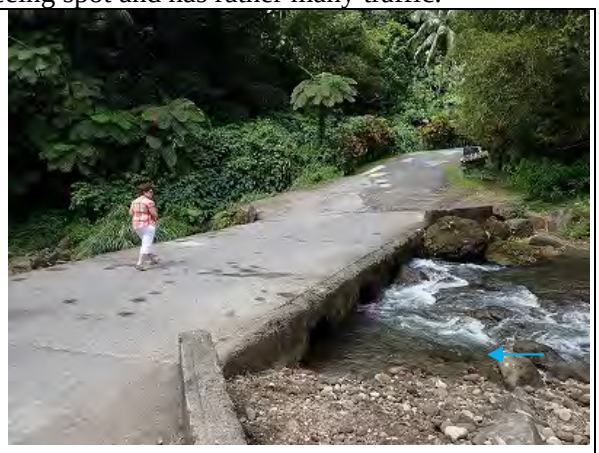
	
Date：March 1, 2015 Site： White River Bridge Outline：The Bailey bridge (right in photo) is deteriorated and closed at present. Instead, a causeway (left in photo) has been used.	Date：March 1, 2015 Site：White River Bridge Outline：Bridge is severely rusted and closed, which is supposed to be caused by sea breeze.

Source：JICA Study Team

Figure 2.9.13　White River Bridge

Trafalgar River Bridge（⑲）

This bridge shown in Figure 2.9.14 is located on a tributary of the Roseau River at the downstream of the Trafalgar Falls. It connects Roseau with a sightseeing spot and has rather many traffic.

	
Date：March 1, 2015 Site：A bridge on the Trafalgar River (view from left bank) Outline：Mountain stream of the Roseau River's tributary. A part of the bridge slab is broken.	Date：March 1, 2015 Site：Bridge on the Trafalgar River (view from upstream) Outline：The bridge is a causeway type; Flood water will overflow the bridgeway.

Source：JICA Study Team

Figure 2.9.14　Trafalgar Bridge

Wotten Waven-Trafalgar Link Bridge（⑲）

This is a 12 m long and 3 m wide bridge made of steel girder with concrete slab crossing a tributary of the Roseau River as seen in Figure 2.9.15. There is a spout of Hot Sulfur Spring at about 30 m upstream of the bridge wherein the sulfide seems to affect the steel of the bridge. Handrail of the bridge has been severely damaged. The said Hot Sulfur Spring is an important sightseeing spot and this bridge is a part of the road connecting to Roseau; therefore, it is strongly desired to replace the bridge.

	
Date：March 3, 2015 Site：A bridge on the Geneva River Outline：This bridge is a portion of the Link Road between Hot Sulfur Spring and Roseau	Date：March 4, 2015 Site：View from downstream left bank Outline：Steel-made handrails have fallen out due to heavy rust.

Source：JICA Study Team

Figure 2.9.15　Wotten Waven-Trafalgar Link Bridge

2) Design Criteria (Earthquake Resistance Standard and Freeboard)

AASHTO or BS is applied as the design standard and the design flood water level is based on the probable 50-year rainfall and clearance is locally determined according to respective districts.

2.9.3 Present Disaster Management

(1) Framework of Disaster Management

In Dominica,the National Emergency Management Plan (NEMP) was established in 1986, and then revised in 2001 and 2009. The present framework of disaster risk management is based on the Emergency Powers (Disaster) Act: Chapter 15:03 - Act 20 of 1987.

The Government of Dominica, as a member of CDEMA, has been implementing the strengthening of building, disaster mitigation, as well as development and operation of the disaster correspondence organization by applying the policy of comprehensive disaster management.

In 2014, a draft of the Comprehensive Disaster Management Bill was prepared with the support of CDEMA and the Dominican government is proceeding with the enactment of the bill, which will provide for various regulations for comprehensive disaster management, early warning system, urgent shelter, volunteers, evacuation, disaster relief, and supports.

(2) Office of Disaster Management (ODM)

The National Disaster Coordinator controls the Office of Disaster Management (ODM) under the supervision of the Undersecretary for Minister for National Security, Immigration and Labour. ODM's task is to protect the people and the national economy from the impact due to disasters through efforts in cooperation with ODM personnel, government, and regional and international agencies as well as prior and prompt correspondence. ODM keeps close cooperation with the National Emergency Planning Organization (NEPO), which is a government organization that undertakes plan formulation and organizational development concerning disaster correspondence at the central state level.

The main task of NEPO is to develop, operate, and maintain the National Emergency Operations Centre in accordance with the prescription in the National Disaster Plan. Detailed functions are stipulated in the National Disaster Plan 2001. ODM in cooperation with NEPO deals with every scope of disaster management including disaster protection, disaster mitigation, prior preparadness, and restoration.

2.9.4 Meteorological and Hydrologic Services

(1) Meteorological and Hydrologic Agencies and Duties

The meteorological service (MPWEP-MS) office under the Ministry of Water, Land, Environment and Climate Change exists at the Canefield Airport.

The Ministry of Agriculture, Fisheries and Forestry, Agriculture Division (MA-AD) has been conducting agro-meteorological observation since the 1970s aimed at crop management as well as flood and drought management.

(2) Outline of Meteorological and Hydrologic Agencies (Personnel and Budget)

MPWEP-MS personel consists of ten staffs of technical experts including two meteologists and two staffs for the operation and maintenance works. An annual budget amounts to about US$20,000 which amount is not enough for participating the outside training program. Annually allocated amount for the operation and maintenance works is in the range of US$2,000 to US$3,000.

(3) Meteorological and Hydrologic Observations

1) Meteorological Observations（Surface and Upper Air）

MPWEP-MS conducts meteorological observation in the airports at two locations.

MA-AD carries out agro-meteorological observation at ten agro-meteorological stations including Stowe, Grandbay, Soufriere, Botanic Gardens, Bells, Concord, Castle Bruce, Londondary, Woodford Hill, Vielle Case, Portsmouth, Syndicate, Salisbury, and Giruadel, and rainfall observation at four observatories.

Agro-meteorological observatories are automatic, but three stations, namely: Soufriere, Bells, and Concord, are not functioning. On the other hand, rainfall observation is carried out by visual observation.

Observations are made on a daily basis and data are sent to the headquarters monthly at the end of each month.

2) Meteorological Radar Observation

No meteorological radar system is installed in Dominica but radar observation information from Martinique Island and Guadeloupe are available. No installation plan is conceivable.

3) Hydrologic Observation (River)

River water level observation is carried out by DOWASCO.

4) Tide and Surge Observation

Tide level observation is undertaken at one location.

(4) Dissemination of Weather Information, Forecast, and Warning

Flood forecasting and warning system is not available so far in Dominica; however, such system and the strengthening of meteor-hydrological observation system are going to be introduced under the World Bank's Regional Disaster Vulnerability Reduction Project (DVRP).

Water level/rainfall stations installed in the Roseau River basin under JICA CADM 2 have not been functioning since about one year ago due to insufficient O&M works.

(5) Cooperation with Other Related Meteorological Agencies

Cooperation with other meteorological agencies is made through CIMH, the Intergovernmental oceanographic Commission (IOC) and World Meteorological Organization (WMO) to share the meteorological information in the Caribbean area. Hurricane information is obtained through the hotline with NHC.

2.9.5 Support of the Japanese Government

No individual support is undertaken by the Japanese government in the disaster management field; technical assistance for hazard mapping in the pilot project area and formulation of the community disaster management plan were carried out in the JICA Caribbean Disaster Management Project, Phase 2 (CADM 2, from 2009 to 2012). However, no action was taken afterwards in the other river basins for the hazard mapping in the pilot project area and for the formulation of the community disaster management plan.

The Ministry of Foreign Affair of Japan sets the construction of drainage channel as part of the disaster mitigation project for the benefit of Bagatelle Community through the Grassroots Human Security Project (GGP) in coordination with the Dominica Association of Local Community Authorities (DALCA).

2.9.6 Support of Other Donors

Restoration works of damaged bridges and rivers have been implemented based on the support of each donor. Among these, the World Bank DVRP is promoting comprehensive disaster management measures for the slope failure together with improvement of roads and bridges, early warning system, and public relations activities in cooperation with the agencies concerned.

(1) World Bank

The World Bank has been implementing DVRP starting from August 2014, which has a project period of five years and to be completed in 2019. There are 11 staffs working in the World Bank Dominica Office; they are experts for economics, finance, environment, society, civil works,and other fields. DVRP is composed of the following four components:

<u>Component-1: Prevention and Adaptation Investments</u>

- Improvement of infrastructures for water storage and water supply
- Slope stabilization
- Rehabilitation of traffic infrastructure including road and bridge
- Improvement of drainage system

<u>Component-2: Capacity Building and Data Development, Hazard Risk Management and Evaluation</u>

- Preparation of high resolution digital
- elevation model and digital ocean water depth model

- Preparation of high resolution soil map
- Design and establishment of strong hydro-meteorological observation network
- Preparation of climate adaptation plan at regional and community level

Component-3: Natural Disaster Response Investments

- Funding for urgent correspondence and rebuilding of subproject during disaster occurrence

Component-4: Project Management and Implementation Support

- Other than DVRP, the Grobal Facility Disaster Reduction and Recovery Project is undertaken, in which the survey for shelters is executed aiming at ODM.

(2) Other Donors

ODM is supported by many donor countries including Australia, Canada, British, China, Morocco, USA, and Italy. Establishment of the early warning system for the fishery sector is under implementation and mainly supported by the Caribbean Community Climate Change Centre (5Cs). In this system, the Smart Fish Aggregation Devices (Smart-FADs) is applied to collect data on sea water temperature, ocean current, and turbidity.

2.10 Trinidad and Tobago

2.10.1 Profile

(1) Basic Data

The basic data of Trinidad and Tobago are shown in Table 2.10.1.

Table 2.10.1 Basic Data of Trinidad and Tobago

Profile	
Population	1,341,000 persons (2013, World Bank)
Land area	5,128 km^2 (World Bank)
Capital	Port of Spain
Largest city	San Fernando
GDP	US$24.64 billion (2013, World Bank)
GDP per capita	US$18,372 (2013, World Bank)
GNI (Atlas method)	US$21.13 billion (2013, World Bank)
GNI per capita	US$15,760 (2013, World Bank)
GDP growth rate	1.6% (2013, World Bank)
GFCF (% GDP)	-- (2013, World Bank)
Current account	US$4,172.3 million (2010, MOFA)
Assistance received total	US$4.33 million (2010, World Bank)
Income level	High Income Level
Independence	August 31, 1962
Currency	Trinidad and Tobago Dollar (TT$)
Climate	Tropical Climate
Administrative division	14 districts
Residents	African 41%, Indian 41%, Mixed 16%, etc.
Language	Official Language: English
Religion	Catholic 63%, Hindu 18%, Muslim 5%, etc.
Principal industry	Oil/Natural Gas, Petrochemistry, Tourism
Major Development Index	
HDI index	0.766 (2012, UNDP)
Literacy rate (15-24 years old)	--
Primary school enrollment rate	97.4%（2010, MOFA）
Infant mortality rate (per 1,000 births)	20.3 persons (2013, World Bank)
Mortality rate of pregnant women and nursing mothers (per 1,000 cases)	46 persons (2010, MOFA)
HIV infection rate (15-49 years old)	1.7% (2013, World Bank)
Improved water service rate	93.9% (2011, MOFA)
Improved sanitation rate	92% (2012, World Bank)
GINI index	40.3 (1992, UNISDR, GAR)
Life expectancy at birth (years)	69.8 (2012, UNISDR, GAR)
Poverty gap at national poverty lines (%)	--
Social expenditure (% of GDP)	10.18 (UNISDR, GAR)
Governance Indicators	
Rule of law	-0.22 (2013, UNISDR, GAR)
Government effectiveness	0.35 (2013, UNISDR, GAR)
Voice and accountability	0.44 (2013, UNISDR, GAR)
Control of corruption	-0.35 (2013, UNISDR, GAR)
Environment	
Ecological footprint	3.09 (2007, UNISDR, GAR)
Environmental performance index	52.3 (2013, UNISDR, GAR)

Forest change	-3.5% (2000-2012, UNISDR, GAR)
Freshwater withdrawals (% of internal resource)	6.0 (2002, UNISDR, GAR)
Climate Change	
Electricity production from renewable energy	0.0% (2010, UNISDR, GAR)
CO_2 emissions	38.16 m^3/capita (2010, UNISDR, GAR)

Source: World Bank, UNDP, CIA World Fact Book, MOFA (Data Book by ODA target country), UNISDR

(2) Natural Overview

1) Topography and Geology

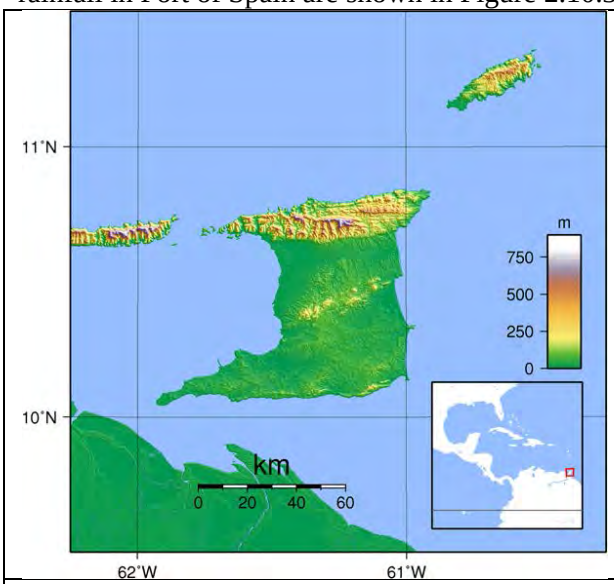
The Republic of Trinidad and Tobago is a twin island country consisting of the Trinidad and Tobago islands, and covers a land area of about 5,100 km^2. Trinidad Island is about 4,770 km^2 in area, which occupies 93% of the country's total area. Tobago Island has an area of about 300 km^2. Trinidad Island has three distinct mountain ranges, namely: northern range, central range, and southern range. The highest point in the country reaches 940 m above sea level in the northern range. Trinidad Island is drained by several rivers including the Ortoire River, which is 50 km long, and the Caroni River, which is 40 km long. Tobago Island is mountainous with steep slopes, and its highest point is 640 m above sea level. Tobago Island is volcanic in origin, but there is no volcanic activity at present.

In Trinidad, the Northern Range consists mainly of Upper Jurassic and Cretaceous metamorphic rocks. The Northern Lowlands consist of younger shallow marine clastic sediments. South of this, the Central Range fold and thrust belt consists of Cretaceous and Eocene sedimentary rocks. The Southern Lowlands consist of Miocene and Pliocene sands, clays, and gravels. The Southern Range consists of sandstones, shales and siltstones and clays formed in the Miocene and uplifted in the Pleistocene.

Topography of the Trinidad and Tobago islands is presented in Figure 2.10.1. Geology of Trinidad Island is shown in Figure 2.10.2.

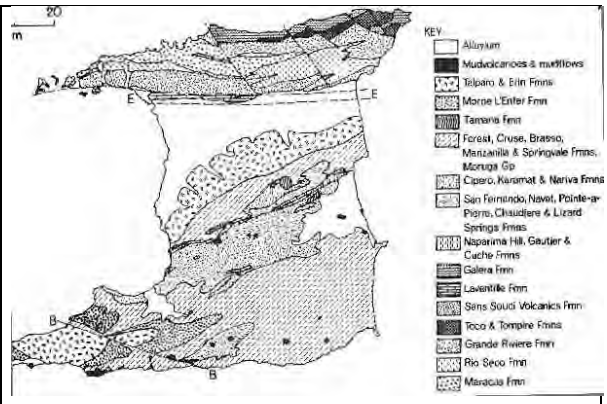
2) Climate

Trinidad and Tobago is located between 10º-11ºN latitude and around 61ºW longitude and in the tropical climate zone. Monthly average temperature ranges between about 25 ºC and 28 ºC. January to February is the lowest temperature period, while April to May is the highest. It is rainy season from June to November, and dry season from January to May. The average annual rainfall in Trinidad Island is about 1,900 mm. The monthly mean maximum and minimum temperatures and monthly mean rainfall in Port of Spain are shown in Figure 2.10.3.



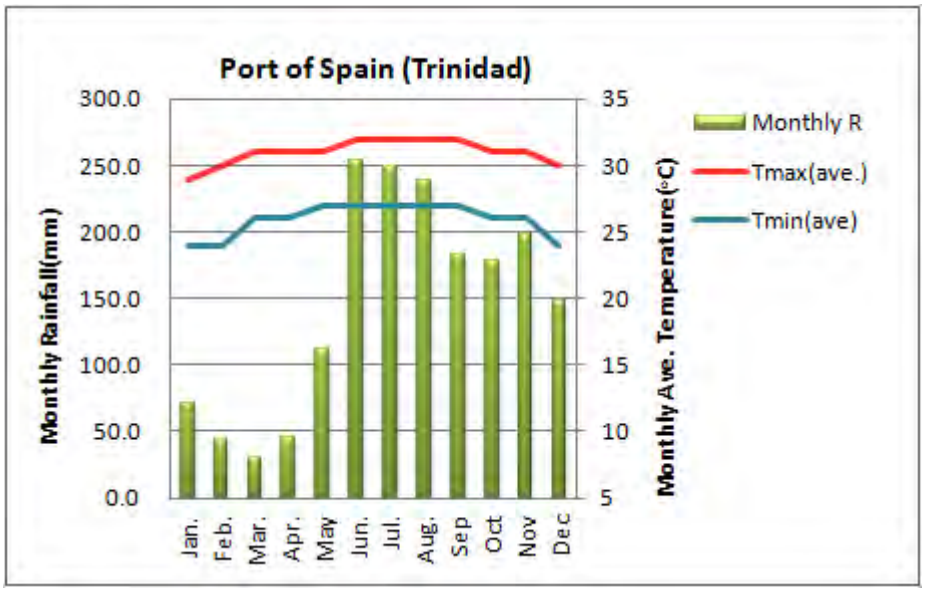
Source:http://www.vidiani.com/large-detailed-topographical-map-of-trinidad-and-tobago/

Figure 2.10.1 Topography of Trinidad and Tobago



Source: http://tt80.tripod.com/html/trin_geo.html

Figure 2.10.2 Geology of the Trinidad Island



Source : http://www2m.biglobe.ne.jp/ZenTech/world/kion/Trinidad_and_Tobago/Port_of_Spain.htm

Figure 2.10.3 Climate Feature in Port of Spain (Trinidad Island)

(3) Socioeconomic Condition

1) Political Situation

Trinidad and Tobago gained its independence from the United Kingdom in 1962 as one of the British Commonwealth kingdoms and then changed over to a republic in 1976. Tobago has been given domestic autonomy in 1987.

Trinidad and Tobago has a constitutional republic government with a two-party system and a bicameral parliamentary system. The president is elected through indirect election by the House and Senate whose term of office is five years. Parliament is composed of the Senate and the House of Representatives, both of which have a term of five years.

Major political parties in Trinidad and Tobago are the center-left People's National Movement (PNM) and the left wing United National Congress (UNC). Tobago has its own parliament which also plays a role as the executive authority responsible for internal affairs and autonomy of the island.

2) Population

According to the World Bank's survey, the total population is estimated at 1,340,000 in 2013, 9% of which live in the urban area. The number of residents in the urban area has been decreasing since 2000, and the ratio of urban residents against the total population has also slightly decreased. Table 2.10.2 shows the trend of population change in Trinidad and Tobago.

Table 2.10.2 Change in Population in Trinidad and Tobago

Indicator	1990	2000	2005	2010	2012	2013
Total population (person)	1,221,904	1,267,980	1,296,933	1,328,095	1,337,439	1,341,151
Population growth rate (annual %)	0.7	0.3	0.5	0.4	0.3	0.3
Urban population (person)	104,277	136,650	128,422	120,750	117,628	116,624
Urban population (% of total)	8.5	10.8	9.9	9.1	8.8	8.7
Rural population (person)	1,117,627	1,131,330	1,168,511	1,207,345	1,219,811	1,224,927
Rural population (% of total)	91.5	89.2	90.1	90.9	91.2	91.3

Source: World Bank, World Data Bank

3) GNI and GDP

The nominal GNI per capita and nominal GDP per capita of Trinidad and Tobago are around US$16,000 to US$17,000 as shown in Table 2.10.3.

Table 2.10.3 Nominal GNI and GDP per Capita in Trinidad and Tobago

Indicator	2008	2009	2010	2011	2012	2013
GNI per capita, Atlas method (US$)	17,460	16,320	15,800	13,810	14,780	15,760
GDP per capita (US$)	21,395	14,618	15,630	17,760	17,523	18,373

Source: World Bank, World Data Bank

4) Government Agencies and Administrative Divisions

The ministries of the Government of Trinidad and Tobago are enumerated in Table 2.10.4.

Table 2.10.4 Central Government Agencies of Trinidad and Tobago

Central Government Agencies
Office of the Prime Minister
Ministry of Community Development
Ministry of Education
Ministry of Energy and Energy Affairs
Ministry of Finance and the Economy
Ministry of Food Production
Ministry of Foreign Affairs
Ministry of Gender, Youth and Child Development
Ministry of Health
Ministry of Housing and Urban Development
Ministry of Justice
Ministry of Labour and Small and Micro-Enterprise Development
Ministry of Legal Affairs
Ministry of Local Government
Ministry of National Diversity and Social Integration
Ministry of National Security
Ministry of Planning and Sustainable Development
Ministry of Public Administration
Ministry of Public Utilities
Ministry of Science and Technology
Ministry of Sport
Ministry of Tertiary Education and Skills Training
Ministry of Tobago Development
Ministry of Tourism
Ministry of Trade, Industry, Investment and Communications
Ministry of Transport
Ministry of Works and Infrastructure
Ministry of the Arts and Multiculturalism
Ministry of the Attorney General
Ministry of the Environment and Water Resources
Ministry of the People and Social Development

Source: https://www.ttconnect.gov.tt/

The local administrative districts in Trinidad are composed of nine regional corporations and five municipalities. The island of Tobago has been given domestic autonomy, and is governed by the Tobago House of Assembly. Table 2.10.5 shows 14 administrative districts of Trinidad and their land areas/ population including those of Tobago.

Table 2.10.5 Local Administrative Districts in Trinidad and Tobago

No.		Corporation	Area (km^2)	Population (head)*
1	Municipality	Port of Spain City Corporation	12	37,074
2		San Fernando City Corporation	19	48,838
3		Chaguanas Borough Corporation	59	83,516
4		Arima Borough Corporation	12	33,606
5		Point Fortin Borough Corporation	25	20,235
6	Regional Corporation	Couva-Tabaquite-Talparo Regional Corporation	723	178,410
7		Diego Martin Regional Corporation	126	102,957
8		Penal-Debe Regional Corporation	246	89,392
9		Princes Town Regional Corporation	620	102,375
10		Rio Claro-Moyaro Regional Corporation	814	35,650
11		San Juan-Laventille Regional Corporation	239	157,258
12		Sangre Grande Regional Corporation	927	65,680
13		Siparia Regional Corporation	495	86,949
14		Tunapuna-Piarco Regional Corporation	510	215,119
Tobago			300	60,874

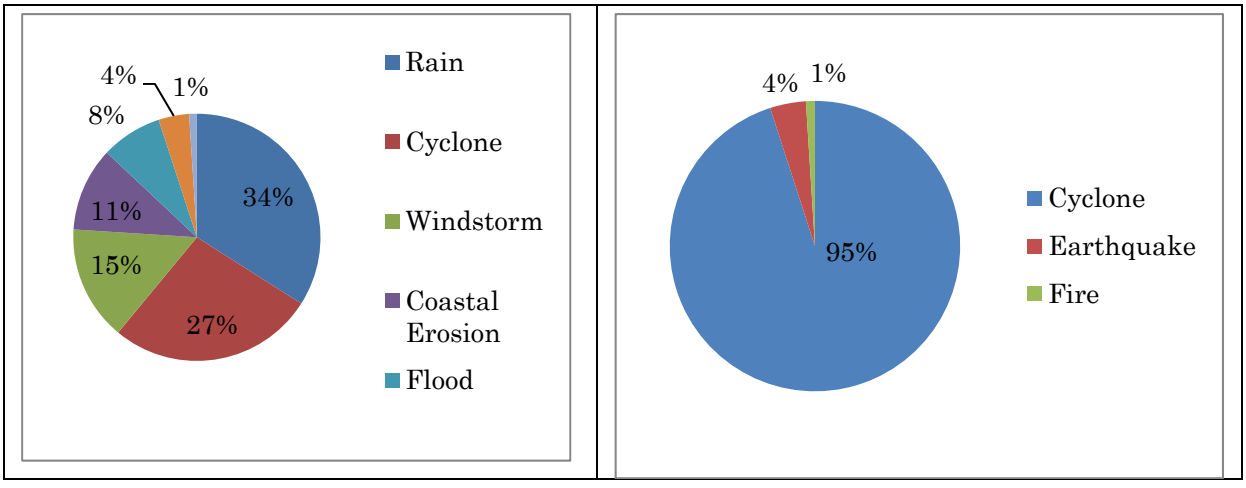
Note* Census data in 2011 (Total population in Trinidad and Tobago: 1,223,916 (2014 estimate))

Source: http://www.citypopulation.de/Trinidad.html

2.10.2 Disaster Situation

(1) General

The outline of disasters in every survey country is described in the Global Assessment Report on Disaster Risk Reduction 2015, which is issued by UNISDR. The occurrence rate by disaster and the cause-specific percentage of economic losses in Trinidad and Tobago are shown in Figures 2.10.4 and 2.10.5, respectively. According to the figures, the most frequent disaster in Trinidad and Tobago from 1990 to 2014 is that due to heavy rains, while cyclones have resulted in the most serious economic losses.



Source: Global Assessment Report on Disaster Risk Reduction

Note: The term “Cyclone” is used as in the source.

Figure 2.10.4 Occurrence Rate by Disaster in Trinidad and Tobago

Figure 2.10.5 Cause-specific Percentage of Economic Loss in Trinidad and Tobago

(2) Flood

1) Record of Major Floods

The records of tropical storms and hurricanes which affected the Trinidad and Tobago islands are shown in Table 2.10.6. According to the table, Trinidad and Tobago has been less affected by tropical storms or hurricanes compared with the other Caribbean countries. However, Tobago Island has been much affected compared with Trinidad Island.

Table 2.10.6 Records of Tropical Storms and Hurricanes in Trinidad and Tobago

Date	Name	Date	Name
July 20, 1961	Anna (TS)	July 20, 1961	Anna (TS)
October 1, 1963	Flora (H3)	October 1, 1963	Flora (H3)
August 14, 1974	Alma (TS)	August 14, 1974	Alma (TS)
		August 11, 1978	Cora (TS)
		October 14, 1988	Joan (TS)
July 25, 1990	Arthur (TS)	July 25, 1990	Arthur (TS)
August 7, 1993	Bret (TS)	August 7, 1993	Bret (TS)
October 1, 2000	Joyce (TS)	October 1, 2000	Joyce (TS)
		August 15, 2004	Earl (TS)
		September 7, 2004	Ivan (H3)
		July 14, 2005	Emily (H1)
		September 1, 2007	Felix (TS)

Source: Trinidad Island: http://stormcarib.com/climatology/TTPP_all_isl.htm,
Tobago Island: http://stormcarib.com/climatology/TTPT_all_isl.htm

Note) TS: Tropical storm, H: Hurricane (Figures mean the category.)

The hurricanes and tropical storms which caused rather severe damages among those shown in Table 2.10.6 and several flood records are presented hereunder.

(a) Hurricane Flora

Hurricane Flora damaged the Trinidad and Tobago islands severely on October 1, 1963. The damages comprised 7,500 completely destroyed houses, 3,500 partially destroyed houses, as well as 18 and 2 dead persons in Trinidad and Tobago islands, respectively. The economic loss amounted to US$30 million in the agricultural sector, which was 4.4% of GDP of US$680 million in 1963.

(b) Tropical Storm Alma

Tropical Storm Alma caused the damage to Plum Mitan Strip of California in the south of Cova on August 14, 1974. The damage comprised death toll of one person, and economic loss of US$5 million which was equivalent to 0.25% of GDP of US$2 billion in 1974.

(c) Flood in 1985

The flood that occurred in 1985 was nationwide, and its damage comprised damages to 621 ha of agricultural land and economic loss of TT$15 million.

(d) Flood in 1993

The flood that occurred in 1993 resulted in a death toll of five persons in Port of Spain.

(e) Floods in 2010

Several floods occurred in 2010, which resulted in the death toll of one person and disruption of public services.

2) Field Inspection and Confirmation of Site Condition

The lower Oropuche River basin is a lowland located in Naparima in the south of Trinidad Island. The basin is inundated every rainy season, and houses in the basin are damaged by the floods. The government is preparing a flood control plan for the basin at present, and going to implement the plan. Figure 2.10.6 shows typical flood prone areas.

This area is flooded with water depth of 1 m above the road surface during the rainy season.

The plain land is inundated as a natural retarding basin during flood.

Source: JICA Study Team

Figure 2.10.6 Flood Prone Area in the Trinidad Island

(3) Sediment Disasters

1) Major Sediment Disaster Records

Records of major sediment disasters that occurred recently in Trinidad and Tobago are shown in Table 2.10.7. Trinidad and Tobago suffers from many sediment disasters every year. According to the Country Disaster Risk Evaluation Report (2013) prepared by IDB, the number of landslides amounted to about 200 in total from 2009 to 2012.

Table 2.10.7 Recent Sediment Disasters in Trinidad and Tobago

Occurrence	Disaster Area	Type and Magnitude	Cause	Disaster Situation	Note
2012	Diego Martin	Mudflow	Rainfall	2 dead	-
2011	North Coast Road to Maracas	Landslide	Rainfall	Blockage of North Coast Road (several hours), Damage to upstream area of La Seiva (Road Maraval)	-
2010	Western Main Road to Chaguaramas	Rockfall	Rainfall	Blockage of Western Main Road	-
November 12, 2004	Delaford on Tobago's west end	Landslide	Rainfall of 208.7 mm (6 hours)	2 dead, 5 injured, 1,200 persons affected, Economic loss of US$9 million	-

Source: Base on the Disaster Risk Reduction Country Document, Trinidad and Tobago, 2014, ODPM, the JICA Study Team prepared the table above.

2) Field Inspection and Confirmation of Site Condition

Sediment disaster areas inspected by the JICA Study Team are described below.

(a) Sediment Disasters in North Coast Road in the North of Trinidad Island

Roads located in the north of the capital of Port of Spain including Diego Martin Road, Morne Coco Road, and North Coast Road run through steep slope areas with weak weathered metamorphic rocks, so that they suffer

Source: JICA Survey Team

Figure 2.10.7 Slope Collapse in North Coast Road in the Trinidad Island

from sediment disasters such as slope collapses every year. As seen in Figure 2.10.7, there are many disaster areas having only the removal of collapsed soil after the slope collapse without countermeasures.

(b) Landslide on San Feancique Road in the South of Trinidad Island

San Feancique Road in the south of Trinidad Island runs through less rolling area, but it has been damaged by landslides at many places. As there are many houses built on the roadsides, these houses have been destroyed by the landslides too. Concrete walls are mainly used as structural countermeasures against landslide. However, the concrete walls and additionally used steel sheet piles have not worked to stop movements of landslides at some places. Figure 2.10.8 shows the damaged sites due to landslides on the San Feancique Road.

The road surface has been deformed by the landslide. The concrete walls and additional steel sheet piles have failed to stop the movement of landslide.

The road surface has been deformed by the landslide. The concrete walls constructed as countermeasures have fallen down due to the sliding of soil masses.

Source: JICA Study Team

Figure 2.10.8 Damages of Road due to Landslides in San Feancique Road in the South of Trinidad Island

(4) Storm Surge

The eastern and southern coasts of Trinidad Island have been eroded seriously by storm surges. Although repair works for maintenance only have been made at the eroded portions at present, the countermeasures planned in the Coastal Zone Management Plan are about to be implemented.

(5) Strong Wind

According to the "Disaster Risk Reduction Country Document, Trinidad and Tobago, 2014, ODPM", the number of damages due to strong winds amounted to 277 from 2011 to 2014.

(6) Earthquake

Records of disasters caused by past major earthquakes in Trinidad and Tobago are shown in Table 2.10.8.

Table 2.10.8 Major Earthquakes in Trinidad and Tobago

Occurrence	Disaster Area	Magnitude	Disaster Situation
2010	Felt throughout Trinidad from Carenage to Moruga and Matura	M4.7	No dead, no injured
2009	On land and felt in Sangre Grande and Penal	M4.8	No dead, no injured
2008	East coast and felt mainly in Galeota	M5.6	No dead, no injured
November 29, 2007	Felt throughout Eastern Caribbean from Puerto Rico to Guyana, St.	M7.3	-

Occurrence	Disaster Area	Magnitude	Disaster Situation
	Lucia, St. Vincent and Barbados		
September 29, 2006	Felt throughout Trinidad	M5.8	3 injured in Point Lisas
April 22, 1997	South coast of Tobago	M6.1	2 injured, 6 houses destroyed, estimated loss of US$25 million in Tobago Island
January 1, 1996	North of Trinidad	M5.2	No dead, no injured
1988	East coast of Trinidad	M6.3	No dead, no injured
March 10, 1988	Throughout the Lesser Antilles from Trinidad to St. Vincent	M7.5	-
March 1982	Near Tobago	M5.2	-
September 20, 1968	Port of Spain in Trinidad, Venezuela	M7.0	Damage of Hilton Hotel in Port of Spain, etc.
December 4, 1954	Northeast coast of Trinidad	M6.5	1 dead, several persons injured, stone masonry buildings destroyed in Port of Spain
February 24, 1918	Northwest of Trinidad	M6.5	Stone masonry buildings destroyed in Port of Spain
1888	From Trinidad to St. Vincent	M7.5	-
October 21, 1766	Trinidad's then capital San Jose	M7.9	Recorded maximum in Trinidad and Tobago, stone masonry buildings destroyed, 2 aftershocks

Source: The JICA Study Team prepared based on the Disaster Risk Reduction Country Document of Trinidad and Tobago (ODPM, 2014) and Country Disaster Risk Evaluation Report (IDB, 2013)

(7) Tsunami

Records of past major tsunami in Trinidad and Tobago are shown in Table 2.10.9. As seen in the table, the number of tsunami is less in Trinidad and Tobago compared with that of other Caribbean countries.

Table 2.10.9 Past Tsunami that Attacked Trinidad and Tobago

Date of Attack	Tsunami Height (m)	Description
December 3, 1831	Unknown	Tsunami caused by earthquake

Source: Tablet: Preliminary List of Caribbean Tsunamis, (http://poseidon.uprm.edu/lander/tabla1a.htm)

(8) Water Shortage

Trinidad and Tobago suffered from drought in 2010, which started from October 2009. The CIMH issued the drought warning to the East Caribbean Countries.

2.10.3 Present Disaster Management

(1) Framework of Disaster Management

The Office of Disaster Preparedness and Management (ODPM) is the supervising agency for disaster management in Trinidad and Tobago, which supervises disaster response as well as preparedness, countermeasures, mitigation, and restoration. ODPM was organized in 2005 by transforming it from the National Disaster Management Agency (NDMA). ODPM is an organization under the Ministry of National Security.

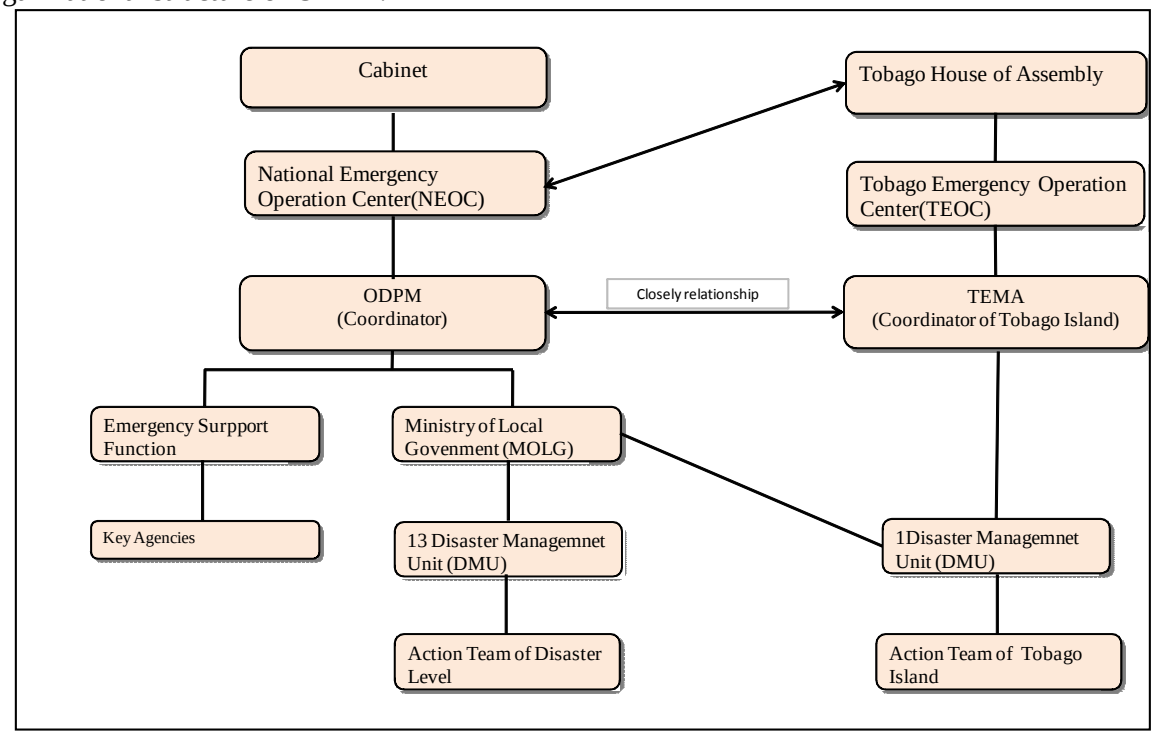
The vision and tasks of ODPM are described as follows:

Vision : To become the premier regional Disaster Risk Management Organization.

Tasks : To build national disaster risk management and climate change adaptation capabilities with its partners and coordinate response and recovery operations in order to protect the people, environment and economy and ensure a disaster resilient nation.

On the other hand, the Tobago Emergency Management Agency (TEMA) is functioning under the Tobago House of Assembly in Tobago Island. TEMA's tasks are almost the same as those of ODPM, although the tasks are limited within Tobago Island. ODPM executes supports to Tobago Island in case of disasters.

In addition to the above, it is noted that local level activities are made by the district level organizations for disaster management under the Ministry of Local Government (MOLG) in the event of disasters. Therefore, involvement of MOLG in the local level activities is substantial. Figure 2.10.9 shows the organizational structure of ODPM.



Source: Prepared by the JICA Study Team based on hearing

Figure 2.10.9 Organizational Structure of ODPM and Relationship with TEMA

Organization and Budget of ODPM Secretariat

The ODPM Secretariat currently comprises 29 members, 14 of whom are technical staffs. The budget of ODPM for operation is US$10 million allocated from the national budget. The secretariat consists of five units, namely: Mitigation, Operation, Training and Education, Corporate Services, and Project Management.

2.10.4 Meteorological and Hydrologic Services

(1) Meteorological and Hydrologic Agencies and Duties

The meteorological service office of Trinidad and Tobago is one of the divisions of the Ministry of the Environment and Water Resources, whose main office exists in the complex of the Piarco International Airport. Provision of meteorological information for the traffic control of the airport is one of the main tasks of the services.

The main office in the airport, as the main synoptic station, conducts ground meteorological observation, upper air observation, forecasting, and data collection and analyses. The ground observation and meteorological information provision is made also at the ANR Robinson Airport in Tobago.

The Water and Sewerage Authority (WASA) has been established as a management agency of service water and sewage. It conducts river water level and discharge observation as a water resources agency at present.

(2) Outline of Meteorological and Hydrologic Agencies (Personnel and Budget)

The meteorological service office in Trinidad and Tobago has 33 staffs in Trinidad and seven in Tobago. It has eight meteorologists/forecasters.

Total annual budget amounts to TT$25 million; however, technical-related budget such as for procurement of equipment and O&M costs is only TT$2.5 million. No government budget is appropriated for research, which has been covered by the donation of WMO or under joint research with university.

(3) Meteorological and Hydrologic Observations

1) Meteorological Observations (Surface and Altostratus)

In Trinidad and Tobago, there are two manned observatories at each airport as well as meteorological and agro-meteorological automatic stations (AWS) at six locations. The most recent installation of AWS was made in 2008-09 and the observation period is from 1946 for manned stations and from 2007 for AWS.

Data transmission to the main office from six AWS is designed to be by radio communication; however, the present situation is that data stored in the data logger are downloaded and hand-carried by the staff instead of automatic transmission due to some issues such as power source, radio communication parts and telecommunication troubles. Data transmission from the observatories located in the southeast and east parts of Trinidad to the main office in Port of Spain is to be through the relay station at a mountain; however, no communication is possible at all due to invisible radio line between the relay station and the same observatories.

In Trinidad and Tobago, automatic and direct data transmission to CIMH from the automatic stations is not carried out but through the main office unlike the other CMO member countries.

2) Meteorological Radar Observation

The Doppler type meteorological radar system is installed at Brasso Venado in central Trinidad which replaced the previous one in 2007-08. Replacement to the new type (Doppler type) was made in a similar manner to those in Barbados, Belize, and Guyana. Other than those above, radar systems are installed in and around the Caribbean area including Dominican Republic, Jamaica, Guadeloupe and Guyane Francaise.

Annual O&M cost amounts to about TT$1.0 million for the building only and about TT$2.0 million for equipment and instrument. Meanwhile, electric bill is said to be not an issue which is different from the situation in Barbados.

In CMO, it is determined that regular maintenance of the radar system is carried out for about three weeks a year based on the regional maintenance program.

3) Hydrologic Observation (River)

According to WASA, information related to water level and discharge measurement, which is conducted in major rivers in Trinidad, is provided by WASA to the meteorological service. The WASA website shows that these data are available at a cost; however, there is no specific information about the available data such as observation sites and data period.

WASA is operating dams at three locations in Trinidad and one location in Tobago, where spilled out discharge is not measured.

4) Tide and Surge Observations

According to the meteorological service, resumption of tide level measurement is desired; however, no specific plan is realized in terms of funding source.

5) Observation Database System

Most of the collected observation data are stored in the Climate Database which does not allow direct access yet. Meanwhile, the Government of Trinidad and Tobago is planning to establish a multipurpose database system accessible by the agencies and organizations concerned.

(4) Dissemination of Weather Information, Forecast and Warning

Several warnings are issued concerning “storm/hurricane”, “severe weather”, “flood/landslide”, and “rough sea” in text style bulletins which are sent out and disseminated to the government agencies, media, related private companies, and public through e-mail, fax, and website.

As for landslide, such warning is issued to the landslide prone area when expecting heavy rains and/or observing continuous torrential rain that appropriate alert is required. No numerical criteria is specifically determined.

(5) Cooperation with Other Related Meteorological Agencies

CMO divides its member countries into four groups and determine the focal country of each group of countries. Trinidad is the focal point of the most southern group of the Caribbean countries and provides meteorological information and forecast to Tobago and Grenada; however, mutual complement is made only with Guyana according to the Trinidad meteorological service.

2.10.5 Support of the Japanese Government

As Trinidad and Tobago is categorized as a high income level country, the recent supports by the Japanese government are limited to technical cooperation.

2.10.6 Support of Other Donors

The scheme of “Disaster Risk Evaluation” was implemented with the financial assistance of IDB. The projects for drainage improvement of Port of Spain and erosion mitigation for the coasts are implemented, too. A drainage project financed by the Spanish government is also ongoing.

2.11 Barbados

2.11.1 Profile

(1) Basic Data

The basic data of Barbados are shown in Table 2.11.1.

Table 2.11.1 Basic Data of Barbados

Profile	
Population	284,600 persons (2013, World Bank)
Land area	430 km^2 (World Bank)
Capital	Bridgetown
Largest city	Bridgetown
GDP	US$4.225 billion (2012, World Bank)
GDP per capita	US$14,917 (2012, World Bank)
GNI (Atlas method)	US$4.270 billion (2012, World Bank)
GNI per capita	US$15,080 (2012, World Bank)
GDP growth rate	0.0% (2012, World Bank)
GFCF (% GDP)	18.4 (2013, World Bank)
Current account	US$(-)218.41 million (2010, MOFA)
Assistance received total	US$16.2 million (2010, World Bank)
Income level	High Income Level
Independence	November 30, 1966
Currency	Barbadian Dollar (Bds$)
Climate	Tropical Monsoon Climate
Administrative division	11 parishes
Residents	African 90%, European ancestry 4%, Asian and Mixed 6%
Language	Official Language: English
Religion	Christian 71%, Others
Principal industry	Tourism, Light industry, Assembling parts for export, Agriculture
Major Development Index	
HDI index	0.825 (2012, UNDP)
Literacy rate (15-24 years old)	--
Primary school enrollment rate	--
Infant mortality rate (per 1,000 births)	10.93 persons (2014, CIA World Fact Book)
Mortality rate of pregnant women and nursing mothers (per 1,000 cases)	64 persons (2008, MOFA)
HIV infection rate (15-49 years old)	0.9% (2013, World Bank)
Improved water service rate	100% (2012, World Bank)
Improved sanitation rate	--
GINI index	0.0 (2009, UNISDR, GAR)
Life expectancy at birth (years)	75.1 years
Poverty gap at national poverty lines (%)	--
Social expenditure (% GDP)	0.0
Governance Indicators	
Rule of law	1.00 (2013, UNISDR, GAR)
Government effectiveness	1.35 (2013, UNISDR, GAR)
Voice and accountability	1.18 (2013, UNISDR, GAR)
Control of corruption	1.61 (2013, UNISDR, GAR)
Environment	
Ecological footprint	0.00 (UNISDR, GAR)
Environmental performance index	45.5 (UNISDR, GAR)

Forest change	0.00% (2000-2012, UNISDR, GAR)
Freshwater withdrawals (% of internal resource)	126.3% (UNISDR, GAR)
Climate Change	
Electricity production from renewable energy	1.00% (UNISDR, GAR)
CO_2 emissions	5.36 m^3/capita (UNISDR, GAR)

Source: World Bank, UNDP, CIA World Fact Book, MOFA (Data Book by ODA target country), UNISDR

(2) Natural Overview

1) Topography and Geology

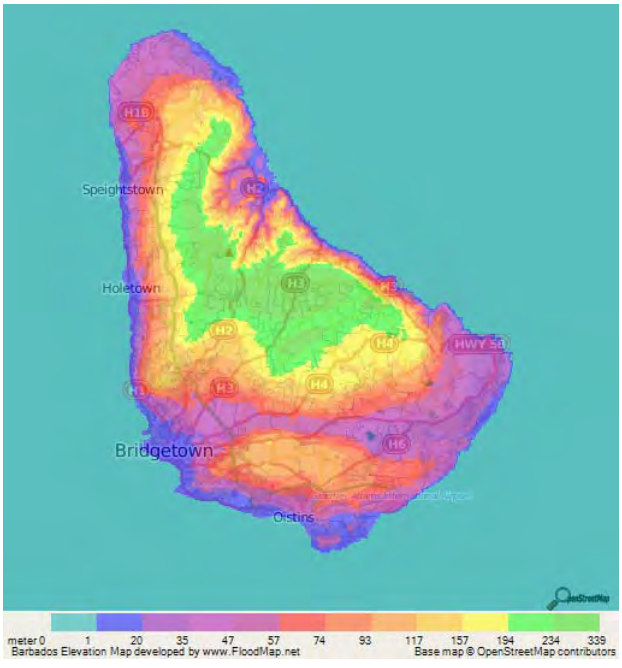
Barbados is the easternmost island of the Lesser Antilles in the West Indies with a total land area of 430 km^2. The island is relatively flat rising gently to the central highland region with the highest Mount Hillaby's peak of 330 m above sea level.

The island is divided into two in terms of geology. The 85% of the island is covered by Pleistocene coral reef limestone cap, and the remaining 15% is an inlier of Tertiary sedimentary rocks of marine origin. The limestone forms terraces in the western part of the island. Erosion of the limestone has resulted in the formation of various caves and gullies. The sedimentary rocks crop out in a triangular region in the northeast Barbados called the Scotland District. The said district is more prone to landslides and soil erosion due to folds and faults compared with any other part of the country.

Figures 2.11.1 and 2.11.2 show the topography and geology of Barbados, respectively.

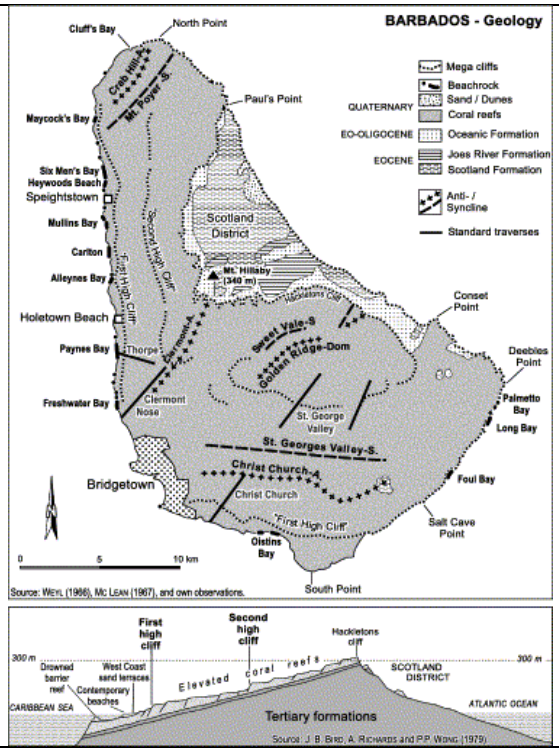
2) Climate

Barbados is located at 13ºN latitude and 59ºW longitude, and is in the tropical rainforest climate zone. Monthly average temperature ranges between 25ºC and 28ºC. January and February is the lowest temperature period, while May to October is the highest. It is rainy season from August to November, and dry season from January to April. The average annual rainfall in Barbados Island is about 1,350 mm. The monthly mean maximum and minimum temperatures and monthly mean rainfall in Bridgetown are shown in Figure 2.11.3.



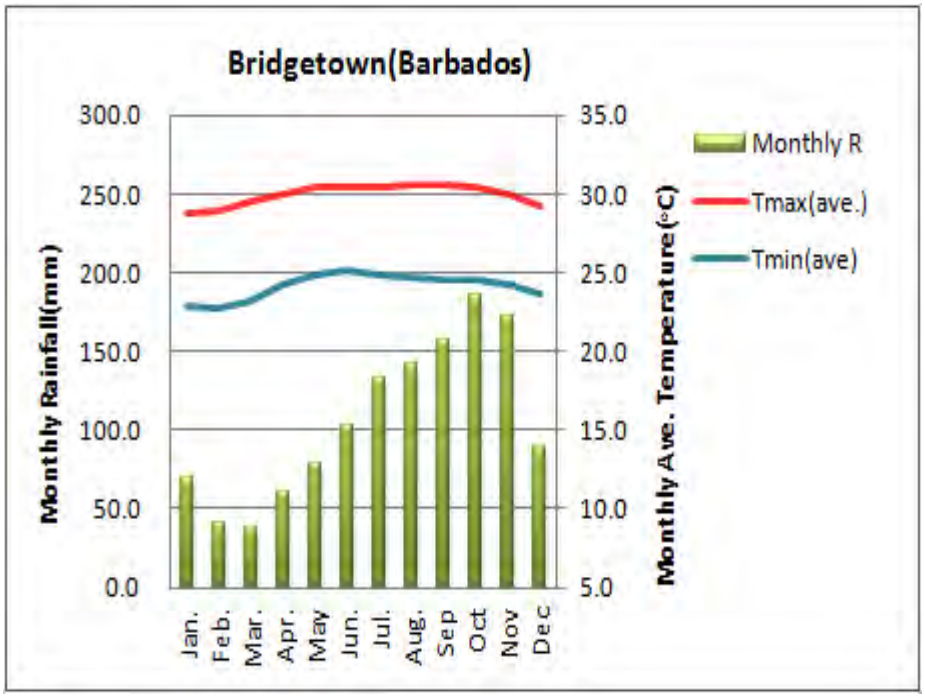
Source: http://www.floodmap.net/

Figure 2.11.1 Land Form of Barbados



Source:http://www.sjdkj.net/index.php?m=content&c=index&a=show&catid=24&id=3203

Figure 2.11.2 Geological Map of Barbados



Source : http://www2m.biglobe.ne.jp/ZenTech/world/kion/Barbados/Bridgetown.htm

Figure 2.11.3 Climate Feature in Bridgetown (Barbados)

(3) Socioeconomic Condition

1) Political Situation

Barbados got autonomy from the United Kingdom in 1961, and gained its independence in 1966 being a member of the Commonwealth of Nations. Since its independence, one of the two major political parties, namely, Democratic Labour Party (DLP) and Barbados Labour Party (BLP), have been in office alternately through democratic elections. The present ruling party is DLP. The parties other than the DLP and BLP have less influence.

2) Population

According to the World Bank's survey, the estimated total population was 285,000 in 2013, 32% of which reside in the urban areas. Table 2.11.2 shows the trend of population change in Barbados from 1988. It is observed from the table that although the urban population has increased, the ratio of urban population to total population has decreased.

Table 2.11.2 Change in Population in Barbados

Indicator	1988	1993	1998	2003	2008	2013
Total population (person)	257,497	261,714	265,370	270,844	277,634	284,644
Population growth rate (annual %)	0.39	0.29	0.29	0.49	0.49	0.50
Urban population (person)	87,240	86,407	89,252	90,175	89,981	90,096
Urban population (% of total)	33.88	33.02	33.63	33.29	32.41	31.65
Rural population (person)	170,257	175,307	176,118	180,669	187,653	194,548
Rural population (% of total)	66.12	66.98	66.37	66.71	67.59	68.35

Source: World Bank, World Data Bank

GNI and GDP

The nominal GNI per capita and nominal GDP per capita in Barbados are about US$15,000 as shown in Table 2.11.3.

Table 2.11.3 Nominal GNI and GDP per Capita in Barbados

Indicator	2008	2009	2010	2011	2012
GNI per capita, Atlas method (US$)	15,850	15,650	15,710	15,660	15,080
GDP per capita (US$)	16,358	16,461	15,812	15,503	14,917

Source: World Bank, World Data Bank

4) Government Agencies and Administrative Division

The ministries of the Barbadian government are enumerated in Table 2.11.4.

Table 2.11.4 Central Government Agencies of Barbados

Central Government Agencies
Prime Minister's Office
Ministry of National Security, The Public Service and Urban Development
Ministry of Home Affairs
Ministry of Finance and Economic Affairs
Ministry of Education, Science, Technology and Innovation
Ministry of Tourism and International Transport
Ministry of Social Care, Constituency Empowerment and Community Development
Ministry of Health
Ministry of Culture, Sports and Youth
Ministry of Industry, International Business, Commerce and Small Business Development
Ministry of the Environment and Drainage
Ministry of Agriculture, Food, Fisheries and Water Resources Management
Ministry of Foreign Affairs and Foreign Trade
Ministry of Housing, Lands and Rural Development
Ministry of Transport and Works
Ministry of Labour, Social Security and Human Resource Development
Ministry of International Business and International Transport

Source: http://www.gov.bb/bigportal/gov/

The local administrative districts are composed of 11 parishes as shown in Table 2.11.5.

Table 2.11.5 Parishes in Barbados

No.	Parish	Area (km^2)	Population (head)*
1	Christ Church	57	54,336
2	Saint Andrew	36	5,139
3	Saint George	44	19,767
4	Saint James	31	28,498
5	Saint John	34	8,963
6	Saint Joseph	26	6,620
7	Saint Lucy	38	9,758
8	Saint Michael	39	88,529
9	Saint Peter	34	11,300
10	Saint Philip	60	30,662
11	Saint Thomas	34	14,249

Remark* Census data in 2010 (Total population in Barbados: 277,821)

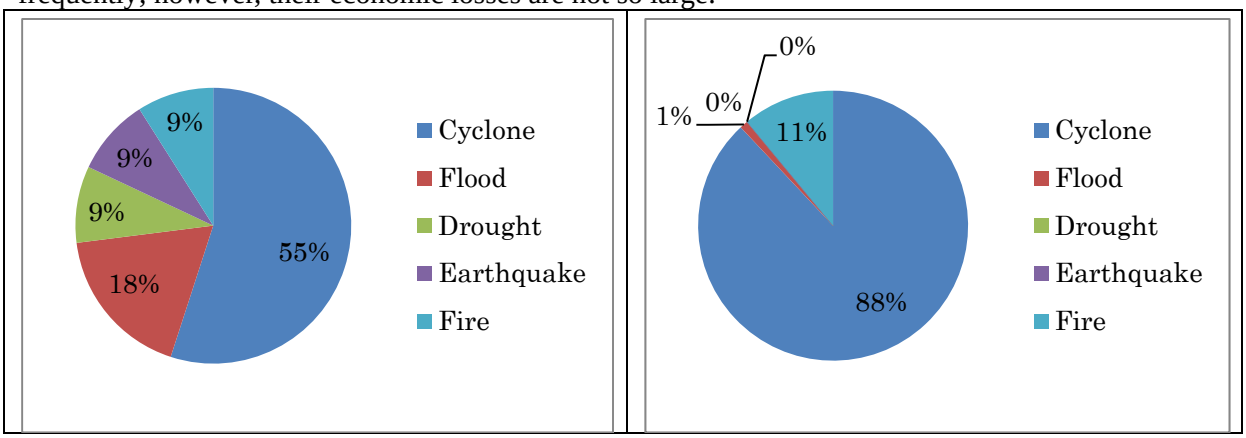
Source: http://www.citypopulation.de/Barbados.html

2.11.2 Disaster Situation

(1) General

The outline of disasters in every survey country is described in the Global Assessment Report on Disaster Risk Reduction 2015, which is issued by UNISDR. The occurrence rate by disaster and the cause-specific percentage of economic losses in Barbados are shown in Figures 2.11.4 and 2.11.5, respectively. According to the figures, the most frequent disaster in Barbados from 1990 to 2014 is that

due to cyclones (wind), which also leads to the most serious economic losses. Floods also occur frequently; however, their economic losses are not so large.



Source: Global Assessment Report on Disaster Risk Reduction

Note: The term "Cyclone" is used as in the source.

Figure 2.11.4 Occurrence Rate by Disaster in Barbados

Figure 2.11.5 Cause-specific Percentage of Economic Loss in Barbados

(2) Flood

1) Record of Major Hurricanes

The records of hurricanes which affected Barbados from 1954 to 2010 are shown in Table 2.11.6.

Table 2.11.6 Major Hurricanes in Barbados

Name	Day/Month/Year
Janet	22 September 1955
Abby	10 July 1960
Edith	25 September 1963
Allen	4 August 1980
Marilyn	14 September 1995
Tomas	30 October 2010

Source: http://stormcarib.com/climatology/TBPB_all_isl.htm

The hurricanes which caused rather severe damages among those shown in Table 2.11.6 and floods are presented hereunder.

(a) Hurricane Janet

Hurricane Janet strengthened within 12 hours on September 22, 1955, and the Category 3 hurricane damaged Barbados with strong winds and heavy rains. The hurricane resulted in a death toll of 38 persons and economic losses of US$5 million. The ratio of the economic loss to GDP is not calculated since GDP is not available.

(b) Hurricane Allen

Hurricane Allen passed through the north of Barbados on August 4, 1980, which caused damages to Barbados including 5,007 affected persons and economic loss of US$1.5 million, which is equivalent to 0.2% of GDP of US$860 million.

(c) Flood in October 1970

Heavy rainfall continued from October 1 to 2 in 1970 causing floods and resulting in damages including a death toll of three persons and economic loss of US$500,000. In addition to the flood, big floods occurred due to tropical storms and heavy rains in 1984, 1986, 1988, 1998, and 2004.

2) Field Inspection and Confirmation of Site Condition

There are two types of floods in Barbados, namely, floods in the lowlands such as Speightstown, Holetown, and Bridgetown located along the coasts and floods which spread at the foot of the terraces

of limestone in the midlands. Only the former was inspected by the JICA Study Team since specific sites of the latter could not be found.

In Speightstown, it was observed that river improvement works were carried out between the river mouth and highway running in the town in order to increase its insufficient flow capacity caused by floods, which is shown in Figure 2.11.6 (upper 2 pictures) It was also observed that no river improvement works were done in the section upstream of the highway, which might lead to floods near the section in the future.

In Holetown, it was observed that river improvement works were made in the same manner as that in Speightstown. Moreover, some walls were constructed by inhabitants beside the river in some sections of the river. It is supposed that the river will be flooded from the sections without the walls mentioned above when its flow discharge is beyond the flow capacity of the river.

In Bridgetown, Garden Land is an area of inundation, in which the upstream drainage canal with narrow width is connected to the downstream trunk drainage canal running toward the Constitution River as shown in Figure 2.11.6 (lower 2 pictures). Small flow capacity of the upstream drainage canal may cause the inundation.

	
River mouth in Speightstown, where sand is deposited and river flow is almost blocked. It was explained that the sand was removed before the rainy season.	Drainage culverts beneath the highway in Speightstown, which have insufficient flow capacity resulting in floods in the upstream area. It was explained that improvement works would be carried out for the upstream section of the river.
	
Garden Land in Bridgetown, in which the trunk drainage canal runs. The drainage canal located upstream of the trunk canal has less flow capacity, causing floods.	Houses located near the connection point of the trunk drainage canal and upstream canal. The houses in the low elevation area are inundated due to insufficient flow capacity of the upstream canal.

Source: JICA Study Team

Figure 2.11.6 Flood Prone Areas

(3) Sediment Disasters

1) Major Sediment Disaster Records

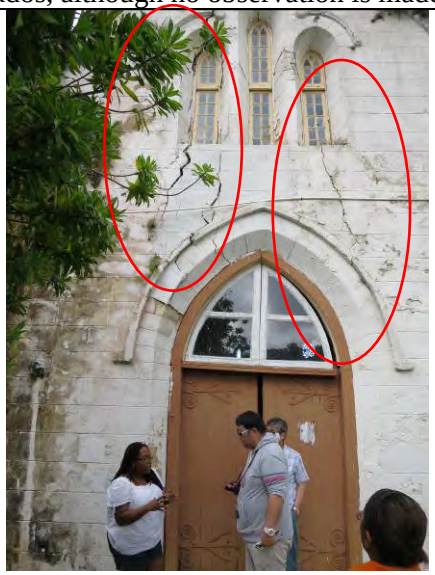
Sediment disaster records are not kept in order by any agency in Barbados, and records or articles on sediment disasters are not also available on the internet. However, the Scotland District covered by sedimentary rocks is vulnerable to sediment disasters such as landslides and slope collapses.

2) Field Inspection and Confirmation of Site Condition

(a) Damages due to Landslide in Saint Joseph's Church Area of Scotland District

The area around Saint Joseph's Church is covered by the Oceanic Group, which is composed of alternate layers of radiolarian rock, marl, and tuff. Saint Joseph's Church has been damaged by landslide, resulting in cracks in its walls and deformation of doors. According to information from the Natural Resources Department, the landslide has been activated since the earthquake in 2007, although its movement was detected from long time ago. Houses located near the church have also been damaged with obvious cracks. Cracks and differences in level are observed on roads, too. These damages are shown in Figure 2.11.7.

It is assumed, on the basis of the deformation of structures and land form, that the landslide has a mass of more than 100 m wide. The Soil Conservation Unit pays the highest attention to the landslide of this area in Barbados, although no observation is made for the movement.



Cracks and deformation of the door in Saint Joseph's Church

Difference in level and deformation of the road

Source: JICA Study Team

Figure 2.11.7 Damages due to Landslide in Saint Joseph's Church Area

(b) Damages to Roads in the White Hill Area of Scotland District

The White Hill Area is covered by the Jose Riverbed composed of mudstone, between layers of which sandstone is intercalated. The area is one of those prone to sediment disasters in Barbados. The road section damaged by landslide due to heavy rainfall on November 23, 2014 was inspected by the JICA Study Team as shown in Figure 2.11.8. It was observed during the inspection that the width of the landslide was about 80 m. The Ministry of Transport and Works is responsible for the restoration of the damaged section of the road; however, the section was not restored as of February 2015.

Damage to road due to landslide (1)


Damage to road due to landslide (2)

Source: JICA Study Team

Figure 2.11.8 Damages to Roads due to Landslide in November 2014 (White Hill Area)

(4) Storm Surge

Although the coasts seem to have been affected by storm surges in Barbados, coastal erosion has not been reported as a major disaster. Minor damages, due to the storm surges, to part of the bank protection works were observed in the coast of Speightstown. The Coastal Zone Management Unit is preparing the Coastal Zone Management Plan at present.

(5) Strong Wind

Major cause of destruction of houses is considered to be strong winds when hurricane with higher category attacks.

(6) Earthquake

Records of disasters caused by past major earthquakes in Barbados are shown in Table 2.11.7.

Table 2.11.7 Major Earthquakes in Barbados

Occurrence	Disaster Area	Magnitude	Disaster Situation	Note
February 18, 2014	Martinique	M6.5	No major disaster	-
November 29, 2007	Martinique	M7.4	2 injured, several houses destroyed in Barbados	-
March 19, 1953	Barbados, St. Lucia, St. Vincent	Unknown	Houses damaged	-
August 30, 1844	St. Vincent, Barbados	Unknown	Details unknown	-

Source: Prepared by the JICA Study Team based on home page of Seismic Research Center and others.

(7) Tsunami

Records of past major tsunami in Barbados are shown in Table 2.11.8.

Table 2.11.8 Past Tsunami that Attacked Barbados

Date of Attack	Tsunami Height (m)	Description
March 31, 1761	Unknown	Affected by the earthquake in Lisbon, Portugal
April 24, 1767	Unknown	-
December 25, 1969	0.46 m	-

Source: Preliminary List of Caribbean Tsunamis, (http://poseidon.uprm.edu/lander/tabla1a.htm)

(8) Water Shortage

Barbados suffered from drought of drinking water in 2010, which started from October 2009. The CIMH issued the drought warning to the East Caribbean countries. The drought in 2014 caused the shortage of irrigation water.

2.11.3 Present Disaster Management

(1) Framework of Disaster Management

The Department of Emergency Management (DEM) is the supervising agency for disaster management in Barbados, which supervises disaster response as well as preparedness, countermeasures, mitigation, and restoration. DEM was established in 2007 in accordance with the Emergency Management Act 2006.

The vision and tasks of DEM are as follows:

Vision : To develop, promote, and maintain a comprehensive National Disaster Management Programme which will educate all citizens about the various elements of disaster management.

Task : To coordinate all emergency management activities in Barbados; evaluate and modify plans on disaster management and its education; and guide for effective restoration.

The National Emergency Management System (NEMS) is the overarching mechanism which facilitates the emergency management in Barbados. DEM is responsible for the coordination of activities of the following groups comprising NEMS:

1) Emergency Management Advisory Council (EMAC)
2) Emergency Operations Center/ Emergency Management Teams
3) 15 Emergency Management Standing Committees under EMAC
4) 30 District Emergency Organizations (DEOs) composed of volunteers

Organization and Budget of DEM

DEM comprises 14 members, five of whom are technical staffs. The annual budget for DEM is Bds$1.5 million.

2.11.4 Meteorological and Hydrologic Services

(1) Meteorological and Hydrologic Agencies and Duties

The meteorological service office is under the Ministry of Agriculture and has its main office at the Grantley Adams International Airport, whose service covers meteorological monitoring, research, and meteorological services including observation, forecasting, and warning.

Hydrological observation including water level and discharge measurement is said to be a task of the Drainage Division of the Ministry of the Environment and Drainage; however regular and continuous observation has not been conducted.

Tide level and surge observations are undertaken by the Coastal Zone Management Unit (CZMU) of the Ministry of the Environment and Drainage.

(2) Outline of Meteorological and Hydrologic Agencies (Personnel and Budget)

Meteorological service office has an annual budget of US$2 million on the average and personnel of 34 staffs including 30 technical persons.

Observations conducted in Barbados are ground and upper air observations in the airport, automatic observations at two existing stations and two under installation, and meteorological radar observation. Other than these, rainfall observation conducted in a private facility is collected.

The start of the observation is in 1942 and it is fully conducted since 1963.

(3) Meteorological and Hydrologic Observations

1) Meteorological Observations (Surface and Altostratus)

The ground observations are undertaken as shown in Table 2.11.9.

Table 2.11.9 Surface Meteorological Observations in Barbados

Station	No(s).	Location	Note
Stations under direct control			
Synoptic station	1	Grantley Adams International Airport (GAIA)	Every hour observation
Automatic station (operational)	2	St. George and GAIA	Every 5 min observation
Automatic station (to be operated)	2	St. Michael and St. Philips (End point at the east end of the island)	
Stations under other organizations			
CIMH	1	St. James	
Stations in plantation (manned)	About 25		Rainfall only

Source: JICA Study Team

Rainfall data observed mainly at a private sugarcane plantation are collected daily through telephone. Data sheets are then collected monthly.

2) Meteorological Radar Observation

The Doppler wave type meteorological radar donated by EU has been operated in Castle Grant since 2008. Annual operation and maintenance cost is about US$25,000, of which about US$18,000 is the required electric bill.

3) Hydrologic Observation (River)

Although the Drainage Division of the Ministry of the Environment and Drainage is responsible for observation of water level and discharge, no regular and continuous observation has been conducted but as required only when a project needs data for planning and design.

4) Tide and Surge Observations

Tide level and surge observations are made by CZMU as shown in Table 2.11.10.

Table 2.11.10 Tide Level and Surge Observation Stations in Barbados

Station	No(s).	Location	Note
Tide level observation station (automatic)	1	Port St. Charles (St Peter, west coast)	Representing tide level observation station in Barbados
Wave recorder			
・Data logger system	3	Crane Beach, Holetown, near Oistins)	
・Automatic observation (radio transmission)	1	East coast	

Source: JICA Study Team

5) Observation Database System

The computerized system of database, monitoring, and data transmission/receiving is installed at the main office in the airport. Hardware system has no particular problem but the operating system (OS) of the database system seemed to be a rather old model (maybe in DOS model).

All observation data including ground and radar observations are stored in the data server at the main office, which is for internal use only and no external access is allowed.

(4) Dissemination of Weather Information, Forecast, and Warning

Warnings concerning hurricane and storm, which are based on the information from NHC, are disseminated to the disaster-related agencies and media.

(5) Cooperation with Other Related Meteorological Agencies

All information concerned are provided and exchanged through CIMH.

2.11.5 Support of the Japanese Government

As Barbados is categorized as a high income level country, the recent supports by the Japanese government are limited to technical cooperation.

2.11.6 Support of Other Donors

The project of Road Rehabilitation and Improving Connectivity of Road Infrastructure is scheduled to be implemented, and the Coastal Risk Assessment and Management Program is in progress. Both of these projects are under IDB's loan schemes.

There are many grant aids from EU, although these are not in the category of disaster management. (EU committed an aid amount of Bds$100 million in February 2014.)

2.12 Belize

2.12.1 Profile

(1) Basic Data

The basic data of Belize are shown in Table 2.12.1.

Table 2.12.1 Basic Data of Belize

Profile	
Population	331,900 persons (2013, WB)
Land area	22,970 km^2 (WB)
Capital	Belmopan
Largest city	Belize City
GDP	US$1.6.24 billion (2013, WB)
GDP per capita	US$4,894 (2013, WB)
GNI (Atlas method)	US$1.506 billion (2013, WB)
GNI per capita	US$ 4,510 (2013, WB)
GDP growth rate	1.53% (2013, WB)
GFCF (%GDP)	13.6 (2015, UNISDR, GAR)
Current account	US$(-)19 million (2013, Balance of Payments Manual, IMF)
Assistance received total	US$25 million (2012, WB)
Income level	High/Middle Income level
Independence	September 21, 1981
Currency	Belize Dollar (BZD)
Climate	Tropical Rainforest Climate
Administrative division	6 countries
Residents	Sutiso 52.9%, Creole 25.9%, Maya 11.3%, East Indian 3.9%, Others (2011,CIA World Fact Book)
Language	Official Language: English
Religion	Christian 71.6%, etc.
Principal industry	Agriculture, Fishery
Major Development Indices	
HDI index	0.702 (2012, UNDP)
Literacy rate (15-24 years old)	76.4% (1991, WB)
Primary school enrollment rate	96.6% (2013, WB)
Infant mortality rate (per 1,000 births)	20.31 persons (2014, CIA World Fact Book)
Mortality rate of pregnant women and nursing mothers (per 1,000 cases)	45 persons (2013, CIA World Fact Book)
HIV infection rate (15-49 years old)	1.5% (2013, WB)
Improved water service rate	99.3% (2012, WB)
Improved sanitation rate	90.5% (2012, WB)
GINI index	53.1 (2015, UNISDR, GAR)
Life expectancy at birth (years)	73.9 years (2013, WB)
Poverty gap at national poverty lines (%)	12.2% (1999, Millennium Development Indicators)
Social expenditure (% of GDP)	--
Governance Indicators	
Rule of law	-0.45 (2015, UNISDR, GAR)
Government effectiveness	-0.19 (2015, UNISDR, GAR)
Voice and accountability	0.70 (2015, UNISDR, GAR)
Control of corruption	0.02 (2015, UNISDR, GAR)
Environment	
Ecological footprint	-- (2015, UNISDR, GAR)

Environmental performance index	50.5 (2015, UNISDR, GAR)
Forest change	-6.3(2015, UNISDR, GAR)
Freshwater withdrawals (% of internal resource)	0.7 (2015, UNISDR, GAR)
Climate Change	
Electricity production from renewable energy	0.0% (2015, UNISDR, GAR)
CO_2 emissions	1.37 metric ton/capita (2015, UNISDR, GAR)

Source：World Bank (WB), UNDP, CIA World Fact Book, MOFA Japan (ODA Country Data Book), UNISDR

(2) Overview of Natural Situation

1) Topography and Geology

Belize is located in the Yucatan Peninsula of Central America in the area between 15°45'N and 18°30N latitude and between 87°0'W and 89°15'W, and covers 22,960 km^2. About 95% of the whole area belongs to the mainland in the continent part and the remaining 5% is occupied by more than 1,060 islands in the Caribbean Sea.

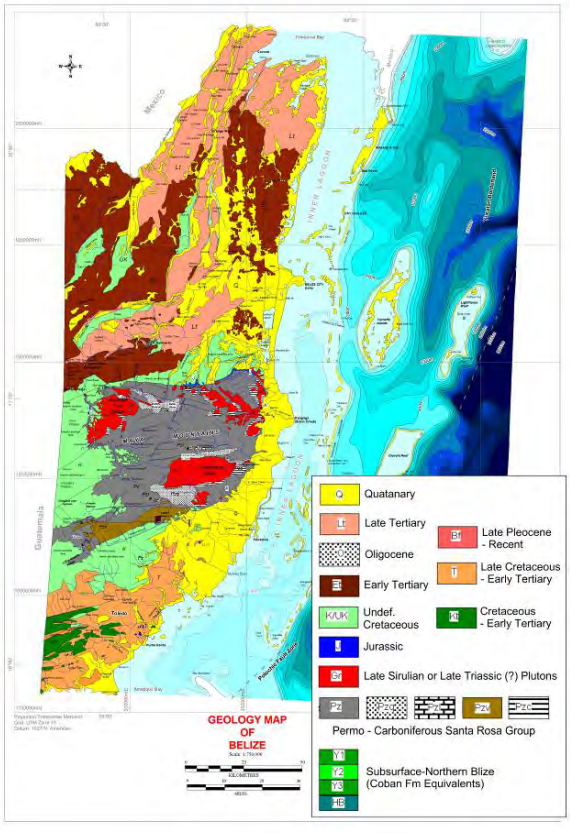
Topographical feature of the Belizean landscape is classified into two main physiographic regions, i.e., south and north. The Maya Mountains (highest elevation is 1,120 m) with the studded basins and plateaus therein dominate the southern area, and the narrow coastal plain exists along the shore of the Caribbean Sea. Almost all regions in the north area comprise lowlands below 150 m above sea level. Especially, 18 major rivers and many perennial streams drain low-lying coastal areas in the northern and central parts of the country, which are flat and swampy, with many lagoons.

Belizean geology comprises large varieties of limestone, with the notable exception of the Maya Mountains. A huge uplifted block of intrusive Paleozoic granite and sediments run northeast to southwest across the south-central part of the country.

Topographic and geological maps of Belize are shown in Figures 2.12.1 and 2.12.2, respectively

Source：Hydro-meteorological Office

Figure 2.12.1 Topography of Belize

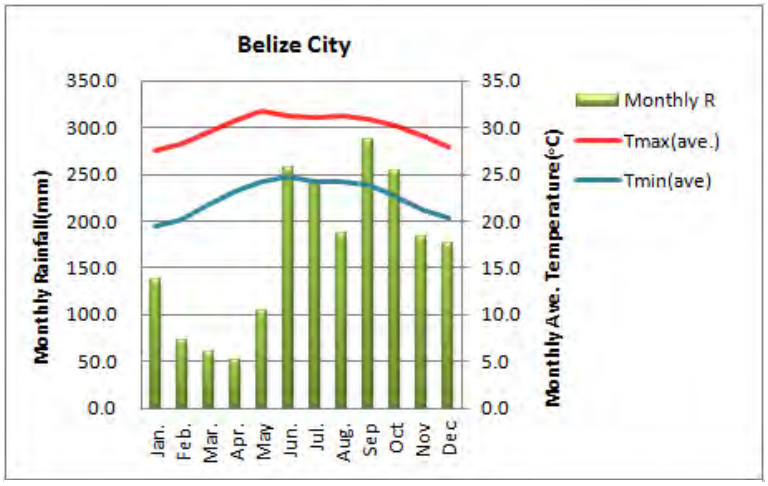


Source：Ministry of Energy, Science and Technology and Public Utilities, Geology and Petroleum Department

Figure 2.12.2 Geology of Belize

2) Climate

The northern part of Belize is in the semi-tropical climate zone with an annual rainfall of 1,500 mm, while the southern area is in the tropical climate zone with an annual rainfall of 3,800 mm. Rainy season starts from the middle of May and middle of June in the southern and northern parts, respectively, and until November. Rainfall amount in the rainy season is 60% of the annual amount. Monthly average maximum and minimum temperatures are 29.4°C and 21.1°C, respectively



Source: http://www2m.biglobe.ne.jp/ZenTech/world/kion/Belize/index.htm

Figure 2.12.3 Monthly Mean Temperature and Rainfall in Belize City (Belize)

(3) Socioeconomic Condition

1) Political Situation

Belize became independent from Britain in 1981. It has a two-party system comprising the United Democratic Party (UDP) and the People's United Party (PUP). UDP had taken power in February 2008 and then UDP won by a narrow margin and took power in March 2012.

2) Population

According to the World Bank's survey, it is estimated that the total population of Belize was 330,000 as of 2013, 55% of which are living in the urban area. Table 2.12.2 shows the change of population in Belize.

Table 2.12.2 Change in Population in Belize

Indicator	1988	1993	1998	2003	2008	2013
Total population (person)	178,906	198,420	225,083	258,346	293,544	331,900
Population growth rate (annual %)	2.64	1.79	2.98	2.58	2.54	2.39
Urban population (person)	93,307	104,379	117,905	137,308	159,979	184,875
Urban population (% of total)	52.15	52.61	52.38	53.15	54.50	55.70
Rural population (person)	85,599	94,041	107,178	121,038	133,565	147,025
Rural population (% of total)	47.85	47.40	47.62	46.85	45.50	44.30

Source: World Bank, World Data Bank

3) GNI and GDP

Nominal GNI per capita and nominal GDP per capita of Belize are US$4,400 and US$4,850, respectively as shown in Table 2.12.3.

Table 2.12.3 Nominal GNI and GDP per Capita in Belize

Indicator	2009	2010	2011	2012	2013
GNI per capita, Atlas method (US$)	4,110	4,310	4,140	4,310	4,420
GDP per capita (US$)	4,662	4,441	4,527	4,702	4,857

Source: World Bank, World Data Bank

4) Government Agencies and Administrative Division

The ministries of the Belizean government are enumerated in Table 2.12.4.

Table 2.12.4 Central Government Agencies of Belize

Central Government Agencies
Attorney General's Ministry and Ministry of Foreign Affairs
Ministry of Energy, Science and Technology and Public Utilities
Ministry of Education, Youth and Sports
Ministry of Finance and Economic Development
Ministry of Forestry, Fisheries and Sustainable Development
Ministry of Health
Ministry of Housing and Urban Development
Ministry of Human Development, Social Transformation and Poverty Alleviation
Ministry of Labour, Local Government, Rural Development, NEMO and Immigration
Ministry of National Security
Ministry of Natural Resources and Agriculture
Ministry of Public Service and Elections and Boundaries
Ministry of Tourism and Culture
Ministry of Trade, Investment Promotion, Private Sector Development and Consumer Protection
Ministry of Works and Transport

Source： The Official Government Portal, Government of Belize

Belize has six local administrative districts as shown in Table 2.12.5.

Table 2.12.5 Administrative Districts in Belize

District	Area (km^2)	Population (2010)
Corozal	1,860	41,061
Orange Walk	4,636	45,946
Belize	4,204	95,291
Cayo	5,196	75,046
Stann Creek	2,554	34,324
Toledo	4,413	30,785

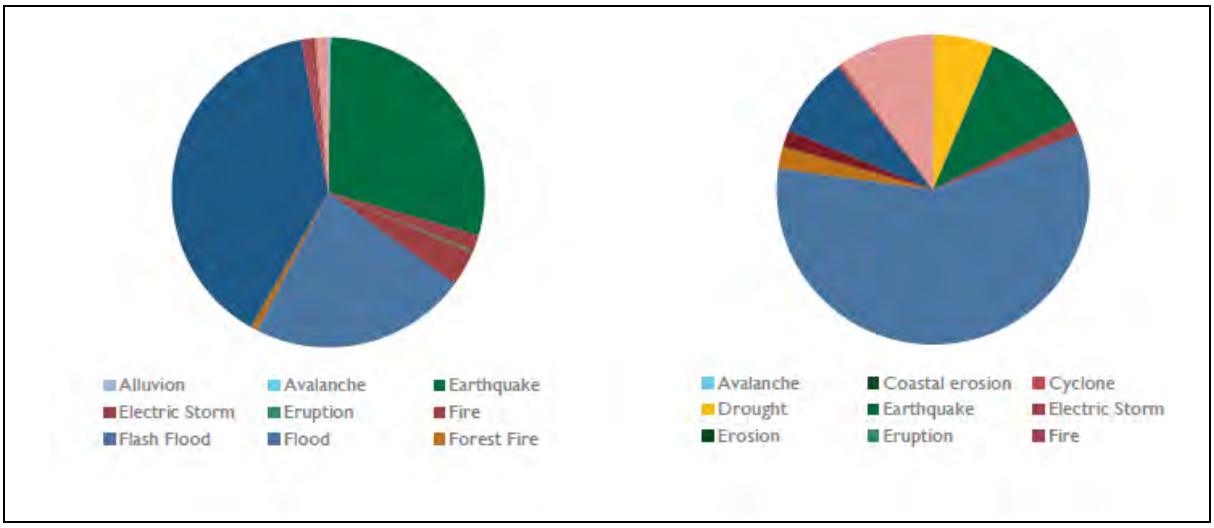
Source: http://www.citypopulation.de/Belize.html

2.12.2 Disaster Situation

(1) General

Belize is a continental country with vast expanse of land whose natural environment varies between the inland and coastal areas. Most of the population lives in the low areas of the coastal plain. Natural disasters in Belize are caused mainly by flood, storm surge, and high waves.

Referring to the Global Assessment Report on Disaster Risk Reduction 2015 prepared by UNISDR, the occurrence rate by disaster and cause-specific percentage of economic loss by disasters are shown in Figure 2.12.3.



Source: Global Assessment Report on Disaster Risk Reduction

Note: The term "Cyclone" is used as in the source.

Figure 2.12.4 Occurrence Rate by Disaster (left) and Cause-specific Percentage of Economic Loss by Disasters (right)

(2) Flood

1) Feature of Floods

Feature of floods in Belize is quite different depending on the northern and southern areas according to the topographic characteristics of the land. In most of the northeast land, the lowland plain suffers flood inundation for long-term around the downstream lagoon of the Belize River. On the other hand, the southern part of the land is a mountainous region where floods characterized as flash floods frequently occur and cause casualties.

2) Record of Floods

Belize is located in the hurricane belt zone similar to the other Caribbean countries and has sometimes suffered severe flood disasters. Disasters due to hurricanes are those in 1931 with 1,500 deaths, 1941, 1955, 1961, 1969, 1974, and 1978. Hurricane Keith in 2000 and Hurricane Iris in 2001 caused damages recently.

Belize City, which was formerly the capital of Belize, located in the peninsula which sticks out to the sea, has suffered devastating damages due to Hurricane Hatti in 1961 and the death toll reached 275. Because of this disaster, the capital was relocated from Belize City to Belmopan in 1971.

Currently, most of the main central government agencies have been relocated to Belmopan; however, Belize City is still the center of economy and has a large population but is vulnerable to flood and storm surge disasters.

In 2008, flood disasters occurred all over Belize and about 50,000 persons which is about one sixth of the total population were affected. Furthermore, more than 100 communities were damaged such as those in Eastern Cayo, Belize, Orange Walk, and Corozal districts.

3) Field Inspection and Confirmation of Site Condition

i) Flooding in Lagoon of the Belize (Crooked Tree Point)

The Crooked Tree Village was one of the target communities for community disaster management in the Caribbean Disaster Management Project, Phase II (CADM2 from January 2009 to June 2012), which is located at the downstream lagoon of the Belize River with a population of about 1,000. Inundation occurs in this community every year when the water level of the lagoon rises; in 2014, the situation where there is no other access than using boat lasted for about three to four months. Present condition of the Crooked Tree Village is shown in Figure 2.12.5.

The water level gauges installed under CADM2 in the lagoon have been used for community flood disaster mitigation activities under the management of the National Emergency Management Organization (NEMO).

	
Date：April 2, 2015 Outline：Environment conservation center in a village. Flood water is under the floor level of the center.	Date：April 4, 2015 Outline：Sole access route to the community is inundated during the rainy season and land traffic is suspended.

Source: JICA Study Team

Figure 2.12.5 Flood-affected Area near Crooked Tree Point

ii) Flash Flood (North Stann Creek River in the Southern Area)

In the North Stann Creek River basin in the southeast area of Belize, flash flood occurred in 2008 around Middlesex Bridge of the Hummingbird Highway, which resulted in three dead residents at the downstream section of the bridge. During the flood, inundation depth reached to 10 cm above the floor and 1 m on the ground. At this site, the road bridge constructed in 1982 was damaged by the flood in 2008 and rehabilitated to the present one in December 2010 under the EU-supported Belize Rural Development Program.

Present condition of the Crooked Tree Village is shown in Figure 2.12.6.

	
Date：April 4, 2015 Outline：Upstream view of the North Stann Creek River from Middlesex Bridge	Date：April 4, 2015 Outline：Houses inundated during 2008 flood.

Source: JICA Study Team

Figure 2.12.6 North Stann Creek River, Middlesex Bridges

iii) Overflow of Rivers (Rio Hondo River, Dagras)

The Dagras Village is a flood prone area and has suffered inundation once every three years during the rainy season. It is located at the right bank of the Rio Hondo River flowing along the border with Mexico. The maximum depth of inundation reaches to 5 ft.

As a countermeasure against flood, a resettlement plan is proposed and partly carried out by the government; however, the resettlement has not much progress except for limited houses since there are

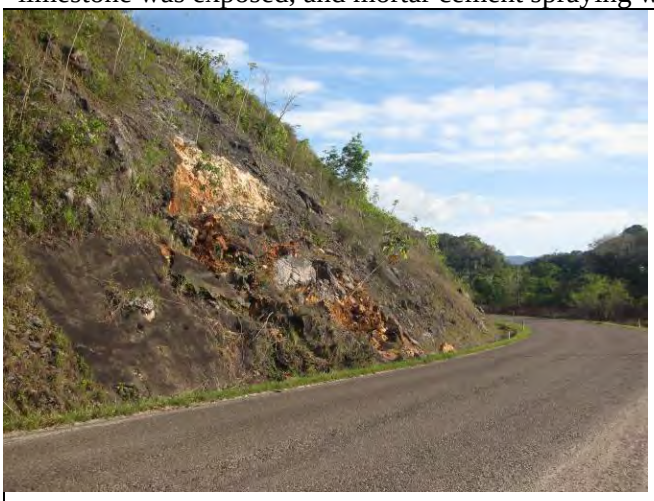
many residents who do not desire to leave the land where the family has lived on for generations. Therefore, the government conducts the feasibility study of the alternative of construction of levee and will assess whether the resettlement should be carried out as it is.

(3) Sediment Disasters

In Belize, sediment disasters occur mainly in the mountainous region. Whenever slope failures occur along the main road, the road is temporarily closed to remove the debris and reopened to traffic afterwards.

1) Site Inspection

Figure 2.12.7 shows the site of small slope failure along the Hummingbird Highway. Weathered limestone was exposed, and mortar cement spraying was implemented at the bottom of the slope.



Date: April 6, 2015

Location: Stop 1 – Slope Failure Site

Description: Small slope failure site on Hummingbird Highway. Source：JICA Study Team

Figure 2.12.7 Slope Failure Site and Locations in Belize

(4) Storm Surge

More than 60% of the total population lives in the coastal area; therefore, once high tide period coincides with hurricane or long-term inundation type of flood, serious inundation disasters would be caused. In the past, storm surge due to hurricane caused inundation in the Corozal region, from the coastal line up to one to two miles inland from the coast.

Meanwhile, seawalls are developed in many coastal cities; however, many locations of beaches and coasts suffered coastal erosion. Coast erosion has progressed in the last 30 years in Dangriga, the Monkey River, Mango Creek, and Punta Gorda.

(5) Strong Wind

Fallen trees disasters due to strong winds during hurricane have been reported; however, the economic damages in the agriculture and other sectors are rather small.

(6) Earthquake

Belize is close to the northern margin of the Caribbean Plate with minor earthquake risk concentrated in the southern part of the country. The country has not been subject to any major earthquake events in recorded history. However, large earthquakes occurred in the past in Honduras and Guatemala that caused damages to infrastructure.

An M7.3 earthquake that occurred off the coast of Honduras in 2009 hit Belize and many of the houses in Monkey River Town were damaged. Although details are unclear, shaking of the 1912 earthquake off the coast of Belize, the 1999 earthquake in Honduras, and the 2007 earthquake in Guatemala (M6.7) were observed in Belize.

(7) Tsunami

Only small-scale tsunami has been generated around Belize to date including that caused by the earthquake which occurred off the coast of Honduras in 2009.

(8) Drought

When Belize City experienced serious drought situation in 1975, water intake from the source of water supply became impossible due to the lowering of the water level of the Belize River, which supplies 17% of the total water supply.

(9) Bridge

According to the Ministry of Works and Transport (MOWT) in charge of roads and bridges, the government requires the bridges damaged by the disasters to be repaired and improved as follows:

Bridges Damaged by the Disasters

Kendal Bridge : Destroyed by Tropical Storm Arthur in June 2008 and the new bridge was in service in 2012.

Mullin River Bridge : Destroyed at almost the same time as the Kendal Bridge, and a temporary bridge is in use at present.

Beaver Dam Bridge : Overflowed; the existing steel girder bridge was constructed in 2007.

Rancho Dolores Bridge : Broken at the time of earthquake with an epicenter in Guatemala.

More Tomorrow Bridge : - ditto - -

Bridges to be Improved and Replaced according to the Government

Halilover Bridge : Old and decaying; located at the gateway of Belize City on the Philip Gordon Highway (North Highway)

Sister bridges around Alta Vista : Road bridge with one lane modified from a railroad bridge on Hummingbird Highway

St Margaret's River Bridge : Need a new bridge instead of the existing ferry service

Laguna Sea Corozal Districts : Need a new bridge instead of the existing ferry service

Baking Pot (Ferry) Cayo District : Need a new bridge instead of the existing ferry service

Salfillo (Ferry) Corozal : Need a new bridge instead of the existing ferry service

Sun Eastern (Narrow Road)

1) Field Inspection and Confirmation of Site Condition

The JICA Study Team conducted site inspections mainly for the trunk roads shown in Table 2.12.6, whose locations are indicated in Figure 2.12.8.

Table 2.12.6 Inspected Bridges in Belize

No	Bridge Name	Road	Damage Situation	Present Situation
1.	Sibun River	HBH	Broken	Rebuilt in 2004
2.	Gap River Bridge	HBH	Overflowed	Used as before
3.	Middlesex Bridges	HBH	Broken	Newly built in 2011
4.	Narrow 5 Bridges	HBH	Old and deteriorated	Risky but used as before
5.	Mullin River Bridge	HBH	Broken	Rebuilt
6.	Melinda Bridge	HBH	Overflowed	Used as before
7.	Dangriga Bridge	HBH	Not affected	Used as before
8.	Kendal Bridge	SH	Broken in 2008	Rebuilt in 2014
9.	Rio Swasey River	SH	Not affected	Used as before
10.	Rio Bladen River	SH	Not affected	Used as before
11.	Rio Grande River	SH	Not affected	Used as before
12.	Belize River Boom Bridge -1	BBC	Not affected	Used as before
13.	Belize River Boom Bridge -2	NH	Overflowed	Used as before
14.	Crooked Tree(April2)		Flooded	Used as before

No	Bridge Name	Road	Damage Situation	Present Situation
15.	New River, Bridge -1	NH	Not affected	Used as before
16.	New River, Bridge -2	NH	Not affected	Used as before
17.	New River, Bridge -3	NH	Not affected	Used as before
18.	New River, Bridge -4	NH	Not affected	Used as before
19.	Ferry crossing new river mouth		Not affected	Used as before

Source：JICA Study Team

○: Inspected bridge

Source：JICA Study Team

Figure 2.12.8　Locations of Field Inspection in Belize (Bridges)

1) Bridge on the Hummingbird Highway

Present situation of the narrow bridges on the Hummingbbird Highway is presented in Figure 2.12.9.

Valley Community Bridge

Concrete girder bridge with a width of one lane that disturbs smooth traffic along the trunk road and has a risk against safe traffic. It was constructed as a railway bridge in the 1950s and then modified to the road bridge. It is getting decrepit.

Date：April 4, 2015　10:09 AM
Site：　Valley Community Bridge 1
Outline：Three-span 20 m long bridge with concrete girders, which is less secure against transportation due to one lane availability.

Date：March 29, 2015
Site：Valley Community Bridge 1 (side view)
Outline：Pier is composed of four concrete pillars joined by concrete girders.

Date：April 4, 2015　10:14 AM
Site：Valley Community Bridge 2
Outline：Six-span 40 m long bridge with concrete girders; constructed in the 1950s

Date：April 4, 2015
Site：Valley Community Bridge 2
Outline：River valley was so deep and covered by thickly grown trees that riverbed was not clearly seen.

Figure 2.12.9　Bridges in and around Hummingbird Highway (1/2)

	
Date：April 4, 2015　10:20 AM Site：Valley Community Bridge 3 Outline：A 30 m long bridge with concrete girders; Traffic of trucks and trailers are frequent because of a huge juice factory along the road.	Date：April 4, 2015 Site：Valley Community Bridge 3 Outline：Piers are composed of rectangular pillars connected with girders and individual gatepost type.
	
Date：April 4, 2015　10:34 AM Site：Valley Community Bridge 4 Outline：Concrete girder bridge, which is 75 m long. Two-lane road becomes narrow at the bridge with one lane.	Date：April 4, 2015　11:35 AM Site：Valley Community Bridge 5 Outline：Concrete girder bridge, which is 55 m long.
Source: JICA Study Team	

Figure 2.12.9 Bridges in and around Hummingbird Highway (2/2)

2)　Kendal Bridge on the Sittee River

It is a steel girder bridge across the Sittee River which was constructed with the support of CDB and completed in November 2014 as shown in Figure 2.12.10. The old bridge constructed in 1975 was washed away during flood due to Tropical Storm Arthur in 2008. Taking this into consideration, the new bridge was raised by 3 m higher than the old bridge. The new bridge is 90 m long, and has 8 m wide vehicle lane and 1.3 m wide sidewalk.

	
Date：April 4, 2015　12:18 PM Outline：Steel truss bridge completed in November 2004 with CDB's support. The old bridge was washed away during Tropical Storm Arthur in 2008.	Date：April 04, 2015 Outline：Old bridge's abutment is left in front of the abutment of the new bridge protected by steel sheet piles and gabions. New bridge is raised by 3 m from the old one.

Source: JICA Study Team

Figure 2.12.10　Sittee River, Kendal Bridge

3)　Mullin River Bridge

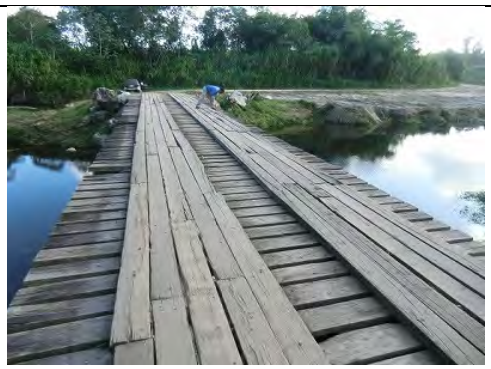
It is a bridge on the Coastal Highway across the Mullin River. It was washed away during the flood caused by continuous rain for four days due to Tropical Storm Arthur on June 4, 2008, which is the same day that the Kendal Bridge was washed away. There is still wreckage of the destroyed bridge. There is a detour bridge whose road surface is rather close to the river water level. A reconstruction work of the bridge may be done by Korea International Cooperation Agency (KOICA).

Figures 2.12.11 and 2.12.12 respectively shows the previous location of the Mullin Bridge and the temporary Mullin Bridge site.

	
Date：April 10, 2015 Outline：Most of the bridge structures were washed away except the abutment in the foreground of the photo. The bridge was broken during Tropical Storm Arthur in June 2008.	Date：April 10, 2015 Outline：Previous bridge with five piers was damaged due to many driftwoods caught in the piers.

Source: JICA Study Team

Figure 2.12.11　Location of Previous Mullin Bridge

	
Date：April 10, 2015 Site：Temporary bridge as detour of the original Mullin River Bridge Outline：Temporary bridge which is about 21 m long and 3.5 m wide situated at the downstream side of the broken bridge.	Date：April 4, 2015 Site： Temporary bridge which is about 21 m long at the downstream side of the Rio Mullin River.

Source: JICA Study Team

Figure 2.12.12 Temporary Mullin Bridge Site

4) Design Criteria (Earthquake Resistance Standard, Freeboard)

AASHTO is applied as the design standard and the design flood water level is based on the probable 50-year rainfall and clearance is determined depending on the respective regions.

2.12.3 Present Disaster Management

(1) Framework of Disaster Management

In Belize, the Disaster Preparedness and Response Act was enacted in 2000 which stipulate the framework of disaster management and duties of NEMO. In 2004, the National Hazard Management Policy, which sets the vision and goal for hazard management, and defines the policy, goal, strategy, and requirements for implementation of the disaster mitigation measures, was enacted. Afterwards, the National Hazard Management Plan was formulated, and it summarized the preparedness and corresponding plans classified by hazard such as hurricane and flood, the national recovery and disaster mitigation plans, the evacuation plan, the search and rescue plans, and the telecommunication plans.

(2) National Emergency Management Organization (NEMO)

The National Emergency Management Organization (NEMO) has been established as the disaster coordination agency to respond to any emergency situation including threat stage, to guard people's lives and national properties, and to mitigate impact of emergency, in collaboration with each emergency management committee as well as public and private agencies and organizations.

NEMO is composed of the cabinet chaired by the Prime Minister, the cabinet secretariat, the NEMO secretariat, and the committees headed by the undersecretary of each ministry. Other regular members are the Belize Red Cross, Belize Teacher's Union, the Director for the Meteorological Service, the Commander of the Belize Armed Forces, and the Director of the National Police Agency.

Present personnel of NEMO consist of 25 staffs including seven technical staff and 18 supporting staffs. As for the organizational aspect, it has three layers composed of the National Emergency Operation Center (NEOC) at the national level, the District Emergency Operation Center (DEOC) at the regional level, and the Village Emergency Operation Center (VEOC) at the community level. At the national level, there are 14 committees including nine in each district, two in Cayo Region, and three in Belize City. At the district level, the committees are similarly formed.

NEMO instructs actions to be taken in case of flooding to each regional organization through the communication networks such as the meteorological information system of the Meteorological Office and the traffic control communication system of MOW.

The disaster management plan for tsunami and earthquake has been set up in April 2015, but not disclosed yet because of pending approval.

The storage is facilitated at five sites in Orange Walk, Belize City, Independence, Belmopan, and Punta Gorda. The evacuation centers for hurricane are available for more than 200 locations over the country at schools, churches, and community centers of the respective regions.

2.12.4 Meteorological and Hydrologic Services

(1) Meteorological and Hydrologic Agencies and Duties

The meteorological service is conducted by the National Meteorological Service (NMS) under the Ministry of Labor, Local Government, Rural Development, NEMO and Immigration and Nationality (MLLGRD-NEMO-NMS).

The Hydrological Unit under the Ministry of Natural Resources and Agriculture (MNRA-HD) is the agency to conduct hydrological observation and management of permits and licenses of water use. Before the reorganization of the government agencies in 2012, MNRA-HD was under same ministry as NMS.

(2) Outline of Meteorological and Hydrologic Agencies (Personnel and Budget)

NMS has 26 staffs including 21 technical staffs as well as annual budgets equivalent to US$424,000 (2012) and US$534,000 (2014).

MNRA-HD has only four staffs at present.

(3) Meteorological and Hydrologic Observations

1) Meteorological Observations（Surface and Upper Air）

MLLGRD-NEMO-NMS conducts meteorological service with the synoptic stations at 20 locations nationwide and automatic stations at eight locations. Five of the eight automatic stations have been established by 5Cs and the remaining three by the Belizean government. Upper air observation by radiosonde is conducted two times every day in the morning and evening.

2) Meteorological Radar Observation

Radar observation is based on the satellite picture information sent from NHC as well as outcome of the country's own Doppler radar installed in 2009 under EU donor funding, which has a range of 400 km diameter and covers the neighboring Honduras. Operation staff of the NMS radar system consists of an engineer and an administrative staff with an annual O&M budget equivalent to US$25,000.

3) Hydrologic Observation (River)

At present, water level observation is conducted at 32 locations. Past water level-discharge curve, which was constructed based on the river cross section survey and discharge measurement by current meter, is required to be updated.

Neither groundwater nor water quality measurement is carried out so far.

The water level stations at four locations and a rainfall station were installed in 2011-2012 under CADM2, wherein the water level station at Banana Bank was damaged during recent flood and to be moved to a higher place. The other stations are still operational in terms of observation and recording aspects.

4) Observation Database System

Generalization of the database system by NMS is in progress. A database system has been set up in the related overseas organization such as CIMH and in Costa Rica to date. Such database system is to be unified in the national comprehensive database system.

(4) Dissemination of Weather Information, Forecast, and Warning

Data transmission from the automatic stations is through satellite communication and mobile telephone communication. As for the agro-meteorological stations, daily rainfall observation is undertaken by the observer and sent out by telephone.

The early warning system installed under CADM2 functions as observation and recording system; however, communication and early warning systems are not operational due to the operating software of the communication equipment. Observed data are periodically collected at sites by downloading from the data logger.

(5) Cooperation with Other Related Meteorological Agencies

Cooperation with Mexico has been promoted by the organizing committee. In addition, agreement and protocol concerning the Rio Hondo River exist with Mexico. No agreement and protocol exist with Guatemala regarding the Belize River.

2.12.5 Support of the Japanese Government

There is no individual support by the Japanese government in the disaster management field; technical assistance for hazard mapping in the pilot project area and formulation of community disaster management plan were carried out in the JICA Caribbean Disaster Management Project, Phase II (CADM2, from 2009 to 2012). However, no action was taken afterwards in other river basins for hazard mapping in the pilot project area and for formulation of the community disaster management plan.

2.12.6 Support of Other Donors

(1) World Bank

The Climate Resilient Infrastructure Project under the World Bank is in progress at present. In the course of the project, the Belizean government has formulated the National Climate Resilience Investment Plan (NCRIP). In conformity with this plan, the Belize Climate Resilient Infrastructure Project (BCRIP) is being implemented.

MOWT is going to carry out the improvement of roads, drainages, and public buildings, which were in dangerous situation. Necessity of improvement works by NCRIP has also been confirmed by MOWT. Meanwhile, BCRIP will implement the works including rehabilitation of roads with a distance of 30 km, training of 100 personnel for repair works, and improvement of 12 bridges and culverts.

Furthermore, the World Bank is taking the lead in conducting the CHARIM, in which the workshop for capacity building against disasters including earthquake and landslide as well as the preparation of training materials and development of hazard maps are undertaken.

(2) IDB

The implementation of an Integrated Disaster Risk Management (IDRM) plan was executed for two years since 2010 with the support of IDB and was completed already. The project was composed of the following two components:

Component-1 : Organization reinforcement of NEMO and capacity building

Strengthening of the state comprehensive risk management capacity focused on identification, prevention and mitigation, and financial risk management.

Component-2 : Mitigation of flood risk in agriculture field

Building of a comprehensive flood prevention and mitigation program in the agriculture field as a pilot project of the state IDRM plan.

The IDB-supported Flood Mitigation Infrastructure Program for Belize City is progressing as an infrastructure countermeasure project against floods in Belize City. The project components comprise urban drainage improvement works through drainage canal improvement, improvement of road and gutter, and coastal revetment development at seven locations over Belize City including central city area and airport; total project cost is US$10 million.

(3) Other Donors

The Red Cross is working on community disaster management through grassroots approach. As part of the disaster mitigation training for communities, the Red Cross in cooperation with NEMO and Flood Mitigation Team carry out the trainings on the monitoring of river discharge and water levels for the volunteer river-keepers in Belize City and San Pedro.

2.13 Organization of CARICOM

2.13.1 Caribbean Disaster Emergency Management Agency (CDEMA)

(1) Organization

The Caribbean Disaster Emergency Management Agency (CDEMA) was established in September 2009. The CDEMA's predecessor was the Caribbean Disaster Emergency Response Agency (CDERA) founded in September 1991. CDEMA was set up under CARICOM for disaster management. The number of CDEMA's member countries and area is 18 in total at present as shown in Table 2.13.1.

Table 2.13.1 CDEMA's Member Countries and Area

No.	Country and Area	No.	Country and Area	No.	Country and Area
1	Anguilla	7	Grenada	13	Saint Lucia
2	Antigua and Barbuda	8	Republic of Guyana	14	Saint Vincent and the Grenadines
3	Commonwealth of the Bahamas	9	Haiti	15	Suriname
4	Barbados	10	Jamaica	16	Republic of Trinidad and Tobago
5	Belize	11	The British Montserrat	17	Turks and Caicos Islands
6	Commonwealth of Dominica	12	Saint Christopher and Nevis	18	The Virgin Islands

Source: http://www.cdema.org/publications/Overview_of_CDEMA.pdf

The headquarters of CDEMA is located in Barbados. The area covering the 18 member countries/area is divided into four sub-regions, and actions for disaster management are to be taken from one of the four Sub-regional Focal Points. Table 2.13.2 shows the Sub-regional Focal Points and countries for which actions are to be taken.

Table 2.13.2 Sub-Regional Focal Points and Countries/Area

Sub-Regional Focal Point	Countries/Area for which Actions are to be Taken			
Antigua and Barbuda (NODS)	Anguilla	Virgin Island	The British Montserrat	Saint Christopher and Nevis
Barbados (DEM)	Dominica	Saint Lucia	Saint Vincent and the Grenadines	
Jamaica (ODPEM)	Bahamas	Belize	Haiti	Turks and Caicos Islands
Trinidad and Tobago (ODPM)	Grenada	Guyana	Suriname	

Source: http://www.cdema.org/publications/Overview_of_CDEMA.pdf

(2) Current Situation

CDEMA prepared recently the Regional Comprehensive Development Management Strategy and Programming Framework 2014-2024 in order to pursue the comprehensive disaster management (CDM). The member countries use the Regional Strategy and Framework, or prepare/are preparing their own strategies conforming to the Regional one.

Furthermore, CDEMA prepares guidelines on disaster management reflecting conditions of the member countries; assesses vulnerabilities of the member countries; introduces community disaster management; and trains the government agencies relating to the disaster management.

(3) Supports by Other Donors

The donors' activities/supports for the Caribbean countries include the following:

1) By IDB : Regional Disaster Risk Management for Sustainable Tourism in the Caribbean Project

2) By EU : Enhancing Disaster Preparedness in the Caribbean Project

3) By CIDA : Caribbean Hazard Mitigation Capacity Building Programme, Caribbean Disaster Risk Management Program

4) By DFID : Draft Regional Assistance Plan for the Caribbean, Enhanced CDM Strategy and Programming Framework

2.13.2 Caribbean Institute for Meteorology and Hydrology (CIMH)

(1) Organization

The Caribbean Institute for Meteorology and Hydrology (CIMH) is founded in Barbados through the joint investment of the 16 member nations and area of the Caribbean Meteorological Organization (CMO) with headquarters in Port of Spain, Trinidad and Tobago.

16 Member Nations and Area

- Anguilla
- Antigua and Barbuda
- Barbados
- Belize
- British Virgin Islands
- Cayman Islands
- Dominica
- Grenada
- Guyana
- Jamaica
- the British Montserrat
- Saint Christopher and Nevis
- Saint Lucia
- Saint Vincent and the Grenadines
- Trinidad and Tobago
- Turks and Caicos Islands

CIMH is the merged organization of the Caribbean Meteorological Institute (CMI) established in 1967 and the Caribbean Operational Hydrological Institute (COHI) established in 1982. A virtual merge was made in the middle of 1980s and it formally changed its name in September 1999.

Present organization of CIMH comprises four departments including Management, Meteorology, Hydrology, and Applied Meteorology and Climatology. Total number of staffs of CIMH is 45, 20 of whom are technical staffs including four experts holding PhD degree. Required annual budget is about US$3.5 million; however, actual budget provided is only 70% of the requirement.

(2) Present Situation

The main tasks of CIMH are as follows:

i) Research and Meteorological Center of CMO;

ii) Calibration and maintenance center of the instrument in the Caribbean area; and

iii) Training for the meteorology majors in theoretical and applied science undergraduates in collaboration with the Cave Hill Campus, the University of West Indies.

According to the principal of CIMH, the ongoing activities and programs are as follows:

To and from the member countries; Real-time collection through satellite communication of observed data by the automatic observatory in the corresponding countries, which are set up with CMO fund; Provision of summary data on CIMH home page of the stored data in the database system; Only meteorological data is open to the public.

Exchange of information and data between countries through WMO.

Setting-up plan of Global Forecast System (GFS) dataset by means of the numerical forecast model.

Launching and research of new numeric model/database; Establishment of Tsunami Information Center according to the concern of member countries; Planning to undertake research of high tidal waves.

Execution of various training and enlightenment programs which will benefit the staffs of the meteorological services in the member countries.

(3) Supports by Other Donors

There is a research project on drought forecasting supported by the Caribbean Agro-meteorological Initiative (CAMI), USAID, and Canadian government.

2.13.3 Seismic Research Center

(1) Organization

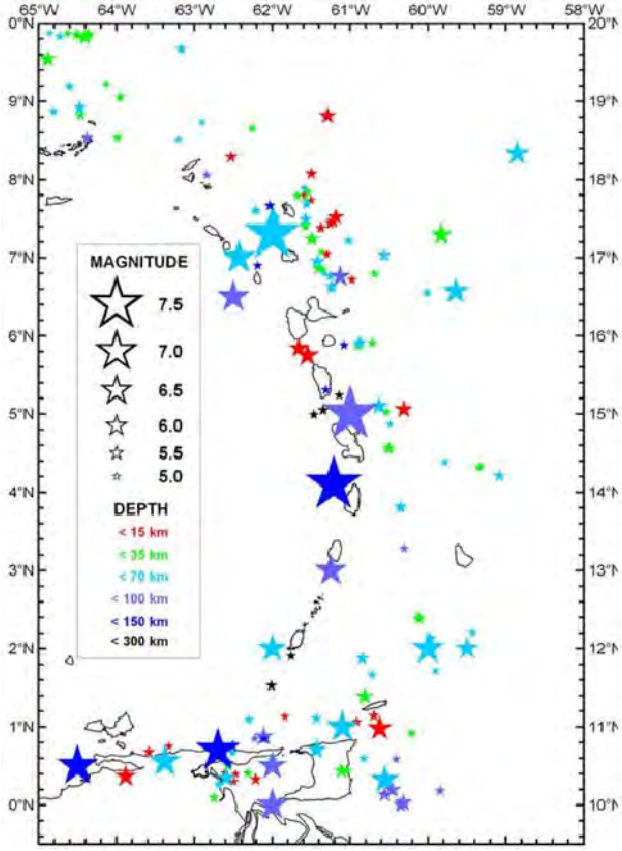
The Seismic Research Centre (SRC) of the University of the West Indies was established in 1952. The SRC monitors and studies earthquakes and volcanoes in the English-speaking islands of the Eastern Caribbean. Currently, the SRC has 24 staffs. There are resident researchers of SRC in Montserrat only. The SRC has geothermal experts but no tsunami expert.

(2) Current Situation

The Eastern Caribbean islands are located at an active plate boundary between the South American Plate and the Caribbean Plate. The area near the boundary has intense seismic activity, including frequent earthquakes as shown in Figure 2.13.1 and volcanic eruptions.

The SRC maintains a volcanic surveillance and warning system in its contributing territories; conducts researches on the distribution and frequency of earthquakes in the Eastern Caribbean; and provides advice on earthquake and volcano-related issues to the governments of the nine contributing countries listed in Table 2.13.3.

The system to monitor earthquakes and volcanoes, which is called TRN Network, comprises about 60 seismic stations as of April 2015 as shown in Figure 2.13.2. Of the 60 seismic stations, 13 stations are strong motion stations according to information from SRC.



Source: Seismic Research Centre, UWI (http://www.uwiseismic.com/Downloads/EqEC_map2

Figure 2.13.1 Recorded Earthquakes Greater than M5.0 that Occurred in Eastern Caribbean (1900-2005)

Table 2.13.3 Contributing Countries to the Seismic Research Centre

Countries	Monitoring Targets
Trinidad and Tobago	Earthquake monitoring
Barbados	Earthquake monitoring
Grenada	Earthquake monitoring, Volcanic monitoring
Saint Vincent and the Grenadines	Earthquake monitoring, Volcanic monitoring
Saint Lucia	Earthquake monitoring, Volcanic monitoring
Dominica	Earthquake monitoring, Volcanic monitoring
Saint Kitts and Nevis	Earthquake monitoring, Volcanic monitoring
Antigua and Barbuda	Earthquake monitoring
Montserrat	Earthquake monitoring, Volcanic monitoring

Source: Seismic Research Centre, UWI

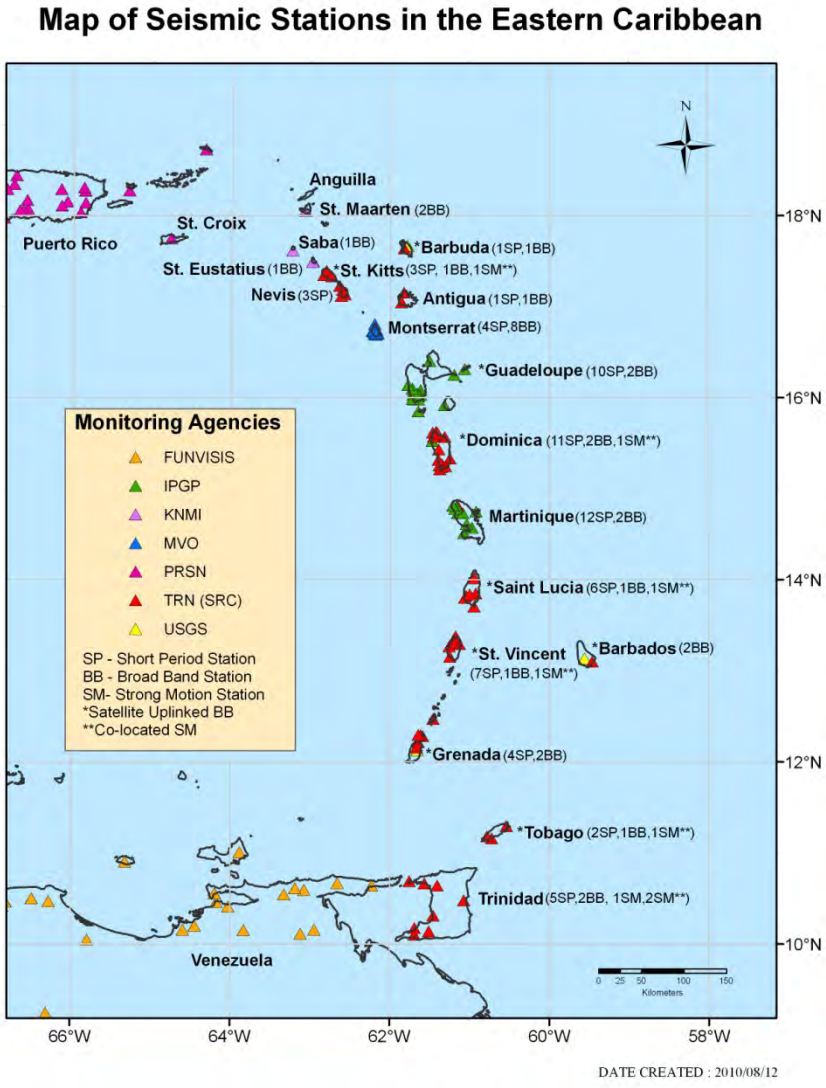
Data observed around the clock at the seismometer are transmitted in real time or near real time to the headquarters of SRC in Trinidad and Tobago through the base computer at each node using the improved satellite connection introduced by the assistance of USAID in place of the dial-up internet or telephone.

When an earthquake occurs, the SRC immediately issues information to persons concerned by automatic text e-mail. In addition, the SRC issues earthquake information to the public through the

media such as TV, radio, Twitter or Facebook. The SRC issues the information to the government agencies for disaster management at each country by telephone if required.

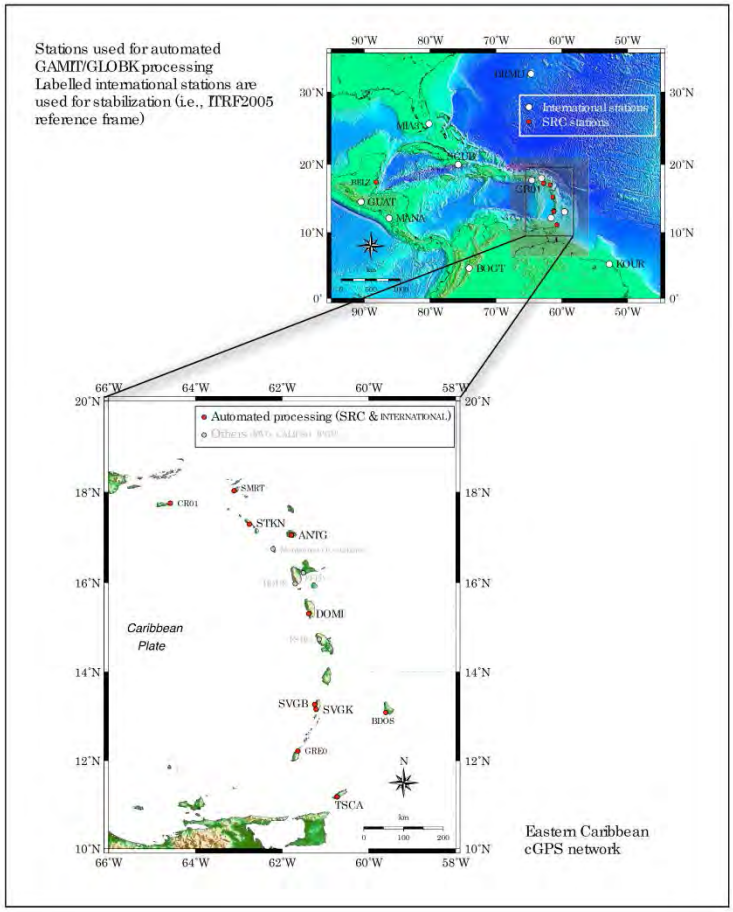
In September 2006, the SRC embarked on a project to significantly upgrade its seismic monitoring network as part of this regional effort to establish a Caribbean tsunami early warning system. This project was made possible through the generous support of the American people via the USAID Office of Foreign Disaster Assistance (USAID/OFDA) grant of US$249,680. The project also received financial support from the Government of Trinidad and Tobago. Tsunami information should be issued to each country in accordance with the tsunami protocol.

Furthermore, the SRC has a network of GPS monitoring in all the volcanic islands as shown Figure 2.13.3.



Source: Seismic Research Centre, UWI (http://www.uwiseismic.com/General.aspx?id=3)

Figure 2.13.2 Network of Earthquake Monitoring in Eastern Caribbean



Source: Seismic Research Centre, UWI (http://www.uwiseismic.com/Downloads/cGPSnetProc_SRC.pdf)

Figure 2.13.3 GPS Network of Seismic Research Centre

(3) Projects with Other Donors

Table 2.13.4 shows the profiles of donor projects by the SRC.

Table 2.13.4 Project Profiles of SRC Projects with Donors

Name of Project	Implementing Agency	Funding Agency	Description	Project Term and Value
Caribbean Tsunami Early Warning System - Communications and Protocols	Seismic Research Centre	USAID/OFDA and the Government of Trinidad and Tobago	This project aims to strengthen the capacity of the Seismic Research Unit to detect, monitor, and warn people at risk from tsunami and other related geologic hazards. It provides for the purchasing of equipment and the development of software to enable automated solutions of earthquakes and for the more rapid transmission of information regarding these events to vulnerable communities in the Eastern Caribbean.	18 months from August 2006 US$444,796 (USAID US$249,680) (GOTT US$140,200)
Empowering Coastal Communities to	Seismic Research Centre,	USAID/OFDA	The SRC is collaborating with CDEMA and its participating states to empower coastal	2 years from July 2007

Name of Project	Implementing Agency	Funding Agency	Description	Project Term and Value
Prepare for and Respond to Tsunamis and Other Coastal Hazards	CDEMA		communities to prepare for and respond to tsunamis and coastal hazards (in support of the Tsunami and Coastal Hazards Warning System – TCHWS). Funding is being provided for the development of community-based education materials and information which aim to heighten the awareness of vulnerable populations – particularly those located on or near the coast. The project also involves the development of warning dissemination protocols and the procedures for their transmission to the vulnerable communities.	US$475,200 (to CDEMA)
ICT Applications in Disaster Management	Seismic Research Centre, CDEMA	International Development Research Centre of Canada	The SRC is collaborating with the Caribbean Disaster Response Agency (CDERA) and the National Disaster Organizations in the Caribbean to test and analyze the role of ICTs to strengthen community knowledge and support in the collection of post event information for earthquakes in the Eastern Caribbean.	2 years US$354,766 (to CDERA)
Volcanic Hazard Atlas of the Lesser Antilles - Multimedia Version	Seismic Research Centre	CDB, USAID	Published by the SRC in May 2005, the Volcanic Hazard Atlas of the Lesser Antilles (VHA) is a comprehensive reference work summarizing the current state of knowledge of each 'live' volcano in the volcanic islands of the Lesser Antilles.	US$15,000
Disaster Risk Reduction Centre (DRRC) - Risk Atlas Project	Seismic Research Centre, St. Augustine, Trinidad	UWI Disaster Risk Reduction Centre, Mona, Jamaica	The primary objective of the project is to develop a methodology for seismic risk assessment in the Caribbean for three pilot states, namely: Jamaica, Grenada, and Barbados. It aims to provide guidelines and open-source software for the estimation of earthquake loss using available socioeconomic data.	Unspecified

Source: JICA Study Team prepared based on information from the home page of the Seismic Research Centre

CHAPTER 3 ISSUES ON DISASTER MANAGEMENT OF SURVEY COUNTRIES

3.1 Antigua and Barbuda

3.1.1 Issues on Disaster Prevention Administration

The National Office of Disaster Services (NODS) is the coordination body for the disaster situation in Antigua and Barbuda and has the responsibility to prepare a guideline for the disaster management administration and conduct of disaster education.

NODS made issue identification as a disaster management body through the SWOT analysis in the "National Disaster Management Plan - Basic Plan, Reviewed". As a result of the analysis, the issues are identified as: 1) Governance; 2) Insufficient capability of the staff; 3) Budget insufficiency; 4) Vulnerability for hazard; 5) Climate change; 6) Impact on the economy; 7) Collaboration with other domestic sectors, and; 8) Impact on society.

The aforementioned issues recognized by NODS are specified hereunder.

(1) Governance

The Disaster Management Act, which was enacted in 2002, is necessary to be reviewed for improvement since it does not incorporate the concept of Comprehensive Disaster Management and seems to be out of date.

The National Disaster Executive (NDE) is established to execute all disaster countermeasures prescribed by the National Disaster Coordination (NDC), in which the chairperson is the Prime Minister and is composed of 25 members coming from multiple sectors. However, the NDC and NDE concern is mostly with the disasters caused by hurricane, and meeting is seldom held regarding other disasters.

(2) Staff

It is recognized by NODS that capacity improvement of its staffs is necessary on disaster mitigation plan, monitoring, assessment and evaluation, and project and program management. However, it is rather difficult to execute these due to budget constraint.

(3) Budget

Since much expense for risk management and initial actions for the frequent disasters is required, the NODS budget allocated by the government is not enough.

(4) Vulnerability to Hazard

From the viewpoints of engineering response, measure aspects, hydrologic aspects, and geological aspects, Antigua and Barbuda is a vulnerable country to natural hazards, and is one of the mostly affected countries by hurricane. Among the East Caribbean countries, Antigua and Barbuda suffers a loss amounting to more than EC$1.5 billion since 1989 from the nine times of disasters caused by severe tropical climate. In the last 22 years, this country has experienced strong wind due to hurricane, storm surge, drought, earthquake, flood, and landslide. The loss in infrastructure from the earthquake in 1974 is estimated to be approximately US$25 million to US$30 million.

(5) Climate Change

The threat in Antigua and Barbuda due to climate change is a serious issue against sustainable development that the Prime Minister raised in the United Nations (UN) General Assembly in 2013.

(6) Impact on Economy

Antigua and Barbuda has been improving from the situation affected by the worldwide economic recession in addition to the bankrupts of foreign investment companies, as well as the United Kingdom (UK) insurance company and the insurer of the United States (US)/Trinidad and Tobago. However, the government debt is still a very big burden against the gross domestic product (GDP). Drastic cut in the government's expense caused the negative impact of weak domestic economy. Government's income including tourism income is decreasing and direct investment from foreign investors is the mainstream of the present economic condition. The government faces a crossroad to make judgment whether it

shall provide financial assistance to the disaster preparedness program or other similarly important sector(s).

(7) Coordination with Domestic Sectors

The government ministries and agencies have not been cooperative to each other since before therefore this caused unproductivity. As for the private sectors, they are interested in increasing their profits and market share but not on participating with the program activity, which affects directly their business profits.

(8) Impact on Society

Antigua and Barbuda has experienced local flooding in the flood plain but has not been affected by severe hurricane and other disasters for the recent ten years. Therefore, people failed to prepare for the disasters.

The following subjects are to be considered as administrative issues:

1) Improvement of NODS Staffs Insufficiency

Based on the hearing from NODS, the present number of staffs is 12 including seven technical staffs although there are 14 positions. Out of these positions and staffs, one staff concurrently holds two positions such as the secretary and administrator, and another one as the geographic information system (GIS) specialist and database manager.

Such situation shall be resolved by hiring additional staffs. For staffs who are handling two positions such as the secretary and administrator case, these positions are not technical positions, thus it is supposed to be due to budgetary constraint. While, in the case of the GIS specialist and database manager, since they are technical positions, it is probable that the reasons are limited budget and insufficient human resources.

2) Capacity Improvement

As recognized by NODS, such requirement is not individually satisfied due to budget constraint and that capacity improvement of staffs is necessary on disaster mitigation plan, monitoring, assessment and evaluation, and project and program management. NODS staffs participated in the training held by donors to improve their capacity. Director Mullin also participated in the Japan International Cooperation Agency (JICA) seminar on disaster management. However, it was observed that those staffs who participated in the training improved their capacity but did not share or help the other staff to obtained capacity improvement yet.

3) Improvement of Budget Insufficiency

The Government of Antigua and Barbuda is forced to adopt austerity measures because of large government debt. Comparison of the gross national income (GNI) shows that the GNI in 2013 is less than that in 2012, and 95% of GNI in 2009 for a five-year span. This trend is estimated to be unchanged also from now on.

Furthermore, it is a reason for budget reduction that the government is reviewing the budget allocation for the disaster management field taking into account of no serious disaster in the last ten years.

4) Governance

The Disaster Management Act, which was enacted in 2002, is necessary to be reviewed for improvement since it does not incorporate the concept of Comprehensive Disaster Management (CDM) and seems to be out of date. Under such situation, the Disaster Risk Management Policy was prepared in 2014 as draft and the National Disaster Management Plan was reviewed in 2014 as well. Such preparation and review are to be made consistent with the Regional CDM Strategy prepared by the Caribbean Disaster Management Agency (CDEMA).

The Disaster Management Act shall be reviewed and updated from now on in conformity with the aforementioned “Policy” and “Plan”. Furthermore, it is anticipated that recently the government is not concern about the scarce disasters experienced in the country such as earthquake, tsunami, and so on, and that the government’s measures and response against disasters are being neglected.

5) Strengthening of Cooperation System of NODS with Domestic Organizations

It is required to examine how NODS will improve its effort of coordination with other agencies with the reorganization wherein the cooperation between other ministries and agencies is weak according to country's nature.

3.1.2 Issues on Structural Measures

(1) River

1) River Administrator

Countermeasure for the flood is conceivable as structural measures in the river works as well as for the sediment such as debris flow. In Antigua and Barbuda, the operation and maintenance (O&M) service has not been carried out since the river administrator is not clearly determined. As the government agencies concerning the river, the Ministry of Health and the Environment, Ministry of Agriculture, Lands, Fisheries and Barbuda Affairs, and Ministry of Works and Housing are specified.

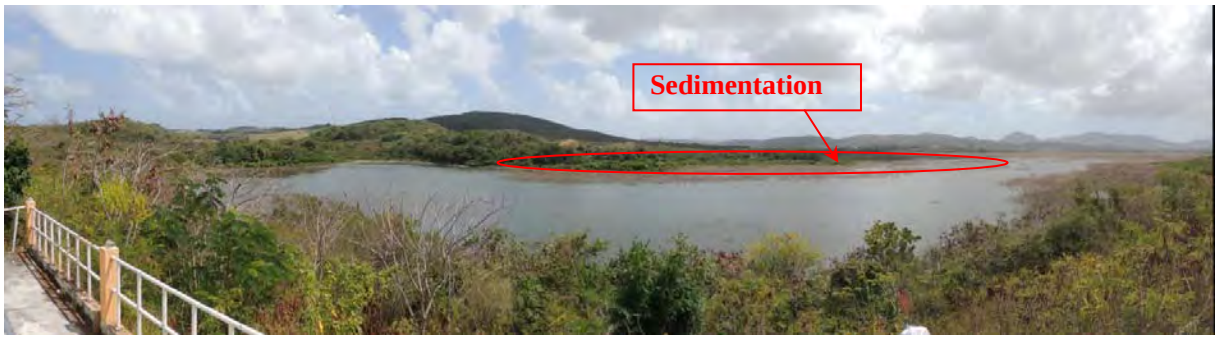
The river management system is not a definite function in the current government organization since government agencies are restructured every time there is a new prime minister appointed, therefore, the previous department and sections concerning the river management were moved to another ministry. In addition, such intention is conceivable as the budget for the O&M works will be decreased considering the ministry's limited budget.

2) Levee

All the rivers in Antigua and Barbuda are still natural rivers without any levee. No measure is taken against flood in the rivers with levee and so on.

3) Dam

There are several dams constructed in Antigua and Barbuda but not for flood control. The largest dam in the country is the Potwork Dam in Antigua Island. With 47 years had passed after its construction, the sedimentation problem becomes evident. The reservoir capacity is 4.5 million m^3 and dam operator is the Antigua Public Utility Authority (APUA). This serious sedimentation is supposed to be the reason for the shallow reservoir since about 50 years has already passed since its construction. Present situation of the Potworks Dam Reservoir is shown in Figure 3.1.1.



Source: JICA Survey Team

Figure 3.1.1 Potwork Dam Reservoir

(2) Coast

The coastal erosion damages were caused by Hurricane Luis in 1995 along the coasts between Boons Bay and near Fort Bay in the north-west of Antigua Island, and between Deep Bay in the west and Carlisle Bay in the south of the island.

The restoration of such damages have been completed by the Ministry of Works and Housing, while no proactive measures for the coastal erosion has not been taken yet. Only countermeasures are taken after the disaster since an appropriate proactive structural measure cannot be found yet because of no coastal zone management plan at present.

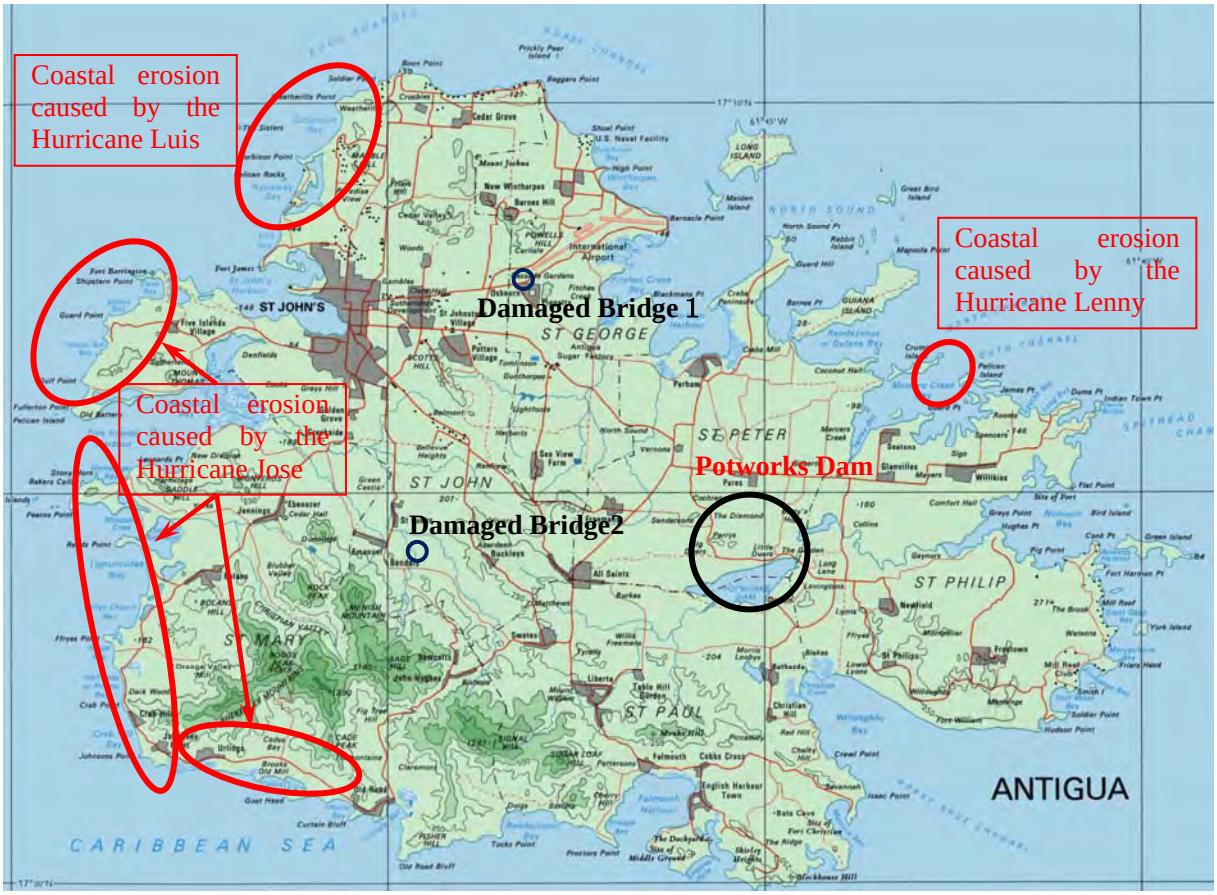
(3) Road

Main roads are extended to 710 km in total in Antigua Island and the secondary roads to about 200 km. In Barbuda Island, a total of 11 km paved road is available. The O&M works of the main roads are

conducted by the Ministry of Works and Housing normally, but no regular inspection is being carried out.

In case sediment disaster has occurred on the road, the Ministry of Works and Housing takes an action of the construction of concrete structures such as leaning wall. For the design of such structures, neither the design standard nor design guideline are prepared yet. The quality of the design depends on the engineer's experience and capability.

A slope failure occurred on the slope along the road around the Monks Hill in the south-west part of the island when it rained heavily during the hurricane in 1999. The slope was about 70 m high and traces of small scale collapse are seen at the middle and top of the slope. There are no works done yet but extension of slope failure is not found. However, since the most roads run on flat terrain in Antigua and Barbuda, sediment disaster scarcely occurs along the road. Recent disaster affected area in the Antigua Island is shown in Figure 3.1.2.



Source : Map got from http://www.remote.org/frederik/culture/antigua/img/large/mapcol-huge.gif の URL and arranged by the JICA Survey Team

Figure3.1.2 Disaster Area in the Antigua Island

(4) Bridge

Field inspection for the bridges was conducted based on the information of the Ministry of Works and Housing. It was observed that one bridge was washed away and another was damaged in abutment.

The road, where the bridge was washed out, is not currently being used, therefore motorists need to take a roundabout route, which is paralleled toward the airport.

Another Banderz Bridge is located on the road, utilized as a detour to the main road, and to control the entry of heavy vehicles, a road sign is erected, as shown in Figure 3.1.3. According to the observation of the JICA Survey Team, frequent traffic was found during inspection, even though specific traffic volume was unknown, including trucks.

Considering the condition mentioned above, the Banderz Bridge, which is in use requires to be rehabilitated or reinforced.

Source: JICA Survey Team

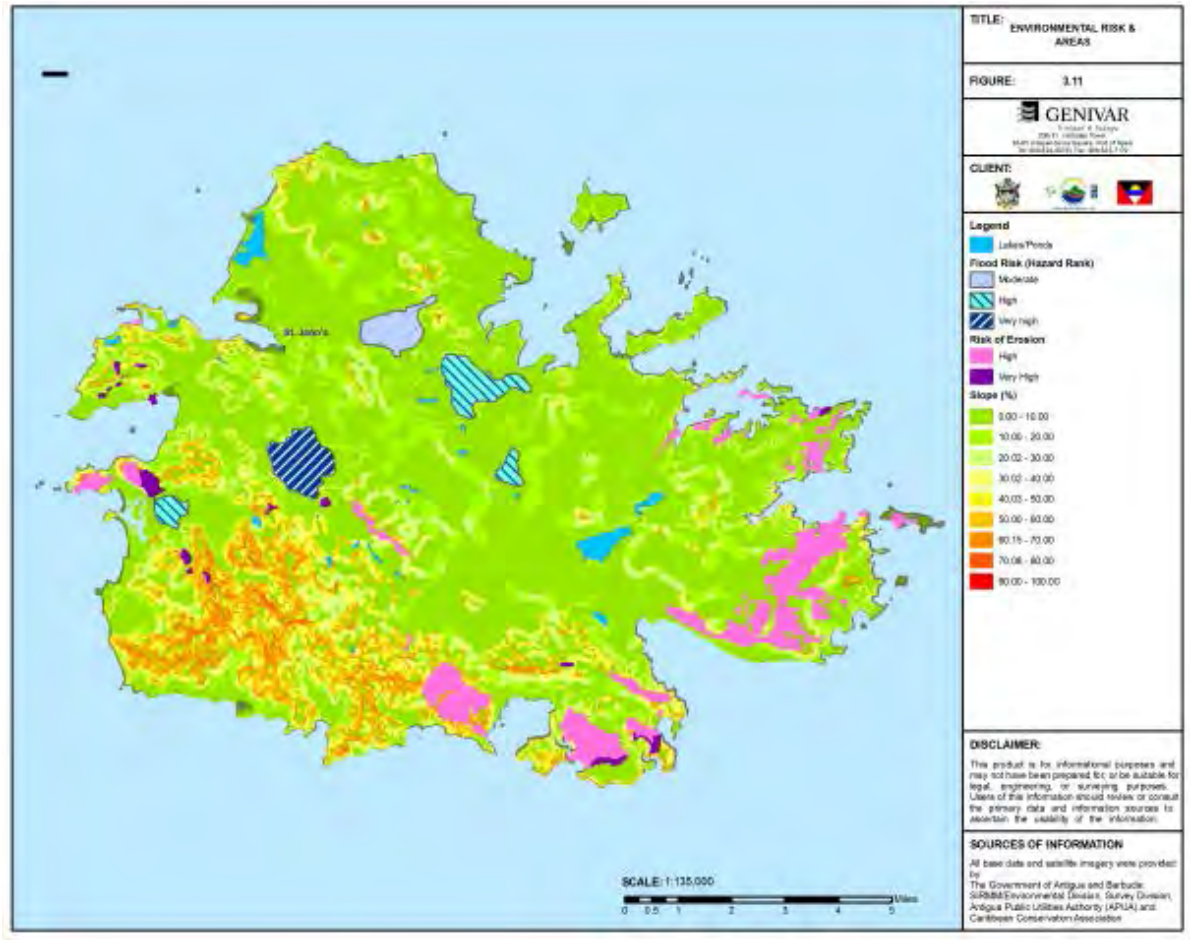
Figure 3.1.3 Road Sign at the Banderz Bridge

3.1.3 Issues on Non-structural Measures

(1) Hazard Map

The risk maps in the whole Antigua Island are available for flood and soil erosion. However, hazard map has not been prepared yet for the sediment disaster as well as the risk map for earthquake as shown in Figure 3.1.4.

It is considered necessary to prepare the hazard map for earthquake in the course of the capital disaster mitigation plan formulation due to the earthquakes occurred in 2004, 2007, and 2014. NODS recognizes the necessity of disaster response and measures for disasters other than hurricane and flood.



Source：Sustainable Island Resource Management Zoning Plan for Antigua and Barbuda, 2011, GENIVAR

Figure 3.1.4 Disaster Risk Map in the Antigua Island

(2) Community Disaster Prevention

The national disaster mitigation strategy is being considered in consistent with the comprehensive regional disaster mitigation strategy proposed by CDEMA, in which CDEMA emphasized the importance of community-based disaster management as well as training for the community.

In the NODS policy documents, it is proposed that:

Systematic supports in the central and regional levels for the comprehensive disaster mitigation management program;

Establishment and execution of the program for the comprehensive disaster mitigation management and accumulation;

Mainstreaming of the disaster risk management on the national level and mainstreaming of the disaster management in the key sectors of the national economy; and

Strengthening of the community resilience to respond and mitigate impacts due to climate change and disasters.

Among those mentioned above, it is required to make efforts on capacity building and increasing the number of NODS staffs as well as linkage between organizations related to disaster mitigation. In addition, the activities are necessary to raise community resilience for disasters. So as to raise resiliency, although structural measure is one of the ways, and the effort to conduct capacity building of the community by itself through community disaster prevention is also an effective way.

It is said that the Red Cross carries out the community disaster mitigation education instead of NODS due to its limited budget. However, non-government organization (NGO) has also limited budget to undertake enough education on disaster mitigation for the community.

As far as evaluating the present and future disaster management policy, the community disaster prevention is necessary to raise minimum capacity of the community disaster management.

(3) Building

1) Earthquake Resistant Design Standard

In Antigua and Barbuda, any preferable standards are applied for the civil works depending on the designers, mainly such as the American Association of State and Highway Transportation Officials (AASHTO) standards and/or British Standards (BS).

The Caribbean Uniform Building Codes is used as the building code in the country. The Development Control Agency (DCA), which controls the building code, hopes to prepare its own building code in the future but it is not realized yet due to budget constraint.

No earthquake resistance standard is prepared yet and there is no building with anti seismic reinforcement and no base isolation structure.

Considering that there are nests of earthquake in the Puerto Rico and Hisupanora Trenches and that the severe earthquake caused serious damages in Haiti, the design standard concerning earthquake shall be prepared by individual country or for the Caribbean area.

2) Improvement of Design Standard for Strong Winds

Most of the strong winds have been caused by hurricanes, such main damages are when a roof of a residential house is blown away by strong winds and when banana trees are completely broken.

As a building design code, the Caribbean Uniform Building Code is applicable for ordinary residential houses; however, any preferable code is used by the designer for a tall building.

In a residential house case, roof damage is caused by weak connection to the build portion, thus, reinforcement of the connection shall be incorporated in the revision of the present building code. As for a tall building case, wind loads and direction shall be definitely stipulated in the building code.

Considering the Caribbean countries as hurricane prone area, the design standard concerning wind load shall be defined by individual country or for the Caribbean area.

(4) Watershed Management

A lowland area in watershed has a function of a retarding basin but is a vulnerable area for floods. Such area has scarcely suffered inundation from the hurricane disasters for a long time. Then, the area has been developed as residential area and farmland. However, such developed area frequently

suffered big damages from inundation due to several hurricanes since the Hurricane Hugo attacked in 1989.

Antigua and Barbuda is prone to drought, thus, low water development is one of the countermeasure for drought.

In the upstream reaches of watershed, cultivation of the lemon grass is increasing instead of the sugar cane that was cultivated in the upper area by the early 2000s, but declined due to price reduction. The cultivation of lemon grass applies slash-and-burn farming that cause the increasing of sediment runoff and high peak flood runoff.

The conceivable factors to cause complicated problems are: 1) low-land development; 2) drought prone region, and; 3) change of agriculture form due to cropping change.

The Ministry of Health and the Environment is planning to take various actions based on the integrated water resources management plan to be formulated. In engineering and political views, the integrated watershed management is to be undertaken.

(5) Earthquake Disaster Prevention Plan for Capital City

In the area around Antigua and Barbuda, earthquakes with M7.5 scale and M6.0 scale occurred in 1974 and 2014, respectively. However, no earthquake disaster mitigation plan is formulated for the capital of Saint John's. Although NODS recognizes the necessity of an earthquake disaster mitigation plan, it is not realized yet because there is no know-how to prepare an earthquake disaster mitigation plan, and that no budget is available for such actions.

Antigua and Barbuda is rather a prone area for earthquake and many buildings and houses are built close together in the central area of Saint John's. Furthermore, there are some gas (fuel) storage tanks near the residential area. Hence, the earthquake disaster mitigation plan shall be decided and familiarized by the residents based on the earthquake risk assessment to know the vulnerability of the area, buildings, and public facilities for the earthquake damages.

(6) Evacuation Plan for Tsunami

In Figure 2.1.11 shows the frequency of tsunami occurrence in the Caribbean countries as well as wave height records. According to the figure, high waves due to tsunami were recorded around Antigua and Barbuda. While, the beach and hotels nearby on the coastal flat area are likely to be affected by tsunami.

The country's present economic condition is not good. However, beaches and hotels are important to be protected in viewpoint of national economy because tourism is the major industry of this country.

It is very important to secure the evacuation system, evacuation routes, and evacuation centers, and to share this information with concerned hotels. It is also important to establish a system to help visitors to evacuate without difficulties and damages.

3.1.4 Issues Related to Meteorological and Hydrologic Observations

(1) Insufficient Number of Staff and Budget for Meteorological Service

The present meteorological services presently fill only 35 staffs out of the 58 quota positions, which shows only 60% sufficiency. In particular, lack of forecaster is remarkable that the present number of Forecasters I and II are one and two, respectively, as against that targeting numbers of Forecasters I and II are four (4) and three (3), respectively. The reason of insufficient number of staffs is considered a budgetary constraint.

Antigua and Barbuda, as a focal point of the Leeward Islands, provides meteorological information and forecast for the countries and islands in the area. Hence, high technical level of training is required so as to solve the current problem of insufficient number of forecasters.

The required annual budget is said to be EC$3 billion, while the actual approved amount is about 70% of the requirement. The actual required personnel cost corresponds to about 50% of the said required budget. To solve this staffing shortfall, it is to be considered not only the necessity of staff training but also the constraints of available budget.

(2) Poor Operation and Maintenance Services of the Existing Observation and Communication Equipment

There are 14 existing meteorological observation stations in Antigua and Barbuda, all of these stations are automatic. From these, 13 stations are rather evenly situated in Antigua Island except the parts of eastern and north-east corner.

Among the said 14 stations, two observatories have not been operational due to equipment and battery problems. Several stations do not send the observed data automatically due to the malfunctioning communication equipment although observation equipment is working. Furthermore, automatic rainfall stations do not send data to the Caribbean Institute of Meteorology and Hydrology (CIMH) in Barbados although it has an automatic sending function through satellite communication.

The automatic observation stations have been installed through the funds of the donors such as the European countries and the Organization of Eastern Caribbean States (OECS) except one station that was installed through the national budget. Those stations have not been fulfilled the functions due to lack of O&M works of the equipment.

Such present condition seems to be caused by the situation that the O&M capability of data transmission function and/or communication system is inadequate due to insufficient capability of the electric and communication technical staff as well as lack of staff concerned.

3.1.5 Related Issues on Disaster Prevention in Antigua and Barbuda

Based on assessment and evaluation of the aforementioned issues, several issues in Antigua and Barbuda are identified as listed in Table 3.1.1.

Table 3.1.1 Issues Related to Disaster Management in Antigua and Barbuda

Field	No.	Issue
General for Disaster Management	AB-1	Improvement of insufficiency of NODS staff
	AB-2	Capacity improvement of NCCR staff (Community-based disaster mitigation)
	AB-3	Improvement of budget insufficiency of NODS
	AB-4	Governance
	AB-5	Strengthening of cooperating system of NODS with domestic organizations
	AB-6	Strengthening of community disaster mitigation
Flood	AB-7	Elimination of submergence of the low lying flat plain
	AB-8	Mandate of the administrator of Rive
	AB-9	Rehabilitation of damages on the bridge
Storm Surge	AB-10	Planned response to coastal erosion
Earthquake	AB-11	Development of hazard map for earthquake
	AB-12	Development of disaster management plan for earthquake for the capital
Tsunami	AB-13	Formulation of disaster management plan for tsunami
Earthquake/Strong Wind	AB-14	Development of design standard methods against seismic load and wind load
Drought	AB-15	Solution of sedimentation in the reservoir of Potwork Dam
Meteorological Observation	AB-16	Increase of forecasters and staffs for maintenance of equipment
	AB-17	Improvement of insufficient capabilities of meteorological observer
	AB-18	Improvement of insufficiency of budget allocated to meteorological observation
	AB-19	Prompt fixing of damaged equipment to observe meteoro-hydrology
	AB-20	Improvement of insufficient capability in maintenance of meteoro-hydrologic observation System

Source: JICA Survey Team

3.2 Guyana

3.2.1 Issues on Disaster Prevention Administration

The tasks of CDC are as follows:

To prepare state-level disaster mitigation plan and launch for regional operation in cooperation with the local governments;

To reduce and mitigate damages due to disasters;

To develop and promote services by volunteers in the disaster management; and

To conduct training and education concerning disaster management.

In order to overcome a situation that there are various tasks and limited number of staffs, it is necessary to rely on the individual capability of each staff so far although sufficient capacity strengthening has been not fulfilled yet. Particularly, the CDC staffs recognize their weak capability such as i) Formulation of disaster management plan and monitoring method, ii) Knowledge on GIS, and iii) Method to prepare a hazard map.

Currently, the community-based disaster management plan with community participation is under preparation supported by EU. For a preparation of the final disaster management plan by the community residents as well as execution of training based on the plan, CDC supports that activities in the manner of providing training cost, human resources and materials. However, the insufficient CDC budget is difficult to meet such expenses.

Present issues of CDC as the disaster management organization are i) Capacity improvement of CDC staff and ii) Improvement of budget insufficiency.

3.2.2 Issues on Structural Measures

(1) Local Drainage

The coastal lowland, where big cities are located, is a vulnerable area to flood and storm surges. Big population is concentrated in such area and there is inadequate drainage capacity therein. For the drainage system in the coastal low-lying area, pumping-up is necessary but entails high cost of initial investment for the system and in O&M. Furthermore, the existing drainage system is becoming deteriorated.

It is planned to develop and improve the drainage system in Georgetown based on the formulated disaster management project plan.

Table 3.2.1 Local Drainage Project In Georgetown

Disaster Management Project	Project Cost（US$）
Improvement of the East Demerara Conservancy	45,000,000
Strengthening of Levee of the East Demerara Conservancy	54,002,500
Improvement of Drainage in the East Coastal Area	20,048,000
Improvement of Drainage in the East Coastal Area (Urban Drainage excluding Agricultural Waste Water Drainage)	4,735,000
Stability Upgrading of the Existing Hydraulic Structure	730,000

Source：Disaster Risk Management Projects for Guyana, NDIA (February 2015)

Currently, in accordance with the said project plan, the construction of pumping station and so forth have started under the assistance of a donor agency. The construction of pumping station at 50 locations is proposed under the development plan. The World Bank (WB) has decided to support this project with a finance equivalent to US$11.9 million, of which US$2.0 million will be allocated for the project to strengthen the existing dykes in the East Demerara Conservancy.

Regarding the improvement of pumping systems, three units of drainage pumps will be introduced with the WB loan. The Indian government finances the development of 14 pumping stations, of which ten stations have been completed. In connection with this project, the request for the Japanese government for financial assistance was submitted to the JICA Expert to rehabilitate and improve the drainage system(s) located in the east coastal area.

Table3.2.2 Local Drainage Project In Georgetown (Proposed Project Expecting Japanese Support)

Disaster Management Project	Project Cost（US$）
Improvement of Drainage in the East Coastal Area	
- Improvement of Liliendaal Pump Station	1,130,000
- Improvement of Ogle Pump Station and Levee Heightening	2,349,000
- Improvement of Mon Repos/Annandale Pump Station	2,019,000
Construction of Enterprise/Strathspey/Paradise Pump Stations, Widening of Culvert and Canal	7,190,000

Source：Disaster Risk Management Projects for Guyana, NDIA (February 2015)

(2) Coast

The coastal roads in and around Georgetown suffer wave over-topping during the spring tide period. The existing coastal dykes were raised by 1.0 m to 1.5 m in 2014. This raising works were based on the highest storm surge. Another raising works must be required in case of a higher storm surge surpassed the highest high wave.

The lowland below mean sea level existed and pumping-up of the groundwater is undertaken therein. Considering such present situations, it is anticipated that the subsidence is highly probable to be progressed. High vulnerability of the area for flood and storm surge is supposed to be much higher in case that it leaves this situation without proper action and measures taken.

In addition, it is required to have guidance about the design of coastal dikes and structures although there is no professional staff on coastal engineering in the Ministry of Public Service (MPS).

(3) Road

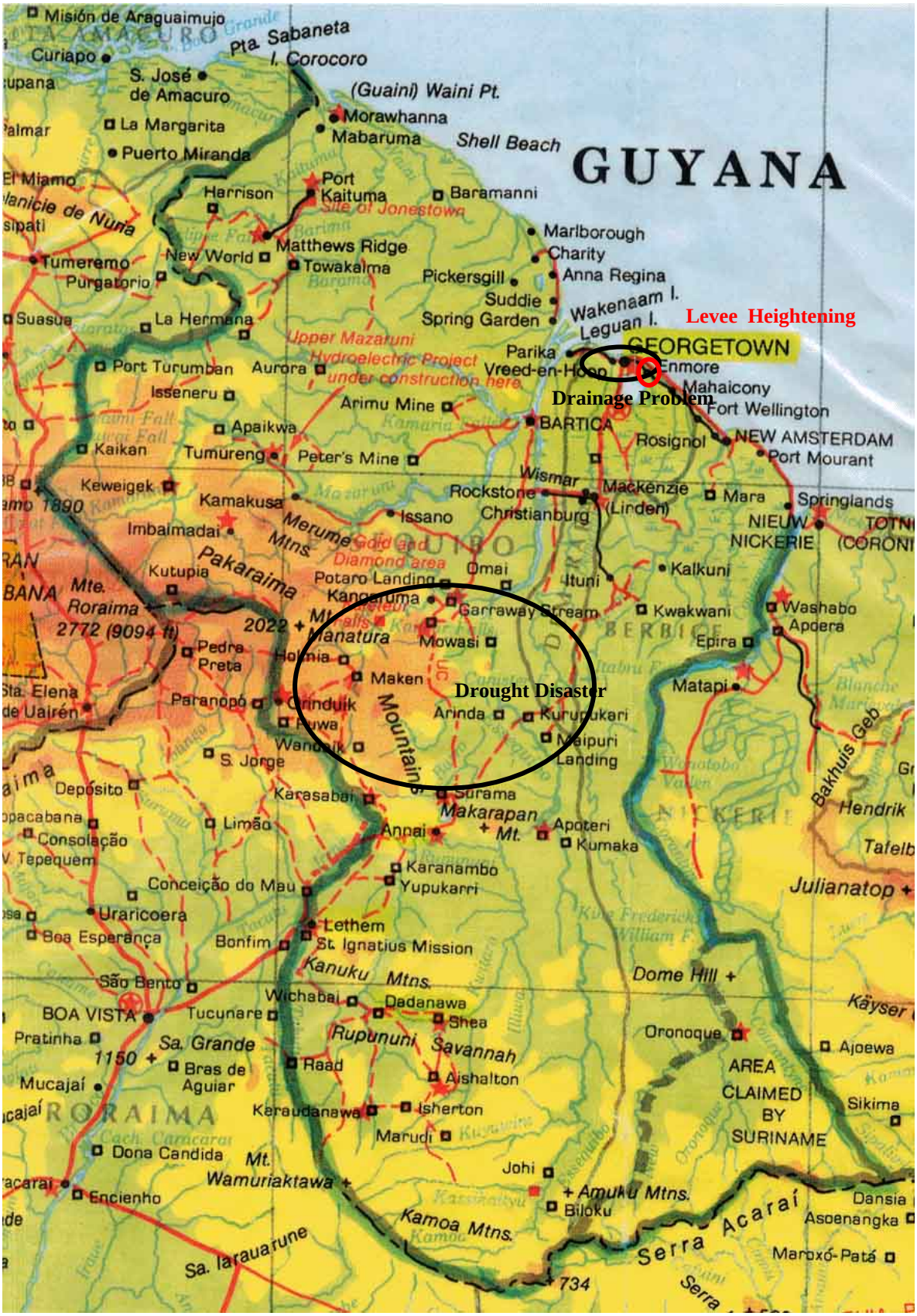
In Guyana, since most of sediment disasters occur in inland Regions 8, 9, and 10, it is not recognized as major problem by the government. However, the section between Linden and Lethem is a prone area for sediment disaster among the trunk roads that links Georgetown and the inland area. At present, there is a little traffic in the said section and low disaster risk thereat; however a measure may be required in the future since regional development plan is in progress.

(4) Bridge

The Demerara Harbour Bridge crossing the Demerara River flowing through Georgetown is the longest one in the world as a pontoon type. Thirty-five years had passed since its completion, traffic has been increasing recently (15,000 units in daily average), and therefore it might be a time to replace it with a new bridge considering its lifetime as well.

This bridge is a part of the important trunk road that links Georgetown and several cities in the western area. Replacement or rehabilitation of the bridge is highly necessary in view of that evacuation and transportation roads shall be secured in case of disaster.

Figure 3.2.1 shows locations of the disaster affected area in Guiana.



Source：Map got from http://www.mappery.com/map-of/Guyana-Topographic-Map and arranged by the JICA Survey Team

Figure3.2.1　Disaster Area in Guyana

3.2.3 Issues on Non-structural Measures

(1) Hazard Map

Guyana comprises ten administrative regions in total. Out of these, the flood hazard map is only available in Region 6 and Region 9, and the flood map in 2005 flood was prepared in Region 4, mostly in the eastern area. No flood hazard map is available in other regions. An earthquake hazard map over a wide area is available, but none for the sediment disaster hazard map and tsunami hazard map as well.

(2) Community Disaster Prevention

Concerning education of the community on disaster prevention, the Red Cross fulfills their roles and CDC works as well.

Specifically, CDC prepares an educational program and executes the training for the community on the basis that they assess, together with the residents, the vulnerability and adaptability of the community for disasters. However, the Red Cross did not implement the education on disaster mitigation as planned due to insufficient budget.

(3) Building

In Guyana, any measure for earthquake has not been taken for the building structure because there are no experiences on earthquake in the country although the Building Code was enacted in 2005. The Guyana National Bureau of Standards (GNBS) being launched in 1984 operates and maintains the existing standards under the supervision of the National Standards Council. In the Building Code, some description about earthquake is found but is not a specific design standard.

(4) Evacuation Plan for Tsunami

Potential risk of earthquake and tsunami is conceivable in case of eruption of the submarine volcano Kick'em Jenny located between Grenada and Saint Vincent. The officials concerned in disaster management including CDC personnel in charge recognize some potential risk of tsunami and earthquake, even though their concern about disaster mitigation to tsunami and earthquake are rather low compared with those of other island countries.

In the coastal area, the land is generally flat from the coast towards inland and has small difference between grand level and sea level. No evacuation plan in case of tsunami is prepared on the coastal cities although affected area seems to be extended over wide area once upon tsunami attacked.

(5) Drought in Inland Area

Drought situation is caused in the inland area such as Regions 8 and 9 during dry season and affects water supply for the crops and livestock, which cause serious damages in inland agriculture.

3.2.4 Issues Related to Meteorological and Hydrologic Observations

Meteorological and hydrologic services have been carried out by the Hydro-meteorological Department under the Ministry of Agriculture (HD-MA) since 1992. The total personnel number of HD-MA is 79 persons, of which the engineers are 65 persons.

The Doppler type meteorological radar system is equipped at the Cheedi Jegan International Airport (CJIA), which is managed and maintained by two electrical engineers, two telecommunication engineers, and one information management engineer.

(1) Insufficient Number of Staff and Budget Insufficiency for Operation and Maintenance Services

There are 27 automatic water level observation stations but four out of 27 are not working because of insufficiency of O&M budget and insufficient number of O&M staffs. The number of maintenance staffs is six including one staff for the software, hence the remaining five staffs is not enough to cover the O&M works for the whole country with not so improved traffic network.

(2) Insufficient Meteorological and Hydrologic Observatories in Inland Area

Out of the existing 202 rainfall stations and 41 water level stations, automatic stations exist in 16 rainfall and 27 water level stations. Among the 27 automatic water level stations, four stations are not working. In addition, meteorological and hydrologic stations are insufficiently distributed in the inland area, and need to be improved.

(3) O&M Difficulty in Accessibility to the Existing Observatories in Inland Area

Many of the stations encounter difficulty in maintenance due to difficult accessibility. Therefore, a remote observation and real time monitoring are desired to ease such situation.

(4) Deteriorated Database System

The present database system has deteriorated, which system was installed in the 1990s.

3.2.5 Related Issues on Disaster Prevention in Guyana

Based on the assessment and evaluation of the aforementioned issues, several issues in Guyana are identified as listed in Table 3.2.1.

Table 3.2.3 Issues Related to Disaster Management in Guyana

Field	No.	Issue
General for Disaster Management	GY-1	Capability improvement of CDC staff
	GY-2	Improvement of budget insufficiency allocated to CDC
Flood	GY-3	Mitigation of flood in the low lying Surrounding Areas of the Capital, Georgetown due to high tide and poor drainage
	GY-4	Superannuation of Demerara Harbour bridge
Storm Surge	GY-5	Mitigation of damage due to high tide and coastal erosion along coastal areas
	GY-6	Subsidence in the coastal areas
	GY-7	Cultivation of the coastal engineering experts
Earthquake	GY-8	Preparation of disaster mitigation plan against earthquake for the capital
Tsunami	GY-9	Development of hazard map for tsunami
	GY-10	Preparation of evacuation plan against tsunami
Earthquake/Strong Wind	GY-11	Development of standard design methods against seismic load and wind load
Drought	GY-12	Mitigation of damage due to water shortage in inland in the southwestern area
Meteorological Observation	GY-13	Improvement of insufficiency of maintenance staff
	GY-14	Improvement of insufficiency of budget for maintenance
	GY-15	Improvement of meteoro-hydrologic data collection in the inland areas

Source: JICA Survey Team

3.3 Grenada

3.3.1 Issues on Disaster Prevention Administration

In the "Grenada National Disaster Management Organization in a State of Emergency", which is a material prepared by the National Disaster Management Agency (NaDMA), describes the tasks of main related organizations to disaster management, and recommendations of future necessary improvements as to: i) NaDMA's budget; ii) Legislation; iii) Strengthening of relations between regions and communities, and; iv) Strengthening of relations between the stakeholder and central committees.

(1) Budget of NaDMA

According to the NaDMA's verbal explanation, NaDMA has no allocated budget but its operation and other expenses are covered, as required, as a part of the budget of the Ministry of National Security as the higher agency, and no used amount is indicated.

However, as specified in the aforementioned material prepared by NaDMA, the budget is supposed to be insufficient as it cannot help hiring 80% of all its staffs on a contract basis and that expense would be increased if more regular staffs are employed.

It is required to have a budget exclusively allocated for NaDMA.

(2) Insufficient Number of NaDMA Staffs

Currently, out of the 15 NaDMA staffs, the number of proper staff is three only and the remaining 12 are hired on a contract basis. The hiring contract period is unknown. It is supposed that the personnel cost is reduced by hiring many staffs on a contract basis.

It is anticipated that such present situation will lead to capacity lowering for the disaster management because training and education will be required for the new staff(s) to be employed when employment contract of the currently employed staffs is not extended.

(3) Cooperation between Central Government and Community

In the Grenada National Disaster Management Organization in a State of Emergency as aforementioned, it is recommended that relations between regions and communities are to be strengthened, as well as the relations between stakeholders and the central committees.

Meanwhile, the JICA Survey Team visited one community during the field survey. It was noticed that people in the community did not know the leader of the disaster committee at the district level when it was confirmed on the situation of disaster prevention education and activities. Furthermore, although the representative of community had the opportunity to be educated in NaDMA on disaster management, the results of the education are not shared in the community.

The reasons of the aforementioned situation are supposed to be as follows:

Decline of the awareness concerning disaster prevention because the community has not suffered serious damages from disasters recently;

Public relations activities for the community residents by NaDMA are not sufficient; and

The disaster prevention educations by NaDMA are conducted by convening community representative to the headquarter, but no direct activities to the community like making a visit to the community.

3.3.2 Issues on Structural Measures

(1) River

The rivers in Grenada are mostly in natural condition without river improvement measure. The areas, where inundation by river overflow from the past floods occurred are Saint Georges, Gouyave, and Victoria.

1) Saint George's

The Saint John's River flowing into the northern part of Saint George's causes inundation damages to the residential houses along the River Road due to its low flow capacity in the lower reaches. That situation is not improved yet but the countermeasure works is going to be carried out by WB for the Saint John's River basin. Hence, this issue will not be regarded as an objective area of this survey.

2) Gouyave

Gouyave suffers inundation damages from the flood of the Little River. The pier of the bridge located at the upstream reach of Gouyave was damaged by crushed large stone flown from the upstream. So far no measure has been taken but it will not be an objective of this survey because the project of the bridge rehabilitation and the river improvement of lower reach will be implemented under WB.

On the other hand, many large stones and sediments have been deposited in the Little River channel. Flood is anticipated to cause more damages in the downstream reaches with flow catching rocks and sediments deposits.

The Florida District is located in the upstream reaches of the Little River where it was identified in the Grenada National Hazard Mitigation Plan (2006) as one of the highest priority areas, where countermeasure for the sediment disaster shall be taken. Clear differences in level were found on the road passing this district, where there are many traces of slope collapse. In view of this situation, it is probable that the landslide area covers the whole area.

In this connection, another countermeasure for sediment disaster in the upstream reaches of the Little River is necessary.

3) Victoria

Victoria suffered flood damages but levee construction and bank protection works have been completed after the flood with the support of Chinese Fund.

As stated above, the rivers passing through the towns previously damaged have been rehabilitated or to be improved with support from the donor agencies. Hence, it is judged that no particular issue is identified concerning the rivers since the existing issue is expected to be resolved.

However, some issues in the upstream area are left as stated above in terms of sediment disaster.

4) Intake Weir of Water Supply

The water resources for water supply in Grenada depend mostly on the surface flow. It takes service water at the fixed weirs of 24 locations in upstream reaches. Height of the weir is at 6 to 7 m the highest.

Maintenance works are not carried out other than works to remove sediment deposit in front of the weir according to the field inspection. Further, it is distinguished that deterioration of the auxiliary facilities of the weir has progressed.

(2) Local Drainage

It sometimes suffers inundation due to poor local drainage in the area between the Tanteen Road and the HA Braise Street in Saint George's. This is because of the following:

Outlet of the drainage channel faces to the sea and be affected by tide;

The area is the most low-lying area compared with the surrounding area; and

Short of drainage channel capacity.

(3) Coast

Coastal erosion is currently progressive in the southern area of the Great River Bay in the north of Grenville although no effective measure is taken. It is supposed to be a reason of no measure taken that the hinterland of affected area is left unused for the farm land or residential area.

However, the Coastal Zone Management Plan covering the whole Grenada has to be formulated and some structural measures are to be taken beforehand taking into account some coastal erosion damages are caused in Saint George's in case of high surge.

(4) Road

1) Sendall Tunnel

The slope of the cliff collapsed in September 2014 for about 15 m wide due to heavy rains, where it is close to the pithead of the Sendall Tunnel in the Capital Saint George's in 1895. There is a historic tourism site at the top of the cliff and there is a heavy traffic of vehicles and pedestrian nearby.

The slope stabilization and protection works is scheduled to be undertaken under the Regional Disaster Vulnerability Reduction Projects (RDVRP) supported by WB. Hence, aforementioned works will not be an objective of this survey.

2) Slope Failure along the West Coast Road

On the slopes beside the road going around the island along the west coast, there are many traces of slope collapse and rockfall. There is a high risky section to cause slope collapse and falling rocks in the future.

As a first step of the countermeasures, the slope risk assessment on the objective section is to be conducted, and then the permanent countermeasure works shall be followed in descending order of priority with regular budget to be secured every year.

3) Trunk Road between Saint Georges and Grenville

The central road in the island that links the main cities and the capital is passing through a land full of undulations. Such road situation requires slope stabilization measures to be taken although no measures are taken so far.

However, the slope stabilization measures will be taken in the Constantine Road under the RDVRP scheduled to be supported by WB. The said Constantine Road is a Saint George's side part of the central road; hence, this road will not be identified as an objective of this survey.

4) Ministry of Communications, Works, Physical Development, Public Utilities, ICT, and Community Development

The O&M works of the road is carried out by the Ministry of Communications, Works, Physical Development, Public Utilities, ICT and Community Development that simplified visual road inspection is conducted about once a year. However, the management capabilities seem not enough about sediment disasters in the following viewpoints:

No records are well arranged about road disasters;

Lack of knowledge and understanding on the risk assessment method of slope and the monitoring method of the slope; and

Ad hoc measure is taken after suffering damages, which shows no design standard nor design guideline available.

(5) Building

1) Earthquake Resistant Design Standard

Concerning the civil works standards in Grenada, AASHTO standard and BS are applied.

As for the building code, the own Grenada Building Code was enacted on the basis of the Caribbean Uniform Building Code in 1999 as well as the Grenada Building Guidelines in 1999. The Grenada Building Guidelines is applicable for the design and construction of a relatively small-scale building with an area of less than 3,000 square feet such as a residential house and a store. In the guideline, descriptions regarding hurricane and earthquake are included. It mentioned about the concepts of the earthquake resistant buildings and hurricane resistant buildings.

However, it is considered that the earthquake resistance standard is not satisfactorily prescribed and that improvement of the earthquake resistance standard by incorporating Grenada's actual situation is required. Meanwhile, there is no building with anti-seismic reinforcement and no base isolation structure.

2) Improvement of Design Standard for Strong Winds

Most of the strong winds have been caused by hurricanes and main damages in the Caribbean Community (CARICOM) area are: a roof of a residential house is blown away by strong winds and that banana trees are completely broken.

As a building design code, the Caribbean Uniform Building Code is applicable for the ordinary residential houses; however, any preferable code is used by the designer for the tall buildings.

In a residential house case, roof damage is due to weak connection to the build portion; therefore, reinforcement of the connection shall be incorporated in the revision of the present building code. As

for the tall building case, the wind loads and direction shall be definitely stipulated in the building code.

Considering the Caribbean countries as hurricane prone area, the design standard concerning wind load shall be defined by individual country or for the Caribbean area.

Source: JICA Survey Team

Figure 3.3.1 Disaster Vulnerable Sites in Grenada

3.3.3 Issues on Non-structural Measures

(1) Hazard Map

It is considered that the hazard maps for flood and landslide in Grenada are well prepared and available. The land use map applying the Pleiades satellites picture analysis is prepared already as well

as the flash flood hazard map based on the flood analysis, the landslide inventory map based on the Pleiades satellites picture analysis and disaster track records, and that the Digital Elevation Method (DEM) data have been developed by the Light Detection and Ranging (LiDAR) survey. However, a detail seismic hazard map has not been prepared.

(2) Other Issues

1) Earthquake Disaster Prevention Plan for Saint George's

In the southern Caribbean area, a 6.1 magnitude of earthquake occurred in 2013, but no effort has been made in the preparation for earthquake. In the vicinity of the capital Saint George's where there exists a small plain partly located beside the coast, many houses are constructed on the steep terrain with pile foundation on the slope. No consideration about earthquake is made in the design of houses.

It is considered necessary that the earthquake risk assessment has to be carried out with emphasis on collapse possibility of buildings constructed on the slope, as well as, risk of sediment disaster, and that formulation of an earthquake disaster prevention plan for the capital is followed.

2) Development of Tsunami Disaster Prevention Plan Targeting Submarine Volcano Kick'em Jenny

The submarine Volcano Kick'em Jenny caused tsunami when it erupted in 1939 and recently erupted in 2001. It shows that the volcano is anticipated to cause tsunami in case of large-scale explosive eruption. However, no hazard map is prepared against the eruption of Volcano Kick'em Jenny, which may cause tsunami. In addition, no tsunami disaster mitigation plan is formulated despite that the residents living on the coastal towns do not know how and where they shall evacuate. Hence, it is necessary to make a further assessment on the tsunami risk to be caused by the eruption of Volcano Kick'em Jenny, also it is important to decide the mechanism on how to spread the tsunami disaster management plan among the residents.

One of the reasons why no management plan is considered to date yet it is because the National Executive Council does not have high concerns on the earthquake and tsunami since these disasters occur less frequently as compared with the hurricane.

However, NaDMA itself which undertake practical disaster prevention management services has recognized the importance of plan formulation but it is not realize yet because the lack of know-how and budget is not secured.

3.3.4 Issues Related to Meteorological and Hydrologic Observations

(1) Improvement of Observation Data Transmission System (Rehabilitation)

Meteorological observation in Grenada is conducted at four automatic stations in Grenada Island including inside of the international airport as well as one automatic station in Carriacou Island, which cover precipitation, wind, atmospheric pressure, temperature, humidity, etc.

Observed data at the said stations, except data in the international airport, are currently collected manually and brought to the meteorological office in the airport due to malfunctioning of communication system, which originally allows automatic data transmission. Such situation has to be rehabilitated and improved since the automatic data transmission does not work and no real time monitoring of the meteorological condition is carried out.

(2) Review of the Existing Operation System

The Early Warning System (EWS) established in the Great River basin in 2012 under CADM2 Project, with one automatic water level station and two automatic rainfall stations, has not functioned properly as EWS but also its individual observation. This is due to neglect of proper O&M works since the responsible O&M body has not definitely determined. This situation has to be improved in order to restore the system function by identifying the specific implementation body through a certain review of operating system.

3.3.5 Related Issues on Disaster Prevention in Grenada

Based on assessment and evaluation of the aforementioned issues, several issues in Grenada are identified as listed in Table 3.3.1.

Table 3.3.1 Issues Related to Disaster Management in Grenada

Field	No.	Issue
General for Disaster Management	GR-1	Improvement of insufficiency of staff for NaDMA
	GR-2	Improvement of coordination between NaDMA and the communities
Flood	GR-3	Mitigation of inundation in Saint George's due to the landside water
Sediment	GR-4	Mitigation of disasters due to landslide in the upstream area of the Little River and debris Flow
	GR-5	Mitigation of damages due to slope failure and rockfall along West Coast Road
	GR-6	Improvement of insufficient capacity of the countermeasure on sediment disaster along the road
Storm Surge	GR-7	Mitigation of coastal erosion in the north coast of Grenville
Earthquake	GR-8	Development of hazard map related to earthquake is not available
	GR-9	Preparation of disaster mitigation plan against earthquake for the capital
Tsunami	GR-10	Formulation of an evacuation plan for tsunami
Earthquake/Strong Wind	GR-11	Development of standard design methods against the seismic load and wind load
Drought	GR-12	Superannuation of the appurtenant facilities of the weir
Meteorological Observation	GR-13	To Secure telecommunication facility
	GR-14	Clarification of responsible organization for the operation of observation and warning system

Source: JICA Survey Team

3.4 Jamaica

The Jamaica and Saint Lucia data collection survey conducted in 2014 compiled the recommendations in disaster management aspects, the structural measures to be taken, and the issues on non-structural measures.

The issues having identified through this JICA survey are described hereunder.

3.4.1 Issues on Structural Measures

(1) River

1) River

In the rivers of the south-east area, the riverbed aggradations have been caused due to the accumulation of transported sediment by the debris flow during flooding. It is anticipated that bridges on the A4 trunk road (Bull Bay Main Road) between Kingston and Bull Bay are probably destroyed by aggradations of the riverbed caused by much sediment transported during heavy rainfall. While those accumulated sediment on the riverbed is used as construction material. Even if the anticipated bridges to be destroyed are restored without improvement of the river condition, it is feared that the bridges would be washed away again.

Basically, it is desired to make river and bridge improvement based on the comprehensive basin-wide sediment management plan to be formulated. However, it is necessary to determine the design flood level through the riverbed fluctuation analysis at the objective bridges if the comprehensive sediment management plan would be difficult to decide.

2) Bridge

The Flat Bridge on the Rio Cobre River is a submerged-type bridge with concrete slab and is famous as tourism site but is only a narrow bridge with single lane only.

The approach roads to the bridge along both sides of the river have lower altitude than the bridge surface or at the same level, which situation easily suspends the traffic every time the road is inundated. Hence, some improvement of the bridge and approach road is necessary.

However, rehabilitation of the Flat Bridge is to be done carefully taking into consideration the implementation progress and schedule of the highway, which will be a bypass of this bridge route.

(2) Road

A large-scale sediment disaster has occurred in the north-east area (Portland). Small scale sediment disasters frequently happened in Saint Andrew area, which seems to be caused by the increasing unstable slopes due to urban development.

In the steep mountainous road section between Agulala Vale and Golden Spring of the Trunk Road A3 that links Port Maria in the north coastal area and the capital Kingston, many damages have been frequently caused by falling rocks, slope failure, and landslide.

This road is the shortest way that links Port Maria and Kingston and the traffic is heavy. Although traffic suspension due to sediment disaster would cause serious impact on logistics, the fundamental slope stabilization measures are not taken for the main trunk roads even though the prone sites are specified.

Source：Map got from http://dikb.info/13051-jamaica-map and arranged by the JICA Survey Team

Figure3.4.1 Disaster Vulnerable Sites in Jamaica

3.4.2 Issues on Non-structural Measures

(1) Hazard Map

There are limited watersheds where flood disaster risk assessment is undertaken. The hazard map of national level is available but the regional hazard maps by parish are available in four out of 13 administrative parishes. No detailed hazard map for the earthquake is available.

3.4.3 Related Issues on Disaster Prevention in Jamaica

Based on assessment and evaluation of the aforementioned issues, several issues in Jamaica are identified as listed in Table 3.4.1.

Table 3.4.1 Issues Related to Disaster Management in Jamaica

Field	No.	Issue
Flood	JA-1	Improvement of the bridge in the middle reach of the Rio Cobre River to solve Traffic Interruption due to the flood
	JA-2	Prevention of mudflow on the rivers in the southeast region
Sediment	JA-3	Prevention of slope failure between Agulala Vale and Golden Spring
	JA-4	Development of detailed road hazard map is not available

Source: JICA Survey Team

3.5 Suriname

3.5.1 Issues on Disaster Prevention Administration

The National Coordination Center for Disaster (NCCR) was a department under the Ministry of Defense and has been operated in the ministry's building. However, due to a recent reformation of the government agencies, NCCR is under the Ministry of Internal Affair right now and no space is available for its operation. In general, the agency in other countries, working as a disaster management coordination body has a base building where the general meeting is to be held during disaster as well as a facility to store the equipment and materials for disaster response. However, NCCR has no such building or facility.

Besides, NCCR is functioning as a coordination body only and has only eight staffs, of which six staffs are the director and managers. It means that there are few active staffs. Furthermore, this organization has insufficient capacity for the disaster mitigation education, and no hazard map is available. NCCR leaves it to the other organizations to conduct the disaster management education at the community level as well as at the district level.

3.5.2 Issues on Structural Measures

(1) Local Drainage

About 50% of the total population in Suriname lives in Paramaribo, although the drainage situation in Paramaribo is rather poor due to conventional drainage system.

(2) Coast

Coastal erosion problem was not identified along the north coastal line in Paramaribo because the mangrove forest protects the shoreline. However, retreat of the shoreline has been so progressive that the coastal erosion is currently a serious issue. These situations are remarkable continually along the shoreline between Tottoness and the west of Paramaribo.

Construction of dyke is in progress with the European Union (EU) fund for about 13 km near Tottoness. The government announced that dyke construction is scheduled around the west of Paramaribo. Meanwhile, the United Nations Development Programme (UNDP) has noticed this issue and prepared a project design. However, due to budget constraint, it is not realized yet.

(3) Road

In every rainy season, a section of road running east to west between Apoera and Zanderiji (the area where many small rivers exist; between Pikin Saron and Witagron) is suspended to traffic due to heavy rains. It is considered that 1) construction work quality of the road itself was not good; 2) low road surface level; and 3) drainage condition of the road is not good.

This road is vital and has to be kept passable anytime, in view of the disaster mitigation, since this is the route to be used for supplies transportation during disaster from Paramaribo to Apoera.

The section of the said road between Zanderiji and Pikin Saron is under rehabilitation with Chinese loan.

3.5.3 Issues on Non-structural Measures

(1) Community Disaster Prevention

The Lawa River, which flows along the national boundary with French Guyana meets the Tapanahony River at the downstream of Benanu, then becomes the Maroeijne River, which also flows along the borderline. In case of heavy rain in the Tapanahony River basin in the Suriname territory, upstream section of the confluence is inundated. Transportation in the area is available only by boat on the river or by airplane, but no land transportation. It means that the way for evacuation is very limited.

(2) Other Issues

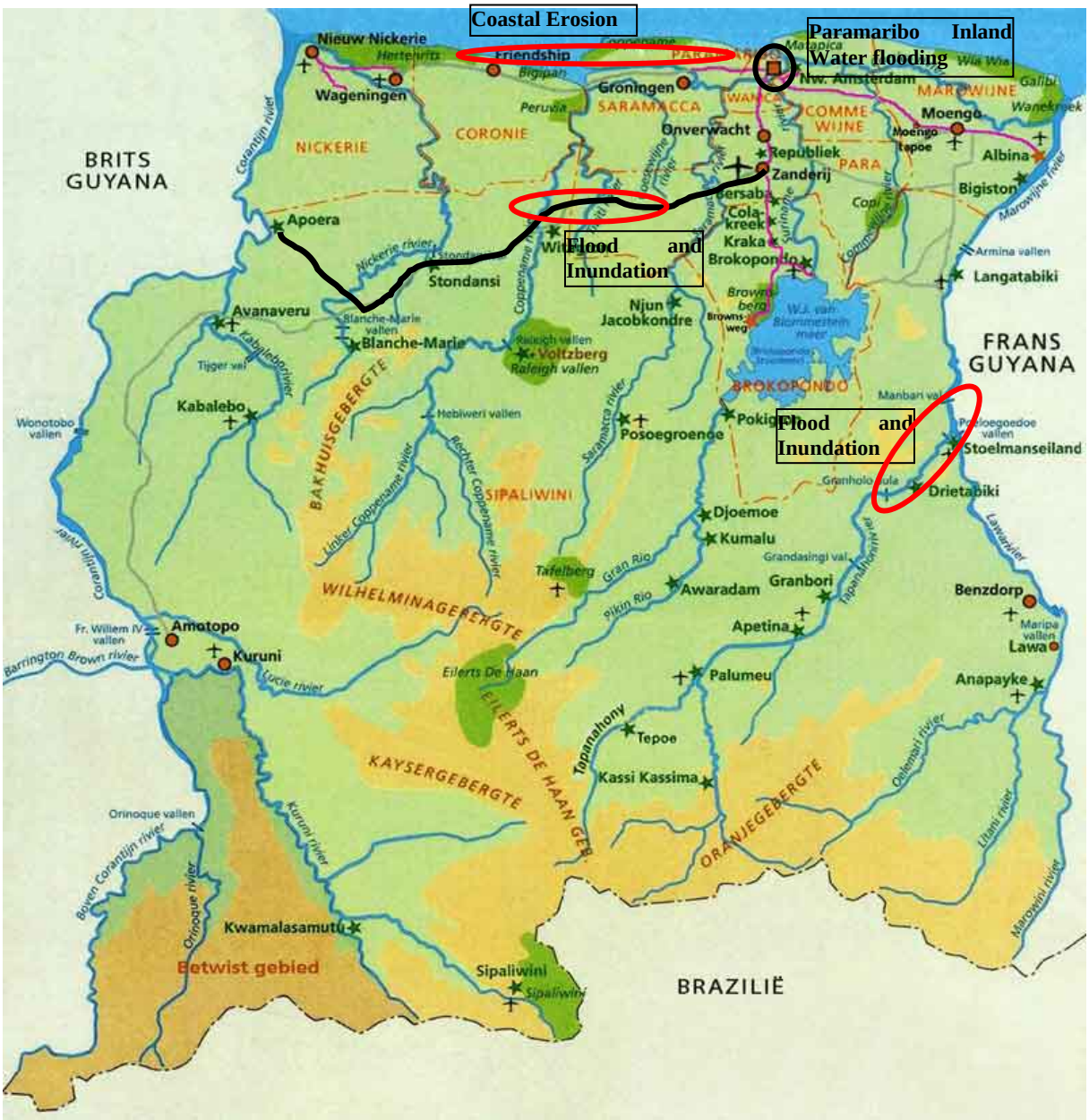
1) Preparation of Base Map and Database

In Suriname, the base map is not so available. According to the Ministry of Spatial Planning, Land, and Forest Management, the topographic map with a scale of 1 to 100,000 is available for the whole country. In addition, the topographic maps with a scale of 1 to 5,000 or 1 to 10,000 are partially available in a hardcopy basis. However, they are rather old ones based on the survey in around 1975 without digital data. It is quite necessary to prepare the base map, the topographic map particularly,

which is to be digitized in the database so as to be the basic data for any planning, and it is to be shared by each agency.

2) Improvement of Tsunami Observation Network

In Suriname, the monitoring equipment of the earthquake and tsunami are not installed by the Seismic Research Center and no earthquake observation station is installed by the U.S. Geological Survey (USGS） as well. It is not so probable to suffer damage from earthquake motion in Suriname, but some damage by tsunami is anticipated. Hence, it is considered necessary to develop an observation network.



Source : Map got from https://ecotravelrally.files.wordpress.com/2014/08/map-of-surinam_2.jpg and arranged by the JICA Survey Team

Figure 3.5.1 Disaster Vulnerable Area in Suriname

3.5.4 Issues Related to Meteorological and Hydrologic Observations

(1) Expansion of Rainfall Observation System in Inland Area

Existing rainfall stations in Suriname are concentrated in the coastal area. Automatic stations exist at seven locations in and around the capital Paramaribo as well as in the western part of the coastal area. Out of the 70 manned stations, about 40 stations are located in the coastal area and most of the remaining 30 stations are installed mostly in the local small airport of inland provinces.

It is targeted that present observation situation would be improved in the remote area, particularly in the inland area by means of automatization of the existing manned stations. In such future plan, data transmission would be through satellite and/or internet communication.

(2) Expansion of Observation on River Water Level and Discharge

The existing water level stations at 20 locations are in downstream reaches of the rivers affected by tide where discharge is estimated based on the observed water level incorporating tide effect. Water level and discharge observations in the upstream section where no tide effect was observed were carried out only once around 1986 in the upstream reaches of the rivers. At present, water level observations are conducted only in the downstream tidal reaches, therefore, exact and correct discharge estimate seems to be hard.

Considering such present situation, it is required to improve the hydrologic observation system in the seven major river basins including the Courantyne River, the Nickerie River, the Coppename River, the Suramacca River, the Suriname River, the Cattica River, and the Marowijne River by automatic data collection and improvement of the observation system in the inland area.

Among the existing water level stations at 20 locations, one station has been automated and other five stations are going to be automated, for which equipment are procured already.

Regarding the water level stations in the coastal area, the increase in the number of station itself is not considered to be necessary but what is required is the promotion of the automation of stations at important locations with due consideration on the station arrangement.

As for those in the inland area, it is required to improve the observation system in terms of number of stations and automation in consideration of the number, arrangement, and O&M easiness. However, it is required to continue the present observation at the several local airports either manned or automatic manner.

(3) Increase of Technical Personnel and Capacity Building

The number of staffs in the meteorological service office is 70 in the whole country, of which 34 persons belong to the headquarters. Only two technical staffs among the 34 persons are available who are responsible for O&M works of the observation instrument in the whole country. Because of such situation, regular maintenance of all stations in the country is made only once every year. The most important issue is to improve the present O&M capacity. In order to develop the automatic observation system, the target is staff training and personnel enhancement including the information technology (IT) engineers.

The number of staffs in the Hydraulic Research Division is 27, of which only one bachelor graduate personnel works in the division. The present issues are insufficiency and aging of personnel, and necessity is not only increasing the number of staff but also capacity improvement of personnel.

(4) Strengthening of Dam Management on the Suriname River

The Brommestein Dam is being operated as a single purpose for hydropower generation. At present, no warning will be disseminated to the downstream area when excess water is spilled out. In order to mitigate conceivable flood damage due to spill-out of excess water, dam operation management including discharge warning system is to be improved.

3.5.5 Related Issues on Disaster Prevention in Suriname

Based on assessment and evaluation of the aforementioned issues, several issues in Suriname are identified as listed in Table 3.5.1.

Table 3.5.1 Issues Related to Disaster Management in Suriname

Field	No.	Issue
General for Disaster Management	SU-1	Improvement of insufficiency of NCCR staff
	SU-2	Improvement of insufficient capacity of NCCR staff
	SU-3	Provision of NCCR home office
	SU-4	Preparation of base map
Flood	SU-5	Improvement of drainage in Paramaribo
	SU-6	Evacuation response to flooding in the middle reach of the Marowijine River
	SU-7	Improvement of the Road to Prevent Annual Road Closure in the Section between Apoera and Zanderij due to Flooding
Storm Surge	SU-8	Mitigation of coastal erosion
Tsunami	SU-9	Monitoring and Collection of Tsunami Information in and around Suriname
Meteorological Observation	SU-10	Improvement of Insufficiency of staff
	SU-11	Improvement of rainfall observation network
	SU-12	Execution of observation of the water level and discharge measurement at no-tide affected section
	SU-13	Mitigation of Man-made flooding due to the discharge from Brommestein Dam

Source：JICA Survey Team

3.6 Saint Christopher and Nevis

3.6.1 Issues on Disaster Prevention Administration

The National Emergency Management Agency (NEMA) is organized in Saint Christopher Island for national disaster management as well as the same for the island. In addition, in Nevis Island, the Nevis local government presides the whole administration of Nevis Island, under which administration, the Nevis Disaster Management Department (NDMD) is established as the disaster management organization.

In this connection, so as to consider the disaster management administration in Saint Christopher and Nevis, it is to be taken into consideration, not only NEMA but also NDMD.

(1) NEMA

NEMA applies the Regional CDM Strategy prepared by CDEMA as the national disaster management strategy because Saint Christopher and Nevis has no own national strategy. The present national disaster management plan is based on the CDEMA's strategy but not the latest strategy. Hence, the national disaster management plan is going to be updated in accordance with the latest CDEMA's strategy.

The number of NEMA staff is seven only but the volunteers support NEMA's activities to fill the insufficiency of the proper staff. Concerning education for the community residents, for instance, there are exclusive volunteer for such education that they are dispatched to the community and private firms in order to conduct the briefing session in case NEMA receives the requests from the community and/or private firm. However, the trainings such as evacuation are not carried out because of insufficient budget.

(2) NDMD

The activities of NDMD are similar to those of NEMA except the operation area in Nevis Island only. It is an issue of NDMD that Nevis Island has no own disaster management strategy and is referring to the regional comprehensive disaster management strategy of CDEMA. Another issue is that the number of staffs and budget are insufficient although fulfilling volunteers are working together.

3.6.2 Issues on Structural Measures

(1) Local Drainage

The drainage channels for flood water in Basseterre are built on the road surface and its capacity is insufficient. The drained water directly flows into the sea; therefore, the drained water is affected by tidal level and is liable to cause inundation. Drainage condition in the city has not cope with heavy rains of high intensity. Therefore the problem it faces is that the road is used for both traffic and drainage channel.

(2) Coast

Saint Christopher and Nevis suffers with not so serious damage on the beach from coastal erosion as compared with other countries. Such damage is possible to be restored by littoral nourishment using dredger(s) for few days.

(3) Road

The roads in Saint Christopher and Nevis extend for about 1,600 km in total including the main highways, major road, and ordinary road. The management and maintenance of the ordinary paved roads are the tasks of the Ministry of Transport and Works, but no regular inspection is being conducted.

The last inspections undertaken for all roads in the country were in 1992. In view of road disaster mitigation, inspections shall be carried out before and after the rainy season; in hurricane season in particular, prior measures and prompt repairs have to be conducted so as to prevent the spread of damages.

1) Vehicle Traffic Suspension at Causeway in Flood Time

There is no large river in Saint Christopher and Nevis. The causeway is built on the road going around the island, particularly along the west coast, at a crossing with a stream of 7 to 8 m wide. Pedestrian is

passable by using the pedestrian bridge although vehicle traffic is suspended due to overflow on the road through the causeway, which is an issue for access way in case of a disaster.

Causeway 1 at the Western Area of the Island

Causeway 2 at the Western Area of the Island

Source: JICA Survey Team

Figure 3.6.1 Causeways along the West Coastal Road in the Saint Christopher Island

2) Old Road Bay Area Affected by Storm Surge

Near the Old Road Bay, the road is constructed closely along the shoreline and traffic is apt to be suspended affected by the storm surge and high waves during hurricane, which prevent the access in case of the disaster.

3) Slope Failure along the Road towards Southern Peninsula in Saint Christopher Island

The road going to the southern peninsula of Saint Christopher Island is constructed by cutting the steep slope without any slope protection, where rocks fall down from the weathering sandstone slope. However, it seems that the scale of slope failure is small relatively.

Source：http://www.vidiani.com/large-detailed-physical-map-of-saint-kitts-and-nevis-with-roads-and-cities/

Figure 3.6.2 Road Networks in the Saint Christopher and Nevis

(4) Other Issues

1) Flood Caused from the Development Area Located in the North-west of Basseterre

In the north-western area of Basseterre, housing development is in progress in the hillside without building drainage facilities such as drainage channel and retarding basin. It causes more surface discharge in case of rain than before development. Such discharge flow, crosses the main roads into the western part of Basseterre, which cause flood damages.

3.6.3 Issues on Non-structural Measures

(1) Hazard Map

Progress in the preparation and availability of the hazard maps are different from each other, between Saint Christopher Island and Nevis Island. Hazard maps in Saint Christopher Island are available for the inland erosion, coastal erosion, flood, and strong wind but not for an earthquake. As for Nevis Island, the hazard map is available only for flood.

(2) Building

1) Earthquake Resistant Design Standard

Concerning the civil works standards in Saint Christopher and Nevis, AASHTO standard and BS are applied for. As for the Building Code, their own Saint Kitts and Nevis Building Code is decided incorporating building legislation. The building legislation is included in the Development Control and Planning Act 2000. However, no code or standard was confirmed, which incorporate definitely the concept of earthquake resistance standard.

The CARICOM countries including Saint Christopher and Nevis suffers earthquake many times, hence, the design code related to earthquake shall be developed individually by each country or as unified in CARICOM area. The said code needs to be spread well. While, there is no building with anti-seismic reinforcement and no base isolation structure.

2) Improvement of Design Standard for Strong Wind

Most of strong winds have been caused by hurricanes, and main damages of strong wind are such when the roof of a residential house is blown away and that banana trees are completely broken.

As a building design code, the Caribbean Uniform Building Code is applicable for the ordinary residential houses; however, any preferable code is used by the designer for the tall building.

In a residential house case, the cause of roof damage is due to weak connection to the building frame, thus, reinforcement of the connection shall be incorporated in the revision of the present building code. As for the tall building case, the wind loads and direction shall be definitely stipulated in the building code.

Considering the Caribbean countries as hurricane prone area, the design standard concerning wind load shall be defined by individual country or for the Caribbean area.

(3) Other Issues

1) Hotels Constructed around the North Frigate Bay as Vulnerable Area for Flood, Storm Surge, and Tsunami

The North Frigate Bay area is highly vulnerable to flood, storm surge, and tsunami although there are many hotels such as Marriott constructed in there. The information about the evacuation system, evacuation routes, and evacuation centers are not available and not provided for the guests and visitors of the hotels. This will make it difficult for the guests and visitors to follow the evacuation guidance.

2) Earthquake Disaster Prevention Plan for Basseterre

In spite of the earthquake occurred recently, the earthquake disaster mitigation plan has not been prepared yet for the capital area even though there was no damage caused by an earthquake. It is considered necessary for the capital Basseterre to decide on an earthquake disaster management plan.

3.6.4 Issues Related to Meteorological and Hydrologic Observation

(1) Establishment of Independent Organization Meteorological Service

Meteorological service in Saint Christopher is conducted by the meteorological office, which is an internal division of the Saint Christopher Air and Sea Port Authority（SCASPA）. The meteorological office does not conduct their own meteorological observation and forecast except those for air traffic control. The meteorological office disseminate meteorological information and weather forecast to the domestic, which are provided by Antigua and Barbuda. Similarly in Nevis, the meteorological service is conducted as a part-time service by the Nevis Air and Sea Port Authority (NASPA), which is in charge of the Vance W. Amory Airport.

Among the member countries of CMO, Saint Christopher and Nevis is the sole country that conducts the meteorological service under such system. As for the other countries, there are a certain number where the service is conducted by the government organization although the main task is the meteorological observation in the airport, or the main office exists in the airport.

Although some independent organizations conduct meteorological service, it is considered necessary that a government agency has to be set up even if it its main task is to conduct meteorological service for the airport traffic control.

(2) Improvement of Meteorological Observation System

Only observed data in the airport are managed by the Saint Christopher Meteorological Office, however, the data observed at the other automatic stations installed by the funds of CMO or CIMH are directly sent to CIMH. The meteorological office receives and monitors those data through CIMH data server.

Most of the information contained only those provided by Antigua and Barbuda even though the weather forecast is sent out to the domestic media incorporating observed information at the airport.

So as to improve such observed situation, solution to the institutional issue is essential. Furthermore, the observation system has to be improved so that their own observation facilities will be established other than those in the airport and that domestic observation information is to be directly monitored at a real time basis.

3.6.5 Related Issues on Disaster Prevention in Saint Christopher and Nevis

Based on assessment and evaluation of the aforementioned issues, several issues in Saint Christopher and Nevis are identified as listed in Table 3.6.1.

Table 3.6.1 Issues Related to Disaster Management in Saint Christopher and Nevis

Field	No.	Issue
General for Disaster Management	CN-1	Determination of National Disaster Management Strategy
	CN-2	Improvement of insufficiency of NEMA staff
	CN-3	Improvement of insufficient budget allocation to NEMA
	CN-4	Requirement to develop hazard map for disasters in Nevis Island other than flood
	CN-5	Improvement of drainage capacity in Basseterre
	CN-6	Bridge improvement to prevent temporary closure of the Causeway Ring Road along the west coast due to flood
	CN-7	Floodwater control from the northwestern areas of Basseterre
Sediment	CN-8	Risk of slope failure on the steep slopes along the road towards the southern peninsula.
Storm Surge	CN-9	Countermeasure against high tide to Cause Road closure at the Old Road Bay area
Flood-Storm Surge-Tsunami	CN-10	Provision system of information to the customers of the hotels in North Frigate Bay which is vulnerable to flood, high tide, and tsunami
Earthquake	CN-11	Preparation of earthquake hazard map in Saint Christopher
	CN-12	Preparation of disaster mitigation plan for earthquake for the capital
Earthquake/Strong Wind	CN-13	Development of standard design methods against seismic load and wind load

Field	No.	Issue
Meteorological Observation	CN-14	Establishment of independent office instead of a section of the airport managing company to conduct the observation
	CN-15	Own weather forecasting and meteorological information
	CN-16	Preparation of an observation system

Source: JICA Survey Team

3.7 Saint Vincent and the Grenadines

3.7.1 Issues on Disaster Prevention Administration

The National Emergency Management Office (NEMO) comprises 13 staffs in total including four technical staffs. NEMO requires additional eight staffs comprising i) Civil engineer, ii) Building engineer, iii) GIS specialist, iv) Social development officer, and v) Program officer which requires four persons.

NEMO does not encounter a budget problem particularly for the additional employment. A part of the training cost required for staff capacity strengthening could be covered by the training program to be conducted by donors such as WB and UNDP in addition to the government regular budget. However, in future, it is anticipated that NEMO will face to budget insufficiency provided that all operation cost is covered by the government budget only in medium-long term aspect.

Furthermore, insufficient capacity of staffs is issues of NEMO regarding the flood mapping technology applying GIS, the knowledge management and early warning monitoring.

The present situation is that it is insufficient number of staffs and O&M works is not fully executed due to insufficient budget and staffs in number. In addition, it is identified as an issue that the staff's capability is insufficient for flood mapping techniques and O&M of the radio stations.

3.7.2 Issues on Structural Measures

(1) River

1) Flood Damage in Cumberland River

The Cumberland River basin is one of the most damaged river basins during the Christmas flood in 2013, where the restoration works are still in progress. The restoration works have been carried out based on the priority provided by the assessment of damaged situation. There are some areas where restoration works are not completed yet.

Replacement of the Bailey bridge with permanent bridge

Bridge on the trunk road collapsed during the flood in the 1990s. The Bailey bridge was temporarily installed and has been used to date. The flood flowed over the bridge in 2013 but no serious damage was caused and still passable. However, it is noted that the freeboard of bridge seems not sufficient according to the flow record over bridge.

It is considered necessary to replace the existing bridge on the main road with a permanent one in view of disaster prevention

Scoring of the bridge foundation

In the upstream reach of the hydropower station No.3, the culvert type road bridge and aqueduct located at the downstream were damaged by scouring in bridge foundation due to flood overflow.

(2) Coast

1) Saint Vincent Island

The coastal erosion on the shoreline east coast of Saint Vincent Island is getting serious at a considerable speed, where there are many areas at risk of coastal erosion by storm surge and high sea waves during hurricane and tropical storm.

Further, the Windward Highway is constructed along the coastal line with cliff at the mountain side with a height of 15 m in maximum where falling rocks and sediment outflow are observed.

It is required to make a countermeasure for the coastal erosion along the coastal road as well as a measure for road slope protection. In a part of the east coast area, the survey is ongoing for the coastal protection and slope protection by CDB and WB.

2) Bequia Island

The coastal road in Bequia Island was constructed at the east side of the airport and the south part of the island along the cliff facing the beach. At present, the lowest parts of the cliff have been eroded by waves and the cliff is being overhang. It is anticipated to collapse in the near future. The survey for this matter has been done in advanced by WB and this study is being undertaken so as to replace the present road with a new route.

(3) Road

Fundamental slope protection works are scarcely made except such temporary measure taken repeatedly. Traffic is temporarily suspended to remove sediment on the road and then the road is open to traffic again. Since the road slope is steep cut on the east coast road especially, there are frequently road blocked due to collapse and rockfall.

1) Damages due to Sediment Disaster on Trunk Road in Mesopotamia District

A part of the trunk road in the Mesopotamia District has been damaged due to a landslide and still under traffic suspension. The restoration measure survey is being conducted under the Government of Saint Vincent and the Grenadines as well as the World Bank.

Source：Map got from http://www.mappery.com/map-of/St-Vincent-and-Grenadines arranged by the JICA Survey Team

Figure 3.7.1 Disaster Area in the Saint Vincent Island

3.7.3 Issues on Non-structural Measures

(1) Hazard Map

Hazard maps have been prepared and are made available by the Ministry of Housing, Informal Human Settlements, and Physical Planning Office for flood, storm surge, and tsunami. As for the landslide hazard map, it is prepared by NEMO, while no hazard map for earthquake is available even though there is a frequent occurrence of an earthquake.

(2) Community Disaster Prevention

The activities on community disaster prevention are currently carried out mainly by WB and NEMO as well as the Red Cross. The WB and NEMO set up a pilot community to make a hazard map and conduct education and training.

The Red Cross activities are that Community Disaster Risk Reduction (CDRR) Team is organized and emphasized in the education for the disaster prevention and mitigation by the community itself.

The University of West Indies-Seismic Research Center (UWI-SRC), in cooperation with NEMO and Red Cross, carries out the enlightenment activities as well as education and training for the community.

WB has supported NEMO in the community disaster prevention.

(3) Building

Although it has been observed, earthquakes occurred for five times within Saint Vincent and the Grenadines after 1900, no serious damage happened yet so far. Saint Vincent and the Grenadines have suffered serious damages from volcanic eruption rather than earthquake, therefore the countermeasure for volcanic eruption precedes that for earthquake.

However, there is a risk of having damages by an earthquake including volcanic earthquake and it is required to make an assessment and review regarding the earthquake resistant standard.

(4) Other Issues

1) Earthquake Disaster Prevention Plan for the Capital Area

Disasters due to earthquake and tsunami occur less frequently but cause more serious damages compared with hurricanes and flood cases. However, the disaster response organizations including NEMO deal with the frequently occurred disaster response as main services and the response of disaster mitigation for the earthquake and tsunami are left behind.

There are no definite plans formulated yet for disaster mitigation of earthquake in the capital city. Hence, it is required through earthquake risk assessment to decide the disaster mitigation plan of earthquake incorporating the evacuation route and evacuation centers as well as the disaster mitigation plan of tsunami specifying evacuation routes and evacuation area.

2) Development of Disaster Mitigation Plan for Tsunami in Main Coastal Cities

Tsunami disaster is not so frequently caused by hurricanes, but the potential risk of tsunami is conceivable in case of eruption of the submarine volcano Kick'em Jenny. The tsunami's travelling time from near the hypocenter of the earthquake is short and is quite necessary to decide the tsunami disaster mitigation plan incorporating what response shall be done within such short time and how evacuation shall be done appropriately.

3) Drought

The Grenadine Islands including Bequia Island has a different topography and climate from Saint Vincent Island, which receives less rainfall than Saint Vincent Island. This situation has caused many times of drought damages due to chronic water shortage and no surface and river water resources.

3.7.4 Issues Related to Meteorological and Hydrologic Observations

The Saint Vincent and the Grenadines Meteorological Office under Ministry of National Security and Air and Seaports Development (MNSASPD-SVGMT) conducts meteorological observations at three airports including the E.T. Joshua Airport in Saint Vincent Island and local airports in Bequia and the Union Islands.

In addition, the Central Water and Sewage Authority (CWSA) conduct meteorological observation at 33 locations, and discharge measurement at seven locations. The observation equipment has been installed with the support of the Disaster Vulnerability Reduction Project (DVRP) under the WB for instance, which however, was damaged by flood and no restorations have been provided since after.

(1) Insufficient Staff for Equipment Maintenance

There are only one O&M staff in MNSASPD-SVGMT and three staffs in CWSA, respectively.

(2) Improvement of Maintenance Capacity for Observation Equipment

The meteorological observation facilities under CWSA are mostly of automatic observation, some of which malfunctioned due to insufficient O&M budget.

Technical staffs of MNSASPD-SVGMT and CWSA have received certain trainings undertaken by CIMH but are not accompanied with practical techniques in an elementary level training in case of CWSA.

(3) Insufficient Number of Observatories

Hydrologic observations have been currently made in seven river basins, which do not cover all the basins in the country. Thus, expansion of observation facilities in the other basins is necessary. Considering a runoff characteristic of rainfall within short time, observation improvement in terms of accuracy and increasing of observation stations in upstream area are also necessary.

3.7.5 Related Issues on Disaster Prevention in Saint Vincent and the Grenadines

Based on the assessment and evaluation of the aforementioned issues, several issues in Saint Vincent and the Grenadines are identified as listed in Table 3.7.1.

Table 3.7.1 Issues Related to Disaster Management in Saint Vincent and the Grenadines

Field	No.	Issue
General for Disaster Management	SV-1	Improvement of insufficiency of NEMO staff
	SV-2	Capability improvement of NEMO staff
	SV-3	Improvement of Budget Insufficiency allocated to NEMO
	SV-4	Mitigation of damages due to the flood caused by the Cumberland River
Sediment	SV-5	Mitigation of slope failure of the mountain side of the road along the east coast
Storm Surge	SV-6	Mitigation of coastal erosion along the east coast
Earthquake	SV-7	Development of hazard map regarding earthquake
	SV-8	Formulation of disaster mitigation plan for earthquake for the capital
Tsunami	SV-9	Formulation of evacuation plan for tsunami
Earthquake/Strong Wind	SV-10	Development of standard design methods against seismic load and wind load
Drought	SV-11	Formulation of countermeasure for water shortage in the Grenadines
Meteorological Observation	SV-12	Insufficient number of staffs for the observation
	SV-13	Insufficient capacity of the staffs
	SV-14	Insufficient budget
	SV-15	Deteriorated equipment are left unrepaired

Source: JICA Survey Team

3.8 Saint Lucia

3.8.1 Issues on Disaster Prevention Administration

NEMO has the main tasks of education and enlightenment activities of disaster management as well as emergency operation in case of disaster; however, it encounters the following issues:

Insufficient environmental level of the Information Communication Technology (ICT) and its management is considered not enough even under such level. Mutual communication capability in disaster situation is weak between the relevant agencies such as NEMO, SLMS, WRMA, so on;

It is necessary to assign capable persons in NEMO such as people who will take charge of the media, communication, project sustainable plan, and big-scale events coordinator, and

The National Emergency Management Office (NEMO) comprises 9 staffs. NEMO requires eight staffs comprising i) Civil engineer, ii) Building engineer, iii) GIS specialist, iv) Social development officer, and v) Program officer which requires four persons.

NEMO encounters budget insufficiency for additional staff employment, capacity improvement of staffs and O&M works.

Effort of capacity improvement is on the way with supports of donors for the following subjects which are identified as insufficient capability of staffs:

- Response for mass casualty in occurrence of disaster,
- Community-based disaster management,
- Exercise on the related plan and design to disasters,
- GIS,
- Communication in crisis,
- Method of hazard risk assessment,
- Method of hazard map preparation, and
- Capacity regarding search and rescue activities.

3.8.2 Issues on Structural Measures

(1) River

1) John Compton Dam

The John Compton Dam is the sole dam in Saint Lucia constructed for the purpose of water supply. It was built in 1995 with the support of the Canadian International Development Agency (CIDA) and sedimentation in the reservoir has been progressive. The present reservoir capacity is one to seventh or less to the original capacity in the planning stage. In the upstream reaches of the dam, landslide occurred many times and those sediments flow into the reservoir from the area where no measure was taken for slope stabilization.

Currently, the feasibility study is being undertaken on the countermeasure for reservoir sedimentation. Based on the study, it is necessary to implement the projects on the countermeasure for sedimentation and mitigation of sediment production in the upstream area.

2) Inundation in Two International Airports during Flood

Both the Hewanorra Airport and the George FL Charles Airport suffer inundation damages from flood coming from the river in case of heavy rains. It is scheduled to conduct the flood mitigation measures under DVRP of WB.

(2) Road

1) Slope Protection Measure for Truck Ring Road in Island

The east coastal road and the west coastal road are major roads in Saint Lucia linking the two airports in the north and south, respectively: both of roads are not provided the permanent slope protection works. There are many sediment disaster prone areas in the section between Canaries and Soufriere of the west side coastal road. In the area, only temporary measures are taken repeatedly in cases where traffic is temporarily suspended to remove sediments on the road and then open to traffic.

2) Improvement and Rehabilitation of Pavement of Millennium Highway

The Millennium Highway was constructed 15 years ago with funding of Kuwait, which is a part of the trunk road running east and west starting from Castries. That road is the most important trunk road in the country and an important route for supplies transportation and other support to the disaster-stricken area. Hence, rehabilitation of the pavement is the request of the government.

It is generally observed that pavement condition of the highway is not very deteriorated except a part of section.

3) Bridge

Some bridges in the Cul de Sac River basin, which includes the Cul de Sac Bridge, the Ferrands Bridge and the Ravine Poisson Bridge are vital parts of the road going around the island. These bridges become impassable because of flood inundation and traffic suspension due to insufficiency of the water cross section.

The Ministry of Infrastructure, Port Services, and Transport shows their request of bridge improvement and river improvement.

(3) Other Issues

1) Countermeasures for Disasters on Agricultural and Fishery Facilities

The agricultural and fishery facilities under the Ministry of Agriculture, Food Production, Fisheries, Cooperatives and Rural Development suffered damages from the Christmas flood in 2013. It suffered damages in farm road, pump equipment, and fishery facilities from floods and storm surge as well as sedimentation in the drainage facilities. Issues are identified as the restoration of damaged facilities, as well as the disaster management education and capacity strengthening related to disaster mitigation in the agriculture and fishery sectors.

2) Water Intake Facility

Saint Lucia suffered severe drought damage in 2010. Meanwhile, the Water and Sewerage Company (WASCO), in charge of water supply, maintains the water intake facilities that have suffered damages of landslide, flooding, and sediment intrusion from the recent hurricanes. Furthermore, the sedimentation in the water intake facilities is so serious that a facility was evitable to transfer the intake site. Therefore, it is identified as issues in preparation for drought to take countermeasures for disasters in the water intake facilities as well as its O&M works.

3.8.3 Issues on Non-structural Measures

(1) Hazard Map

No other hazard map is available than that for flood.

(2) Community Disaster Prevention

The educational activities on the community disaster prevention have been undertaken by the Red Cross with a central role and other organizations. The activity is to grasp the community's vulnerability for disaster and to prepare programs for disaster prevention and mitigation through vulnerability and capacity assessment.

In order to carry out the education and training, the Self-defense Commission is formed and establishes an agreement for the activities. The Management of Slope Stability in Communities (MoSSaiC) project is implemented, which is a similar activity to the above.

(3) Building

The Caribbean Uniform Building Code (CUBiC) decided by the Organization of Eastern Caribbean States (OECS) is applied as the building code in the country. It was expected according to the news that a new building code would be decided in 2009 based on the study in 2001 on the earthquake resistance standards; however, there is no sign that it has been made public.

(4) Disaster Mitigation Plans for Earthquake and Tsunami

By the shocks of an earthquake felt in 1953 in Castries with a magnitude of 7.3, a part of the building collapsed. This building had also been damaged by a previous fire. It suffers damages from the earthquake but required measures are not taken properly for disaster mitigation of earthquake and tsunami.

This is because disaster response organizations including NEMO deal with the frequently occurring disaster response as main services and the responses on disaster mitigation for earthquake and tsunami are left behind, although earthquake and tsunami occur not frequently but cause more serious damages compared with hurricanes and floods.

There is no definite plan formulated yet for the disaster mitigation of earthquake in the capital city and of tsunami in the coastal cities. Hence, it is required to decide the disaster mitigation plan of earthquake incorporating the evacuation route and evacuation centers as well as the disaster mitigation plan of tsunami specifying evacuation routes and evacuation area.

3.8.4 Issues Related to Meteorological and Hydrologic Observations

(1) Malfunctioning of Many Existing Rainfall Observatories

Rainfall stations under the Water Resource Management Agency (WRMA) exist at 35 locations nationwide, of which, however, 12 stations are not functioning with no restoration effort due to financial constraint. It is required to repair such equipment, which has been out-of-order caused by deficiency of O&M.

(2) Insufficient Number of Rainfall Station

The Saint Lucia Meteorological Service under the Ministry of Infrastructure, Port Service, and Transport (MISPT-SLMS), the management agency responsible for the rainfall observation, require improvement of present situation together with observatories under WRMA by increasing the number of rainfall stations, which is presently insufficient.

(3) Insufficient Cooperation between Observation Agencies

Meteorological and hydrologic observations are conducted respectively by MISPT-SLMS and WRMA, however, the coordination of both ministries is not enough.

(4) Malfunctioning and Deterioration of Observed Database System

It was found out in the computer servers handling the observation system under MISPT-SLMS that one of these is out of order and another one is aging.

(5) Deterioration and Inundation Damages in Meteorological Observatory at the Hewanorra Airport

During the flood in 2013, the meteorological observatory at the Hewanorra Airport suffered inundation or flooding up to knee level, causing damages to the equipment and wiring system. The observation control room is getting decrepit.

Source：Map got from http://www.america-atlas.com/saint-lucia.htm, arranged by the JICA Survey Team

Figure 3.8.1 Disaster Area in the Saint Lucia Island

3.8.5 Related Issues on Disaster Prevention in Saint Lucia

Based on assessment and evaluation of the aforementioned issues, several issues in Saint Lucia are identified as listed in Table 3.8.1.

Table 3.8.1 Issues Related to Disaster Management in Saint Lucia

Field	No.	Issue
General for Disaster Management	SL-1	Improvement of insufficiency of NEMO staff
	SL-2	Capacity improvement of the NEMO staffs
	SL-3	Improvement of budget insufficiency allocated to NEMO
	SL-4	Improvement of communication among organizations disaster-related organization
Flood	SL-5	Mitigation of damages in the bridges on the Trunk Ring Road in the island
Sediment	SL-6	Mitigation of slope failure along on the mountain side slope of the trunk ring road in the island
Earthquake	SL-7	No hazard map for earthquake is available
	SL-8	Preparation of disaster mitigation plan for capital against earthquake
Tsunami	SL-9	Preparation of evacuation plan for tsunami
Earthquake/Strong Wind	SL-10	Development of standard design methods against seismic load and wind load
Drought	SL-11	Improvement of sediment siltation in John Compton Dam Reservoir
Meteorological Observation	SL-12	Increasing staff for meteorological observation
	SL-13	Capacity improvement of the maintenance staffs
	SL-14	Improvement of the budget insufficiency allocated to the observation
	SL-15	Repair of equipment for the meteoro-hydrologic observation

Source: JICA Survey Team

3.9 Dominica

3.9.1 Issues on Disaster Prevention Administration

The Office of Disaster Management (ODM) comprises 5 staffs only in total including three technical and two administrative staffs. Requirement of staff increasing from the present is directed by the central government to control. However, NEMO requires additional seven staffs comprising i) Communication specialist, ii) Education, iii) IT, iv) Logistics, v) Public relation, vi) Department coordinator, and vii) Project officer.

The Office of Disaster Management (ODM) is being operated with an annual budget amounting to US$500,000 equivalent. ODM encounters such budget insufficiency that renovation of the office is difficult.

The office building of ODM is durable for the resistance standard for hurricane at category 3 but do not satisfy that for the category 5. Further, the office space and facilities are to be improved and extended in the public relations room, accommodation, and emergency power source.

The evacuation centers are facilitated in most of the communities by availing the existing churches and schools. However, the facilities and equipment in the center are not enough and it is pointed out that the present evacuation centers are not appropriate for evacuation for a long duration.

Some issues are identified in the locations of the existing evacuation centers such as the hurricane shelter exists in the sediment disaster hazardous area or near the beach where the area is at high risk for tsunami and storm surge disaster.

3.9.2 Issues on Structural Measures

(1) River

1) Flood Damage of Trafalgar Bridge on the Trunk Road in Resorts in Suburbs of the Capital City

At a junction of community connecting roads with the trunk road in the vicinity of the capital, sediment disaster is apt to occur in case of flood. In addition, in upstream of the Trafalgar Village along this connecting road, traffic is suspended in case of flood at the Trafalgar Bridge which is a causeway type bridge; hence the Trafalgar Village is isolated for several days during flood. It is required to secure access to the capital.

2) Water Supply Pipeline Accompanied with a Bridge was Washing Away on the Tributary of the Roseau River

The pipeline of water supply for the capital territory was washed away during the flood in 2007. The pipeline was attached to the bridge on a tributary of the Roseau River. The temporary bridge has been constructed in the causeway type, but the pipeline is not reinstalled.

The said pipeline was part of the main water supply system for the capital city. The water supply at present comes from another water intake far from the city through another system. Hence, the vulnerability of the capital for drought is high.

(2) Coast

Coastal protections have been improved in line with the road development and improvement under the support of the WB, CDB, China, so on. It is necessary that such improvement has to be continually undertaken in many other places. According to the Disaster Risk Reduction Country Profile 2014, coastal cities nationwide are vulnerable to storm surge and coastal damages. However, no plan with priority is formulated yet.

It is necessary that the coastal infrastructure improvement is to be implemented in accordance with the coastal zone management plan, which shall be formulated prior to the infrastructure development.

(3) Road

1) Slope Failures along the South-west Coastal Road

Road damage is caused by sediment disasters in almost all over the island, but especially at the coastal road in the southwest island, the road slope is steep cut slope and collapse and falling rocks are frequent without a permanent countermeasure.

2) Road Damage caused by Antrim Landslide in Spring Field

The active Antrim landslide is located in spring field area along the important highway which connects the air port with the capital city. Although working to repair such as paving of the road has been carried out, road and water pipeline damage is still continuing.

Source : Map got from http://www.ezilon.com/maps/north-america/dominica-physical-maps.html, arranged by the JICA Survey Team

Figure 3.9.1 Disaster Area in Dominica

3.9.3 Issues on Non-structural Measures

(1) Hazard Map

The comprehensive hazard assessment study in the national level was conducted in 2006 with the support from the United States Agency for International Development (USAID) that the hazard maps over the country were provided individually for flood, landslide, storm surge, earthquake, volcano, and

strong wind as well as the comprehensive hazard map incorporating overall vulnerability for the natural disasters.

Those hazard maps show generally the disaster risks, and the Lands and Surveys Division (LSD) is working to improve the maps with higher precision for landslide and flood.

Risk mapping along the road is being prepared under the Caribbean Handbook on Risk Information Management (CHARIM) as well as the latest road map.

The present earthquake hazard map is not so accurate with the level to cope with the specific structural assessment at the peculiar point. It is necessary to make the existing earthquake hazard map with higher precision so as to establish the capital disaster mitigation plan for the earthquake.

(2) Community Disaster Prevention

There are more than 100 big and small communities in Dominica, in which a disaster management committee is established.

The educational activities on the community disaster prevention have been undertaken by the Red Cross with a central role and other organizations. The activity is to grasp community vulnerability for disaster and to prepare programs of disaster prevention and mitigation through the vulnerability and capacity assessment. Furthermore, the Management of Slope Stability in Communities (MoSSaiC) project is implemented aiming at the communities by WB.

The educational activities on the community disaster prevention are made under the Red Cross and WB projects; however, such activities do not cover all communities. It is necessary to make efforts that all communities would be covered by such educational activities.

(3) Building

The building code is not officially enacted. The standard based on the Caribbean Building Code (CUBiC) prepared in the 1990s are used as the building code. It is necessary to revise the present one with a new one in accordance with the assessment and real situation in the present earthquake resistant standard.

(4) Other Issues

1) Earthquake Disaster Prevention Plan for the Capital City

Tremors of earthquake are observed every year in Dominica and the risks of earthquake are recognized well. It is pointed out the possibility that the liquefaction to be caused by earthquake might be caused in several areas in the Roseau Valley where the capital Roseau exists therein.

Disasters due to earthquake and tsunami occur not so frequently but cause more serious damages compared with hurricanes and flood cases. However, the disaster response organizations including ODM deal with the frequently occurring disaster response as main services and the responses on disaster mitigation for the earthquake and tsunami are left behind.

There is no definite plans formulated yet for the disaster mitigation of earthquake in the capital city. Hence, it is required through earthquake risk assessment to decide the disaster mitigation plan of earthquake incorporating the evacuation route and evacuation centers as well as the disaster mitigation plan of tsunami specifying evacuation routes and evacuation area.

2) Decision of Tsunami Disaster Mitigation Plan for Major Coastal Cities

Tsunami disaster is caused rarely compared with that of hurricanes, but the potential risk of tsunami is conceivable. The tsunami travelling time from near the hypocenter of the earthquake is short that it is quite necessary to decide the tsunami disaster mitigation plan incorporating how response shall be done within such short time and how evacuation shall be done appropriately.

3) Drought

During 2009 to 2010, Dominica suffered serious drought disaster in the dry season that urgent water supply and distribution were carried out using water distribution vehicles. At present, surface water is the only water source for supply in Dominica and little ground water is used. As a measure against drought, a feasibility study of groundwater use is necessary to be studied.

3.9.4 Issues Related to Meteorological and Hydrologic Observations

(1) Unified Management of Observed Meteorological and Hydrologic Data

The uniform management of the meteorological and hydrologic observation data is not undertaken since these two different organizations i.e., the Meteorological Service (MPWEP-MS) office under the Ministry of Water, Land, Environment, and Climate Change and the Ministry of Agriculture, Fisheries and Forestry, Agriculture Division（MA-AD) conduct the observations individually. This situation is expected to be improved by formulating an hydro-meteorological committee involving MPWEP-MS, forestry bureau, agricultural bureau, DOWASCO, etc., under WB's DVRP.

(2) Insufficient Number of Staffs

The number of technical management staff is ten for the meteorological observatories at two for airports under MPWEP-MS. Technical capacity building is required for the technical management staffs of the execution bodies including MPWEP-MS and the forestry bureau.

3.9.5 Related Issues on Disaster Prevention in Dominica

Based on assessment and evaluation of the aforementioned issues, several issues in Dominica are identified as listed in Table 3.9.1.

Table 3.9.1 Issues Related to Disaster Management in Dominica

Field	No.	Issue
General for Disaster Management	DM-1	Improvement of insufficiency of ODM staff
	DM-2	Improvement of budget insufficiency allocated to ODM
	DM-3	Rehabilitation of the damaged shelters and improvement of the functions of evacuation facilities
Flood	DM-4	Improvement of Trafalgar Bridge to Secure Access Route during Flooding from Trafalgar Village to the Capital
	DM-5	Re-installation of the Pipeline which was Washed Away by Flood to Secure Conveying Water to the Capital
Sediment	DM-6	Mitigation of slope failure along the coastal road in the southwest area
	DM-7	Mitigation of road damage caused by Antrim landslide
Coast	DM-8	Mitigation of Damages due to Coastal Erosion
Earthquake	DM-9	Formulation of disaster mitigation plan against earthquake for the capital
Tsunami	DM-10	Formulation of disaster mitigation plan in the capital against tsunami
Earthquake/Strong Wind	DM-11	Development of the standard design methods against seismic load and wind load
Drought	DM-12	Improvement of recent serious water shortage
Meteorological Observation	DM-13	Improvement of insufficiency of staffs for the observation
	DM-14	Capacity improvement of the maintenance staffs
	DM-15	Improvement of budget insufficiency for observation
	DM-16	Repair of equipment a

Source: JICA Survey Team

3.10 Trinidad and Tobago

3.10.1 Issues on Disaster Prevention Administration

The Office of Disaster Preparedness and Management (ODPM) is the disaster management organization for the whole country of Trinidad and Tobago and the island of Trinidad, while the Tobago Emergency Management Agency (TEMA) is in charge of Tobago Island only. The practice operation of the Emergency Operation Center (EOC) under ODPM is conducted at least once a year. ODPM has substantial staffs and no particular issue is identified in terms of staff and budget.

The District Management Unit is the one responsible to conduct field response actions under the Ministry of Local Government (MOLG). The department and sections in charge of the disasters are required to do field response actions. However, the personnel do not have enough experience and their capacity building is necessary.

3.10.2 Issues on Structural Measure

(1) River

It is the responsibility of the drainage unit under the Ministry of the Environment and Water Resource to take flood control and mitigation measures.

The downstream area of the Orpouche River extends in low-lying area and suffers inundation damages every year from flood. That area functions as a retarding basin where it is dotted with residential houses, which suffers inundation damages every year.

There are seven main river basins in Trinidad Island, out of which the integrated water resources management plans have been formulated for the four basins. In another river basin in the southern Trinidad Island, a water resources management plan is under preparation by a foreign consultant.

In the four river basins, the plan formulation stage is followed by the design stage at present. The remaining three basins are expected to proceed to the formulation of water resources management plans.

It is judged that no issue is identified in terms of the river structural measures because they have been working on from a drastic point of view.

As for the dams and reservoirs, the dams for water supply purpose are located at three sites in Trinidad Island as well as one site in Tobago Island. Dams were constructed long ago and it is currently significant of sedimentation in reservoirs.

Table 3.10.1 Dams in Trinidad and Tobago

Name	Location	Completion	Reservoir Area	Storage Volume (Million m^3)
Navet	Trinidad Island	1962	324 ha	1.90
Hollis	Trinidad Island	1936	unknown	4.75
Hillsborough	Tobago Island	1952	unknown	1.02
Arena	Trinidad Island	unknown	680 ha	unknown

Source：Water and Sewerage Authority (WASA)

(2) Coast

The measures for coastal erosion are implemented by the Coastal Zone Unit under the Ministry of Works and Infrastructure. The remarkably affected areas by coastal erosion are in the coastal areas of the east, south-east, and south-west of the island. Countermeasure works for coastal erosion have been executed with priorities provided by the coastal zone management plan. In some locations where shoreline retreat is remarkable, the maintenance and restoration works are carried out according to the respective site situations.

It is intended to implement the countermeasure works based on the coastal zone management plan with national fund or the Inter-American Development Bank (IDB) fund.

(3) Road

The roads in Trinidad and Tobago extend for about 9,600 km in total including the highways main road, and secondary road. The management and maintenance of the main roads, which accounts for about 20% of the total length, are the task of the Ministry of Works and Infrastructure.

The other rural roads and farm roads are maintained by the Ministry of Local Government.

As far as the major roads are concerned, the visual road inspection is conducted once about three months by the Ministry of Works and Infrastructure, but no road inventory is available.

1) Sediment Disaster on the Coastal Road in Northern Trinidad

Around the northern coastal road, the slope failure along the road is caused by steep topography and weak geology distributed. No fundamental measure is taken but ad hoc measure such as removing collapsed sediments.

2) Networking of Roads in the Northern Area of Trinidad

The present situation along the north coastal line is that the roads between Port of Spain and Blanchisseuse as well as between Toco and Matelot are separately available but no link road between Blanchisseuse and Matelot. Previously, Matelot was isolated due to interruptions on the road going to Matelot.

Source : Map got from https://photosandmotors.files.wordpress.com/2010/04/trinidad_1.gif , arranged by the JICA Survey Team

Figure 3.10.1 Disaster Vulnerable Area in Trinidad and Tobago

3.10.3 Issues on Non-structural Measures

Various hazard maps have been prepared and are available. The disaster mitigation map disclosed on the homepage (HP) of ODPM indicates not only the risk area of landslides and floods but also the locations of shelter, hospital, police office, fire station, and evacuation routes by the administrative districts. It is possible to browse easily on HP those disaster mitigation maps shown in the geographic information system (GIS-ESRI: Environmental Systems Research Institute)

The earthquake hazard map in Trinidad is published on HP of the Seismic Research Center

The detailed assessment for earthquake was undertaken in the Country Risk Evaluation Project supported by IDB, which was completed in November 2011.

The Trinidad and Tobago Seismic Microzonation Studies Project covering the Port of Spain and several other cities are being implemented with the national budget of the Ministry of Planning and the Economy amounting to TT$11 million, which is equivalent to about US$1.7 million for ten years.

Considering the present situation mentioned above, it is said that the hazard maps are well prepared and available.

(2) Building

Earthquake Resistant Design Standard

In Trinidad and Tobago, the AASHTO standard is applied as the civil works standard. Although the National Building Code is not available, the Trinidad and Tobago Bureau Standards, 2006 is applicable as the Small Building Code for the design and construction of a relatively small-scale building such as a residential house, in which code descriptions regarding hurricane and earthquake are included.

It is being invested for the earthquake-resistant reinforcement of public facilities such as schools and hospitals although the earthquake-resistant code is not sufficiently applicable in Trinidad and Tobago.

Buildings in Trinidad and Tobago sometimes suffer damages from earthquakes, hence, the National Building Code incorporating more detailed earthquake-resistant criteria shall be developed and such code needs to be spread well.

(3) Measures to be Taken Against Sediment Disaster

The road management and maintenance is undertaken by the Ministry of Works and Infrastructure, of which the slope failure disasters along the road is concerned by the Programme for Upgrading Roads Efficiency (PURE). PURE is responsible for the services including slope stabilization measures of the main road, restoration of road, detour construction, and traffic management, for which the services PURE undertakes are the investigation, design, and project management.

Every year, the road disasters due to slope failure and landslide are caused across the country, for which PURE mainly carries out rehabilitation works with the national budget. As structural measures, such measures are taken including the concrete retaining wall, gabion, steel sheet piles, concrete spraying, drainage structures as well as the ground anchoring and steel piling as rather high techniques. Prior to the structural design, geological investigation is conducted. As such, it has a certain technical capabilities for sediment disasters in Trinidad and Tobago.

Meanwhile, the following are the present issues: i) road inventory becomes unavailable; ii) the design standard and guideline for the slope countermeasure works are not satisfactorily prepared; iii) the slope monitoring technology and the early warning method are not responsive and understood; and iv) restoration works are not appropriately done. Taking such present situations into account, it is desired to further strengthen the engineering capacity, especially for investigation and design.

On the other hand, the national budget and fund are sufficiently enough.

3.10.4 Issues Related to Meteorological and Hydrologic Observations

(1) Malfunction of Transmission System of Observed Information

Data transmission to the main office in the Port of Spain from the stations located in the south-east and southern parts of Trinidad Island have not fulfilled its automatic transmission function since the beginning because of some communications defect. It is supposed that site conditions for communication and O&M of the stations are not adequately considered at the design and/or installation stages.

(2) Insufficient O&M Services for the Existing Observation Equipment

In Trinidad and Tobago, there are manned observatories at the two airports as well as meteorological and agro-meteorological automatic weather stations (AWS) at six locations.

Data transmission to the main office from six AWS is designed to be by radio communication, however, in the present situation, data stored in data logger are downloaded and hand carried by the staff instead of automatic transmission due to some defects such as power source, radio communication parts, and telecommunication troubles.

3.10.5 Related Issues on Disaster Prevention in Trinidad and Tobago

Based on assessment and evaluation of the aforementioned issues, several issues in Trinidad and Tobago are identified as listed in Table 3.10.2.

Table 3.10.2 Issues Related to Disaster Management in Trinidad and Tobago

Field	No.	Issue
General for Disaster Management	TT-1	Capacity improvement of the staff of the Ministry of Local Government
Sediment	TT-2	Mitigation of slope failure along the North Coastal Road in Trinidad Island
	TT-3	Building of the northern road network
	TT-4	Capacity improvement of PURE for slope stabilization works
Earthquake	TT-5	Development of the standard design methods against seismic load and wind load
Drought	TT-6	Mitigation of sediment silting in the reservoirs
Meteorological Observation	TT-7	Improvement and troubleshooting of the observed data transmission system
	TT-8	Improvement of maintenance of the observation facilities

Source: JICA Survey Team

3.11 Barbados

3.11.1 Issues on Disaster Prevention Administration

Barbados applies the Regional CDM Strategy prepared by CDEMA because Barbados has no national disaster prevention strategy. The Department of Emergency Management (DEM) has no intention to establish its own strategy.

DEM has less personnel and insufficient budget, which lead to devote themselves to the coordination only in disaster management.

As for the disaster mitigation education, DEM carries out the public relations activities by preparation of pamphlets regarding various disasters.

3.11.2 Issues on Structural Measures

(1) River

No large river exists in Barbados. Small rivers become underground rivers during dry season because the island is composed mainly of limestone for about 80%. While in the rainy season, the discharge from the limestone layer causes flood damage. Among those, the rivers in the town area, which cause flooding, are rivers in Speightstown and Holetown. The river within Speightstown completed its improvement, and the upper reach is said that improvement will be done with the national budget. The river in Holetown has improved its flow capacity.

As for the measures for the discharge from the limestone layer, it was studied by "Barbados Storm Water Drainage Study, CDB & GoB" in 1996, but no implementation yet.

(2) Local Drainage

The surrounding area of the Garden Land in Bridgetown is a flood plain. Inundation is caused due to small capacity of the secondary channel, which connects to the main channel around the flooding area. The main channel finally meets the Constitution River.

(3) Coast

Coastal erosion issue is identified in Barbados and the Coastal Zone Management Unit prepares the management plan concerned.

(4) Road

The roads in Barbados extend for about 1,600 km in total including the main highways, major road, and ordinary road. Road management is the task of the Ministry of Transport and Works, but no regular inspection is conducted.

The Soil Conservation Unit under the Ministry of Agriculture is in charge of slope stabilization measures in the Scotland District where the area is vulnerable for sediment disaster. The same unit copes with slope failure and landslide on the road by constructing the gabion made retaining wall, gabion made channel works, and groundwater drainage works. Those construction works are based on their field experience but without structural calculation. In addition, no design standard or design guideline is available. Furthermore, it is assessed that capacity of sediment disaster management of the Soil Conservation Unit is not enough taking into account of that they are not familiar with the slope monitoring technique as well as early watching technique.

1) Damages Caused by Landslide at the Saint Joseph Church Area

The Saint Joseph Church is located along the main road No.3 in the Scotland of Saint Joseph Parish where there are residential houses and churches therein. In the said district, roads and houses have been suffered damages from sluggishly moving landslide. According to the Soil Conservation Unit, Scotland area is the most critical area in Barbados although no survey and investigation for the landslide movement are conducted and any countermeasure is taken. It is required to take some measures for the aforementioned landslide.

2) Damages Caused by Landslide at the White Hill Area

The White Hill is one of the sediment disaster prone areas in Barbados where damage on the road was caused. The landslide caused traffic suspension in the area due to about 80 m wide but no measure is taken by the Ministry of Transport and Works. Hence, the road restoration works is necessary including landslide countermeasure.

3) Land Subsidence

Barbados is composed of limestone for about 85% of the island; hence, complicated groundwater veins are formed underground as well as cavity. In August 2007, the residential area in Brittons Hill District suddenly subsided. Furthermore, the subsidence damages on the road were caused in Dash Valley District of Saint George after the torrential rain on November 21 and 22, 2014.

(5) Bridge

Damages are found in the abutments of two bridges on the trunk road No.2 in Scotland. It was temporarily reinforced by the H-beams but there is no plan for a bridge replacement. The trunk road No.8 is used as the land transportation route for the sand, for which there is a diversion route even though it is long detour.

There is damage in the Bawden's Bridge on the road, which is not a main one but used for a bus route. Traffic is suspended at the bridge site and another detour road is used for the bus route.

http://www.caribbean-on-line.com/br/images/Barbados.gif

Figure 3.11.1 Disaster Vulnerable Area in Barbados

3.11.3 Issues on Non-structural Measures

(1) Hazard Map

Hazard maps for the earthquakes, flood, and landslide are available. However, the hazard map for earthquake is not so accurate as to be used for the formulation of the earthquake disaster mitigation plan even though the hazard map is disclosed on HP of the Seismic Research Center.

(2) Community Disaster Prevention

The government and the people have high concerns on earthquake and tsunami, however, their related knowledge is poor. In addition, because there is no definite plans regarding earthquake and tsunami, the materials for the residents education is inevitably to be general one.

(3) Building

1) Earthquake Resistant Design Standard

The AASHTO standard or BS is applied as civil works standard in Barbados. The Barbados National Building Code enacted in 1993 is applicable as the national building code but the earthquake-resistant standard was not confirmed of its availability.

Buildings in Barbados suffer damages from earthquakes many times, hence, the design code related to the earthquake shall be developed as an individual one by each country or as unified one in the CARICOM area. The said code needs to be spread well. While, there is no building with anti-seismic reinforcement and no base isolation structure.

(4) Other Issues

1) Earthquake Disaster Prevention Plan for Bridgetown

The government and the people have high concerns on earthquake and tsunami and recognize the necessity of earthquake disaster mitigation plan, but it is not decided yet. It is because there is no know-how on the preparation of the earthquake disaster mitigation plan by the concerned agencies and that no budget is available for such action.

In 2007, an earthquake with magnitude of 7.4 occurred around Barbados and it caused injured residents and building collapsed, hence the earthquake disaster mitigation plan shall be decided and spread in the country. It is proposed to decide such plan for Bridgetown as a priority target area.

2) Evacuation Plan for Tsunami

Both the government and the people have high concerns on earthquake and tsunami, but no evacuation plan is prepared in case of tsunami.

3.11.4 Issues Related to Meteorological and Hydrologic Observations

(1) Insufficient Meteorological and Rainfall Observation Systems

Meteorological observation stations including synoptic ones and exclusive rainfall stations in Barbados are composed of automatic observation and transmission stations at three locations, two automatic ones under preparation of installation, and manned rainfall stations operated in the private plantation. Those five automatic observatories including the ones at the airport are located in the southern area of the island. Even though the rainfall observation stations located in several plantations are not specifically identified of its locations, most of the sugarcane plantations have been abolished and the remaining rainfall stations are located in the southern area of the island.

There is concern about sustainability of rainfall observation because of the following issues:

The rainfall stations under the meteorological service office is scarcely located in the central area, north-east area, and northern area of the island;

Some doubt is observed in terms of accuracy of the observation in the plantation; and

Active plantations have been decreased.

(2) Improvement of Database System

Meteorological information of satellite pictures and domestic observation information including the meteorological radar monitoring information are integrated in the computer data server of the operation center in the main meteorological office located at the airport. The computer hardware

seems to have no particular issue. However, it seems difficult for effective information retrieval since the operation system of the database system is out-of-date.

Furthermore, the access to that database system is available only in the operation center and data sharing with the related agencies is difficult because of the old style system.

(3) O&M Service of Meteorological Radar Station

The meteorological radar system, which was replaced in 2008 with the European Union (EU) grant aid, is required to secure its steady operation since Barbados plays a key role in CMO, and that Barbados is located in the most eastern area of the East Caribbean countries.

The radar system was suspended in operation due to replacement of parts at the time of this survey in Barbados. It is necessary to secure sustainable O&M system and budget to cope with issues such as: i) lack of spare parts; ii) only two operation staffs including one each of radar engineer and electrical engineer; and iii) to require solar power system against rather costly electrical charge of US$18,000/year of annual O&M cost of US$25,000/year.

3.11.5 Related Issues on Disaster Prevention in Barbados

Based on assessment and evaluation of the aforementioned issues, several g issues in Barbados are identified as listed in Table 3.11.1.

Table 3.11.1 Issues Related to Disaster Management in Barbados

Field	No.	Issue
General for Disaster Management	BA-1	Determination of National Disaster Management Strategy
	BA-2	Increasing of staffs of DEM
	BA-3	Improvement of budget insufficiency of DEM
	BA-4	Capability improvement of DEM staff
Flood	BA-5	Mitigation of Flood Caused by spring coming out from limestone cracks
	BA-6	Preventive measures inundation in Bridgetown due to the landside water
	BA-7	Rehabilitation of the damaged bridges on No. 2 trunk route
	BA-8	Rehabilitation of damaged Bawden's Bridge
Sediment	BA-9	Mitigation of damages due to Landslide in St. Joseph's Church Area
	BA-10	Mitigation of damages due to landslide in White Hill
	BA-11	Identification of risky caving in of the land
	BA-12	Capacity improvement of the Soil Conservation Unit regarding slope stabilization
Earthquake	BA-13	Development of standard design methods against seismic load and wind load
	BA-14	Formulation of disaster mitigation plan for earthquake in the capital
Tsunami	BA-15	Preparation of evacuation plan for tsunami
Meteorological Observation	BA-16	Improvement of meteoro-rainfall observation network
	BA-17	Enhancement of a database system

Source: JICA Survey Team

3.12 Belize

3.12.1 Issues on Disaster Prevention Administration

The operation of NEMO is held in the headquarters located in the capital Belmopan and the regional offices are established in the respective districts. The activities of the regional office are made in close contact with the communities. The disaster prevention facilities are sufficient ones with appropriate management by assignment of O&M staffs.

However, there is staff insufficiency issue since the actual number of technical staffs is seven for the 14 technical positions. NEMO is going to fill such vacancy by outsourcing, but it is rather difficult to find the applicants because of lower salary level than that in private sector.

As to the capacity building of the existing staffs, the internal training is executed and the excellent staffs are dispatched to participate in the training program undertaken or supported by CDEMA as well as other donor agencies such as UNDP, IDB or including JICA training. No particular issue would be identified provided that efforts of such capacity building are sustained by participating with the internal and outside training programs.

Regarding the budget for NEMO, it is allowed to secure an additional budget in case the estimated expenditure will exceed its original budget amount. However, an excess of expenditure over the original budget shall be suspended and any operations shall be made within the original budget until the time when the additional budget is approved. Similarly, in case that the expense of an item exceeds the budget amount of the same item, adjustment between items is allowed with necessary approval of reallocation. It seems that there is no issue of budget insufficiency in terms of budget amount but another issue of the budget is the flexibility use, which might affect emergency actions.

In addition to the above, the vehicles as well as equipment and materials for rescue are not sufficiently available.

3.12.2 Issues on Structural Measures

(1) River

Belize suffers two types of floods, one is the overflowing of large rivers in the low-lying plain of the Belize River basin in northern Belize, and another is the flash flood caused by rivers originating from the south-eastern mountain region. Feature of most of the rivers is of natural river without dike protections and levee excluding the bridge sections and main cities area.

Crooked Tree Village in the lagoon of the Belize River is isolated in the rainy season since the sole access road to the village is suspended to traffic due to inundation.

(2) Coast

In many cities in the coastal area, the coastal facilities are constructed and maintained with the seawall and mangrove forest even though there are many places damaged by coastal erosion. The causes of such coastal erosion are estimated as follows:

Change of land use condition such as decrease of the forest;

Gradual changing of ocean current characteristics; and

Decrease of river discharge caused by irrigation water intake.

Particularly in the southern coastal zone from Dangriga, the coastal erosion is progressive in the last 30 years.

(3) Road

1) Narrow Bridge on Hamming Bird Highway

The main roads in Belize are as follows:

- Road connecting Belize City and Belmopan;
- Road connecting Dangriga and Belmopa;
- Road from Belize City going to Mexico;
- Road from Belmopan going to Guatemala; and
- Road from Dangriga going southward.

Among those, the road that links Dangriga and Belmopa is called as the Hummingbird Highway, which is the important trunk road connecting the capital Belmopan and the southern regions and important as well, connecting the southern regions and the largest city of Belize City through the capital Belmopan. There is another coastal road between Dangriga and Belize City, which is, however, unpaved road and difficult to use as a main road during the rainy season or disaster.

Under such situation, the Hummingbird Highway is of high importance as a trunk line as well as evacuation road and transportation route during disaster, although this is a road with double lanes only and narrow bridges at six locations with single lane without sidewalk.

Under such situation, the Government of Belize has conducted the design with the grant aid of the Kuwait government for the improvement works of the Hummingbird Highway. Improvement works for the entire route is divided into four sections, and the No.1 and No.4 sections will undertake construction (improvement) works with the Kuwait loan. It is under tendering process now.

On the other hand, the No.2 and No. 3 sections finished their design stage where the narrow bridges are located therein. Furthermore, the other roads construction/rehabilitation works will be undertaken with the loans of WB and IDB, therefore, the total foreign credit amount from the donors reached to the maximum. In view of such financial constraints, it is hard to execute the improvements of No.2 and No.3 sections even though the effects of No.1 and No.4 improvements will weaken unless the entire sections are facilitated with double lanes in minimum through the narrow river improvement.

In this connection, it is very important to improve the narrow bridges in No.2 and No. 3 sections. The synergy of both improvements under the Kuwait loan and those for No.2 and No. 3 sections are considered great.

2) Deterioration of Halilover Bridge

The Halilover Bridge as the gateway of Belize City, the largest city in Belize, has passed several decades already after construction. It is a high requirement to reconstruct the bridge so as to ensure access to the area where it is the most populated in the country. This replacement is scheduled to be undertaken with CDB supports.

3) Disaster Mitigation of the Slope along Road

Sediment disasters in Belize mainly triggered in the mountainous region. It is not recognized as a serious issue because the disaster area is scarcely populated.

Collapse of the road side slopes occurred on the trunk road passing through the mountain regions. In such occurrence, such temporary measures are repeatedly taken like traffic is temporarily suspended to remove sediment on the road and then open to traffic again.

No survey has been made concerning occurrence distribution of the sediment disasters; hence, the fact-finding survey on the occurrence of sediment disasters must be primarily necessary.

3.12.3 Issues on Non-structural Measures

(1) Hazard Map

The flood hazard map is under preparation with the ongoing CHARIM (Caribbean Handbook on Risk Management) led by WB. The integrated hazard map of strong wind, storm surge, and coastal erosion were prepared under the Caribbean Disaster Emergency Response Agency (CDERA) for San Pedro in Ambergris Caye as the pilot objective survey area.

Regarding the sediment disaster hazard map, it is not prepared yet because the objective area will be the southern mountain region with scarce population, although a necessity is recognized.

The aforementioned hazard map prepared by CDERA is the one covering a wide range and is based on the risk assessment applying the existing topography with low spatial resolution and the existing seabed topographic data. It is, therefore, pointed out that the said hazard map is not sufficiently accurate. It is necessary by applying DEM with high spatial resolution and more accurate seabed topographic data to carry out a risk assessment for storm surge and coastal erosion, and to improve hazard map accuracy.

Source: http://www.bluemapguide.com/belize-map/

Figure 3.12.1 Disaster Vulnerable Area in Belize

(2) Community Disaster Prevention

The Red Cross has been working on educating the community on disaster prevention in collaboration with NEMO. However, Red Cross encounters difficulty to promote the education activities as programmed due to insufficient budget.

(3) Building

Taking the occasion where Belize suffered damages from Hurricane Mitch in 1998, the Organization of American States (OAS) and USAID established the Belize Residential Construction Guidelines and the Belize Building Standards in May 2000 to respond to a middle scale earthquake.

An earthquake with magnitude of 7.3 occurred off Honduras in 2009 that caused residential damages in the southern regions. Regardless of such experience, the aforementioned guideline and standards have been seldom applied, but the designers apply the building codes of the countries where he/she learned the building technology.

(4) Other Issues

1) Earthquake Disaster Prevention Plan for Metropolis and Evacuation Plan for Tsunami

The houses in the southern regions suffered damages from the earthquake that occurred in 2009. Although the scale of the tsunami was small, the damage was feared. There is a high potential risk of tsunami and earthquake in Belize, but flood disasters are prioritized in the establishment of measures according to its frequent occurrence. Thus, the Earthquake and Tsunami Plan targeting the whole country has been formulated in April 2015, which is subject to the cabinet approval as of July 2015. Meanwhile, the disaster prevention plan for earthquake in the capital and the evacuation plan for tsunami in the coastal cities are not formulated yet.

2) Drought

Belize suffered severe drought in 2010. There is a little rainfall originally in the northern regions where there is a major sugarcane production area. Belize depends on the surface water for irrigation water, therefore, the amount of rainfall greatly affect the production. In Belize, surface water covers more than 90% of presently available water resources.

As described in Sub-clause 2.12.1, the annual rainfall amount is 1,500 mm and 3,800 mm in the northern and southern regions, respectively. There is a difference of rainfall between the northern and southern regions, and between the rainy and dry seasons. Seasonal rainfall variation is not regulated and river flow during the rainy season discharges directly into the sea because there is no regulating dam in the northern regions, therefore it causes drought condition in the dry season.

It is necessary to study the development of groundwater as a measure for drought as well as the development of dam and reservoir to regulate seasonal variation of surface water.

3.12.4 Issues Related to Meteorological and Hydrologic Observations

Meteorological and hydrologic observation services are conducted by the National Meteorological Service (NMS) under the Ministry of Labor, Local Government, Rural Development (MLLGRD) and the hydrology unit under the Ministry of Natural Resources and Agriculture (MNRA).

MLLGRD-NEMO-NMS

The meteorological service is conducted with 26 staffs including 21 technical staffs. The service is conducted with the synoptic stations at 20 locations nationwide and automatic stations at eight locations. Out of the automatic stations, five locations have been established by 5Cs and three locations by the Belize government. In addition, it is scheduled to install additional automatic observation stations at 20 locations in 2016, for which procurement of equipment will be completed by October 2015.

Hydrology Unit

The hydrology unit is operated with extremely insufficient number of staffs that are four persons only.

At present, the river water level observation is conducted at 32 locations. Manual observations are carried out for two times at 6:00 a.m. and 6:00 p.m. every day, which results are reported three times a week on Monday, Wednesday, and Friday. Even under a condition of limited staffs and budget constraint, regular and periodical data collection is required to be realized.

(1) Improvement of Observation System of National Meteorological Service

The number of O&M staffs is only three including one for equipment and two for electrical matter. There is a plan to increase the automatic observation stations from existing eight to proposed 28, and

therefore, insufficiency of the O&M staffs will be more critical. Meanwhile, increasing O&M staffs and their capacity improvement is difficult due to insufficient budget.

(2) Reinforcement of Hydrology Unit

The hydrology unit, which has been under the Ministry of Natural Resources and Agriculture since 2012 has been conducting the hydrologic observation of surface water at 32 locations by four staffs, thus, regular observation is rather difficult.

(3) Improvement of Versatility of Database System

The meteorological and hydrologic observation data is managed in other country's database systems in the related agencies such as CIMH and in Costa Rica to date. Currently, the plan to be realized is to unify such systems into the national database system for versatile use and the existing ones would be utilized as a backup system.

3.12.5 Related Issues on Disaster Prevention in Belize

Based on assessment and evaluation of the aforementioned issues, several issues in Belize are identified as listed in Table 3.12.1.

Table 3.12.1 Issues Related to Disaster Management in Belize

Field	No.	Issue
General for Disaster Management	BZ-1	Improvement of insufficiency of staff of NEMO
	BZ-2	Prompt processing for addition and reallocation of NEMO budget
Flood	BZ-3	Improvement of narrow bridge on the major trunk road(Hummingbird Highway) to secure traffic capacity
Sediment	BZ-4	Mitigation of Vulnerability to Sediment Disaster in the surrounding areas of Maya Mountains
Storm Surge	BZ-5	Mitigation of water surging and coastal erosion occurred in the coastal area
Earthquake	BZ-6	Formulation of disaster mitigation plan for earthquake in Belize City
Tsunami	BZ-7	Preparation of Hazard map and evacuation plan for tsunami
Earthquake/Strong Wind	BZ-8	Development of standard design methods against seismic load and wind load
Drought	BZ-9	Solution of water shortage in the northern inland
Meteorological Observation	BZ-10	Improvement of insufficiency of the maintenance staff
	BZ-11	Improvement of budget insufficiency for maintenance
	BZ-12	Capacity improvement of staffs of the meteorological service
	BZ-13	Database system used is developed in other country

Source: JICA Survey Team

CHAPTER 4 PROPOSED MEASURES BY NATION

4.1 Antigua and Barbuda

Table 3.1.1 demonstrates the identified issues regarding disaster management in Antigua and Barbuda. The JICA Survey Team scrutinized the issues and proposed countermeasures to mitigate the issues. The JICA Survey Team proposed the terms until the initiation of the countermeasures as well.

4.1.1 General Matters for Disaster Management

(1) AB-1: Improvement of Insufficiency of National Office of Disaster Services (NODS) Staffs

1) Countermeasures

Increase in the number of NODS staff is crucial to solve the problem. The conceivable ways to increase the number of staff are: i) recruitment of candidates in the country and ii) transferring the staffs of other agencies to NODS.

(a) Recruitment of candidates in the country

The measure is to employ new staffs through recruitment in the country. In parallel with the recruitment, procedural preparation is required to secure the budget for the increase in employment cost to execute the measure smoothly.

(b) Transferring the staffs of other agencies

There may be a case where staffs are to be transferred to NODS temporarily. In this case, the agency of the said staff will shoulder their salary. Therefore, the expenses of NODS are only for other expenses such as special allowances and no substantial increase in budget is necessary. The measure is practical for NODS provided that necessary legal preparation is completed. Further, it is natural to consider that the transferred staff has strong channels with his mother agency. The measure is expected to strengthen the cooperation between NODS and the agency.

2) Term until initiation

It may take a certain time for the abovementioned preparatory works. Subsequently, the term would be medium span to long span.

The terms are defined as follows: the short term is within five years, the medium term is within ten years, and the long term is over ten years.

3) Others

The proposed measure to increase the number of staff requires the establishment of internal procedures like the preparation of budget and personnel changes. The activities for the implementation of the measures are to be conducted by the government itself.

(2) AB-2: Capability Improvement of NODS Staff

1) Countermeasures

The required fields for capacity building are planning, monitoring, assessment, and project/program management. The root cause of this is the limited budget for capacity building. However, capacity building through participation in the seminars and trainings to be conducted by donors or Caribbean Disaster Emergency Management Agency (CDEMA) could be a practical solution. In this connection, a program that facilitates dissemination or sharing of acquired knowledge to other staffs within NODS may be effective to enhance the capacity of NODS. The study on the program is another countermeasure.

2) Term until initiation

Capacity building is an urgent requirement and can be started with the existing staffs. The term for the initiation could be short or medium.

3) Others

In addition to the attendance in training, utilization and practice of the knowledge sharing system to be developed by NODS could be effective to enhance the capacity of NODS as a whole.

(3) AB-3: Improvement of Budget Insufficiency of NODS

1) Countermeasure

So far, the government focuses only on hurricane as a natural disaster. It is necessary to encourage members of the National Disaster Executive (NDE) and the National Disaster Committee (NDC) to pay attention to other natural disasters and to secure additional budget for preparedness. Further, the preparation of regulatory procedures to transfer a staff of another agency to NODS under the condition that the salary is paid by the original agency is tantamount to increasing the budget of NODS. The regulatory preparation should be completed within five years and the period of the transfer should be 2 to 3 years.

2) Term until initiation

The terms until initiation should coincide with that of the increase in number of staff inter alia medium term or long term.

3) Others

Action of the central government is necessary for regulatory preparation because inter-ministerial coordination is fundamental.

(4) AB-4: Governance

1) Countermeasures

Preliminary diagnosis identified problems as 1) the existing regulatory preparations for disaster management are outdated and 2) NDC and NDE are less concerned on disasters other than main disasters. The countermeasures thereof are: 1) update of regulatory preparation and 2) formulate a seismic disaster prevention plan for the capital and a tsunami disaster prevention plan for the urbanized areas along the seashore since damages caused by these disasters are mostly significant although the frequency of occurrence is rather low. Further, NODS should take initiative to conduct evacuation training and development of shelters in line with the programs proposed in the above formulated plans.

2) Term until initiation

CDEMA has issued the Comprehensive Disaster Management Strategy in 2015, which indicates the time frame of various disaster management activities. The timing of the legal update for disaster management and plan formulation on disaster management against disasters with low occurrence frequency but with significant damage would be in line with the proposed time frame in the strategy including the formulation of seismic disaster prevention plan and a tsunami disaster prevention plan. However, sufficient manpower is imperative to implement the proposed countermeasures. Short and medium terms should be envisaged for initiations of the countermeasures.

3) Others

NODS is responsible to prepare the draft amendment plan on the law for disaster management and submit it to the assembly. On the other hand, various technical investigations and analyses are crucial to formulate plans for disaster prevention against earthquake and tsunami. It may be a practical option to request assistance from donors on these matters.

(5) AB-5: Strengthening of Cooperating System of NODS with Domestic Organizations

1) Countermeasures

In general, cooperation between two ministries is seldom in the country. As discussed in the above countermeasure AB-1, insufficient number of staff, transferring staffs from other agencies will foster mutual reliance and will contribute in building the basis of cooperation. After 2 to 3 years since the transfer, when the staffs return to their mother agency, it may be another opportunity for the agency to tie up with NODS.

2) Term until initiation

In line with the countermeasure for the insufficient number of staff, medium or long term is necessary for the implementation.

3) Others

The central government should take initiative for coordination since the matter is dependent on the cooperation among the ministries.

(6) AB-6: Strengthening of Community-based Disaster Mitigation

1) Countermeasure

The Regional CDM Strategy envisions the regional or country-based disaster mitigation plan, and community-based activity is seldom to be seen in this field. The staffs of NODS should enhance their knowledge about community-based disaster mitigation through trainings and pilot projects to be implemented by donors as the first step. In addition, trainings for community disaster mitigation should be conducted all over the island in collaboration with the Red Cross.

The staffs of NODS should train volunteers in order to raise sufficient number of instructors on disaster mitigation for communities because the insufficiency in the number of staff makes it difficult for NODS to instruct the communities directly.

Evacuation training claims a certain amount of cost. A representative training of evacuation is effective if the budget does not afford field training.

2) Term until initiation

The measure requires a step-wise implementation as the trainings of the NODS staffs as well as the volunteers are sufficient to the whole communities in the island. In this respect, the terms of measure should be medium to long term.

3) Others

The trainings by donors or CDEMA are important for the staffs of NODS until they understand community disaster mitigation and implement it effectively. However, NODS or Red Cross could implement the measure by themselves thereafter.

Table 4.1.1 summarizes the issues, countermeasures, and terms regarding general disaster management.

Table 4.1.1 Issues, Countermeasures and Terms Regarding General Matters for Disaster Management in Antigua and Barbuda

No	Issue	Countermeasure	Terms	Others
AB-1	Improvement of insufficiency of NODS staff	Recruitment Temporary transfer of staffs from other ministries	Medium Long	Action by the central government is fundamental
AB-2	Capacity improvement of NCCR staff (Community-based disaster mitigation)	Participation in the training programs to be held by donors and CDEMA Knowledge sharing system	Short Medium	Offering of effective training programs by donors and CDEMA Development of knowledge sharing system by NODS
AB-3	Improvement of budget insufficiency of NODS	Securing of budget	Medium Long	Negotiation of NODS with the central government
AB-4	Governance	Amendment of Disaster Management Act Preparedness against earthquake and tsunami with low occurrence frequencies	Short Medium	Amendment by NODS Request to donors to formulate disaster mitigation plans for earthquake and tsunami
AB-5	Strengthening of cooperating system of NODS with domestic organizations	Transferring of staffs of other agencies to NODS	Medium Long	Control by NODS and the central government

No	Issue	Countermeasure	Terms	Others
AB-6	Strengthening of community disaster mitigation	Training of NODS staffs Training of volunteers Community disaster mitigation headed by volunteers	Medium Long	Offering of effective training programs by donors and CDEMA Development of program to bring up volunteers by NODS

Source: JICA Survey Team

4.1.2 Flood

(1) AB-7: Elimination of Submergence of the Low Lying Flat Plain

1) Countermeasures

The development of the flat plains was remarkable in the period from 1950 to 1990 because the influences of hurricane to these areas were not so significant in the same period although these areas should have been reserved for natural retarding basins for the flood water. However, hurricanes that made landfall in these areas after the 1990s and the flood damages in these areas have become significant.

Today, basin-wide flood management is necessary because the areas were developed without substantial flood prevention works and the basin has lost these areas as they accept the flood water.

Further, the development in the upstream areas has amplified the peak discharge of flood. The development therein has increased the sediment concentration of the flood water.

In addition, water shortage for utilization becomes significant today. Eventually, the formulation of an integrated water resources management (IWRM) plan is necessary to respond to water resources utilization, flood mitigation, and preservation of water resources including water quality or sediment concentration.

After the formulation of the IWRM plan, the measures proposed should be implemented in line with the formulated plan.

2) Terms until initiation

The formulation of the IWRM plan should be initiated in the short term considering the measures following the plan are urgently needed.

3) Others

Formulation of IWRM plan by the staff of the central government is not practical. The government should request technical assistance to donors on this matter. Employment of consultants using own budget is another option.

(2) AB-8: Mandate of the Administrator of River

1) Countermeasures

Reorganization is often after an election in Antigua and Barbuda. Sometimes reorganization means transferring a department of a ministry to another ministry. Eventually, the Ministry of Health and the Environment; the Ministry of Agriculture, Lands, Fisheries and Barbuda Affairs; and the Ministry of Works and Housing are mandated to manage the river basins now. However, there are some problems in the management of the rivers because the responsibilities of these three bodies are not clarified.

The countermeasure for the above is to establish a committee composed of the said three bodies. The committee will clarify the items to be implemented in relation to river management. Further, the committee will specify the responsible organization for each item. The responsibility specified should be provided in the documents such as laws and acts.

It is necessary to define the rules that will enable them to adapt to the reorganization.

2) Terms until initiation

The management of a river is a day-to-day work. Therefore, the term should be in a short span.

3) Others

The substantial work is to foster agreement among the three ministries. The measure could be conducted by the government.

(3) AB-9: Rehabilitation of Damage on the Bridge

1) Countermeasures

The bridge built in the vicinity of the airport was washed away completely. At present, the detour is available and the users have no significant inconvenience. The rehabilitation of the bridge is not necessary.

Only vehicles within the maximum allowable weight limits can pass through the Bandels Bridge according to the warning board placed beside the bridge. The road is a link connecting the trunk roads to the flood prone flat plains. The traffic on the road is heavy; thus, it is important for disaster management of these areas. Accordingly, the rehabilitation or renovation of the bridge is necessary.

2) Terms until initiation

Considering the importance of disaster mitigation and heavy traffic, the rehabilitation or renovation of the Bandels Bridge should be initiated within the short or medium term.

3) Others

It is desirable to rehabilitate or renovate the Bandels Bridge using own budget. However, the shortage of budget has hampered the construction of planned bridges and even the rehabilitation of damaged bridges in the country for the past ten years. Since the location of Bandels Bridge is important for disaster management, the need for rehabilitation or renovation thereof is urgent and the assistance from donors is advisable in order to remove the impediment in the rehabilitation or renovation of the bridge.

Table 4.1.2 summarizes the issues, countermeasures, and terms regarding flood management.

Table 4.1.2 Issues, Countermeasures and Terms Regarding Flood Management in Antigua and Barbuda

No	Issue	Countermeasure	Terms	Other
AB-7	Elimination of submergence of the low lying flat plain	Formulation of the Integrated Water Resources Management Plan	Short	Employment of consultancy firm by the central government or assistance by donors
AB-8	Mandate of the administrator of Rive	Establishment of a committee to define the responsibilities Preparation of the rules responding to reorganization.	Short	Agreements among the stakeholder ministries
AB-9	Rehabilitation of damages on the bridge	Rehabilitation or renovation of the Bandels Bridge	Short or Medium	Implementation by the central government Assistance by donors

Source: JICA Survey Team

4.1.3 High Tide, Earthquake, Tsunami, Strong Wind, and Drought

(1) AB-10: Planned Response to Coastal Erosion

1) Countermeasures

At present, the response to coastal erosion is rather haphazard. The establishment of a Coastal Area Management Plan is necessary to secure an integrated approach. The countermeasures should be in line with the plan.

2) Terms until initiation

The plan formulation of coastal zone management is the first step to respond to coastal erosion. The initiation of the plan formulation should be in the short term.

3) Other

The formulation of coastal zone management plan requires various fields of knowledge and experiences such as coastal engineering in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available for employment. Request for assistance from donors on this matter may be another option.

In this respect, capacity building of government staffs is necessary especially on coastal engineering. Participation in the training program to be held by donors is effective for capacity building. Acquired knowledge has to be shared with other staffs through knowledge sharing system to be established in the government. The enhancement of the technical level of the government is very important for sustainable disaster management.

(2) AB-11: Development of Hazard Maps Related to Earthquake
AB-12: Development of Disaster Mitigation Plan Against Earthquake for the Capital

1) Countermeasures

Earthquake is rather frequent in the country. However, there is no hazard map or risk map available. Maps are fundamental to formulate the disaster mitigation plan against earthquake for the capital. The premier countermeasure is to prepare a hazard map or risk map for the capital by compiling the assessed results of vulnerability by areas. The disaster mitigation plan will be formulated on the basis of the prepared hazard map identifying the evacuation routes and the allocations and layouts of the shelters.

2) Terms until initiation

The term for the initiation of the risk map preparation should be short since the occurrence of earthquake is frequent, and the map is the basic and urgent requirement for the disaster mitigation plan. Meanwhile, preparatory works such as development of risk maps may take a certain time before the formulation of disaster mitigation plan for the capital. The term for the initiation is short or medium span for the formulation of disaster mitigation plan.

3) Others

The formulation of disaster mitigation plan against earthquake requires various fields of knowledge and experiences such as seismology in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(3) AB-13: Formulation of Evacuation Plan for Tsunami

1) Countermeasures

Tsunami has brought high waves to Antigua and Barbuda. There are several hotels with access on beachfront situated on the flat coastal land. These beaches are vulnerable against high waves brought by tsunami. A hazard map is available but it is already superannuated.

In order to mitigate any casualty caused by a tsunami, the renewal of the hazard maps and the formulation of evacuation plan are necessary for identifying the evacuation routes and locations of shelters and evacuation sites.

2) Terms until initiation

Tsunami is not frequent but it is highly possible to bring serious damage once it occurs. Therefore, formulation of an evacuation plan is urgently needed. The terms for the initiation of the measure should be short or medium span.

3) Others

The formulation of the evacuation plan against tsunami requires various fields of knowledge and experiences such as maritime engineering in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(4) AB-14: Development of Standard Design Methods Against Seismic Load and Wind Load

1) Countermeasure

Among the targeted countries of the survey, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions depend on the designer. Different standards such as the American Association of State Highway and

Transportation Officials (AASHTO) and the British Standards (BS) have been adopted in the country. Some government engineers have asserted the necessity of standardization.

This issue is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of governments of related countries to study the applicability of the standards, which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, a specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for occurrence probability. The basic method is to estimate the intensity on the basis of assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by other countries together with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals, which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with an ordinary height for the eastern Caribbean area should be reviewed referring to the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure may require medium or long term for its initiation.

3) Others

The design standards of several countries are more or less in similar condition. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts from outside as observers to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

(5) AB-15: Solution of Sediment Siltation in the Reservoir of Potwork Dam

1) Countermeasures

Already 47 years have passed since the completion of Potwork Dam, one of the substantial water sources in Antigua Island. Sediment siltation in the reservoir is an obvious and serious issue now. The present water demand is high and the operation rate of the desalination plant is high as 70% even under the ordinary demand. The vulnerability against drought is the first concern in relation to water supply. Accordingly, the extension of the dam life is one of the most important measures to mitigate drought.

The structural measures to mitigate the siltation problem are: 1) to discharge the sediment in the reservoir through the sediment flush gates; 2) to discharge the sediment in the reservoir through sluicing pipe embedded in the reservoir; 3) to discharge flood water with a high sediment concentration through a by-pass tunnel or channel; and 4) dredging out by using a dredging boat. Meanwhile, non-structural measures envisage the decrease in productivity of sediment in the upstream watershed area such as 1) forestation in the upstream watershed areas, and 2) alteration in cropping patterns in the agricultural land in the upstream watershed areas.

The above measure to discharge the sediment trapped in the reservoir may cause environmental effects to the sea which accepts the discharge because the concentration of the discharge is high. The environmental impacts and the solution thereof are other issues.

Sediment silting and the eventual decrease in storage capacity of a reservoir are significant issues in Japan as well. All of the structural measures mentioned above are common practices in Japan. The second measure, sediment trap in reservoir, is rather new even in Japan. The Japan International

Cooperation Agency (JICA) is conducting experimental study on the sediment trap in the reservoir of Wonogiri Dam in Indonesia as the pilot project.

The sediment discharging to Toyama Bay from the reservoir of Unazuki Dam affected the environment of the sea due to the adverse impacts on the environment. The experiences in Japan are useful to formulate countermeasures to the sediment siltation problems in the country.

2) Terms until initiation

As mentioned in the preceding paragraph, a solution is an urgent need since water shortage is impending. The formulation of plan for the countermeasures is the first step, and the initiation of plan formulation should be in the short term. The implementation of the measure should follow the planning. Therefore, the initiation should be short or medium term.

3) Others

An experienced consultant could formulate the plans for the countermeasures proposed above. The government may employ a consultant using its own budget. To request assistance from a donor is an option for the formulation of the plan. The most significant issue to be tackled in the plan formulation is the minimization of adverse impact to the sea.

A contractor will construct selected measures along the plan formulated. Financing for the construction could be borne from own source or economic cooperation by donors. Economic cooperation may apply under either loan or grant system.

Table 4.1.3 presents the identified issues, countermeasures, and terms regarding high tide, earthquake, tsunami, strong wind, and drought in Antigua and Barbuda

Table 4.1.3 Issues, Countermeasures and Terms Regarding High Tide, Earthquake, Tsunami, Strong Wind, and Drought in Antigua and Barbuda

No	Issue	Countermeasure	Terms	Others
AB-10	Planned response to coastal erosion	Formulation of Coastal Zone Management Plan	Short	Employment of consultants by the central government or the cooperation from donor
AB-11	Development of hazard map for earthquake	Formulation of disaster management plan for earthquake that identify the evacuation routes and the location of shelters on the basis of the prepared hazard maps	Short and Medium	Employment of consultants by the central government or the cooperation from donor
AB-12	Development of disaster management plan for earthquake for the capital			
AB-13	Formulation of disaster management plan for tsunami	Formulation of disaster management plan for tsunami that identify the evacuation routes and the location of shelters	Short and medium	Employment of consultants by the central government or the cooperation from donor
AB-14	Development of design standard methods against seismic load and wind load	Establishment of a committee inviting experts from the related countries as members of the committee. The discussions in the committee will find the standards suitable to the local conditions.	Short and medium	The cost to be incurred by the committee will be shouldered by the budget of the member countries. Donors will dispatch observer as long-term experts
AB-15	Solution of sedimentation in the reservoir of Potwork Dam	Implementation of structural and nonstructural measures. Measure to alleviate adverse impacts to the sea by sediment discharge is necessary	Short and Medium term	Self-finance by the central government or the economic cooperation by donors

Source: JICA Survey Team

4.1.4 Meteoro-hydrologic Observation

(1) AB-16: Increase of Forecasters and Staffs for Maintenance of Equipment

1) Countermeasures

The existing staffs of the Meteorological Services are only 60% of the identified required number. Only two forecasters are on service while the allocated sheet stated seven. Although the serving staffs are insufficient, the Meteorological Service is providing observed data and forecasted information to the countries in the Leeward Island areas because Antigua and Barbuda is located in the focal point of the area.

The urgent need is to increase the number of forecasters to strengthen the services. The increase in number of staffs for maintenance of equipment is necessary as well.

The conceivable countermeasures are as follows:

(a) To recruit forecasters through the Caribbean Institute for Meteorology and Hydrology (CIMH) and the Caribbean Meteorological Organization (CMO).

(b) To recruit graduates of meteorological field and to train these recruited graduates in meteorological forecasting in CIMH.

There are some cases of mal-operation of the system. Facilities of data transmission are liable to cause problems. The recruitment of maintenance staffs specializing in data communication equipment is necessary.

2) Terms until initiation

The strengthening of forecaster's capability is an urgent need and the terms of initiation should be short term. Meanwhile the strengthening of maintenance staffs could be short and medium terms.

3) Others

Cooperation from CIMH and CMO is crucial for the recruitment and training of forecasters.

(2) AB-17: Improvement of Insufficient Capabilities of Meteorological Observer

1) Countermeasures

The Meteorological Service of Antigua and Barbuda is responsible to forecast the weather condition of other countries in the Leeward Island areas as mentioned before. To be a forecaster requires high capability. A high level training in CIMH in weather forecasting is necessary.

2) Terms until initiation

Early enhancement of capability in forecasting is necessary. However, the current forecaster is busy in the day-to-day works. The increase in number of forecasting staff is necessary prior to training in order not to hamper forecasting activities due to training. The additional employment of forecasters is the most urgent measure. The increase in staff number is needed in the short term and the enhancement of staff capability is needed in the medium to long term.

3) Others

Forecasting requires high and special capability. The measure should be implemented with the cooperation to be extended by CIMH and CMO.

Participation in training course provided by donors is effective as a countermeasure.

(3) AB-18: Improvement of Insufficiency of Budget Allocated to Meteorological Observation

1) Countermeasures

The approved budget for Meteorological Services is around 70% of the requirement. The budget to be allocated for the increase in staff number and maintenance of facilities is insufficient.

The countermeasures are to foster understanding of the central government and relevant ministry and to request them to strengthen the Meteorological Services.

2) Terms until initiation

The initiation should involve the negotiation of the budget for the next fiscal year. The term should be short.

(4) AB-19: Prompt Fixing of Damaged Equipment to Observe Meteoro-hydrology
AB-20: Improvement of Insufficient Capability in Maintenance of Meteoro-hydrologic Observation System

1) Countermeasures

An automatic observatory is established in Antigua and Barbuda. However, the defect in the communication system is kept unrepaired due to the capability of maintenance team. Therefore, real time collection of the observed data is not possible.

CIMH should conduct the training for maintenance of equipment especially on communication system. The staffs of the Meteorological Services should attend to the training to enhance their capabilities.

2) Terms until initiation

Many of the communication systems of the automatic observatories are out of order. The initiation should be in the short term.

3) Others

The measure should be implemented in cooperation with CIMH and CMO.

Participation in the training course provided by donors is effective as a countermeasure.

Table 4.1.4 presents the summary of issues, countermeasures, and terms for initiation regarding the meteorological and hydrologic observation.

Table 4.1.4 Issues, Countermeasures and Terms Regarding Meteorological and Hydrologic Observation in Antigua and Barbuda

No	Issue	Countermeasure	Term	Other
AB-16	Increase of forecasters and staffs for maintenance of equipment	Recruitment of forecasters through CIMH and CMO Employment and training of university graduates from the meteorological field	Short	Supports from CIMH and CMO are important
AB-17	Improvement of insufficient capabilities of meteorological observer	Training of meteorological observation staffs	Medium and Long	Support from CIMH or the training course of donors
AB-18	Improvement of insufficiency of budget allocated to meteorological observation	Understanding of the central government and the ministry through negotiation	Short	
AB-19	Prompt fixing of damaged equipment to observe meteoro-hydrology	Capacity building of maintenance staffs Repair of damaged equipment	Short and Medium	Support from CIMH or training course of donors
AB-20	Improvement of insufficient capability in maintenance of meteoro-hydrologic observation System			

Source: JICA Survey Team

4.1.5 List of Conceivable Projects

Table 4.1.5 demonstrates the projects proposed in due consideration of issues and countermeasures discussed above.

Table 4.1.5 List of Conceivable Projects in Antigua and Barbuda

No	Terms	Project Title	Component
AB-2	Short, Medium	Capacity building of NODs staff	1) Training for the formulation of disaster mitigation plan, monitoring and evaluation capability
AB-6	Medium, Long	Capacity building for disaster mitigation in the community	1) Training for disaster mitigation for community
AB-7	Short	Formulation of Integrated Water Resources Management	1) Formulation of water utilization plan 2) Formulation of flood management plan 3) Formulation of watershed preservation plan
AB-9	Short, Medium	Rehabilitation Plan of Bendals Bridge	1) Study on natural conditions 2) Design of the bridge 3) Study and design of the river banks 4) Construction planning and cost estimates 5) Construction
AB-10	Short	Formulation of Coastal Zone Management Plan	1) Diagnosis of the present conditions 2) Development of the hazard maps 3) Assessment of the priority of the sites and the predictions of the measure 4) Study on maintenance
AB-11 AB-12	Short, Medium	Formulation of Disaster Mitigation Plan for St. John's against Earthquake	1) Confirmation study on the existing situations 2) Update of the hazard map for earthquake 3) Study on evacuation route and evacuation shelter 4) Evaluation of risk and preparation of scenario 5) Plan formulation for disaster mitigation 6) Preparation of training materials like disaster mitigation maps and evacuation training 7) Fostering of leader for disaster mitigation facilitators
AB-13	Short, Medium	Formulation of Tsunami Disaster Mitigation Plan for the Urbanized Areas along the Coast	1) Confirmation of the present conditions 2) Preparation of hazard maps for tsunami 3) Study on evacuation route and evacuation shelter 4) Study on warning system 5) Formulation of disaster mitigation plan 6) Study on evacuation route and evacuation shelter 7) Fostering of leader for disaster mitigation facilitators and evacuation training
AB-15	Short, Medium	Countermeasure for Sedimentation of Potwork Dam	1) Study on the existing sedimentation 2) Evaluation of countermeasures 3) Construction plan and cost estimates 4) Construction or provision of equipment
AB-17	Medium, Long	Capacity Building of Meteorological Observer	1) Training to enhance the capability of forecaster
AB-20	Short, Medium	Capacity Building of Maintenance Staffs for Meteorological Observation Facilities	1) Training for the maintenance of equipment for meteorological observation (Especially the communication system)

Source: JICA Survey Team

4.2 Guyana

Table 3.2.1 demonstrates the identified issues regarding disaster management in Guyana. The JICA Survey Team scrutinized the issues and proposed countermeasures to mitigate the issues. The JICA Survey Team proposed the terms until the initiation of the countermeasures as well.

4.2.1 General Matters for Disaster Management

(1) GY-1： Capability Improvement of CDC Staff

1) Countermeasures

Capacity improvement of the CDC staffs is required through the training and sharing of what earned in the training for the matters that CDC recognized as weak points of the staffs. The training shall be made for the matters that: i) Preparation of disaster management plan and monitoring method, ii) Knowledge about GIS, iii) Capacity strengthening on the method to prepare the flood hazard map, and the training is expected to be conducted through participations to the education and training program by the World Bank, IDB and others as well as by JICA Knowledge Co-creation Program.

The formulation of a disaster mitigation plan requires complicated works inter alia study on hazard, diagnosis of the society including study on the vulnerability, planning of countermeasures to reduce damage, and the establishment of disaster management system including operation and maintenance of the system. The staffs of CDC should enhance their capability for the works. The staff could raise their capacities through attendance to the seminars on the specific subject to be conducted by the donors. In addition, CDC should develop knowledge sharing system so that the knowledge obtained by their staffs who attended the seminar could be shared to many other staffs of CDC.

2) Terms until initiation

The initiation of the training for the existing staffs should be short term while that for the additional staff could be medium term.

3) Others

In addition to the capacity building through participation in the training programs of donors and CDEMA, the development of a knowledge sharing system and internal utilization of the system developed are effective to enhance the capacity of CDC as a whole as mentioned above.

(2) GY-2： Improvement of Budget Insufficiency Allocated to CDC

1) Countermeasures

The cost for supports to execute the disaster mitigation education and training for communities places stress on the whole budget. Hence it is practical way to secure necessary budget for such cost through negotiation with the central government and the ministry.

2) Terms until initiation

The terms should be medium span taking into account importance of the disaster prevention training.

3) Others

Fostering of the understanding of and cooperation from the central government and the ministry are fundamental to solve the problem.

Table 4.2.1 summarizes the issues, countermeasures, and terms regarding general disaster management.

Table 4.2.1 Issues, Countermeasures and Terms Regarding General Matters for Disaster Management in Guyana

No.	Issue	Countermeasure	Term	Others
GY-1	Capability improvement of CDC staff	Participation in the training programs to be held by donors and CDEMA Knowledge sharing system	Short・Medium	Offering of effective training programs by donors and CDEMA Development of knowledge sharing system by CDC
GY-2	Improvement of budget insufficiency allocated to CDC	Training of CDC staffs Fostering of volunteer Community-based disaster mitigation led by the volunteers	Medium	Offering of effective training programs by donors and CDEMA Development of knowledge sharing system by CDC Implementation of the community-based disaster mitigation by the volunteers under the administration of CDC

Source: JICA Survey Team

4.2.2 Flood

(1) GY-3： Mitigation of Flood in the Low Lying Surrounding Areas of the Capital, Georgetown due to High Tide and Poor Drainage

1) Countermeasures

The master plan prepared by the World Bank (WB) planned to install 50 drainage pump stations. The WB decided to construct 17 out of 50 stations. The remaining 33 stations should be constructed through the financing of the country or the donors.

If drainage pumps manufactured in Japan are to be adopted in these stations, there may be a favorable chance to demonstrate the advantages of the pump produced in Japan in terms of durability and safety.

2) Terms until initiation

The measure is urgent and the construction has been initiated. Short term should be adopted.

(2) GY-4： Superannuation of Demerara Harbour Bridge

1) Countermeasures

The Demerara Harbour Bridge is part of the trunk road which extends from the east to the west of the country. The bridge is important in transporting people and materials once disaster occurs. The bridge is superannuated and renovation is necessary.

The domestic budget may not afford the cost to be incurred in the renovation. The conceivable finance source for the renovation is through a loan by donor.

There are a lot of issues involved in the renovation of the bridge. Relocation of the site is one of the issues. A suitable type of bridge should be studied and selected. There are several alternative ideas with regard to the type of bridge like a suspended bridge for the deepest or longest span or to follow the existing type of floating bridge.

The financial source for the study is not decided yet so far. The works should be conducted in two stages as follows:

1st Step: Feasibility Study + Detailed Design (Government financing or cooperation extended by the donor)

2nd Step: Construction（Loan by the donor）

2) Terms until initiation

Medium or long term should be adopted.

3) Others

Loan by a donor is conceivable considering the scale of the construction works and the required cost which amount is too large to select as an objective grant project in this survey.

Table 4.2.2 presents the identified issues and the proposed countermeasures and terms.

Table 4.2.2 Issue, Countermeasures and Term Related to Flood in Guyana

No	Issue	Countermeasure	Term	Other
GY-3	Mitigation of flood in the low lying Surrounding Areas of the Capital, Georgetown due to high tide and poor drainage	50 pump stations are planned by the master plan prepared by the World Bank（17 stations are to be implemented by the WB） Promotion of the remaining 33 stations	Short	Request to donors
GY-4	Superannuation of Demerara Harbour bridge	To conduct a feasibility study (F/S). The next step will be decided on the basis of the results of the F/S	Medium and Long	Project is feasible but the scale of the construction works will exceed a possible ceiling expected as a grant project, thus it is to be out of proposed list.

Source: JICA Survey Team

4.2.3 High Tide, Earthquake, Tsunami, Strong Wind, and Water Shortage

(1) GY-5: Mitigation of Damage Due to High Tide and Coastal Erosion along Coastal Areas

1) Countermeasures

The parapet wall with a height of 1.0 m to 1.5 m provided on the road, which runs along the coast is the existing countermeasure against surging and coastal erosion in the capital, Georgetown. The existing wall protects the area from the experienced maximum surge and wave. Therefore, further raising of the wall may be necessary to protect lands from higher disasters.

It is necessary to define the design probable height of the wall on the basis of the scale of the town and the importance of the town in order to protect Georgetown. Heightening works are required in the sections where the estimated design heights exceed the height of the existing parapet wall. In this respect, there is no Coastal Engineer available in the Ministry of Public Service. It is necessary to foster experts on coastal engineering through the training programs to be provided by donors.

2) Terms until initiation

The design works should be conducted as soon as possible. The implementation of the works would be in the medium term because the process of budgetary procedure is necessary.

3) Others

The cooperation from donors may be required depending on the scale of the works. If the works are only the partial heightening of the existing wall, their own budget may afford the cost of the works.

(2) GY-6：Subsidence of Land in the Coastal Area

1) Countermeasures

The excessive exploitation of the groundwater is possibly the cause of land subsidence in the area, where the elevation thereof is lower than the mean sea level. A survey of the existing condition is necessary through topographical survey at the sites where subsidence is anticipated. A comparative study on the recorded elevations in the past and that of the surveyed elevations will indicate the subsidence.

Plan formulation is necessary to mitigate the flood and surging damages.

2) Terms until initiation

The planning and design works should be conducted in the short term. The implementation of the works would be in the medium term because the process of budgetary procedures is necessary.

3) Others

Domestic financing may afford the measure because excessive exploitation is seen in limited areas. However, cooperation from donors is conceivable if the scale of the works is large.

(3) GY-7: Cultivation of the Coastal Engineering Experts

1) Countermeasures

Through the education and training opportunities held by the donors, capacity strengthening of the staff is required. The knowledge and learned matters shall be shared with the personnel of the agencies concerned.

2) Terms until initiation

The term for the initiation of the cultivation of the experts should be short so as to share the knowledge.

(4) GY-8 : Preparation of Disaster Mitigation Plan Against Earthquake for the Capital

1) Countermeasures

Earthquake is rather frequent in the country. However, no hazard map or risk map is available. Maps are fundamental to formulate the disaster mitigation plan against earthquake for the capital. The premier countermeasure is to prepare a hazard map or risk map for the capital compiling the assessed results of vulnerability by areas. The disaster mitigation plan will be formulated on the basis of the prepared hazard map identifying the evacuation routes and the allocations and layouts of the shelters.

2) Terms until initiation

The term for the initiation of the risk map preparation should be short since the occurrence of an earthquake is frequent, and the map is a basic and urgent requirement for the disaster mitigation plan. Meanwhile, preparations such as the development of risk maps may take a certain time before the formulation of disaster mitigation plan for the capital. The term for the initiation is short or medium span for the formulation of disaster mitigation plan.

3) Others

The formulation of disaster mitigation plan against earthquake requires various fields of knowledge and experiences such as seismology in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(5) GY-9 : Development of Hazard Map for Tsunami

GY-10 : Preparation of Evacuation Plan Against Tsunami

1) Countermeasures

Nationwide hazard map for tsunami is currently under preparation but still subject to the approval of the central government. However, the accuracy of the hazard map is too low to apply for formulation of the evacuation plan in the coastal cities.

Estimation of the area to be affected by tsunami by scale is difficult because no hazard map is available. Preparation of the hazard map is necessary to facilitate evacuation of people residing from the possibly affected areas. The preparation of evacuation plan, which shows the evacuation routes and evacuation shelters, is necessary for the residents of the towns along the coast.

2) Terms until initiation

The frequency of tsunami is not high but the damages are high once it occurred. The evacuation plan should be prepared as soon as possible. Short or medium term is recommendable.

3) Others

The formulation of a disaster mitigation plan against tsunami requires various fields of knowledge and experiences such as oceanography in addition to socioeconomic knowledge. Employment of an

experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(6) GY-11 : Development of Standard Design Methods Against Seismic Load and Wind Load

1) Countermeasures

Among the targeted countries of the survey, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions depend on the designer. The different standards such as AASHTO and BS have been adopted in the country. Some government engineers have asserted the necessity of standardization.

This issue is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of the governments of related countries to study the applicability of the standards, which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by other countries together with the natural conditions. The committee should conduct the screening of assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals, which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed on the basis of the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure requires medium or long term for its initiation.

3) Others

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of design standards for each country. It is recommendable to invite experts from outside as observers to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

(7) GY-12: Mitigation of Damage due to Water Shortage in Inland in the Southwestern Area

1) Countermeasures

Water shortage has occurred actually in the inland. No demand and supply study has been conducted so far. The demand and supply balance study is necessary to identify the cause of present water shortage. Agriculture and livestock are the substantial consumers of water in the inland. The assessment of water consumptions by these sectors is necessary. Saving of consumption is necessary if overconsumption is detected.

If the water consumption for agriculture and livestock is not extraordinary but water shortage still happens, the variability in precipitation should have been the cause of this disaster. The water shortage may not be seldom in case variability in precipitation happened over years and seasons. Implementation of the countermeasures is necessary to solve the water shortage disaster.

The water demand and supply balance study will identify the sites, timing, and quantity of water shortage. The plan to mitigate the water shortage will be formulated against the projected water

demand in the future on the basis of identified figures as a water resources management plan. The plan to store surface water in the wet season and conjunctive use of surface and groundwater are popular alternative measures together with rationalization of the demand. There are some countries where desalination of sea water is the only measure to respond to the problems. The planned facilities are to be duly designed and constructed.

Through the water demand and supply balance study, the main cause of shortage shall be clearly identified if it is due to excessive water consumption, in particular, utilization for agriculture and livestock.

2) Terms until initiation

The diagnosis by the demand and supply balance study should be short term. The term should be medium to formulate a plan for the selected countermeasures such as water resources management plan. Meanwhile, the implementation of the countermeasure may take a long term.

3) Others

The diagnosis of water shortage and the formulation of the plan for countermeasures require multidisciplinary expertise and should be entrusted to the consultant group to be employed by the government , which is out of a target of this survey.

Table 4.2.3 presents the issues, countermeasures, and terms for surge, earthquake, tsunami, strong wind, and water shortage.

Table 4.2.3 Issues, Countermeasures and Terms for Surge, Earthquake, Tsunami, Strong Wind and Water Shortage in Guyana

No	Issue	Countermeasure	Term	Other
GY-5	Mitigation of damage due to high tide and coastal erosion along coastal areas	It is necessary to define the design probable height of the wall to protect Georgetown on the basis of the scale of the town and the importance of the town. Heightening works are required in the sections where the estimated design heights exceed the height of the existing parapet wall.	Short・Medium	Employment of consultants by the central government or the cooperation from donor The cooperation from donors may be required depending on the scale of the works. If the work is only the partial heightening, they can finance the work using their own budget. Participation in the training on coastal engineering organized by donors
GY-6	Subsidence in the coastal areas	Implement countermeasures after the confirmation of subsidence	Short・Medium	Employment of consultants by the central government for confirmation study The cooperation from donors may be required depending on the scale of the works.
GY-7	Cultivation of the coastal engineering experts	To take an opportunities of the education and training to be held by the donors	Short	
GY-8	Preparation of disaster mitigation plan against earthquake for the capital	Formulation of disaster management plan for the accompanying tsunami indicating the evacuation routes and the location of shelters on	Short・Medium	Employment of consultants by the central government or cooperation from the donors.

No	Issue	Countermeasure	Term	Other
		the basis of the prepared hazard maps		
GY-9	Development of hazard map for tsunami	Formulation of disaster management plan for the coastal zone for tsunami indicating evacuation route and evacuation shelters	Short・Medium	Employment of consultants by the central government or cooperation from the donors.
GY-10	Preparation of evacuation plan against tsunami			
GY-11	Development of standard design methods against seismic load and wind load	Establishment of a committee inviting experts from related countries to act as members of the committee. The discussions in the committee will find the standards suitable to the local conditions	Medium・Long	Financed by the countries concerned Donors will dispatch experts as observers
GY-12	Mitigation of damage due to water shortage in inland in the southwestern area	Diagnosis study on the water resources Countermeasures are to be planned and implemented. Development of dams may be included in the measures.	Medium・Long	Employment of consultants by the central government, which issue is not the target of this survey. Implementation may require the cooperation from the donor

Source: JICA Survey Team

4.2.4 Meteorological and Hydrologic Observation

(1) GY-13： Improvement of Insufficiency of Maintenance Staff

1) Countermeasures

Insufficient budget and the eventual inability to employ an experienced staff are causes of insufficient number of maintenance staffs. Negotiation with the ministry is necessary to secure the budget. If the employment of an experienced engineer in Guyana is difficult, employment of a new graduate from the related faculty of university or technical college may be available after the training in CIMH or funded by donors. Similar cases can be seen in other countries with regard to communication system of the automatic observation facilities.

2) Terms until initiation

To secure the budget is fundamental and it may take medium to long term to implement the measure.

3) Others

The capacity of the new staff may not be sufficient. Capacity building by CIMH or donors of the new staff is necessary

(2) GY-14：Improvement of Insufficiency of Budget for Maintenance

1) Countermeasures

The measure is to negotiate with the ministry to increase the budget.

2) Terms until initiation

Negotiation should be initiated as soon as possible, i.e., in the short term.

(3) GY-15：Improvement of Meteoro-hydrologic Data Collection in the Inland Areas

1) Countermeasures

There are 202 rainfall gauging stations and 41 water level gauging stations. However, data collection in the inland areas is difficult due to the difficulty in access and eventual difficulty in maintenance of the station.

An automatic observation and data transmission should be installed replacing the existing equipment in such stations so that the data recorded therein could be monitored in the headquarters. Thus, the flood warning to the downstream area could be disseminated.

2) Terms until initiation

The refurbishment of equipment should follow the establishment of the maintenance system. The initiation of this measure should be medium to long term.

3) Others

The cooperation from a donor is conceivable for the refurbishment of observatories.

Table 4.2.4 presents the issues, countermeasures, and terms for meteoro-hydrological observation.

Table 4.2.4 Issues, Countermeasures and Terms for Meteoro-Hydrologic Observation in Guyana

No	Issue	Countermeasure	Term	Other
GY-13	Improvement of insufficiency of maintenance staff	Process of budgetary procedure After the processing of the procedure, employment of new graduates from the related faculties of universities or technical colleges. Training of the newly employed staff	Medium・Long	Negotiation with the central government and the ministry
GY-14	Improvement of insufficiency of budget for maintenance	Negotiation with the central government and the ministry to solve the insufficient budget	Medium・Long	
GY-15	Improvement of meteoro-hydrologic data collection in the inland areas	Refurbishment of the observatories Installation of the automatic system	Medium・Long	Cooperation from donor

Source: JICA Survey Team

4.2.5 List of Conceivable Projects

Table 4.2.5 demonstrates the proposed projects.

Table 4.2.5 Project List of Guyana

No	Term	Project Title	Component
GY-1	Short・Medium	Capacity Building of the CDC staffs	2) Training for disaster mitigation planning and monitoring. 3) Training for preparation of hazard map
GY-3	Short	Drainage Improvement for Georgetown	1) Diagnosis 2) Review of design conditions for the pump stations 3) Review of the existing design 4) Design of the pump stations 5) Cost estimates 6) Construction
GY-5, -6	Short	Disaster Mitigation of the Coastal Area Against Surging and Coastal Erosion	1) Diagnosis 2) Surveys for subsidence 3) Alternative study 4) Design for the selected optimum measure 5) Cost estimates 6) Construction

No	Term	Project Title	Component
GY-7	Short	Training of coastal erosion	1) Mechanism on coastal erosion 2) Advantage and disadvantage of countermeasures for the coastal erosion 3) Plan formulation and design of the measures. 4) Monitoring of coastal erosion 5) Coastal conservation plan
GY-8	Short・Medium	Disaster Mitigation Plan for Earthquake in Georgetown	1) Confirmation survey of the present condition 2) Revision of the hazard maps for earthquake 3) Study on evacuation route and evacuation shelter 4) Assessment of risk and preparation of scenario 5) Formulation of disaster mitigation plan 6) Preparation of text such as disaster mitigation map and evacuation training 7 Fostering of leaders for education in disaster mitigation
GY-9 GY-20	Short・Medium	Disaster Mitigation Plan for Tsunami in the Coastal Areas	1) Diagnosis 2) Development of hazard map for tsunami 3) Study on evacuation route and evacuation shelter 4) Study on warning system 5) Formulation of disaster mitigation plan 6) Preparation of text-like disaster mitigation map and evacuation training 7) Fostering of leaders for education in disaster mitigation
GY-13	Medium・Long	Capacity Building of the Staff for Meteorological Works	**1)** Training for the maintenance of equipment
GY-15	Medium・Long	Improvement of Meteoro-hydrologic Data Collection in the Inland Areas	1) Confirmation of present situation 2) Plan formulation on development of meteoro-hydrologic observation network 3) Provision of necessary equipment 4) Installation of observatories 5) Installation and test 6) Preparation of manuals

Source: JICA Survey Team

4.3 Grenada

Table 3.3.1 demonstrates the identified issues regarding disaster management in Grenada. The JICA Survey Team scrutinized the issues and proposed countermeasures to mitigate the issues. The JCIA Survey Team proposed the terms until the initiation of the countermeasures as well.

4.3.1 General Matters for Disaster Management

(1) GR-1 : Improvement of Insufficiency of Staff for NaDMA

1) Countermeasures

Increase in the number of the National Disaster Management Agency (NaDMA) staff is crucial to solve the problem. The conceivable ways to increase are i) recruitment of the candidates in the country and ii) transferring the staffs of other agencies to NaDMA.

i) Recruitment of candidates in the country

The measure is to employ new staffs through recruitment in the country. In parallel with the recruitment, procedural preparation is required to secure the budget for the increase in employment cost to execute the measure smoothly.

ii) Transferring the staffs of other agencies

There may be a case where staffs are to be transferred to NaDMA temporarily. In most of these cases, the agency of the said staff will shoulder their salary. Therefore, the expenses of NaDMA are only other expenses such as special allowances, and therefore, no substantial increase in budget is necessary. The measure is practical for NaDMA provided that necessary legal preparation is completed. Further, it is natural to consider that the transferred staff has strong channels with his mother agency. The measure is expected to strengthen the cooperation between NaDMA and the agency.

2) Terms until initiation

It may take a certain time for the abovementioned preparatory works. Subsequently, the term would be medium span to long span.

3) Others

The proposed measure to increase the number of the staff requires the establishment of internal procedures like preparation of budget and personnel changes. The activities for the implementation of the measures are to be conducted by the government itself.

(2) GR-2 : Improvement of Coordination between NaDMA and the Communities

1) Countermeasures

NaDMA has held several trainings for the communities in relation to disaster mitigation. Some selected members of the community had a chance to attend the training. However, those who attended the training did not transfer the knowledge what they have learned in the training to other members of the community so far. One of the countermeasures to the present problem is that NaDMA should conduct trainings in the community so that all community members could participate. However, with the limited number of NaDMA staff, they could not afford to access all the communities. NaDMA should form a volunteer team. NaDMA should train the volunteer team first as leaders or trainers of disaster mitigation for communities. A trained volunteer will be dispatched to the community in place of a NaDMA staff. It is effective to strengthen the coordination between NaDMA and the communities as well.

First of all, the staff of NaDMA should have sufficient knowledge on community disaster management. Secondly, NaDMA should train the volunteer team about the community disaster management. Participation of the NaDMA staffs in the training programs to be provided by donors or CDEMA is crucial.

2) Terms until initiation

Coordination between NaDMA and the community is fundamental to the disaster mitigation in the area. The term until the initiation of the measure should be short. It may be medium term depending on the training of volunteer.

3) Other

In this connection, a program that facilitates dissemination or sharing of acquired knowledge to other staffs within NaDMA may be effective to enhance the capacity of NaDMA. The study on the program is another countermeasure.

Table 4.3.1 summarizes the issues, countermeasures, and terms regarding general disaster management.

Table 4.3.1 Issues, Countermeasures and Terms Regarding General Matters for Disaster Management in Grenada

No	Issue	Countermeasure	Term	Other
GR-1	**Improvement of insufficiency of staff for NaDMA**	Recruitment Temporary transfer of staffs from other ministries	Medium Long	Action by the central government is fundamental
GR-2	Improvement of coordination between NaDMA and the communities	Capacity improvement on community disaster prevention through participation in the training programs to be held by donors. Knowledge sharing system Fostering leaders for community disaster mitigation through the training of volunteers Plan formulation and training by involvement of community residents	Short・ Medium	Participation in effective training programs by donors and CDEMA Development of knowledge sharing system by NaDMA Training program for volunteers

Source: JICA Survey Team

4.3.2 Flood, Mass Movement, High Tide, Earthquake, Tsunami, and Drought

(1) GR-3： Mitigation of Inundation in Saint George's due to the Landside Water

1) Countermeasures

Inundation is frequent in Saint George's in the area between Tanteen Road and HA Braise Street due to the landside water and poor drainage. The identified causes of problem are: i) backwater of high tide, ii) low elevation of the area, and iii) insufficient discharge capacity of the drainage.

The conceivable countermeasures are: a) to provide a subsurface storage to store the excess water temporarily, b) to provide a drainage pump to push out the landside water, and c) mitigation of submergence availing the conjunctive effects of storage and pump.

Japan has advanced technology regarding subsurface storage and has a lot of successful cases on subsurface storage. Plastic is the main material for the storage structure, and therefore, the period required for construction is short. However, the application of the measure will encounter several difficulties if the groundwater table of the site is high because the density of the material is small. There are areas used as athletic fields in the flood prone area. The underground of the athletic fields are suitable for the provision of subsurface storages.

2) Terms until initiation

There are substantial roads, which serve as main access to the offices of the ministries that run through the area. The countermeasures should be initiated in the short term.

3) Other

Self-financing or cooperation from donors is conceivable.

(2) GR-4 : Mitigation of Disasters due to Landslide in the Upstream Area of the Little River and Debris Flow

1) Countermeasures

The Florida area located in the upstream of the Little River has a lot of potential landslide sites and it is possible to affect Gouyave Town located in the downstream area. The debris flow from the upstream reach is another problem to the downstream areas.

The conceivable countermeasures are to provide measures to restrain the landslide in Florida area and to provide check dam to trap debris in the strategic sites. Slit dam is one of the specific Japanese technology as check dam.

4) Terms until initiation

The World Bank is cooperating with the government for the rehabilitation of Hubble Bridge on the downstream and the bank protection in the downstream reaches. The interventions in the upstream areas should coincide with the works in the downstream areas. The terms for the initiations of the countermeasures should be short or medium.

5) Other

Cooperation from donors or self-financing is conceivable.

(3) GR-5 : Mitigation of Damages due to Slope Failure and Rockfall along West Coast Road

1) Countermeasures

The slope failure and the associated debris in the mountain side of the West Coast Road have affected the road safety. The government has responded to the problem rather haphazardly.

The risk of the slope should be assessed and the priorities of the measures will be decided on the basis of the assessment. The measures will be implemented along with the priorities. As a future plan, preparation of the design guideline to prevent formation of steep slope is necessary.

2) Terms until initiation

The West Coast Road is a section of an important ring road in the island. The initiation should be in the short term.

3) Other

Cooperation from donors or self-financing is conceivable.

(4) GR-6 : Improvement of Insufficient Capacity of the Countermeasure on Sediment Disaster along the Road

1) Countermeasures

Ongoing measures against slope failure are mostly retroactive. No protective work has been implemented. Therefore, it is necessary and effective countermeasure to enhance the capacities of the staff in risk assessment of slope, selection and design of the countermeasures, as well as monitoring of the slope and maintenance.

2) Terms until initiation

There are so many prone sites prone to landslide and debris flow, and urgent initiation is necessary.

3) Other

Participation in the training to be provided by donors is conceivable.

(5) GR-7 : Mitigation of Coastal Erosion in the North Coast of Grenville

1) Countermeasures

Coastal erosion is prominent in the area along the north coast of Grenville and protection works are necessary. Study on the countermeasure is the basis for selection of appropriate protection works and design of structures. The selection of protection works should reflect the land use in the hinterland area.

In addition, the capacity building of staffs in coastal engineering is important to manage the coastal area.

2) Terms until initiation

In order to respond to the developing erosion, the countermeasure should be initiated in the short term.

3) Other

Self-financing is conceivable for the implementation. The capacity building of staffs will be achieved through the participation in the training to be held by donors.

(6) GR-8 : Development of Hazard Map Related to Earthquake is not Available

GR-9 : Preparation of Disaster Mitigation Plan Against Earthquake for the Capital

1) Countermeasures

Earthquake is rather frequent in the country. However, there is no hazard map or risk map available. The maps are fundamentally needed to formulate the disaster mitigation plan against earthquake for the capital. The premier countermeasure is to prepare a hazard map or risk map for the capital by compiling the assessed results of vulnerability by areas. The disaster mitigation plan will be formulated on the basis of the prepared hazard map identifying the evacuation routes and the allocations and layouts of the shelters.

2) Terms until initiation

The terms for the initiation of the risk map preparation should be short since the occurrence of earthquake is frequent, and the map is a basic and urgent requirement for the disaster mitigation plan. Meanwhile, preparations such as the development of the risk maps may take a certain time before the formulation of disaster mitigation plan for the capital. The term for the initiation is short or medium span for the formulation of disaster mitigation plan.

3) Other

The formulation of disaster mitigation plan against earthquake requires various fields of knowledge and experiences such as seismology in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(7) GR-10 : Formulation of an Evacuation Plan for Tsunami

1) Countermeasures

Since no hazard map is available, delineation of the possible damageable zone is not possible. In order to define the evacuation route from the assumed affected area, the development of hazard map is fundamental as a countermeasure. Formulating an evacuation plan which indicates evacuation routes and shelters is another countermeasure against the impending tsunami.

2) Terms until initiation

The frequency of tsunami is not high but significant damages are possible because there are several submarine volcanoes in the vicinity of the country. The initiation of the countermeasure should be in the short or medium term.

3) Other

The formulation of the evacuation plan against tsunami requires various fields of knowledge and experiences such as maritime engineering in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available for the employment. Request for assistance from donors on this matter may be another option.

(8) GR-11 : Development of Standard Design Methods Against the Seismic Load and Wind Load

1) Countermeasures

Among the targeted countries of the survey, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design condition depends on the designer. Different standards such as AASHTO and BS have been adopted in the country. Some engineers of the government have asserted the necessity of standardization.

This subject is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of the governments of related countries to study the applicability of the standards, which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to be a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards being adopted by other countries together with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals, which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed referring to the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure will require medium or long term for its initiation.

3) Other

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts as observers from outside to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

(9) GR-12 : Superannuation of the Appurtenant Facilities of the Weir

1) Countermeasures

The site exploration identified the superannuation of facilities of a weir owned by the National Water Sewerage Authority (NAWASA). Diagnosis of the facilities of other weirs is necessary to identify the problems. The measure to prolong the life period of the facility would be proposed reflecting the results of the diagnosis. The measures are to be implemented as the proposed rehabilitation.

2) Terms until initiation

Diagnosis should be conducted in the short term. Meanwhile, the rehabilitation should be in the medium term.

3) Other

Diagnosis should be financed by WASA. The cooperation from a donor is conceivable for the rehabilitation depending on the amount needed.

However, the measure is to off-take water from the river and it is not the countermeasure for water shortage and disaster mitigation.

Table 4.3.2 presents the issues, countermeasures, and terms against surging, earthquake, tsunami, strong wind, and water shortage.

Table 4.3.2 Issues, Countermeasures and Terms for High Tide, Earthquake, Tsunami, Strong Wind, and Water Shortage in Grenada

No	Issue	Countermeasure	Term	Other
GR-3	Mitigation of inundation in Saint George's due to the landside water	Pump station, underground storage, and combination of the pump and storage	Short	Self-financing or loan by a donor
GR-4	Mitigation of disasters due to landslide in the upstream area of the Little River and debris Flow	Stabilization works in Florida Provision of slit dams	Short・Medium	Self-financing or loan by a donor
GR-5	Mitigation of damages due to slope failure and rockfall along West Coast Road	Prioritization of the measures, selection and design of the measures Construction	Short	Self-financing or loan by a donor
GR-6	Improvement of insufficient capacity of the countermeasure on sediment disaster along the road	Training by donors	Short	Cooperation from donors
GR-7	Mitigation of coastal erosion in the north coast of Grenville	Study on the countermeasures Construction Capacity building of staffs on coastal engineering	Short・Medium	Self-financing for the measures Donor may cooperate in the capacity building
GR-8	Development of hazard map related to earthquake is not available	Development of hazard map Formulation of disaster mitigation plan against earthquake which indicates the evacuation routes and shelters	Short・Medium	Employment of consultant by the central government or cooperation to be extended by the donor
GR-9	Preparation of disaster mitigation plan against earthquake for the capital			
GR-10	Formulation of an evacuation plan for tsunami	Formulation of an evacuation plan in the town located in the riparian area. The plan shall indicate the evacuation route and shelter.	Short・Medium	Employment of consultant by the central government or cooperation to be extended by donors
GR-11	Development of standard design methods against the seismic load and wind load	Establishment of a committee inviting experts from related countries to serve as members of the committee. The discussions in the committee will find the standards suitable to the local condition.	Short・Medium	Financed by the budges of the countries concerned Donors will dispatch experts as observers.
GR-12	Superannuation of the appurtenant facilities of the weir	Diagnosis, formulation of rehabilitation plan, and construction	Medium	Budget of WASA or Loan by a donor

Source: JICA Survey Team

4.3.3 Meteoro-hydrologic Observation

(1) GR-13：To Secure Communication Facility

1) Countermeasure

The deterioration of the data transmission and receiving system is to be restored by replacement of the deteriorated parts. The difficulties in securing budget would be solved through negotiation with the ministry.

2) Terms until initiation

Short term should be adopted.

3) Other

Self-financing is conceivable.

(2) GR-14 : Clarification of Responsible Organization for the Operation of Observation and Warning System

Countermeasure

The responsibility should be clarified among the organizations that have the technical capacity in the operation of observation and warning system. The clarified results should be documented.

Terms until initiation

The measure could be implemented soon and the term should be short.

Other

Self-financing is conceivable.

Table 4.3.3 presents the identified issues, countermeasures, and terms regarding meteoro-hydrologic observation.

Table 4.3.3 Issues, Countermeasures and Terms for Meteoro-Hydrologic Observation in Grenada

No	Issue	Countermeasure	Term	Other
GR-13	To Secure **telec**ommunication **f**acility	Replacement or repair of deteriorated parts	Short	Self-financing
GR-14	Clarification of responsible organization for the operation of observation and warning system	The responsibility should be clarified among the organizations that have the technical capacity. The clarified results should be documented.	Short	Self-financing

Source: JICA Survey Team

4.3.4 List of Conceivable Projects

Table 4.3.4 demonstrates the list of conceivable projects on the basis of the issues and countermeasures.

Table 4.3.4 List of Conceivable Projects in Grenada

No	Term	Title of the Project	Component
GR-2	Short・Medium	Capacity Building of NaDMA Staffs	1) Training for disaster mitigation plan, monitoring, and assessment 2) Method to train the community for disaster mitigation
GR-3	Short	Mitigation of Landside Water Flooding in St. George	1) Diagnosis 2) Conditions for planning 3) Study on the optimal measure 4) Design of the optimum measure 5) Cost estimate 6) Construction

No	Term	Title of the Project	Component
GR-4	Short・Medium	Mitigation of Landslide and Debris Flow in the Little River basin	1) Diagnosis 2) Investigation and Monitoring 3) Study and design of landslide countermeasure 4) Study and design of slit dam 5) Construction plan and cost estimates 6) Construction
GR-5	Short・Medium	Slope Stabilization along the West Coast Road	1) Diagnosis 2) Prioritization of the sites and survey 3) Study and design of the measures 4) Construction planning and cost estimates 5) Construction
GR-6	Short	Training regarding Sediment Disaster	1) Lecture on institution (System, Organization, Regulation, Budgetary procedure) 2) Lecture on erosion phenomena, mechanism, survey, and stabilization menu (Delineation of the dangerous zone, hazard map, structures and warning and evacuation) 3) Site excursion on the stabilization measures in a slope failure dangerous zone 4) Practice on the risk assessment for slope failure : identification of issues and presentation thereof 5) Formulation of an action plan to improve disaster mitigation plan, system and study on the countermeasures
GR-7	Short	Training for Mitigation of Coastal Erosion	1) Cause and the mechanism of coastal erosion 2) Menu of countermeasures and the merit and demerit 3) Forecasting method 4) Monitoring and measuring method 5) Coastal erosion and disaster 6) Design of protection against erosion 7) Preservation of coast and coastal management
GR-8, GR-9	Short・Medium	Formulation of Disaster Mitigation of Earthquake in St. George's	1) Existing plan and confirmation of the conditions 2) Update of hazard map for earthquake 3) Study on evacuation route and shelter 4) Risk analysis and preparation of scenario 5) Formulation of disaster prevention 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Fostering of leader for training
GR-10	Short・Medium	Formulation of Disaster Mitigation of Tsunami in Towns in the Coastal Area	1) Confirmation of the conditions 2) Preparation of hazard map for tsunami 3) Study on evacuation route and shelter 4) Study on warning 5) Formulation of disaster prevention 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Fostering of leader for training

Source: JICA Survey Team

4.4 Jamaica

Table 3.4.1 summarizes the identified issues regarding disaster management in Jamaica. This section discusses countermeasures thereto and the term until initiation of the measures.

4.4.1 Flood

(1) JA-1：Improvement of the Bridge in the Middle Reach of the Rio Cobre River to Solve Traffic Interruption due to the Flood

1) Countermeasure

The rehabilitation of bridges and approach roads is to be determined depending on the schedule of the construction of the bypass road. The rehabilitation is effective if the construction of the bypass takes long term. The rehabilitation is not necessary if the bypass road is to be constructed soon.

In case the schedule is from 10 to 20 years, rehabilitation has to be implemented.

2) Term until initiation

The initiation of the rehabilitation should be within the short term.

3 Other

Rehabilitation itself should be financed by Jamaica.

(2) JA-2：Prevention of Mudflow on the Rivers in the Southeast Region

1) Countermeasure

The sediment discharge from the upstream reach is the cause of the significant aggravation of the river channel. The silted sediment is a good material for construction and has been exploited in the downstream channel. Further, some bridges were washed away.

A basin-wide comprehensive soil management plan is necessary to construct structures which cross the river. Monitoring of the variability of the river channel is necessary after the plan formulation.

A river crossing structure is to be studied on the basis of the formulated plan.

2) Term until initiation

A comprehensive soil management plan is to be formulated in the short term and the construction of the river crossing structures should be in the medium term.

3) Other

In case the restoration of a washed bridge is required although no comprehensive soil management plan is available, the analysis of river channel variability should be conducted to confirm the stability of the restored bridge.

Table 4.4.1 presents the issues, countermeasures, and terms related to flood.

Table 4.4.1 Issues, Countermeasures and Terms Related to Flood in Jamaica

No	Issue	Countermeasure	Term	Other
JA-1	Improvement of the bridge in the middle reach of the Rio Cobre River to solve Traffic Interruption due to the flood	Restoration of bridges depending on the implementation schedule of the construction of the bypass.	Short	Self-financing
JA-2	Prevention of mudflow on the rivers in the southeast region	Plan formulation of the basin-wide soil management. Monitoring	Short・Medium	Employment of consultants using its own budget or cooperation from a donor

Source: JICA Survey Team

4.4.2 Mass Movement

(1) JA-3： Prevention of Slope Failure between Agulala Vale and Golden Spring

1) Countermeasure

The risks of failure are to be assessed and the priority of each site is to be assigned. Study and provision of stabilization measures are the countermeasures for the sites with high priority. Provision of monitoring systems is the countermeasure for the sites with low priority.

2) Term until initiation

Short term should be adopted because the road is a trunk road.

3) Other

Self-financing or cooperation from a donor is available.

(2) JA-4： Development of Detailed Road Hazard Map is not Available

1) Countermeasure

A detailed hazard map is fundamental to mitigate disaster in Jamaica, where slope failure along the road is frequent. Construction of the countermeasure and installation of the monitoring system are to be studied on the basis of the developed maps. Monitoring is useful as preventive activity for impending risk and post response to the occurred disaster.

2) Term until initiation

The term until the first initiation should be short term but may be medium term because the target area is the whole country.

3) Other

Both self-financing and cooperation from donors are conceivable for the works in the study stage but the individual implementation should be financed by the government because of the small-scale investment.

Table 4.4.2 presents the issues, countermeasures, and terms regarding erosion.

Table 4.4.2 Issues, Countermeasures and Terms regarding Erosion in Jamaica

No	Issue	Countermeasure	Term	Other
JA-3	Prevention of slope failure between Agulala Vale and Golden Spring	Define the priority sites through the assessment of slope failure risk. Provide stabilization to the sites with high risk. Provide monitoring system to low risk sites	Short	Self-financing or cooperation from donor
JA-4	Development of detailed road hazard map is not available	Identification of the high risk sites. Provide countermeasures to the sites. Implement monitoring on the sections where no measures are provided	Short・Medium	Both self-financing and cooperation from donors are conceivable for the works in the study stage but the individual implementation should be financed by the government

Source: JICA Survey Team

4.4.3 List of Conceivable Projects

Table 4.4.3 demonstrates the conceivable projects reflecting the issues and the countermeasures.

Table 4.4.3 List of Conceivable Projects in Jamaica

No	Term	Project Title	Component
JA-1	Short	Rehabilitation Plan of Flat Bridge	1) Diagnosis 2) Review of the future plan 3) Natural condition 4) Design of bridge 5) Design of bank protection 6) Cost estimates 7) Construction
JA-2	Short・Medium	Comprehensive Basin-wide Soil Management Plan for the Rivers in the Southeast Area	1) Diagnosis 2) Study on the sediment productivities 3) Analysis for riverbed variability 4) Study on the control of the sediment productivity 5) Surveys of the sand mining 6) Soil management plan, monitoring plan
JA-3	Short	Stabilization of the Slopes along the A3 Road	1) Diagnosis 2) Prioritization and survey 3) Study and design of the countermeasures 4) Cost estimates 5) Construction
JA-4	Short・Medium	Preparation of a Road Hazard Map	1) Diagnosis 2) Development of hazard map for erosion 3) Proposal for monitoring

Source: JICA Survey Team

4.5 Suriname

Table 3.5.1 summarizes the identified issues regarding disaster management in Suriname. This section discusses the countermeasures thereto and the term until initiation of the measures.

4.5.1 General Matters for Disaster Management

(1) SU-1： Improvement of Insufficiency of NCCR Staff

1) Countermeasure

Increase in the number of the National Coordination Center for Disaster Relief (*Nationaal Coördinatie Centrum voor Rampenbeheersing*: NCCR) staff is crucial to solve the problem. The conceivable ways to increase are i) recruitment of the candidates in the country and ii) transferring the staffs of other agencies to NCCR.

i) Recruitment of the candidates in the country

The measure is to employ new staffs through recruitment in the country. In parallel with the recruitment, procedural preparation is required to secure the budget for the increase in employment cost to execute the measure smoothly.

ii) Transferring the staffs of other agencies

There may be cases where staffs are to be transferred to NCCR temporarily. In most of these cases, the agency of the said staff will shoulder their salary. Therefore, the expenses of NCCR are only for other expenses such as special allowances and no substantial increase in budget is necessary. The measure is practical for NCCR provided that necessary legal preparation is completed. Further, it is natural to consider that the transferred staff has strong channels with his mother agency. The measure is expected to strengthen the cooperation between NCCR and the agency.

2) Term until initiation

It may take a certain time for the abovementioned preparatory works. Subsequently, the term would be medium span to long span.

3) Other

The proposed measure to increase the number of the staff requires the establishment of internal procedures like preparation of budget and personnel changes. The activities for the implementation of the measures are to be conducted by the government itself.

(2) SU-2： Improvement of Insufficient Capacity of NCCR for the Training on Disaster Mitigation

1) Countermeasure

The Red Cross is conducting community-based disaster mitigation availing the budget financed by donors. Their activity could not cover the whole country. In order to overcome the issue, the staff of NCCR should attend the training programs so that the staff of NCCR can train others on disaster mitigation. The acquired knowhow should be shared with other NCCR staffs. The NCCR staff should train the volunteers registered to NCCR. The training on community-based disaster mitigation should be promoted by the trained volunteers.

2) Term until initiation

The measure requires stepwise implementation as the training of NCCR staffs and training of volunteers are sufficient to the whole communities in the island. In this respect, the terms of the measure should be medium to long term.

3) Others

The trainings by donors or CDEMA are important for the staffs of NCCR until they can understand community disaster mitigation and implement it effectively.

(3) SU-3： Provision of NCCR Home Office

1) Countermeasure

The competent authority of NCCR has changed; therefore, NCCR lost its home office. NCCR should negotiate with the central government and the ministry to allocate budget for investment in plant and equipment to have its home office.

2) Term until initiation

Having its home office is an urgent need of NCCR and the short term should be adopted.

(4) SU-4： Preparation of Appropriate Base Map

1) Countermeasure

The topographic map available was prepared in 1975-78 and the information in the map is superannuated after a lapse of 40 years. In particular, the map could no longer be used for the plan formulation in and around the capital. To cope with the situation, digital map will be developed for the area along the coast where about 80% of the people are living. The transfer of knowledge to the survey agency of Suriname for the development is necessary.

2) Term until initiation

The development of the map is fundamental in planning and the term shall be short.

3) Other

The development of the map should be made through the transfer of technology with cooperation from the donor.

Table 4.5.1 summarizes the issues, countermeasures, and terms regarding general disaster management.

Table 4.5.1 Issues, Countermeasures and Terms Regarding General Matters for Disaster Management in Suriname

No	Issue	Countermeasure	Term	Other
SU-1	Improvement of insufficiency of NCCR staff	Recruitment Temporary transfer of staffs from other ministries	Medium Long	Action by the central government is fundamental.
SU-2	Improvement of insufficient capacity of NCCR staff	Participation in the training program to be held by donors and CDEMA Knowledge sharing system Training of volunteer team	Short・ Medium	Offering of effective training programs by donors and CDEMA Development of knowledge sharing system regarding the outcome of the training by NCCR
SU-3	Provision of NCCR home office	Establishment of the home office Allocating budget	Short	Negotiation with the central government and the ministry
SU-4	Preparation of base map	Development of map Transferring knowledge to the survey agency	Short	Transfer of knowledge through the cooperation from donors

Source: JICA Survey Team

4.5.2 Flood, High Tide, and Tsunami

(1) SU-5： Improvement of Drainage in Paramaribo

1) Countermeasure

The population in Paramaribo is almost 50% of the national total. The performance of the existing drainage network is poor and it tends to bring flood in the area. Formulation of a drainage improvement plan is necessary. The plan to be formulated should coincide with the future urban development plan.

2) Term until initiation

The formulation of the drainage plan should be initiated within the short term.

3) Other

Both self-financing and the cooperation from a donor are available.

(2) SU-6 : Evacuation Response during Flooding in the Middle Reach of the Marowijine River

1) Countermeasure

A heavy rainfall in the upstream basin of the Marowijine River has brought flood damages in the areas along the tributaries and in the middle reach areas adjacent to the confluence with the main channel. Some donors are promoting the enhancement of community-based disaster mitigation in the areas. However, the activities of the donors do not cover the whole area.

The areas along the middle reach are susceptible to significant flood damages and the access from other areas is not easy. Eventually, the enhancement of community-based disaster mitigation is one of the most practical countermeasures. In this accord, the extension of enhanced community disaster mitigation is necessary to cover more areas.

The main subjects of enhancement are the establishment of the system to disseminate warning for evacuation, establishment and management of shelters, and the training of the residents on the response activities to flood. The improvement of the comfortableness of the shelter is to be considered in the enhancement as well.

2) Term until initiation

In order to respond to the repetitive flooding, the initiation of the countermeasure should be within the short term.

3) Other

Cooperation from donors, NCCR, and Red Cross are conceivable.

(3) SU-7 : Improvement of the Road to Prevent Annual Road Closure in the Section between Apoera and Zanderij due to Flooding

1) Countermeasure

Among the sections between Apoera and Zanderij, there are lots of small rivers in the section between Pikin Saron and Witagron. The closure occurs in this section most frequently.

The conceivable root causes of the closure are: 1) poor construction of the road, 2) low elevation of the road surface, and 3) poor drainage on the road surface. It is necessary to review the assumed root causes and to study the countermeasures against the confirmed root causes.

The betterment of the section between Pikin Saron and Witagron reflecting the root causes is the countermeasure to the identified problem.

2) Term until initiation

The road extends from east to west in the inland area and is the only transportation route connecting the eastern areas and western areas. Therefore, the road plays an important role for disaster mitigation. The initiation of the diagnosis about the disasters and planning for the countermeasures should be in the short term. Meanwhile, the implementation may be initiated in the medium term following the formulated plan.

3) Other

Cooperation from a donor is conceivable for financing of the measure. In this respect, the improvement of the section between Zanderij and Pikin Saron is underway with a loan financed by China.

(4) SU-8 : Mitigation of Coastal Erosion

1) Countermeasure

The northern coast of Suriname is degenerating backward due to coastal erosion. Erosion has occurred in the sections that face to the west on the coast between Tottoness and Paramaribo. The substantial countermeasures as announced by the government are: the construction of 13 km long dyke in Tottoness and the construction of dyke in the west of Paramaribo.

There are two countermeasures in general to cope with coastal erosion, namely, construction of dyke to protect the coast from wave action and planting of mangrove to restore the coast. The ongoing countermeasure adopted is the construction of a dyke.

The proposed countermeasure is to conduct a comparative study on the options inter alia construction of dyke, planting mangrove, and others, if any. The countermeasure selects the optimum option and formulates a plan to implement the selected option.

2) Term until initiation

Some of the areas affected by erosion are in serious condition. The provision of the countermeasure is urgently needed now. The initiation should be in the short term.

3) Other

Both self-financing and cooperation from donors are conceivable to finance the countermeasure.

(5) SU-9 : Monitoring and Collection of Tsunami Information in and around Suriname

1) Countermeasure

Majority of the population are living in the coastal area and the damage would be significant in case the area is hit by a tsunami. It is necessary to install a monitoring facility for tsunami and establish a monitoring system. In this respect, institutional arrangement is necessary to define the mandates of Suriname and Seismic Research Center, which are serving other islands.

2) Term until initiation

No observation equipment is available and the initiation is urgently needed.

3) Other

Both self-financing and cooperation from donors are conceivable to finance the countermeasure.

Table 4.5.2 summarizes the issues, countermeasures, and terms regarding flood, surge, and tsunami.

Table 4.5.2 Issues, Countermeasures and Terms Regarding Flood, Surge and Tsunami in Suriname

No	Issue	Countermeasure	Term	Other
SU-5	Improvement of drainage in Paramaribo	Formulation of drainage plan reflecting the future urban development	Short	Cooperation from the central government or donors
SU-6	Evacuation response to flooding in the middle reach of the Marowijine River	Assistance to the representative towns regarding community-based disaster mitigation Transfer of knowledge to the staff of NCCR regarding community-based disaster mitigation	Short	Cooperation from donors
SU-7	Improvement of the Road to Prevent Annual Road Closure in the Section between Apoera and Zanderij due to Flooding	Betterment of the road at the section between Pikin Saron and Witagron where road closure is frequent	Short・Medium	Cooperation from donor
SU-8	Mitigation of coastal erosion	Selection of optimum intervention and implementation thereof at the sites with high priorities	Short・Medium	Self-financing or cooperation from donor
SU-9	Monitoring and Collection of Tsunami Information in and around Suriname	Installation of observation facilities Monitoring	Short・Medium	Self-financing or cooperation from donor

Source: JICA Survey Team

4.5.3 Meteoro-Hydrologic Observation

(1) SU-10 : Improvement of Insufficiency of Staff

1) Countermeasure

The insufficient number of staffs has hampered meteoro-hydrologic observation. In particular, the insufficient number of maintenance staffs is identified as the cause of this situation. The insufficient budget and eventually, the inability to employ experienced staff are the causes of insufficient number of maintenance staffs. Negotiation with the ministry is necessary to secure the budget. Employment of new graduates from the related faculty of university or technical college may be available through CIMH.

2) Term until initiation

The countermeasure is an urgent need and is to be initiated in the short term.

(2) SU-11 : Improvement of Rainfall Observation Network

1) Countermeasure

The locations of the existing observatories are concentrated in the coastal area. Observatories are installed in the local airport in the inland area. The enhancement of the observation in inland is necessary.

However, data collection in the inland areas is difficult due to the difficulty in access and the eventual difficulty in maintenance of the station.

An automatic observation and data transmission should be installed replacing the existing equipment in such stations so that the data recorded therein could be monitored in the head office.

2) Term until initiation

The refurbishment of equipment should follow the establishment of the maintenance system. The initiation of this measure should be in the medium to long term.

3) Other

Both self-financing and cooperation from donors are conceivable to finance the countermeasure.

(3) SU-12 : Execution of Observation of the Water Level and Discharge Measurement at No Tide-affected Section

1) Countermeasure

All the water level observatories are located in the tidal areas and the records therein do not reflect the accuracy of the water level. The observatories should be transferred to the upstream sections, where the influence of the tide is insignificant, and estimate the river runoff. The refurbishment of the equipment, to afford automatic recording and to make the data collection from the central office possible, is necessary in the inland where the access is difficult.

2) Term until initiation

The refurbishment of equipment should follow the establishment of the maintenance system. The initiation of this measure should be in the medium to long term.

3) Other

Both self-financing and cooperation from donors are conceivable to finance the countermeasure.

(4) SU-13: Mitigation of Man-made Flood due to the Discharge from Brommestein Dam

1) Countermeasure

The objective of Brommestein Dam is power generation. No warning is disseminated to the downstream area when the dam spills out flood water although discharges have sometimes caused flooding in the downstream reaches.

The installation of warning system is necessary in the affected downstream areas. The review of the reservoir operation rules is necessary as well in order not to cause significant flooding.

2) Term until initiation

In order to alleviate the influences to the downstream areas, the initiation of the countermeasure should be in the short term.

3) Other

The power company is requested to shoulder the cost.

Table 4.5.3 presents the issues, countermeasures, and terms for meteoro-hydrological observation.

Table 4.5.3 Issues, Countermeasures and Terms for Meteoro-hydrologic Observation in Suriname

No	Issue	Countermeasure	Term	Other
SU-10	Improvement of Insufficiency of staff	Recruitment of the maintenance staffs	Short	Meteoro-hydrologic observation agency is responsible. The increase in budget should be negotiated with the central government and the ministry
SU-11	Improvement of rainfall observation network	Intensive installation of automatic rainfall gauging stations so that the data collection from the central office becomes possible	Medium・Long	Self-financing or cooperation from donor
SU-12	Execution of observation of the water level and discharge measurement at no-tide affected section	Install automatic gauging stations in the upstream reach where the tidal effect is insignificant	Medium・Long	Self-financing or cooperation from donor
SU-13	Mitigation of Man-made flooding due to the discharge from Brommestein Dam	Installation of warning system Review of reservoir operation rule to avoid flooding in the downstream reach	Short	Responsibility of the power company

Source: JICA Survey Team

4.5.4 List of Conceivable Projects

Table 4.5.4 demonstrates the conceivable projects in Suriname.

Table 4.5.4 List of Conceivable Projects in Suriname

No	Term	Project Title	Component
SU-2	Short・Medium	Capacity Building of NCCR Staff	1) Training for disaster mitigation planning, monitoring, and evaluation 2) Training method for community disaster mitigation
SU-4	Short	Development of Topographic Map of Suriname	1) Shooting of air photo 2) Establishment of standard datum 3) Development of digital map 4) Transfer of knowledge for map development
SU-5	Short・Medium	Drainage Improvement Plan in the Paramaribo Area	1) Diagnosis 2) Study on future development 3) Study on the drainage network 4) Study on the storage 5) Study on the pump station

No	Term	Project Title	Component
			6) Cost estimates
SU-6	Short	Community-based Disaster Mitigation in the Middle Reach Areas of the Marowijine River	1) Diagnosis 2) Development of hazard map 3) Study on shelter and stock yard 4) Study on the evacuation route 5) Training material for community-based disaster management 6) Training for the leader on disaster mitigation
SU-7	Short・Medium	Betterment of the Submerged Road in the Section between Apoera and Zanderij	1) Diagnosis 2) Basic conditions 3) Study on the longitudinal and sectional profiles of the road 4) Study on the countermeasures 5) Design of the selected optimum option 6) Cost estimates 7) Construction
SU-8	Short	Countermeasure for Coastal Erosion on the Northern Coast	1) Diagnosis 2) Comparative study 3) Design of the optimum option 4) Cost Estimates
SU-9	Short・Medium	Strengthening of Disaster Mitigation against Tsunami	1) Planning of the observation 2) Installation of observation facility 3) Establishment of monitoring system 4) Establishment of the system for coordination with other related agencies 5) Establishment of maintenance system
SU-11 SU-12	Medium・Long	Enforcement of Meteoro-hydrologic Observation Facilities	1) Diagnosis 2) Allocation plan of the new rainfall and water level gauging stations 3) Plan for maintenance 4) Installation of equipment (Observation and communication) 5) Renovation of database system

Source: JICA Survey Team

4.6 Saint Christopher and Nevis

Table 3.6.1 summarizes the identified issues regarding disaster management in Saint Christopher and Nevis. This section discusses the countermeasure thereto and the term until its initiation.

4.6.1 General Matters for Disaster Management

(1) CN-1： Determination of National Strategy for Disaster Mitigation

1) Countermeasure

The government has applied the Regional CDM Strategy prepared by CDEMA as the national disaster mitigation strategy. The social conditions and the location of the country are close to those of the region. However, the preparation of the National Disaster Mitigation Strategy is necessary to cope with the conditions specific to the country.

2) Terms until initiation

The strategy is the framework of the entire disaster mitigation activities and the regional strategy has been prepared already. The initiation of the national strategy preparation, therefore, should be within the short term.

3) Others

The government should employ an experienced consultant group using its own budget or cooperation from a donor is conceivable as well.

(2) CN-2： Improvement of Insufficiency of NEMA Staff

1) Countermeasures

Increase in the number of the National Emergency Management Agency (NEMA) staff is crucial to solve the problem. The conceivable ways to increase the number of staff are: i) recruitment of the candidates in the country and ii) transferring the staffs of other agencies to NEMA.

i) Recruitment of the candidates in the country

The measure is to employ new staffs through recruitment in the country. In parallel with the recruitment, processing of procedural preparation is required to secure the budget for the increase in employment cost to execute the measure smoothly.

ii) Transferring the staffs of other agencies

There may be cases where staffs are to be transferred to NEMA temporarily. In most of these cases, the agency of the said staff will shoulder their salary. Therefore, the expenses of NEMA are only for other expenses such as special allowances and no substantial increase in budget is necessary. The measure is practical for NEMA provided that necessary legal preparation is completed. Further, it is natural to consider that the transferred staff has strong channels with his mother agency. The measure is expected to strengthen the cooperation between NEMA and the agency.

2) Terms until initiation

It may take a certain time for the abovementioned preparatory works. Subsequently, the term would be medium span to long span.

3) Others

The proposed measure to increase the number of staff requires the establishment of internal procedures like preparation of budget and personnel changes. The activities for the implementation of the measures are to be conducted by the government itself.

(3) CN-3： Improvement of Insufficient Budget Allocation to NEMA

1) Countermeasure

Insufficient budget allocated to NEMA is the root cause of lack of staff in terms of quantity and quality. Negotiation with the central government and the ministry is a practical way to secure the required minimum budget.

2) Terms until initiation

The terms should be medium and long span coinciding with the term for the alleviation of insufficiency in staff number.

3) Others

Fostering the understanding of and cooperation from the central government and the ministry are fundamental to solve the problem.

(4) CN-4 : Requirement to Develop Hazard Map for Disasters in Nevis Island Other than Flood

1) Countermeasure

To develop hazard maps for disasters in Nevis Island in addition to the existing flood hazard map. The development of maps requires knowledge in various disciplines and it is recommendable to employ an experienced consultant group using its own budget or requesting cooperation from a donor.

2) Terms until initiation

The initiation of the map development should be in the short term to cope with the impending disasters and to identify the vulnerability of the society.

3) Others

The government would entrust the development of maps to the employed consultant. The budget coming from the government or through the cooperation extended by a donor is available for such employment.

Table 4.6.1 summarizes the issues, countermeasures, and terms regarding general disaster management.

Table 4.6.1 Issues, Countermeasures, and Terms Regarding General Matters for Disaster Management in Saint Christopher and Nevis

No	Issue	Countermeasure	Term	Other
CN-1	Determination of National Disaster Management Strategy	Development of the National Disaster Management Strategy	Short	Employment of consultant using its own budget or cooperation from donor
CN-2	Improvement of insufficiency of NEMA staff	Recruitment Temporary transfer of staffs from other ministries	Short・Medium	Negotiation with the central government and the ministry
CN-3	Improvement of insufficient budget allocation to NEMA	To secure the minimum required budget	Medium・Long	Negotiation with the central government and the ministry
CN-4	Requirement to develop hazard map for disasters in Nevis Island other than flood	Development of hazard maps for disasters other than flood	Short	Employment of consultant using government budget or cooperation from donor

Source: JICA Survey Team

4.6.2 Flood

(1) CN-5 : Improvement of Drainage Capacity in Basseterre

1) Countermeasures

The drainage canal in Basseterre shares the drainages or ditches provided to the road to drain the rainwater on the road surface. The capacity of the drainage canal is insufficient to discharge the rainwater in the area. Further, the outlet of the drainage faces to the sea and the drainage is affected by the tide.

Improvement of the drainage network is necessary on the basis of the optimization study on the various options including the provision of temporary storage facility with drainage pumps under the park area.

2) Terms until initiation

The initiation of the optimization study should be in the short term.

3) Others

The government would entrust the development to the employed consultant. The budget coming from the government or cooperation to be extended by the donor is available for such employment.

(2) CN-6 : Bridge Improvement to Prevent Temporary Closure of the Ring Road along the West Coast

1) Countermeasures

Flood water frequently passes over many sections of the causeway road provided along the west coast to close the road. The road plays an important role for transportation in particular during a disaster and the road should be an all-weather type. Provision of a bridge with girder at the submergible section or relocation of the section to the mountain side is the conceivable measure to make an all-weather road. A comparative study on the two conceivable measures would select the most optimum option for the plan to rehabilitate the road. The design and the construction works should follow the plan formulation.

2) Terms until initiation

Since the road is important for disaster mitigation activities, the initiation of the countermeasure should be urgent and the term should be short.

3) Others

Budget coming from the government or cooperation from a donor is available for the implementation of the countermeasure.

(3) CN-7 : Floodwater Control from the Developed Northwestern Areas of Basseterre

1) Countermeasures

The reclaimed residential quarters extend up to the mountain slopes of the area. The flood water from the residential area directly concentrates to the drainage, which is not sufficiently prepared and has caused damages to the area because no storage or retarding basin is provided. Provision of retarding basin to regulate the peak discharge and improvement of the drainage system are the conceivable countermeasures for the problem.

2) Term until initiation

The areas have been reclaimed already and the runoffs from the areas have affected the developed downstream areas. The implementation of the countermeasures is an urgent need. The term should be short.

3) Others

The developer of the area is responsible in implementing the countermeasures.

Table 4.6.2 summarizes the issues, countermeasures, and the terms until their initiation regarding flood.

Table 4.6.2 Issues, Countermeasures and Terms Regarding Flood in Saint Christopher and Nevis

No	Issue	Countermeasure	Term	Other
CN-5	Improvement of drainage capacity in Basseterre	Formulation of drainage improvement plan	Short	Self-financing or cooperation from donor
CN-6	Bridge improvement to prevent temporary closure of the Causeway Ring Road along the west coast	Study on the optimum plan and the implementation of the plan.	Short	Negotiation with the central government and the ministry.

No	Issue	Countermeasure	Term	Other
	due to flood			
CN-7	Floodwater control from the northwestern areas of Basseterre	Improvement of the drainage channel and the provision of retarding basins	Short	Implementation by the developer

Source: JICA Survey Team

4.6.3 Mass Movement, High Tide, Earthquake, Tsunami, and Strong Wind

(1) CN-8 : Possible Slope Failure in the Slopes along the Road to South Peninsula

1) Countermeasures

The countermeasures to the problem are study on the stabilization of slope and the implementation of the permanent stabilization option.

2) Terms until initiation

Slope failures have been experienced and still impending. The implementation of the countermeasure is urgently needed. The term should be short.

3) Others

Self-financing could afford the implementation considering the scale of works.

(2) CN-9 : Countermeasure Against High Tide to Cause Road Closure at the Old Road Bay Area

1) Countermeasures

Road closures have been occurring on the West Coast Road at Old Road Bay due to the surge caused by the hurricanes.

The conceivable countermeasures to the problem are the provision of retaining wall and bank protection works or detour. The implementation of the optimum option through a comparative study is necessary to solve the problem.

2) Terms until initiation

The ring road is very important for the transportation in the island. The term should be short.

3) Others

Self-financing or cooperation from a donor is available.

(3) CN-10 : Provision System of Information to the Customers of the Hotels in North Frigate Bay, which is Vulnerable to Flood, High Tide, and Tsunami

1) Countermeasures

North Frigate Bay is vulnerable to disasters. However, no information about the disaster such as evacuation route is available in the hotel and the customers may have difficulties to find the evacuation site.

Publication of information such as evacuation route and evacuation center is necessary in North Frigate Bay.

2) Terms until initiation

The share of tourism sector in GDP is high. The initiation of the countermeasure should be short.

3) Others

Self-financing or cooperation from a donor is available.

(4) CN-11 : Preparation of Hazard Map Related to Earthquake

CN-12 Preparation of Disaster Mitigation Plan Against Earthquake for the Capital

1) Countermeasures

Earthquake is rather frequent in the country. However, there is no hazard map or risk map available. The maps are fundamental to formulate the disaster mitigation plan against earthquake for the capital. The premier countermeasure is to prepare a hazard map or risk map for the capital by compiling the assessed results of the vulnerability by areas. The disaster mitigation plan will be formulated on the basis of prepared hazard map identifying the evacuation routes and the allocations and layouts of the shelters.

2) Terms until initiation

The term for the initiation of the risk map preparation should be short since the occurrence of earthquake is frequent, and the map is the basic and urgent need for the formulation of a disaster mitigation plan. Meanwhile, preparatory works such as development of risk maps may take a certain time before the formulation of the disaster mitigation plan for the capital. The term for the initiation is short or medium span for the formulation of disaster mitigation plan.

3) Others

The formulation of disaster mitigation plan against earthquake requires various fields of knowledge and experiences such as seismology in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(5) CN-13 : Development of Standard Design Methods Against Seismic Load and Wind Load

1) Countermeasures

Among the targeted countries of the study, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions depend on the designer. Different standards such as AASHTO and BS have been adopted in the country. Some government engineers have asserted the necessity of standardization.

This subject is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of governments of related countries to study the applicability of the standards, which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by other countries together with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals, which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed referring to the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure will require medium or long term for its initiation.

3) Others

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts as observers from outside to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

Table 4.6.3 presents the identified issues, countermeasures, and terms regarding mass movement, high tide, earthquake, tsunami, and strong wind in Saint Christopher and Nevis.

Table 4.6.3 Issues, Countermeasures and Term Regarding Mass Movement, High Tide, Tsunami, Earthquake, and Strong Wind in Saint Christopher and Nevis

No	Issue	Countermeasure	Terms	Others
CN-9	Countermeasure against high tide to Cause Road closure at the Old Road Bay area	Provision of wave protection or detour	Short	Self-financing or cooperation from donor
CN-10	Provision system of information to the customers of the hotels in North Frigate Bay which is vulnerable to flood, high tide, and tsunami	Formulation of evacuation plan which indicates evacuation route and evacuation center. Preparation of materials regarding evacuation (in multi-languages) Dissemination to the tourists	Short	Self-financing or cooperation from donor
CN-11	Preparation of earthquake hazard map in Saint Christopher	Development of a hazard map Formulation of disaster mitigation plan which enunciates the evacuation route and evacuation center	Short・Medium	Employment of a consultant group by the central government or cooperation from donor
CN-12	Preparation of disaster mitigation plan for earthquake for the capital			
CN-13	Development of standard design methods against seismic load and wind load	Establishment of a committee inviting experts from related countries to serve as members of the committee. The discussions in the committee will find the standards suitable to the local conditions	Medium・Long	The cost to be incurred by the committee will be shouldered by the budget of member countries. Donors will dispatch observers as long-term experts

Source: JICA Survey Team

4.6.4 Meteoro-hydrologic Observation

(1) CN-14：Establishment of Independent Office instead of a Section of the Airport Managing Company to Conduct the Observation

1) Countermeasures

An independent department should be established in the central government to be assigned the works related to meteorology and hydrology.

2) Terms until initiation

In order to secure the smooth transfer of jobs, the term should be long.

3) Others

The matter is the organizational reform of the government and the government budget should shoulder the cost to be incurred.

(2) CN-15： Own Weather Forecasting and Meteorological Information

1) Countermeasures

Antigua and Barbuda is the focal point and is forecasting for the area including its neighboring countries. Saint Christopher Island and Nevis Island are availing this forecasting service.

As mentioned in above CN-14, the established department should analyze the information taking into account its own specific conditions and should disseminate the specific forecasting. The establishment of a department requires sufficient number of staffs in terms of quality and quantity accordingly.

2) Terms until initiation

The term should be long including the reformation of the organization.

3) Others

The matter is the organizational reform of the government and the government budget should shoulder the cost to be incurred.

(3) CN-16： Preparation of an Observation System

1) Countermeasures

The existing observation facilities belong to the airport managing company and CIMH or CMO. Preparation of its own facilities is necessary in line with the establishment of a new department.

2) Terms until initiation

The term should be long harmonizing with the establishment of the department.

3) Others

The matter is the organizational reform of the government and the government budget should shoulder the cost to be incurred.

Table 4.6.4 presents the summary of issues, countermeasures, and terms for initiation regarding the meteorological and hydrologic observation.

Table 4.6.4 Identified Issues, Countermeasures and Terms Regarding Meteorological and Hydrologic Observation in Saint Christopher and Nevis

No	Issue	Countermeasure	Term	Other
CN-14	Establishment of independent office instead of a section of the airport managing company to conduct the observation	New specific organization should be established to handle meteorological works. Employment of minimum required staffs for forecasting and facility maintenance is necessary. Preparation of observation equipment and facility is necessary as well.	Short	Government budget should be shared to the establishment. The assistance and cooperation from CIMH and CMO are useful.
CN-15	Own weather forecasting and meteorological information			
CN-16	Preparation of an observation system			

Source: JICA Survey Team

4.6.5 List of Proposed Projects

Table 4.6.5 demonstrates the projects proposed in due consideration of the issues and countermeasures discussed above.

Table 4.6.5 Proposed Projects List for Saint Christopher and Nevis

No	Terms	Project Title	Component
CN-1	Medium・Long	Preparation of National Strategy for Disaster Mitigation	1) Diagnosis of responsible organization for disaster mitigation and NEMA 2) Study on the policy of CDEMA 3) Study on the relationship of NEMA and Nevis Disaster Management Department (NDMD) in Saint Christopher and Nevis 4) Confirmation of the disaster response policy in each island 5) Preparation of the strategy
CN-2	Short・Medium	Capacity Building for the Staffs of NEMA/NDMD	1) Capacity building for general disaster mitigation 2) Capacity building for community disaster mitigation
CN-4	Short	Development of Hazard Map for Nevis Island	1) Diagnosis 2) Development of hazard map
CN-5	Short	Improvement of Drainage Capacity in Basseterre	1) Diagnosis 2) Urban development plan 3) Study on drainage network, pump station, and retarding basin 4) Comparative study 5) Design and implementation of the optimum plan
CN-6	Short	Betterment of Causeway	1) Diagnosis 2) Design condition 3) Comparative study 4) Design of the optimum plan 5) Cost estimates 6) Construction
CN-9	Short	Protection Works for High Tide at Old Road Bay	1) Diagnosis 2) Study on design condition 3) Alternative study 4) Comparative study 5) Cost estimation for the optimum plan 6) Construction
CN-10	Short	Disaster Mitigation Focusing on Tourism	1) Diagnosis 2) Renovation of hazard map for North Frigate Bay 3) Study on evacuation route and evacuation center 4) Preparation of evacuation map in multiple languages 5) Training for evacuation
CN-11	Short	Formulation of Disaster Mitigation Plan for Earthquake in Basseterre	1) Confirmation of the existing plans 2) Renovation of hazard map for earthquake 3) Study on evacuation route and evacuation center 4) Risk assessment and preparation of scenario 5) Formulation of disaster mitigation plan 6) Preparation of disaster mitigation materials like disaster mitigation map and evacuation training 7) Fostering of leaders for disaster mitigation training

Source: JICA Survey Team

4.7 Saint Vincent and the Grenadines

Table 3.7.1 demonstrates the identified issues regarding disaster management in Saint Vincent and the Grenadines. The JICA Survey Team scrutinized the issues and proposed countermeasures to mitigate the issues. The JICA Survey Team proposed the terms until the initiation of the countermeasures as well.

4.7.1 General Matters for Disaster Management

(1) SV-1： Improvement of Insufficiency of NEMO Staff

1) Countermeasures

Increase in the number of the National Emergency Management Office (NEMO) staff is crucial to solve the problem. The conceivable ways to increase the number of staff are: i) recruitment of the candidates in the country and ii) transferring the staffs of other agencies to NEMO.

i) Recruitment of the candidates in the country

The measure is to employ new staffs through recruitment in the country. In parallel with the recruitment, processing of procedural preparation is required to secure the budget for the increase in employment cost to execute the measure smoothly.

ii) Transferring the staffs of other agencies

There may be cases where staffs are to be transferred to NEMO temporarily. In most of these cases, the agency of the said staff will shoulder their salary. Therefore, the expenses of NEMO are only for other expenses such as special allowances and no substantial increase in budget is necessary. The measure is practical for NEMO provided that necessary legal preparation is completed. Further, it is natural to consider that the transferred staff has strong channels with his mother agency. The measure is expected to strengthen the cooperation between NEMO and the agency.

2) Terms until initiation

It may take a certain time for the abovementioned preparatory works. Subsequently, the term would be medium span to long span.

The terms are defined as follows; the short term is within five years, the medium term is within ten years, and the long term is over ten years.

3) Others

The proposed measure to increase the number of the staff requires the establishment of internal procedures like preparation of budget and personnel changes. The activities for the implementation of these measures are to be conducted by the government itself

(2) SV-2： Capability Improvement of NEMO Staff

1) Countermeasures

NEMO is preparing flood map applying GIS, knowledge management, early warning monitoring and operating radio stations. The capability of the staff is not sufficient in general to conduct these works. The enhancement of the capability is necessary through the training to be provided by donors and the cooperation to be extended by CEDMA.

2) Terms until initiation

The measure is urgent and the term should be short.

3) Others

Cooperation of donors is necessary in the field of training and dispatching of experts.

(3) SV-3： Improvement of Budget Insufficiency Allocated to NEMO

1) Countermeasures

The insufficiency of budget allocated to NEMO will be prominent to take measures by the national budget without the donor’s supports in future. By that time, it is necessary to get mutual consensus with the central government and the ministry about budgetary requirement.

2) Terms until initiation

The terms should be short and medium span so as to take budgetary measure in medium and long term.

3) Others

Fostering the understanding of and cooperation from the central government and the ministry are fundamental to solve the problem.

Table 4.7.1 summarizes the issues, countermeasures, and terms regarding general disaster management.

Table 4.7.1 Issues, Countermeasures, and Terms Regarding General Disaster Management in Saint Vincent and the Grenadines

No	Issue	Countermeasure	Term	Others
SV-1	Improvement of insufficiency of NEMO staff	Recruitment Temporary transfer of staffs from other ministries	Medium・Long	Deliberations between NEMO and the central government
SV-2	Capability improvement of NEMO staff	Participation in the training program to be held by donors and CDEMA	Short	Cooperation of donors is crucial
SV-3	Improvement of Budget Insufficiency allocated to NEMO	To secure a proper budget	Short・Medium	Deliberations between NEMO and the central government

Source: JICA Survey Team

4.7.2 Flood, Mass Movement, High Tide, Earthquake, Tsunami, Strong Wind, and Water Shortage

(1) SV-4 : Mitigation of Damages due to the Flood Caused by the Cumberland River

1) Countermeasures

The Christmas Flood in 2013 overflowed the Bailey bridge, which is provided for temporary use. The flood did not cause any serious damage. However, the fact indicates that the elevation of the bridge has no sufficient clearance. This bridge is a substitute of the bridge which was washed away by the flood that occurred in the 1990s. This temporary bridge has already served more than 15 years. It is recommended to renovate the bridge as soon as possible from the safety point of view.

The review of the design water level of the river is the first step of the measure. A new bridge will be designed and constructed with sufficient clearance. The renovation of the approaches is necessary eventually.

2) Terms until initiation

The measure should be initiated within a short span because the renovation is one of the restoration works for the Christmas Flood.

3) Others

The cooperation from donor is conceivable. There is a possibility that the new bridge will substitute the Bailey bridge for temporary use again. Even then, the abutment and approach should not be submerged and breached.

(2) SV-5 : Mitigation of Slope Failure of the Mountain Side of the Road along the East Coast

SV-6 : Mitigation of Coastal Erosion along the East Coast

1) Countermeasures

Slope failure and associated debris in the mountain side of the Windward Highway have affected the safety of the road. Meanwhile, coastal erosion is the damage incurred on the sea side.

Risk assessment of the slope is necessary together with the prioritization of conceivable countermeasures. The measures will be implemented along with the priorities.

The process of the implementation of the countermeasure against coastal erosion is more or less the same with the mountain side. The assessment of the risk is the first step followed by the prioritization. Along the defined priorities, the measures will be designed and constructed.

2) Terms until initiation

Considering the importance of the road, the measures should be implemented within the short and medium terms.

3) Others

Cooperation from donors is conceivable.

(3) SV-7 : Development of Hazard Map Related to Earthquake

SV-8 : Formulation of Disaster Mitigation Plan Against Earthquake for the Capital

1) Countermeasures

Earthquake is rather frequent in the country. However, no hazard map or risk map is available. The maps are fundamental to formulate the disaster mitigation plan against earthquake for the capital. The premier countermeasure is to prepare a hazard map or risk map for the capital by compiling the assessed results of the vulnerability by areas. The disaster mitigation plan will be formulated on the basis of the prepared hazard map identifying the evacuation routes and the allocations and layouts of the shelters.

2) Terms until initiation

The term for the initiation of the risk map preparation should be short since the occurrence of earthquake is frequent and the map is the basic and urgent requirement for the disaster mitigation plan. Meanwhile, preparations such as the development of the risk maps may take a certain time before the formulation of the disaster mitigation plan for the capital. The term for the initiation is short or medium span for the formulation of disaster mitigation plan.

3) Others

The formulation of disaster mitigation plan against earthquake requires various fields of knowledge and experiences such as seismology in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available for the employment. Request for assistance from donors on this matter may be another option.

(4) SV-9 : Formulation of Evacuation Plan for Tsunami

1) Countermeasures

Tsunami has brought high waves to Saint Vincent and the Grenadines. There are several hotels with access on the beachfront situated on the flat coastal land. These beaches are vulnerable against high waves brought by tsunami. A hazard map is available but it is already superannuated.

In order to mitigate any casualty to be caused by a tsunami, the renewal of the hazard maps and the formulation of evacuation plan are necessary identifying the evacuation routes and locations of shelters and evacuation sites.

2) Terms until initiation

Tsunami is not frequent but it is highly possible to bring serious damage once it occurs. Therefore, the formulation of an evacuation plan is urgently needed. The terms for the initiation of the measure should be short or medium span.

3) Others

The formulation of the evacuation plan against tsunami requires various fields of knowledge and experiences such as maritime engineering in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is

available for the employment. Request for assistance from donors on this matter may be another option.

(5) SV-10 : Development of Standard Design Methods Against Seismic Load and Wind Load

1) Countermeasures

Among the targeted countries of the study, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions depend on the designer. Different standards such as AASHTO and BS have been adopted in the country. Some government engineers have asserted the necessity of standardization.

This subject is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of the governments of related countries to study the applicability of the standards, which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to be a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by other countries together with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals, which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed referring to the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure will require medium or long term for its initiation.

3) Others

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts as observers from outside to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

(6) SV-11 : Formulation of Countermeasure for Water Shortage in the Grenadines

1) Countermeasures

The potential of surface water and groundwater in the Grenadines is to be assessed. The balance of the demand and the potential by the target year indicate the necessity of resource development.

The conceivable options to develop water resources in the Grenadines with small watershed area include the installation of a desalination plant and installation of a pipeline to convey water from Saint Vincent Island. The feasibility of the options should be studied for the Grenadines.

2) Terms until initiation

The study should be conducted as soon as possible.

3) Others

Options are: to employ a consultant group under the budget of the government and to request the cooperation from donors.

Table 4.7.2 presents the issues, countermeasures, and terms against flood, erosion, surging, earthquake, tsunami, strong wind, and water shortage.

Table 4.7.2 Issues, Countermeasures and Terms for Flood, Erosion, Surging, Earthquake, Tsunami, Strong Wind, and Water Shortage in Saint Vincent and the Grenadines

No	Issue	Countermeasure	Term	Other
SV-4	Mitigation of damages due to the flood caused by the Cumberland River	Review the design water level Renovation of the Bailey bridge	Short	Cooperation from donor is necessary
SV-5	Mitigation of slope failure of the mountain side of the road along the east coast	To prioritize the conceivable measures on the basis of risk assessment of slope failure and coastal erosion. To formulate the plan and design of the countermeasures Implementation of the measures	Short・Medium	Cooperation from the donor is necessary
SV-6	Mitigation of coastal erosion along the east coast			
SV-7	Development of hazard map regarding earthquake	Development of a hazard map for earthquake Formulation of a disaster mitigation plan for earthquake indicating the evacuation route and evacuation shelter	Short・Medium	Employment of consultants by the central government or cooperation from donor
SV-8	Formulation of disaster mitigation plan for earthquake for the capital			
SV-9	Formulation of evacuation plan for tsunami	Formulation of disaster mitigation plan for tsunami for the towns along the coast indicating the evacuation route and evacuation shelter	Short・Medium	Employment of the consultant by the central government or cooperation from donor
SV-10	Development of standard design methods against seismic load and wind load	Establish a committee inviting experts from the concerned countries. Discussions in the committee are expected to conclude the standard	Medium・Long	Financing coming from the budget of the countries Donors should dispatch experts as observers.
SV-11	Formulation of countermeasure for water shortage in the Grenadines	Diagnosis of the shortage through the water demand and supply balance study on the surface and ground waters in each island Study on the countermeasures to formulate a water resources management plan	Short	Employment of consultants by the central government or cooperation from donor

Source: JICA Survey Team

4.7.3 Observation of Meteoro-Hydrology

(1) SV-12： Increase of Operation and Maintenance Staff

1) Countermeasure

The insufficient number of staffs has hampered meteoro-hydrologic observation. In particular, the insufficiency in the number of maintenance staffs is the identified cause of the situation. Insufficient budget and the eventual inability to employ an experienced staff are the causes of the insufficient number of maintenance staffs. Negotiation with the ministry is necessary to secure the budget. Employment of new graduates from related faculty of university or technical college may be available through CIMH.

2) Terms until initiation

The countermeasure is an urgent need and is to be initiated in the short term.

(2) SV-13： improvement of Capacity of the Staff

1) Counter measures

The staff should attend to the seminars or trainings to be held by donors or CIMH to strengthen their capability of observation and maintenance of the equipment.

2) Terms until initiation

The countermeasure is an urgent need and is to be initiated in the short term.

(3) SV-14： Improvement of Situation of Budget Insufficiency

1) Countermeasures

The measure is to negotiate with the ministry in order to increase the budget for enhancement of the services.

2) Terms until initiation

The activity should be initiated at the negotiation of the budget for the next fiscal year under the short term.

(4) SV-15： Repair of Equipment for the Meteoro-hydrologic Observation

1) Countermeasures

The conceivable causes of the situation are: 1) insufficient budget and 2) insufficient capability of the maintenance staff. Accordingly, the increase in budget and capacity building of the maintenance staffs are the countermeasures.

2) Terms until initiation

The countermeasure to repair the deteriorated system could be implemented following the measures to increase the budget and the capacity building of the maintenance staffs, which are to be initiated under the short term. Eventually, this countermeasure could be initiated under the medium term.

Table 4.7.3 presents the issues, countermeasures, and terms regarding meteoro-hydrologic observation.

Table 4.7.3 Issues, Countermeasures and Terms Regarding Meteoro-Hydrologic Observation in Saint Vincent and the Grenadines

No	Issue	Countermeasure	Term	Other
SV-12	Increase of O&M staff	Recruitment of new graduates from the relevant faculties Proposal of the experienced personnel by CIMH	Short	Cooperation from CIMH
SV-13	Improvement of capacity of the staffs	Training by donors and CIMH	Short	Cooperation from donors
SV-14	Improvement of situation of budget insufficiency	Request to the central government and the ministry	Short	Negotiation with the central government and the ministry
SV-15	Repair of equipment for the meteoro-hydrologic observation	Restoration could follow the solutions for SV-13,-14	Medium	Self-finance

Source: JICA Survey Team

4.7.4 List of Conceivable Projects

Table 4.7.4 demonstrates the conceivable projects in Saint Vincent and the Grenadines.

Table 4.7.4 List of Conceivable Projects in Saint Vincent and the Grenadines

No	Term	Title of the Project	Component
SV-2	Short	Capacity Building of NEMO Staffs	Training to understand disaster mitigation plan, to monitor and to assess
SV-4	Short	Restoration of the Damage Caused by the Flood of the Cumberland River	1) Diagnosis 2) Study on the basic condition 3) Study on the bridges and the appurtenant structures 4) Design of the bridges and the appurtenant structures 5) Construction plan and cost estimates 6) Construction
SV-5, SV-6	Short	Stabilization of the Slope Failure and Coastal Erosion along the Coastal Road in the Eastern Area	1) Diagnosis 2) Selection of the priority sites and survey 3) Study and design of the countermeasure 4) Construction plan and cost estimates 5) Construction
SV-7, SV-8	Short・Medium	Formulation of Disaster Mitigation Plan for Earthquake in Kings Town	1) Diagnosis 2) Update of the hazard map for earthquake 3) Study on evacuation route and shelter 4) Risk assessment and preparation of scenario 5) Formulation of the plan 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Training of leaders for disaster mitigation
SV-9	Short・Medium	Formulation of Disaster Mitigation Plan for Tsunami in Urbanized Areas along the Coast	1) Diagnosis 2) Development of hazard maps for tsunami 3) Study on evacuation route and shelter 4) Study on warning 5) Formulation of disaster management 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Training of leaders for disaster mitigation
SV-11	Short	Water Resources Development Plan for the Grenadines	1) Diagnosis 2) Study on surface and groundwater potential 3) Study on water demand 4) Formulation of water resources development
SV-13	Short	Capacity Building for the Staff for operation and maintenance works	1) Training for the maintenance of equipment
SV-15	Medium	Rehabilitation of Equipment for Meteorological Observation	1) Repair of the damaged equipment

Source: JICA Survey Team

4.8 Saint Lucia

Table 3.8.1 summarizes the issues related to disaster management in Saint Lucia. The following sections discuss the countermeasures and the necessary terms until the measures are to be initiated.

4.8.1 General Matters for Disaster Management

(1) SL-1： Improvement of Insufficiency of NEMO Staff

1) Countermeasures

Increase in the number of the National Emergency Management Office (NEMO) staff is crucial to solve the problem. The conceivable ways to increase are: i) recruitment of the candidates in the country and ii) transferring the staffs of other agencies to NEMO.

i) Recruitment of the candidates in the country

The measure is to employ new staffs through recruitment in the country. In parallel with the recruitment, processing of procedural preparation is required to secure the budget for the increase in employment cost to execute the measure smoothly.

ii) Transferring the staffs of other agencies to NEMO.

There may be cases where staffs are to be transferred to NEMO temporarily. In most of these cases, the agency of the said staff will shoulder the salary. Therefore, the expenses of NEMO are only for other expenses such as special allowances and no substantial increase in budget is necessary. The measure is practical for NEMO provided that necessary legal preparation is completed. Further, it is natural to consider that the transferred staff has strong channels with his mother agency. The measure is expected to strengthen the cooperation between NEMO and the agency.

2) Terms until initiation

It may take a certain time for the abovementioned preparatory works. Subsequently, the term would be medium span to long span.

The terms are defined as follows: the short term is within five years, the medium term is within ten years and the long term is over ten years.

3) Other

The proposed measures to increase the number of the staff require the establishment of internal procedures like preparation of budget and personnel changes. The activities for the implementation of the measures are to be conducted by the government itself

(2) SL-2： Capability Improvement of NEMO Staff

1) Countermeasures

The staffs of NEMO require their capacity building in the fields stated in Sub-section 3.8.1. Capacity building of the staffs of NEMO on this matter through the participation in the training program by donors and CDEMA is fundamental for the disaster management in Saint Lucia.

2) Terms until initiation

The capacity building of the staffs is urgently needed and the term until the initiation shall be short.

3) Other

Cooperation such as conducting training program and dispatching experts by donors is necessary. The JICA training program by specific subjects will be determined taking into consideration overall status of disaster management organization of respective countries.

(3) SL-3： Improvement of Budget Insufficiency Allocated to NEMO

1) Countermeasures

The insufficiency of budget allocated to NEMO is the root cause of the lack of staff in terms of quantity and quality. Negotiation with the central government and the ministry is the practical way to increase the budget.

2) Terms until initiation

The terms should be medium and long span coinciding with the term for the alleviation of insufficiency in staff number.

3) Other

Fostering of the understanding of and cooperation from the central government and the ministry are fundamental to solve the problem.

(4) SL-4 : Improvement of Communications among the Disaster-related Organizations

1) Countermeasures

The abilities of mutual communication system are weak. The strengthening of the communication system is necessary.

2) Terms until initiation

In order to respond to the impending disaster, short term should be adopted.

3) Other

Self-financing or cooperation to be extended by donors is required to implement the measure.

Table 4.8.1 summarizes the issues, countermeasures, and terms regarding general disaster management.

Table 4.8.1 Issues, Countermeasures and Terms Regarding General Matters for Disaster Management in Saint Lucia

No	Issue	Countermeasure	Term	Other
SL-1	Improvement of insufficiency of NEMO staff	Recruitment Temporary transfer of staffs from other ministries	Medium・Long	Issue to be discussed by NEMO and the central government
SL-2	Capacity improvement of the NEMO staffs	Participation in the training program to be held by donors and the cooperation from CDEMA	Short	Cooperation from donors is crucial
SL-3	Improvement of budget insufficiency allocated to NEMO	Securing of budget	Medium・Long	Negotiation of NEMO with the central government
SL-4	Improvement of communication among organizations disaster-related organization	Improvement of communication system	Short	Self-finance or cooperation from donors

Source: JICA Survey Team

4.8.2 Flood, Mass Movement, High Tide, Earthquake, and Tsunami

(1) SL-5 : Mitigation of Damages of the Bridges on the Trunk Ring Road of the Island

1) Countermeasures

The sectional areas of the Cul de Sac River at the three bridges are insufficient to discharge the flood of the river. The floods have occurred at these sections. The replacement of the bridges with new ones is necessary together with river channel improvement at the upstream and downstream reaches from the bridge sections.

The replacement requires the design water level, selection of the sections to be improved, and the study on the approaches to the bridges. The optimum plan is to be selected for implementation.

2) Terms until initiation

Since the bridges cover part of the trunk road, the measure should be implemented in the short term.

3) Other

Self-financing or cooperation by donors is necessary.

(2) SL-6 : Mitigation of Slope Failures on the Mountain Side Slope of the Trunk Ring Road in the Island

1) Countermeasures

Erosion is frequent in the sections between Canaries and Soufriere of the West Coast Road. The priority of the section is to be assessed through risk analysis. The measures are to be planned and designed for each priority section. The sites with high priority are to be implemented first.

2) Terms until initiation

The trunk road requires urgent responses. The term should be short.

3) Other

Self-financing or cooperation by donors is necessary.

(3) SL-7 : Preparation of Hazard Map for Earthquake

SL-8 : Formulation of Disaster Management Plan for Earthquake in the Capital

1) Countermeasures

Earthquake is rather frequent in the country. However, no hazard map or risk map is available. The maps are fundamental requirements to formulate the disaster mitigation plan against earthquake that might happen in the capital. The premier countermeasure is to prepare a hazard map or risk map for the capital by compiling the assessed results of vulnerability by areas. The disaster mitigation plan will be formulated on the basis of the prepared hazard map identifying the evacuation routes and the allocations and layouts of the shelters.

2) Terms until initiation

Term for the initiation of the risk map preparation should be short since the occurrence of earthquake is frequent and the map is the basic and urgent requirement for the disaster mitigation plan. Meanwhile, preparations such as development of the risk maps may take a certain time before the formulation of the disaster mitigation plan for the capital. The term for the initiation for the formulation of disaster mitigation plan is short or medium span.

3) Other

The formulation of disaster mitigation plan against earthquake requires various fields of knowledge and experiences such as seismology in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available for employment. Request for assistance from donors on this matter may be another option.

(4) SL-9 : Preparation of Evacuation Plan for Tsunami

1) Countermeasures

No hazard map against tsunami is available in Saint Lucia. In order to mitigate casualty to be caused by a tsunami, the development of the hazard maps and the formulation of evacuation plan are necessary in identifying the evacuation routes and the locations of shelters and evacuation sites in the towns situated along the coast.

2) Terms until initiation

Tsunami is not frequent but is highly possible to bring a serious damage once it occurs. Therefore, the formulation of the evacuation plan is urgently needed. The term for the initiation of the measure should be short or medium span.

3) Other

The formulation of the evacuation plan against tsunami requires various fields of knowledge and experiences such as maritime engineering in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is

available for the employment. Request for assistance from donors on this matter may be another option.

(5) SL-10 : Development of Standard Design Methods Against Seismic Load and Wind Load

1) Countermeasures

Among the targeted countries of the study, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions depend on the designer. Different standards such as AASHTO and BS have been adopted in the country. Some government engineers have asserted the necessity of standardization.

This subject is common to the several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of the governments of related countries to study the applicability of the standards, which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to be a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by other countries together with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed referring to the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure will require medium or long term for its initiation.

3) Other

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts as observers from outside to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

(6) SL-11 : Improvement of Sediment Siltation in John Compton Dam Reservoir

1) Countermeasures

John Compton Dam is the only dam in Saint Lucia with the purpose of water supply. Canadian International Development Agency (CIDA) extended cooperation to Saint Lucia for the provision of the dam which was constructed in 1995. Since its completion, sediment has silted in the reservoir. The eventual storage capacity is 1/7 of the design storage. The extension of the extremely shortened life of the dam is crucial to cope with the impending water shortage.

The structural measures to mitigate the siltation problem are: 1) discharge the sediment in the reservoir through sediment flush gates; 2) discharging sediment through sluicing pipe embedded in the reservoir; 3) discharge flood water with a high sediment concentration through a bypass tunnel; and 4) dredging out by using a dredging boat. Meanwhile, non-structural measures envisage the decrease in the productivity of sediment in the upstream watershed area such as: 1) forestation in the upstream

watershed areas, and 2) alteration in cropping patterns in the agricultural land in the upstream watershed areas.

CIDA is assisting the government to conduct the feasibility study on the countermeasure against the sedimentation problem. The implementation is to reflect the results of the feasibility study. It is necessary to confirm that CIDA is going to extend the cooperation with the government in the implementation of measure.

2) Terms until initiation

As mentioned in the preceding paragraph, a solution is urgently needed since water shortage is impending. The formulation of plan for the countermeasures is the first step, and the initiation of the plan formulation should be in the short term. The implementation of the measure should follow the planning. Therefore, the initiation should be in the short or medium term.

3) Other

Confirmation of the cooperation plan of CIDA is necessary.

Table 4.8.2 presents the issues, countermeasures, and terms against flood, erosion, surging, earthquake, and tsunami.

Table 4.8.2 Issues, Countermeasures and Terms for Flood, Erosion, Surge, Earthquake, and Tsunami in Saint Lucia

No	Issue	Countermeasure	Term	Other
SL-5	Mitigation of damages in the bridges on the Trunk Ring Road in the island	Rehabilitations of the three bridges in the Cul de Sac River basin	Short	Self-financing or cooperation from donors
SL-6	Mitigation of slope failure along on the mountain side slope of the trunk ring road in the island	Risk assessment of the slope failures, prioritization, study on the countermeasures and construction of the slope protection at the sites with high priority	Short	Self-financing or cooperation from donors
SL-7	No hazard map for earthquake is available	Development of hazard map for earthquake and formulation of disaster mitigation plan that indicates evacuation route and evacuation shelter.	Short・Medium	Employment of consultants by the central government or cooperation from donor
SL-8	Preparation of disaster mitigation plan for capital against earthquake			
SL-9	Preparation of evacuation plan for tsunami	Formulation of disaster management plan for the coastal zone for tsunami indicating evacuation route and evacuation shelters	Short・Medium	Employment of consultants by the central government or cooperation from donor
SL-10	Development of standard design methods against seismic load and wind load	Establishment of a committee inviting experts from the related countries to serve as members of the committee. The discussions in the committee will find the standards suitable to the local conditions	Medium・Long	Financed by the budget of countries concerned Donors will dispatch experts as observers
SL-11	Improvement of sediment siltation in John Compton Dam Reservoir	Implementation of the countermeasures to be proposed by the study by CIDA	Short・Medium	Cooperation from the donor

Source: JICA Survey Team

4.8.3 Meteoro-Hydrologic Observation

(1) SL-12： Increasing Staff for Meteorological Observation

1) Countermeasure

Lack of budget and the eventual inability to employ experienced staff are the causes of insufficiency in number of maintenance staffs. Negotiation with the ministry is necessary to secure the budget. If the employment of an experienced engineer in Saint Lucia is difficult, employment of new graduate from related faculty of university or technical college through the cooperation from CIMH is a solution.

2) Terms until initiation

The countermeasure is an urgent need and is to be initiated in the short term.

(2) SL-13： Capability Improvement of the Staff

1) Countermeasure

The staff should attend the seminars or trainings to be held by donors or CIMH to strengthen the capability of observation and maintenance of the equipment.

2) Terms until initiation

The countermeasure is an urgent need and is to be initiated in the short term.

(3) SL-14： Improvement of the Budget Insufficiency Allocated to the Observation

1) Countermeasure

It is necessary to request the understanding of the central government and the ministry regarding the expansion of Meteorological Services.

2) Terms until initiation

The request should be initiated as the opportunity to negotiate the budget for the next fiscal year. The short term should be adopted.

(4) SL-15： Repair of Equipment for the Meteoro-hydrologic Observation

1) Countermeasure

The conceivable causes of the situation are: 1) insufficient budget and 2) insufficient capability of the maintenance staffs. Accordingly, increase in the budget and capacity building of the maintenance staffs are the countermeasures.

2) Terms until initiation

The countermeasure to repair the deteriorated system could be implemented following the measures to increase the budget and the capacity building of the maintenance staffs, which are to be initiated in the short term. Eventually, this countermeasure could be initiated in the medium term.

Table 4.8.3 presents the identified issues, countermeasures, and terms regarding meteoro-hydrologic observation.

Table 4.8.3 Issues, Countermeasures and Term for Meteoro-Hydrologic Observation in Saint Lucia

No	Issue	Countermeasure	Term	Other
SL-12	Increasing staff for meteorological observation	Recruit new graduate Proposed experienced staff by CIMH	Short	Cooperation from CIMH
SL-13	Capacity improvement of the maintenance staffs	Training by donors and CIMH	Short	Cooperation from donors
SL-14	Improvement of the budget insufficiency allocated to the observation	Request to the central government and the ministry	Short	Self-financing
SL-15	Repair of equipment for the meteoro-hydrologic observation	Repair following the solutions of SL-13,-14	Medium	Self-financing

Source: JICA Survey Team

4.8.4 List of Conceivable Projects

Table 4.8.4 demonstrates the list of conceivable projects on the basis of the issues and countermeasures.

Table 4.8.4 List of Conceivable Projects in Saint Lucia

No	Term	Title of Project	Component
SL-2	Short・Medium	Capacity Building of NEMO Staffs	1) Training to understand disaster mitigation plan, to monitor, and to assess
SL-4	Short・Medium	Strengthening of Communication in Emergency	1) Dispatching of experts for the strengthening of communication system for disaster
SL-5	Short	Rehabilitation of Bridges on the Trunk Ring Road in the Island	1) Diagnosis 2) Study on bridges and appurtenant structures 3) Design of bridges and appurtenant structures 4) Construction plan and cost estimates 5) Rehabilitation works
SL-6	Short	Stabilization of Slopes Along the Trunk Ring Road in the Island	1) Diagnosis 2) Study on priority and survey 3) Study and design of the countermeasure 4) Construction plan and cost estimates 5) Construction
SL-7 SL-8	Short・Medium	Disaster Mitigation Plan for Earthquake in Castries	1) Diagnosis 2) Update of the hazard map 3) Study on evacuation route and shelter 4) Risk assessment and preparation of scenario 5) Formulation of disaster mitigation plan 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Fostering of leader for training on disaster management
SL-9	Short・Medium	Formulation of Disaster Mitigation Plan for Tsunami in the Urbanized Areas along the Coast	1) Diagnosis 2) Development of hazard maps for tsunami 3) Study on evacuation route and shelter 4) Study on warning 5) Formulation of disaster management 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Training of leaders for disaster mitigation
SL-11	Short	Countermeasures for	1) Review of the existing study

No	Term	Title of Project	Component
		Sedimentation in the Reservoir of John Compton Dam	2) Study on the applicability of the technology developed in Japan 3) Review on the watershed management 4) Implementation of the countermeasures for sedimentation
SL-13	Short	Capacity Building for the Staff of Meteorological Observation	1) Training for meteoro-hydrologic observation 2) Training for maintenance of equipment
SL-15	Medium	Rehabilitation of the Meteoro-hydrologic Observation System	1) Rehabilitation of the deteriorated system

Source: JICA Survey Team

4.9 Dominica

Table 3.9.1 summarizes the issues related to disaster management in Dominica. The following sections discuss the countermeasures and the necessary terms until the measures are to be initiated.

4.9.1 General Matters for Disaster Management

(1) DM-1 : Improvement of Insufficiency of ODM Staff

1) Countermeasures

Increase in the number of the Office of Disaster Management (ODM) staff is crucial to solve the problem. Restriction of the number of ODM staff is to be eased first through the negotiation with the central government to secure required number of staffs to fulfill the ODM's tasks so that staff increasing is approved. The conceivable ways to increase are: i) recruitment of the candidates in the country and ii) transferring the staffs of other agencies to ODM.

i) Recruitment of the candidates in the country

The measure is to employ new staffs through recruitment in the country. In parallel with the recruitment, processing of procedural preparation is required to secure the budget for the increase in employment cost to execute the measure smoothly.

ii) Transferring the staffs of other agencies to ODM

There may be cases where staffs are to be transferred to ODM temporarily. In most of these cases, the agency of the said staff will shoulder their salary. Therefore, the expenses of ODM are only for other expenses such as special allowances and no substantial increase in budget is necessary. The measure is practical for ODM provided that necessary legal preparation is completed. Further, it is natural to consider that the transferred staff has strong channels with his mother agency. The measure is expected to strengthen the cooperation between ODM and the agency.

2) Terms until initiation

It may take a certain time for the abovementioned preparatory works. Subsequently, the term would be medium span to long span.

3) Others

The proposed measures to increase the number of staff require the establishment of internal procedures like preparation of budget and personnel changes. The activities for the implementation of the measures are to be conducted by the government itself

(2) DM-2 : Improvement of Budget Insufficiency Allocated to ODM

1) Countermeasures

The lack of budget allocated to ODM is the root cause of the insufficiency of staff in terms of quantity and quality, improvement of the building and rehabilitation of the evacuation centers. Negotiation with the central government and the ministry is a practical way to increase the budget.

2) Terms until initiation

The terms should be medium and long span coinciding with the term for the alleviation of insufficiency in staff number.

3) Other

Fostering the understandings of and cooperation from the central government and the ministry are fundamental to solve the problem.

(3) DM-3 : Rehabilitation of the Damaged Shelters and Improvement of the Functions of Evacuation Facilities

1) Countermeasures

There are some shelters that have been damaged by the past disasters. The facts indicate that the review of the existing design standard is necessary. The proposed countermeasures are the preparation of new standard and the establishment of shelter applying the newly prepared standard.

2) Terms until initiation

The initiation of the countermeasures should be within the short term because disasters are impending.

3) Others

Self-financing or cooperation from a donor is conceivable.

Table 4.9.1 summarizes the identified issues, countermeasures, and terms regarding general disaster management in Dominica

Table 4.9.1 Issues, Countermeasures and Terms Regarding General Matters for Disaster Management in Dominica

No	Issue	Countermeasure	Term	Other
DM-1	Improvement of insufficiency of ODM staff	Increasing necessary staff New recruitment Temporary transfer of the staffs from other ministries	Medium・Long	Issue to be discussed by ODM and the central government
DM-2	Improvement of budget insufficiency allocated to ODM	Securing of budget	Medium・Long	Issue to be discussed by ODM and the central government
DM-3	Rehabilitation of the damaged shelters and improvement of the functions of evacuation facilities	Adoption of new standard for evacuation Renovation of evacuation facilities applying the new standard	Short	Self-financing or cooperation from donors

Source: JICA Survey Team

4.9.2 Flood, Mass Movement, High Tide, Earthquake, and Tsunami

(1) DM-4 : Improvement of Trafalgar Bridge to Secure Access Route during Flooding from Trafalgar Village to the Capital

1) Countermeasures

There is a ring road going to Trafalgar Village branches from the trunk road. In case of heavy rainfall, the Trafalgar Village is isolated because of sediment disaster caused around a junction of the roads as well as traffic suspension at the Trafalgar Bridge due to flooding thereat.

One of the countermeasures for this situation is to renovate Trafalgar Bridge replacing a girder type with a girder type to secure a sufficient surplus height over the design flood level. The renovations of the approach sections are necessary as well. The renovations of the damaged two causeway-type bridges provide the girder type bridges to secure the necessary flow areas. The associated river channel improvements are incidental in the upstream and downstream stretches to secure the necessary flow areas.

2) Terms until initiation

The term until the initiation should be short as the bridges are on the trunk road.

3) Others

The measures would be implemented by self-financing through government budget or through the cooperation extended by a donor.

(2) DM-5 : Re-installation of the Pipeline which was Washed Away by Flood to Secure Conveying Water to the Capital

1) Countermeasures

The pipeline had been laid along the road bridge but was washed away by flood. The bridge was replaced by a temporary Bailey bridge but the pipeline has remained missing.

The options of the countermeasure are to construct a new viaduct or to renovate the bridge to a permanent structure first and to attach the pipeline to the bridge. The first option of the conceivable countermeasure is to construct an aqueduct connecting with the pipelines on the left and right banks to cross the river. The other option is to renovate the bridge to be a permanent crossing structure and to

place a new pipeline on the renovated bridge connecting with the pipelines on the left and right banks. The comparative study on the two options to be conducted will indicate the best option as the countermeasure.

2) Terms until initiation

The role of the pipeline is significant for the activities of the country and the implementation of the countermeasure is urgent. However, the design of the options and the comparative study of the options are the preconditions of the implementation. The term until the initiation of the countermeasure would be medium term.

3) Others

Self-financing may be possible for the implementation. However, cooperation to be extended by a donor is another option to finance the implementation.

(3) DM-6 Mitigation of Slope Failure Along the Coastal Road in the Southwestern Zone

1) Countermeasures

There are several sites where the mountain side slopes have failed along the coastal road in the southwestern zone. No substantial countermeasures are introduced so far.

A risk analysis for the slope failure is fundamental as the substantial activity of the diagnosis. The comparative study to be conducted on the sites will define the priority of each site for the implementation of the countermeasure. Study on the countermeasure will select the most suitable measure for each site to stabilize the slope. The design works will define the structures, facilities, and the construction method.

2) Terms until initiation

The road is a trunk road and the countermeasures should be initiated within the short term.

3) Others

Self-financing may be available for the implementation. However, cooperation extended by a donor is another option to finance the implementation.

(4) DM-7：Mitigation of Road Damage caused by Antrim Landslide

1) Countermeasures

Countermeasure construction against Antrim landslide is needed.

2) Terms until initiation

The countermeasure construction should be initiated within the short term since the landslide is active.

3) Others

Self-financing may be available for the implementation. However, cooperation extended by a donor is another option to finance the implementation.

(5) DM-8： Mitigation of Damages due to Coastal Erosion

1) Countermeasures

Some donors have cooperated to mitigate the damages incurred by coastal erosion. However, the cooperation was rather haphazard because there are no available frameworks like Coastal Zone Management Plan. Prior to the implementation, it is necessary to formulate a Coastal Zone Management Plan. The countermeasures should be studied and implemented in line with the formulated plan.

2) Terms until initiation

The planning of coastal zone management should be initiated in the short term and the design and the implementation of the countermeasure should be conducted in the medium term.

3) Others

Self-financing may be available for the implementation. However, cooperation extended by a donor is another option to finance the implementation.

(6) DM-9： Formulation of Disaster Mitigation Plan for Earthquake in the Capital is Available

1) Countermeasures

The hazard maps or risk maps are fundamentally needed to formulate the disaster mitigation plan against earthquake for the capital. The premier countermeasure is to prepare a hazard map or risk map for the capital by compiling the assessed results of vulnerability by buildings and by areas. The disaster mitigation plan will be formulated on the basis of the prepared hazard map identifying the evacuation routes and the allocations and layouts of the shelters.

2) Terms until initiation

The term for the initiation of the risk map preparation should be short since the occurrence of earthquake is frequent and the map is the basic and urgent requirement for the disaster mitigation plan. Meanwhile, preparatory works such as the development of the risk maps may take a certain time before the formulation of the disaster mitigation plan for the capital. The term for the initiation is short or medium span for the formulation of disaster mitigation plan.

3) Others

The formulation of disaster mitigation plan against earthquake requires various fields of knowledge and experiences such as seismology in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(7) DM-10： Formulation of Evacuation Plan Against Tsunami

1) Countermeasures

Tsunami has brought high waves to Dominica. In order to mitigate casualty to be caused by a tsunami, the development of the hazard maps and the formulation of evacuation plan are necessary in identifying the evacuation routes and the locations of shelters and evacuation sites in the towns situated along the coast.

2) Terms until initiation

Tsunami is not frequent but it is highly possible to bring serious damage once it occurs. Therefore, the formulation of the evacuation plan is urgently needed. The terms for the initiation of the measure should be short or medium span.

3) Others

The formulation of the evacuation plan against tsunami requires various fields of knowledge and experiences such as maritime engineering in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(8) DM-11： Development of the Standard Design Methods Against Seismic Load and Wind Load

1) Countermeasures

Among the targeted countries of the study, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions depend on the designer. Different standards such as AASHTO and BS have been adopted in the country. Some government engineers have asserted the necessity of the standardization.

This subject is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of the governments of related countries to study the applicability of the standards which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where

hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to be a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by the countries in other areas together with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed referring to the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure will require medium or long term for its initiation.

3) Others

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts as observers from outside to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

(9) DM-12： Improvement of Recent Serious Water Shortage

1) Countermeasures

The source for water utilization is mainly surface water in Dominica and the exploitation of groundwater is seldom. The estimation of safe yield of groundwater is necessary in order to use groundwater as the countermeasure for water shortage. Groundwater study will estimate the groundwater potential.

2) Terms until initiation

Data collection of groundwater may take certain time. The study itself may be initiated in the medium or long term.

3) Others

Self-financing may be available for the implementation. However, cooperation by a donor is another option to finance the implementation.

Table 4.9.2 presents the issues, countermeasures, and terms for flood, erosion, surge, earthquake, tsunami, and water shortage.

Table 4.9.2 Issues, Countermeasures and Terms for Flood, Mass Movement, High Tide, Earthquake, and Tsunami in Dominica

No	Issue	Countermeasure	Term	Other
DM-4	Improvement of Trafalgar Bridge to Secure Access Route during Flooding from Trafalgar Village to the Capital	Renovation of bridges and river improvement	Short	Self-financing or cooperation from donors
DM-5	Re-installation of the Pipeline which was Washed Away by Flood to Secure Conveying Water to the Capital	Provision of new aqueduct or provision of new pipeline on the new bridge to be constructed	Medium	Self-financing or cooperation from donors
DM-6	Mitigation of slope failure along the coastal road in the southwest area	Risk assessment, prioritization, selection of the sites for restoration, selection of the measures and	Short	Self-financing or cooperation from donors

No	Issue	Countermeasure	Term	Other
		construction		
DM-7	Mitigation of road damage caused by Antrim landslide	Countermeasure construction	Short	Self-financing or cooperation from donors
DM-8	Mitigation of Damages due to Coastal Erosion	Formulation of a Coastal Zone Management Plan	Short・Medium	Self-financing or cooperation from donors
DM-9	Formulation of disaster mitigation plan against earthquake for the capital	Development of hazard map for earthquake and formulation of disaster mitigation plan that indicates evacuation route and evacuation shelter.	Short・Medium	Self-financing or cooperation from donors
DM-10	Formulation of disaster mitigation plan in the capital against tsunami	Formulation of disaster management plan against tsunami for the coastal zone indicating evacuation route and evacuation shelters	Short・Medium	Self-financing or cooperation from donors
DM-11	Development of the standard design methods against seismic load and wind load	Establishment of a committee inviting experts from related countries to serve as members of the committee. The discussions in the committee will find the standards suitable to the local conditions	Medium・Long	Financed by the budget of countries concerned Donors will dispatch experts as observers
DM-12	Improvement of recent serious water shortage	Study on the possibility to develop groundwater	Medium・Long	Self-financing or cooperation from donors

Source: JICA Survey Team

4.9.3 Meteoro-hydrologic Observation

(1) DM-13： Improvement of Insufficiency of Staffs for the Observation

1) Countermeasures

Among the staff, insufficiency in the number of maintenance staff is significant; therefore, its increase is important. The insufficient budget and the eventual inability to employ experienced staff are the causes of the insufficient number of maintenance staffs. Negotiation with the ministry is necessary to secure the budget. After the successful negotiation, employment of new graduate from related faculty of university or technical college becomes possible. Requesting CIMH to introduce candidates is another option to increase the number of staffs.

2) Terms until initiation

Employment is an urgent need and the initiation should be in the short term.

(2) DM-14： Capacity Improvement of the Maintenance Staff

1) Countermeasures

The capacities of observation and maintenance staffs are insufficient. Participation in the training by donors and CIMH is effective to enhance their capacities.

2) Terms until initiation

Initiation should be soon and the term should be short.

(3) DM-15： Improvement of Budget Insufficiency for Observation

1) Countermeasures

Negotiate with the central government and the ministry to expand meteorological services

2) Terms until initiation

The negotiation shall be initiated at the opportunity to negotiate the budget for the next fiscal year.

The term should be short.

(4) DM-16： Repair of Equipment

1) Countermeasures

The causes of the problem are: 1) insufficiency of budget to repair and 2) insufficiency of the capacity of the maintenance staff. The countermeasures are measures to resolve the causes of the problems.

2) Terms until initiation

Since the term for the countermeasures against the insufficient budget and insufficient capacity of maintenance staff are short, the term for the measure should be medium term.

Table 4.9.3 presents the issues, countermeasures, and terms for meteoro-hydrologic observation.

Table 4.9.3 Issues, Countermeasures and Terms for Meteoro-Hydrologic Observation in Dominica

No	Issue	Countermeasure	Term	Other
DM-13	Improvement of insufficiency of staffs for the observation	Recruitment of new graduate Proposed experienced staff by CIMH	Short	Cooperation from CIMH
DM-14	Capacity improvement of the maintenance staffs	Training by donors and CIMH	Short	Cooperation from donors
DM-15	Improvement of budget insufficiency for observation	Request to the central government and the ministry	Short	Self-financing
DM-16	Repair of equipment a	Repair following the solutions of SL-13,-14	Medium	Self-financing

Source: JICA Survey Team

4.9.4 List of Conceivable Projects

Table 4.9.4 demonstrates the conceivable projects in Dominica.

Table 4.9.4 List of Conceivable Projects in Dominica

No	Term	Project Title	Component
DM-3	Short・Medium	Development and Rehabilitation of Evacuation Shelter	1) Diagnosis of the existing evacuation shelter 2) Establishment and evaluation of criteria for the development and rehabilitation of evacuation shelter 3) Prioritization of the candidates for development and rehabilitation 4) Construction and rehabilitation
DM-4	Short	Rehabilitation of the Bridges on the Ring Road in the Surrounding Areas of the Capital	1) Diagnosis 2) Study on the natural conditions 3) Design of bridge 4) Design of bank protection works 5) Construction plan and cost estimates 6) Construction
DM-5	Short	Rehabilitation of Pipeline to Supply Water to the Capital	1) Diagnosis 2) Study on the natural conditions 3) Design of pipeline and bridges 4) Design of the appurtenant structures 5) Construction plan and cost estimates 6) Construction

No	Term	Project Title	Component
DM-6	Short	Stabilization of the Slopes Along the Road on the West Coast	1) Diagnosis 2) Prioritization of the sites and survey 3) Design of the stabilization measures 4) Construction plan and cost estimates 5) Construction
DM-7	Short	Countermeasure Construction against Antrim Landslide	1) Diagnosis 2) Survey, geological investigation and monitoring 3) Design of the countermeasure 4) Construction plan and cost estimates 5) Construction
DM-8	Short・Medium	Coastal Zone Disaster Management Plan	1) Diagnosis 2) Development of hazard map for coastal erosion 3) Prioritization of sites 4) Study on the countermeasures and projection after the implementation of the measures 5) Study on the proposed institution for maintenance
DM-9	Short・Medium	Disaster Mitigation Plan against Earthquake in Roseau	1) Confirmation of the present condition including the existing plans 2) Update of the hazard map for earthquake 3) Study on evacuation route and shelter 4) Risk assessment and preparation of scenario 5) Preparation of disaster management plan 6) Preparation of training materials like disaster management map and evacuation training 7) Fostering of leaders for training
DM-10	Short・Medium	Formulation of Disaster Mitigation Plan for Tsunami in Urbanized Areas along the Coast	1) Diagnosis 2) Development of hazard maps for tsunami 3) Study on evacuation route and shelter 4) Study on warning 5) Formulation of disaster management plan 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Training of leaders for disaster mitigation
DM-11	Medium・Long	Study on the Design Standard for the Disaster Mitigation Structures for Earthquake and Strong Wind	1) Study on the design concepts adopted in other countries 2) Study on the applicability of the standards adopted in other countries 3) Preparation of the proposed standard
DM-12	Medium・Long	Water Resources Management Plan	1) Diagnosis 2) Study on groundwater 3) Study on the potential 4) Formulation of water resources management plan
DM-13	Medium・Long	Capacity Building of Meteorological Observation Staff	1) Training for observation 2) Training for the maintenance of equipment

Source: JICA Survey Team

4.10 Trinidad and Tobago

Table 3.10.1 summarizes the identified issues related to the disaster management in Trinidad and Tobago. The following sections discuss the countermeasures and the necessary terms until the measures are to be initiated.

4.10.1 General Matters for Disaster Management

(1) TT-1 : Capacity Improvement of the Staff of the Ministry of Local Government

1) Countermeasures

The managing staffs of the Disaster Management Division of the Ministry of Local Government are aware on the insufficient capacities of young staffs in disaster mitigation at the sites. Capacity building of young staffs is necessary through participation in the trainings to be held by donors and CDEMA

In addition, the establishment of procedures for training of young staffs by the experienced senior staff and sharing of information among the section is necessary to make the training effective.

2) Terms until initiation

The initiations of the mentioned countermeasures are urgent needs. The term should be short.

3) Others

The cooperation from donors and CDEMA is crucial.

(2) TT-2 : Mitigation of Slope Failure along the North Coastal Road in Trinidad Island

1) Countermeasures

Slope failures along the North Coastal Road are frequent. The response of the government is mostly post-treatment such as removal of the debris and reopening of the closed road. No preventive works have been provided.

The government should conduct a risk assessment of the slopes along the North Coastal Road to prioritize the slopes. The government should study the stabilization works for the slopes which are identified to be of high priority. The government should implement the stabilization works along with the studied results.

2) Terms until initiation

Failure is frequent and occurs anytime. The study is urgently needed and the implementation should follow the study. The terms should be short and medium.

3) Others

Both self-financing and cooperation from donors are conceivable.

(3) TT-3 : Building of the Northern Road Network

1) Countermeasures

The Northern Road does not link Blanchisseuse and Marelot. Therefore, the area between Blanchisseuse and Marelot are isolated, in case the other existing roads are closed.

A new road which links Blancheisseuse and Marelot is necessary. The area is adjacent to the national park and there are restrictions in land use. Possible slope failure is another prominent feature of the land along the potential alignment of the new road. The plan to develop new road should take these conditions into consideration to design the alignment.

2) Terms until initiation

The implementation of the countermeasure follows the planning and designing of new road. The term should be medium.

3) Others

Both self-financing and cooperation from a donor are conceivable.

(4) TT-4 : Capacity Improvement of PURE for Slope Stabilization Works

1) Countermeasures

The Programme for Upgrading Roads Efficiency (PURE), under the Ministry of Works and Infrastructure, has responsible for investigation, design and construction supervision for slope stabilization works. There are several sites where the failures have occurred although PURE had provided stabilization works. It is necessary to provide opportunity for capacity building on slope stabilization in investigation, planning, designing and construction.

Participation in the training to be provided by donors and the assistance to be provided by the experts dispatched by a donor for a long term are effective to enhance the capacity.

2) Terms until initiation

The initiation of the measure could be within the short term.

3) Others

Participation in the training to be provided by donors and the assistance to be provided by the experts dispatched by a donor on a long term basis are effective. Employment of in-house engineers may be another option to obtain many suggestions.

(5) TT-5 : Development of the Standard Design Methods against Seismic Load and Wind Load

1) Countermeasures

Among the targeted countries of the study, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions depend on the designer. Different standards such as AASHTO and BS have been adopted in the country. Some government engineers have asserted the necessity of standardization.

This subject is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of the governments of related countries to study the applicability of the standards which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to be a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by other countries together with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals, which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed referring to the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure will require medium or long term for its initiation.

3) Others

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts as observers from outside to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

(6) TT-6 : Mitigation of Sediment Silting in the Reservoirs

1) Countermeasures

There are three reservoirs in Trinidad Island and one in Tobago Island. The construction thereof is rather long before and the silting of the sediment in the reservoirs becomes noticeable. The water stored in the reservoir is imperative for the life of the country. The extension of the life of the reservoir is crucial to prepare for drought.

The structural measures to mitigate the siltation problem are: 1) to discharge the sediment in the reservoir through the sediment flush gates; 2) to discharge the sediment in the reservoir through a sluicing pipe embedded in the reservoir; 3) to discharge flood water with a high sediment concentration through a bypass tunnel or channel; and 4) dredging out by using a dredging boat. Meanwhile, non-structural measures envisage the decrease in productivity of sediment in the upstream watershed area such as: 1) forestation in the upstream watershed areas and 2) alteration in cropping patterns in the agricultural land in the upstream watershed areas.

The above measure to discharge the sediment trapped in the reservoir may cause environmental effects to the sea which accept the discharge because the concentration of the discharge is high. The environmental impacts and the solution thereof are other issues.

Sediment silting and the eventual decrease in the storage capacity of the reservoir are significant issues in Japan as well. All of the structural measures mentioned above are the common practices in Japan. The second measure, sediment trap in reservoir, is rather new even in Japan. JICA is conducting experimental study on the sediment trap in the reservoir of Wonogiri Dam in Indonesia as the pilot project.

The sediment discharging to Toyama Bay from the reservoir of Unazuki Dam affected the environment of the sea due to the adverse environmental impacts. The experiences in Japan are useful to formulate countermeasures to the sediment siltation problems in the country.

2) Terms until initiation

The formulation of plan for the countermeasures is the first step and the initiation of the plan formulation should be within the short term. The implementation of the measure should follow the planning. Therefore, the initiation should be short or medium term.

3) Others

An experienced consultant could formulate the plans for the countermeasures proposed above. The government may employ a consultant using its own budget. Requesting assistance from a donor is an option for the formulation of the plan. The most significant issue to be tackled in the plan formulation is the minimization of the adverse impact to the sea.

A contractor will construct the selected measure along the plan formulated. Financing for the construction could be borne from its own source or economic cooperation by donors. The economic cooperation may apply either loan or grant system.

(7) TT-7 : Improvement and Trouble Shooting of the Observed Data Transmission System

1) Countermeasures

The data recorded at the observatories in the southeastern part and in the southern part of Trinidad Island have not been transmitted automatically to the central office in the north. The relay station could not receive the observed data because of the insufficient height of the antenna.

The countermeasure is to construct another relay station between the observatories and the existing relay station. The alternative measure is to relocate the existing relay station to the site where the radio waves from the observatories could be received.

2) Terms until initiation

The initiation of the measure could be medium or long term.

3) Others

The construction cost should be financed by the government.

(8) TT-8： Improvement of Maintenance of the Observation Facilities

1) Countermeasures

Out of the six automatic observatories, some do not send the observed data so far due to defective parts.

Purchase of parts and replacement of the broken parts are necessary to repair the system. The insufficiency of budget is the impediment of the restoration. Negotiation with the central government or ministry is necessary to secure the required budget.

2) Terms until initiation

The required budget may not be significant. The term should be short.

3) Others

Self-financing is conceivable.

Table 4.10.1 summarizes the issues, countermeasures, and the terms until initiation for disaster mitigation in Trinidad and Tobago.

Table 4.10.1 Issues, Countermeasures and Terms Regarding General Matters for Disaster Management in Trinidad and Tobago

No	Issue	Countermeasure	Terms	Others
TT-1	Capacity improvement of the staff of the Ministry of Local Government	Participation in the training provided by donors and CDEMA	Short	Cooperation from the donor and CDEMA
TT-2	Mitigation of slope failure along the North Coastal Road in Trinidad Island	Risk assessment, prioritization, study on the stabilization works Implementation in the priority sites	Short・Medium	Self-financing or cooperation from donor
TT-3	Building of the northern road network	Study on the alignment of the linkage road Construction of the linkage road	Medium	Self-financing or cooperation from donor
TT-4	Capacity improvement of PURE for slope stabilization works	Training for investigation, planning, design and construction for the slope stabilization	Short	Cooperation from donor Long-term dispatching of expert Employment of in-house engineer by PURE
TT-5	Development of the standard design methods against seismic load and wind load	Establishment of a committee inviting experts from related countries to act as members of the committee. The discussions in the committee will find the standards suitable to the local conditions	Medium・Long	The cost to be incurred by the committee will be shouldered by the budget of the member countries. Donors will dispatch observers as long-term experts
TT-6	Mitigation of sediment silting in the reservoirs	Implementation of structural and nonstructural measures. Measure to alleviate adverse impacts to the sea by sediment discharge is necessary	Short・Medium	Self-finance by the central government or economic cooperation by donors
TT-7	Improvement and troubleshooting of the observed data transmission system	Additional relay station or relocation of the existing relay station	Medium・Long	Budget from the central government
TT-8	Improvement of maintenance of the observation facilities	Secure the required budget	Short	Budget from the central government

Source: JICA Survey Team

4.10.2 List of Conceivable Projects

Table 4.10.2 summarizes the conceivable projects in Trinidad and Tobago.

Table 4.10.2 List of Conceivable Projects in Trinidad and Tobago

aa	Terms	Project Title	Component
TT-1	Short・Medium	Capacity Building of the Ministry of Local Government Staff	1) Capacity enhancement for disaster mitigation
TT-2	Short・Medium	Stabilization of Slopes Along the Northern Road	1) Diagnosis 2) Selection of the priority sites 3) Study on the countermeasure 4) Construction plan and cost estimates 5) Construction
TT-3	Medium	Development of Linkage Road of North Coast Road and Paria Main Road	1) Diagnosis 2) Study on alignment 3) Environmental assessment 4) Design 5) Cost estimates 6) Construction
TT-4	Short	Capacity Strengthening for the PURE Staffs for Slope Stabilization Works	1) Seminar on administration for disaster mitigation (system, organization, regulation and budget) 2) Lecture on mechanism, survey and monitoring, stabilization method for mass movement (zoning, hazard map and warning and evacuation) 3) Lecture on design of structural countermeasures 4) Reconnaissance at the site 5) Preparation of the action plan to improve the existing mitigation plan, mitigation system and the countermeasure
TT-5	Medium・Long	Study on the Design Criteria for Earthquake	1) Study on the concept of design criteria in other country 2) Study on the applicability of the criteria adopted in other country 3) Proposal of criteria
TT-6	Short	Implementation of Countermeasure for Sediment Silting in the Reservoir	1) Study on the siltation 2) Study on countermeasure 3) Cost estimates 4) Construction or provision of equipment
TT-7	Medium・Long	Betterment of Meteorological Observation System (in case of additional relay station)	1) Diagnosis 2) Study on the location of the relay station 3) Wave propagation test 4) Design of the relay station 5) Estimation of equipment needed 6) Cost estimates 7) Installation and construction

Source: JICA Survey Team

4.11 Barbados

Table 3.11.1 summarizes the identified issues related to the disaster management in Barbados. The following sections discuss the countermeasures and the necessary terms until the measures are to be initiated.

4.11.1 General Matters of Disaster Mitigation

(1) BA-1： Determination of National Disaster Mitigation Strategy

1) Countermeasure

The government has applied the Regional CDM Strategy prepared by CDEMA as the national disaster mitigation strategy. The social conditions and the location of the country are close to those of the region. However, the preparation of the National Disaster Mitigation Strategy is necessary to cope with the conditions specific to the country.

2) Terms until initiation

The strategy is the framework of the entire disaster mitigation activities and the regional strategy has been prepared already. The initiation of the national strategy preparation, therefore, should be within the short term.

3) Others

The government should employ an experienced consultant group using its own budget or cooperation from a donor is conceivable as well.

(2) BA-2： Increasing of Staff of DEM

1) Countermeasure

Increase in the number of the Department of Emergency Management (DEM) staff is crucial to solve the problem. The conceivable ways to increase are: i) recruitment of the candidates in the country and ii) transferring the staffs of other agencies to DEM.

i) Recruitment of the candidates in the country

The measure is to employ new staffs through recruitment in the country. In parallel with the recruitment, processing of procedural preparation is required to secure the budget for the increase in employment cost to execute the measure smoothly.

ii) Transferring the staffs of other agencies

There may be cases where staffs are to be transferred to DEM temporarily. In most of these cases, the agency of the said staff will shoulder the salary. Therefore, the expenses of DEM are only for other expenses such as special allowances and no substantial increase in budget is necessary. The measure is practical for DEM provided that necessary legal preparation is completed. Further, it is natural to consider that the transferred staff has strong channels with his mother agency. The measure is expected to strengthen the cooperation between DEM and the agency.

2) Terms until initiation

It may take a certain time for the abovementioned preparatory works. Subsequently, the term would be medium span to long span.

3) Others

The proposed measures to increase the number of staff require the establishment of internal procedures like preparation of budget and personnel changes. The activities for the implementation of the measures are to be conducted by the government itself and the works to be entrusted to other bodies like consultant and NGO are very limited.

(3) BA-3： Improvement of Budget Insufficiency of DEM

1) Countermeasure

The limited budget allocated to DEM is the root cause of the insufficiency of staff in terms of quantity and quality. The minimum required budget should be secured. Negotiation with the central government and the ministry is a practical way to secure the required minimum budget.

2) Terms until initiation

The term until initiation should coincide with that of the increase in staff number inter alia medium term or long term.

3) Others

Action of the central government is necessary for regulatory preparation because inter-ministerial coordination is fundamental.

(4) BA-4： Capability Improvement of DEM Staff

1) Countermeasure

At present, the activity of the staff is mostly coordination because of their insufficient capacity. However, capacity building for administration and training on disaster mitigation are necessary considering the assignment of the staff.

2) Terms until initiation

The term should be short because the capacity of the staff affects the disaster mitigation even now.

3) Others

The trainings to be provided by donor and CDEMA are available.

Table 4.11.1 summarizes the issues, countermeasures, and terms regarding general disaster management.

Table 4.11.1 Issues, Countermeasures and Terms Regarding General Matters for Disaster Management in Barbados

No	Issue	Countermeasure	Term	Other
BA-1	Determination of National Disaster Management Strategy	Formulation of specific strategy	Short	Self-financing or cooperation from donors
BA-2	Increasing of staffs of DEM	Recruitment Temporary transfer of staffs from other ministries	Medium・Long	Negotiation of DEM with the central government
BA-3	Improvement of budget insufficiency of DEM	Securing of budget	Medium・Long	Negotiation of DEM with the central government
BA-4	Capability improvement of DEM staff	Participation in the training program to be held by donors and the cooperation from CDEMA	Short	Cooperation from donors and CDEMA is crucial

Source: JICA Survey Team

4.11.2 Flood

(1) BA-5： Mitigation of Flood Caused by Spring Coming Out from the Limestone Cracks

1) Countermeasures

In Barbados, limestone shares about 80% of the country's formation. Rainwater infiltrates through fissures and cracks in the limestone. The concentrated water spring outs from the cracks to cause flood in the downstream reach.

It is necessary to locate the major springs or outlets together with the estimation of discharges. Development of drainages with sufficient discharge capacities is a conceivable countermeasure. Retarding basin is another option to reduce the peak discharge with the regulating effect of the basin.

2) Terms until initiation

The target area is 80% of the land and the term should be medium to long span.

3) Others

Self-financing and cooperation from a donor (loan) are conceivable.

(2) BA-6： Preventive Measures of Inundation in Bridgetown due to the Landside Water

1) Countermeasures

There is an inundation area at Garden Land in Bridgetown. The insufficient capacity of drainage canal is the cause of the inundation. To cope with the situation, a drainage plan should be formulated. In line with the formulated plan, improvement of the canal and temporary storage should be studied. The optimum plan will be selected and constructed.

2) Terms until initiation

There are residential houses in the flood area. The term should be short and medium.

3) Others

Self-financing and cooperation from a donor (loan) are conceivable.

(3) BA-7： Rehabilitation of the Damaged Bridges on No. 2 Trunk Route

1) Countermeasures

There were observed damages on the abutments of two bridges on No. 2 Trunk Road. The damaged parts were reinforced by steel bars with H-section. However, the refurbishments of the bridges are recommendable. It will not require a big amount of investment because of the sizes of the bridges with spans of 10 m.

2) Terms until initiation

The refurbishment should be initiated in the short term.

3) Others

In view of disaster mitigation, existing detour route is available. Both self-financing and cooperation from a donor are conceivable for the refurbishment.

(4) BA-8： Rehabilitation of Damaged Bawden's Bridge

1) Countermeasures

The bridge is on the Bas Road which is not a trunk route. The bridge is damaged and rehabilitation is necessary.

2) Terms until initiation

The rehabilitation should be initiated in the short term.

3) Others

In view of disaster mitigation, existing detour route is available. Both self-financing and cooperation from a donor are conceivable for the refurbishment.

Table 4.11.2 summarizes the issues, countermeasures, and terms regarding flood.

Table 4.11.2 Issues, Countermeasures and Terms against Flood in Barbados

No	Issue	Countermeasure	Term	Other
BA-5	Mitigation of Flood Caused by spring coming out from limestone cracks	Study on drainage and retarding basin for the spring out from the limestone to measure and estimate the volume from the major outlets. Implementation of the drainage and retarding basin should follow the study	Medium・Long	Self-financing or cooperation from donors
BA-6	Preventive measures inundation in Bridgetown due to the landside water	Formulation of drainage plan in the upstream areas Implementation of the plan	Short・Medium	Self-financing or cooperation from donors
BA-7	Rehabilitation of the damaged bridges on No. 2 trunk route	Design and construction of the renovation of the bridge	Short	Self-financing or cooperation from donors

No	Issue	Countermeasure	Term	Other
BA-8	Rehabilitation of damaged Bawden's Bridge	Design and construction of the renovation of the bridge	Short	Self-financing or cooperation from donors

Source: JICA Survey Team

4.11.3 Mass Movement, Earthquake, and Tsunami

(1) BA-9： Mitigation of Damages due to Landslide in St. Joseph's Church Area

1) Countermeasures

A large-scale landslide is sliding in the Saint Joseph's Church area. It is necessary to monitor the movement and to analyze the progress of the movement. Based on the analysis, the optimum countermeasure will be selected and implemented.

2) Terms until initiation

The initiation of monitoring should be in the short term and the implementation would be in the medium term.

3) Others

Both self-financing and cooperation from a donor (loan) are conceivable for the measure.

(2) BA-10： Mitigation of Damages due to Landslide in White Hill

1) Countermeasures

The landslide has damaged the road for about 80 m in White Hill.

A deterrent measure should be implemented to control the landslide. Rehabilitation of the damaged road is necessary as well.

2) Terms until initiation

The damaged road is an important route for the lives of the residents. The term should be short and medium.

3) Others

Both self-financing and cooperation from a donor (loan) are conceivable for the measure.

(3) BA-11： Identification of Risky Caving in of the Land

1) Countermeasures

Limestone shares about 80% of the foundation of the country. Caving in of the land has brought damages from time to time.

Inspection of the land that collapsed is necessary to prepare a cave map. Risk assessment should be conducted to identify the dangerous zone. Monitoring should be conducted in the identified dangerous zone.

2) Terms until initiation

The monitoring is an urgent need and the term should be short.

3) Others

Both self-financing and cooperation from a donor (loan) are conceivable for the measure.

(4) BA-12：Capacity Improvement of Soil Conservation Unit for Slope Stabilization

1) Countermeasures

The Soil Conservation Unit (SCU) has conducted slope stabilization works. However, monitoring methods of landslide is not recognized well and response is done in a rather haphazard manner. Accordingly, it is necessary to conduct capacity building in investigation including monitoring, analysis, design and construction for slope stabilization.

Participation in the training held by donors and the assistance by expert stationed for a long term are effective.

2) Terms until initiation

The measure could be initiated soon and the term should be short.

3) Others

Participation in the training to be provided by donors and the assistance to be provided by the experts dispatched by a donor on a long term basis will be effective. Employment of in-house engineers may be another option to obtain many suggestions.

(5) BA-13： Development of Standard Design Methods Against Seismic Load and Wind Load

1) Countermeasures

Among the targeted countries of the study, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions depend on the designer. Different standards such as AASHTO and BS have been adopted in the country. Some government engineers have asserted the necessity of standardization.

This subject is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of the governments of related countries to study the applicability of the standards which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. The matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by the countries in other areas together with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed referring to the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure will require medium or long term for its initiation

3) Others

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts as observers from outside to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

(6) BA-14： Formulation of Disaster Mitigation Plan for Earthquake in the Capital

1) Countermeasures

Earthquake is rather frequent in the country. However, no hazard map or risk map is available. The maps are fundamentally needed to formulate the disaster mitigation plan against earthquake for the capital. The premier countermeasure is to prepare a hazard map or risk map for the capital by compiling the assessed results of vulnerability by areas. The disaster mitigation plan will be formulated on the basis of the prepared hazard map to identify the evacuation routes and the allocations and layouts of the shelters.

2) Terms until initiation

The term for the initiation of the risk map preparation should be short since the occurrence of earthquake is frequent and the map is the basic and urgent requirement for the disaster mitigation plan. Meanwhile, preparatory works such as the development of the risk maps may take a certain time before the formulation of the disaster mitigation plan for the capital. The term for the initiation is short or medium span for the formulation of disaster mitigation plan.

3) Others

The formulation of disaster mitigation plan against earthquake requires various fields of knowledge and experiences such as seismology in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(7) BA-15： Preparation of Evacuation Plan for Tsunami

1) Countermeasures

No hazard map is available in Barbados. Development of a hazard map is necessary as the first step. On the basis of the map to be developed, evacuation plan should be formulated for the towns along the coast to afford smooth evacuation. The plan should enunciate the evacuation routes and the locations of the evacuation centers.

2) Terms until initiation

Tsunami is not frequent but it is highly possible to bring serious damage once it occurs. Therefore, the formulation of the evacuation plan is an urgent need. The terms for the initiation of the measure should be short or medium span.

3) Others

The formulation of the evacuation plan against tsunami requires various fields of knowledge and experiences such as maritime engineering in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

The Table 4.11.3 presents the identified issues, countermeasures, and terms regarding mass movement, earthquake, and tsunami in Barbados

Table 4.11.3 Issues, Countermeasures and Terms for Erosion, Earthquake, and Tsunami in Barbados

No	Issue	Countermeasure	Term	Other
BA-9	Mitigation of damages due to Landslide in St. Joseph's Church Area	Monitoring of the slide and study on the countermeasure Design and construction of countermeasures	Short・Medium	Self-financing or cooperation from donors
BA-10	Mitigation of damages due to landslide in White Hill	Study on the countermeasure Design of countermeasures Construction of the measures	Short・Medium	Self-financing or cooperation from donors
BA-11	Identification of risky caving in of the land	Development of a cave map Monitoring and rehabilitation	Short	Self-financing or cooperation from donors
BA-12	Capacity improvement of the Soil Conservation Unit regarding slope stabilization	Training by donors on slope stabilization Employ in-house engineer for capacity building for the staffs	Short	Requires cooperation from donors Stationed expatriate expert dispatched by donors Employment of in-house engineer
BA-13	Development of standard design	Establishment of a committee inviting experts from related	Medium・Long	Financed by the budget of the countries concerned

No	Issue	Countermeasure	Term	Other
	methods against seismic load and wind load	countries to act as members of the committee. The discussions in the committee will find the standards suitable to the local conditions		Donors will dispatch experts as observers
BA-14	Formulation of disaster mitigation plan for earthquake in the capital	Development of a hazard map Formulation of disaster management plan that indicates the evacuation route and evacuation shelters	Short・Medium	Self-financing or cooperation from donors
BA-15	Preparation of evacuation plan for tsunami	Formulation of an evacuation plan that indicates the evacuation routes and shelters	Short・Medium	Self-financing or cooperation from donors

Source: JICA Survey Team

4.11.4 Meteoro-Hydrologic Observation

(1) BA-16： Improvement of Meteoro-rainfall Observation Network

1) Countermeasure

The density of the rainfall observatories is small in the center, northeast, and north of the island. Plantations were the sources of rainfall data before. However, some of the plantations stopped their activities today. The available rainfall data are reduced. To cope with the situation, the department should have its own observation network. The network should have automatic observation and automatic data gathering system.

2) Terms until initiation

The term should be medium to long span considering the data collection from plantations.

3) Others

Both self-financing and cooperation from a donor (loan) are conceivable for the measure.

(2) BA-17： Enhancement of Database System

1) Countermeasure

The installed database system is processing rainfall data in the office at the airport. The model and the performance of the system look rather old.

Replacement of the database system by a new model is necessary so that sharing of data and information with other department becomes possible.

2) Terms until initiation

The term for the replacement should be medium span.

3) Others

Both self-financing and cooperation from a donor (loan) are conceivable for the measure.

Table 4.11.4 presents the identified issues, countermeasures, and terms regarding meteoro-hydrologic observation.

Table 4.11.4 Issues, Countermeasures and Terms for Meteoro-Hydrologic Observation in Barbados

No	Issue	Countermeasure	Term	Other
BA-16	Improvement of meteoro-rainfall observation network	Design of new networks Installation of equipment in line with the design	Medium・Long	Self-financing or cooperation from donors
BA-17	Enhancement of a database system	Installation of a new database software	Medium	Self-financing or cooperation from donors

Source: JICA Survey Team

4.11.5 List of Conceivable Projects

Table 4.11.5 demonstrates the list of conceivable projects in Barbados on the basis of the issues and countermeasures.

Table 4.11.5 List of Conceivable Projects in Barbados

No	Term	Title of Project	Component
BA-1	Short	Formulation of a National Disaster Mitigation Strategy	1) Diagnosis of responsible organization for disaster mitigation and DEM 2) Study on the policy of CDEMA 3) Confirmation of the disaster response policy in each island 4) Preparation of the strategy
BA-4	Short	Capacity Building for the DEM Staff	1) Capacity building for general disaster mitigation 2) Capacity building for community disaster mitigation
BA-5	Medium・Long	Mitigation of Flood by Spring Coming Out from Limestone	1) Review on the existing study 2) Diagnosis (mechanism of spring out) 3) Estimation of flood discharge 4) Study on the countermeasures 5) Design 6) Cost estimates 7) Implementation
BA-6	Short・Medium	Mitigation of Inundation by Landside Water in Bridgetown	1) Diagnosis of the inundation 2) Alternative study on drainage network and retarding basin or storage 3) Formulation of drainage plan 4) Design 5) Cost estimates 6) Implementation
BA-9	Short・Medium	Countermeasure Construction against Landslide in St. Joseph's Church Area	1) Diagnosis 2) Topo survey and geological survey 3) Monitoring and analysis 4) Study and design of countermeasure 5) Cost estimates 6) Implementation of construction
BA-10	Short・Medium	Countermeasure Construction against Landslide on road in White Hill	1) Diagnosis 2) Topo survey and geological survey 3) Monitoring and analysis 4) Study and design of countermeasure 5) Cost estimates 6) Implementation of construction
BA-11	Short	Disaster Mitigation of Caving in	1) Diagnosis (preparation of cave map) 2) Study on the countermeasure (prioritization) 3) Comparative study 4) Selection and design of pilot project 5) Implementation of the pilot project
BA-12	Short	Capacity Strengthening of Soil Conservation Unit in Slope Stabilization	1) Lecture on the administration for disaster mitigation (system organization regulation and budget) 2) Lecture on mass movement (mechanism, method of survey and measure to mitigate disaster such as zoning, hazard map, and warning and evacuation) 3) Lecture on design of structural countermeasures 4) Site reconnaissance 5) Practice on risk analysis and identification of issue and presentation 6) Practice on preparation of the action plan for the

No	Term	Title of Project	Component
			improvement of disaster management plan, organization and countermeasures
BA-13	Medium・Long	Study on Design Standard for Earthquake	1) Study on the design concept of other country 2) Applicability of the standard adopted in other countries 3) Proposal of design standard
BA-14	Short・Medium	Disaster Mitigation Plan for Earthquake in Bridgetown	1) Confirmation of the existing plans 2) Renovation of hazard map for earthquake 3) Study on evacuation route and evacuation center 4) Risk assessment and preparation of scenario 5) Formulation of disaster mitigation plan 6) Preparation of disaster mitigation materials like disaster mitigation map and evacuation training 7) Fostering of leaders for disaster mitigation training
BA-15	Short・Medium	Formulation of Disaster Mitigation Plan for Tsunami in the Urbanized Areas along the Coast	1) Diagnosis 2) Development of hazard maps for tsunami 3) Study on evacuation route and shelter 4) Study on warning 5) Formulation of disaster management 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Training of leaders for disaster mitigation
BA-16 BA-17	Medium・Long	Improvement of Meteorological Observation System	1) Improvement plan of rainfall gauging network 2) Installation of observatories and data gathering system 3) Improvement of database system

Source: JICA Survey Team

4.12 Belize

Table 3.12.1 summarizes the issues related to disaster management in Belize. The following sections discuss the countermeasures and the necessary terms until the measures are to be initiated.

4.12.1 General Matters for Disaster Management

(1) BZ-1： Improvement of Insufficiency of Staff of NEMO

1) Countermeasure

The necessary number of technical staff is estimated to be 14. Presently, there are only seven technical staffs.

Increase in the number of the National Emergency Management Organization (NEMO) staff is crucial to solve the problem. The low salary of the government staff is an impediment for employment. The conceivable ways to increase are: i) recruitment of the candidates in the country and ii) transferring the staffs of other agencies to NEMO.

i) Recruitment of the candidates in the country

The measure is to employ new staffs through recruitment in the country. In parallel with the recruitment, processing of procedural preparation is required to secure the budget for the increase in employment cost to execute the measure smoothly.

ii) Transferring the staffs of other agencies to NEMO

There may be cases where staffs are to be transferred to NEMO temporarily. In most of these cases, the agency of the said staff will shoulder the salary. Therefore, the expenses of NEMO are only for other expenses such as special allowances and no substantial increase in budget is necessary. The measure is practical for NEMO provided that necessary legal preparation is completed. Further, it is natural to consider that the transferred staff has strong channels with his mother agency. The measure is expected to strengthen the cooperation between NEMO and the agency.

2) Terms until initiation

It may take a certain time for the abovementioned preparatory works. Subsequently, the term would be medium span to long span.

3) Other

The proposed measures to increase the number of staff require the establishment of internal procedures like preparation of budget and personnel changes. The activities for the implementation of the measures are to be conducted by the government itself

(2) BZ-2： Prompt Processing for Addition and Reallocation of NEMO Budget

1) Countermeasure

The insufficient budget allocated to NEMO is the root cause of the insufficiency of staff in terms of quantity and quality. Negotiation with the central government and the ministry is a practical way to increase the budget.

2) Terms until initiation

The terms should be medium and long spans coinciding with the term for the alleviation of insufficiency in staff number.

3) Other

Fostering the understanding of and cooperation from the central government and the ministry are fundamental to solve the problem.

Table 4.12.1 summarizes the issues, countermeasures, and terms regarding general disaster management.

Table 4.12.1 Issues, Countermeasures and Terms Regarding General Disaster Management in Belize

No	Issue	Countermeasure	Term	Other
BZ-1	Improvement of insufficiency of staff of NEMO	Recruitment Temporary transfer of staffs from other ministries	Medium・Long	Deliberations between NEMO and the central government
BZ-2	Prompt processing for addition and reallocation of NEMO budget	To secure a proper budget	Medium・Long	Deliberations between NEMO and the central government

Source: JICA Survey Team

4.12.2 Flood, Mass Movement, High Tide, Earthquake, Tsunami, Strong Wind, and Water Shortage

(1) BZ-3： Improvement of Narrow Bridge on the Major Trunk Road（Hummingbird Highway）to Secure Traffic Capacity

1) Countermeasure

The Hummingbird Highway is a major trunk road that links Belmopan and Dangria. The road has two lanes in general but the six bridges on the road are single lane and the bridge sections form the bottleneck of the road.

The Government of Belize has a road betterment policy to make all trunk roads have double lanes with pavement. In line with the policy, the government completed the design of betterment under a grant by Kuwait. The government has decided to implement the betterment for No. 1 and No. 4 sections out of the four sections under the loan extended by Kuwait. The total loan amount has already reached the limit including the loan of the two sections of the Hummingbird Highway.

The countermeasure is to provide double lanes to six bridges. The proposed countermeasure will amplify the effect of the loan for the two sections. The design of the bridges will study the topographic conditions of the abutments and define the bridge types, which are best fitted to the site conditions. The countermeasure is the construction of the bridges in line with the design.

2) Terms until initiation

The bottleneck problem has to be solved as soon as possible. The measure has to be initiated in the short term.

3) Other

Self-financing or cooperation from a donor is conceivable.

(2) BZ-4： Mitigation of Vulnerability to Sediment Disaster in the Surrounding Areas of Maya Mountains in the South Zone

1) Countermeasure

The ongoing countermeasures against sediment disaster such as slope failure are rather haphazard activities.

Development of a hazard map and risk assessment, and capacity strengthening of person in charge are needed.

2) Terms until initiation

The initiation of the hazard map development should be in the short term. Monitoring and study on structures may follow the map development in the medium term. The construction should be long-term works.

3) Other

Cooperation from a donor is necessary to develop the hazard map. Meanwhile, the implementation should be financed by the government.

(3) BZ-5 : Mitigation of Water Surging and Coastal Erosion to be Occurred in the Coastal Zone

1) Countermeasure

Coastal erosion could be seen in the south of Dangria. The Integrated Coastal Zone Management Plan was formulated in 2013. The countermeasure is to implement the measures proposed in the plan according to the assigned priorities as well.

2) Terms until initiation

Coastal erosion is progressive and the provision of a countermeasure is an urgent need in the area. The term should be short.

3) Other

Self-financing or cooperation from a donor is conceivable.

(4) BZ-6 : Formulation of Disaster Mitigation Plan for Earthquake in Belize City

1) Countermeasure

The existing hazard map for earthquake is not effective to formulate a disaster mitigation plan. Development of a hazard map or a risk map is necessary. The vulnerability of each major building against earthquake should be assessed. The evacuation routes and the locations of shelter could be defined on the basis of the assessment. Thereby, the disaster mitigation plan would be formulated.

2) Terms until initiation

The term for the initiation of the risk map preparation should be short since the occurrence of earthquake is frequent and the map is the basic and urgent requirement for disaster mitigation plan. Meanwhile, preparations such as the development of the risk maps may take a certain time before the formulation of the disaster mitigation plan for the capital. The term for the initiation is short or medium span for the formulation of disaster mitigation plan.

3) Other

The formulation of disaster mitigation plan against earthquake requires various fields of knowledge and experiences such as seismology in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(4) BZ-7 : Preparation of Hazard Map and Evacuation Plan for Tsunami

1) Countermeasure

No hazard map of tsunami is available in Belize. Preparation of a hazard map is necessary to facilitate evacuation from the possibly affected areas. The preparation of evacuation plan which shows the evacuation routes and evacuation shelters is necessary for the residents of the towns along the coast.

2) Terms until initiation

The frequency of tsunami is not high but the damages to be incurred are high once it occurs. The evacuation plan should be prepared as soon as possible. Short or medium term is recommendable.

3) Other

The formulation of disaster mitigation plan against tsunami requires various fields of knowledge and experiences such as oceanography in addition to socioeconomic knowledge. Employment of an experienced consultant group is recommendable to formulate the plan provided that the budget is available. Request for assistance from donors on this matter may be another option.

(5) BZ-8 : Development of the Standard Design Methods Against Seismic Load and Wind Load

1) Countermeasure

Among the targeted countries of the study, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions

depend on the designer. Different standards such as AASHTO and BS have been adopted in the country. Some government engineers have asserted the necessity of standardization.

This subject is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of the governments of the related countries to study the applicability of the standards, which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by other countries together with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed on the basis of the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure will require medium or long term for its initiation.

3) Other

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts as observers from outside to provide advices to the study. The budget shall be borne by the member countries. The dispatching costs for the experts could be shouldered by donors.

(6) BZ-9： Solution of Water Shortage in the Inland in the Northern Zone

1) Countermeasure

The water shortage in 2010 was serious. The surface water shares more than 90% of the source of the utilization in Belize.

The countermeasure envisages groundwater. The potential study on the groundwater is necessary to estimate the safe yield. The groundwater should be exploited in case a drought impedes the surface water off-take.

2) Terms until initiation

The diagnosis by the demand and supply balance study including the potential study on groundwater should be in the short term. The term should be medium to formulate a plan for the selected countermeasures such as water resources management plan. Meanwhile, the implementation of the countermeasure may take a long term.

3) Other

The diagnosis of water shortage and the formulation of the plan of countermeasures require multidisciplinary expertise and should be entrusted to a consultant group to be employed by the government or donors. A loan is available to implement the countermeasure.

Table 4.12.2 shows the issues, countermeasures, and the terms until initiation of the countermeasures for flood, erosion, surging, earthquake, tsunami, strong wind, and water shortage in Belize.

Table 4.12.2 Issues, Countermeasures and Terms for Flood, Erosion, Surging, Earthquake, Tsunami , Strong Wind, and Water Shortage in Belize

No	Issue	Countermeasure	Term	Other
BZ-3	Improvement of narrow bridge on the major trunk road(Hummingbird Highway) to secure traffic capacity	Enlargement of the width of 6 bridges	Short	Self-financing or cooperation from donor
BZ-4	Mitigation of Vulnerability to Sediment Disaster in the surrounding areas of Maya Mountains	Development of a hazard map Stabilization of the slopes Capacity strengthening	Short Medium・Long	Self-financing or cooperation from donor
BZ-5	Mitigation of water surging and coastal erosion occurred in the coastal area	To implement countermeasures along with Coastal Zone Management Plan	Short	Self-financing or cooperation from donor
BZ-6	Formulation of disaster mitigation plan for earthquake in Belize City	Development of a hazard map for earthquake Formulation of a disaster mitigation plan for earthquake indicating the evacuation route and evacuation shelter	Short・Medium	Self-financing or cooperation from donor
BZ-7	Preparation of Hazard map and evacuation plan for tsunami	Formulation of a disaster mitigation plan for tsunami for the towns along the coast indicating the evacuation route and evacuation shelter	Short・Medium	Self-financing or cooperation from donor
BZ-8	Development of standard design methods against seismic load and wind load	Establish a committee inviting experts from the concerned countries. The discussions in the committee are expected to conclude a standard	Medium・Long	Financing by the budgets of the countries Donors should dispatch experts as observers.
BZ-9	Solution of water shortage in the northern inland	Diagnosis of the shortage through water demand and supply balance study on the surface and groundwater in each island Study on the countermeasures to formulate a water resources management plan	Medium	Self-financing or cooperation from donor

Source JICA Survey Team

4.12.3 Meteoro-Hydrologic Observation

(1) BZ-10 Improvement of Insufficiency of the Maintenance Staff

1) Countermeasure

Among the insufficiency, the number of staff for maintenance is the most serious. The increase in number of staff for this area is imperative.

The limited budget and the eventual inability for additional employment of experienced staff are the causes of insufficiency in the number of maintenance staffs. Negotiation with the ministry is necessary to secure the budget. If the employment of an experienced engineer in Belize is difficult, employment of new graduate from related faculty of university or technical college may be a solution. CIMH may have a means to find the candidates.

2) Terms until initiation

The matter is urgent and short term should be adopted.

(2) BZ-11: Improvement of Budget Insufficiency for Maintenance

1) Countermeasure

Negotiation with the central government and ministry is a countermeasure to increase the budget for maintenance.

2) Terms until initiation

The negotiation should be initiated at the opportunity for negotiation of the budget for the next fiscal year.

(3) BZ-12: Capacity Improvement of Staffs of the Meteorological Service

1) Countermeasure

Training for the maintenance staffs and observation staffs to improve their capacities shall be undertaken. It is difficult to conduct such trainings by the national budget, thus, participation to the training program by CIMH and other donors is to be encouraged.

2) Terms until initiation

The capacity building is necessary to be conducted in short term because the automatic observation system is going to be installed in 2016 for three times or more.

(4) BZ-13: The Database being used is Developed in Other Country

1) Countermeasure

The data served to other related organization should be integrated in one database.

The data recorded at the gauging stations should be gathered in the data server of the National Meteorological Service. The new system aims to disseminate the gathered data to the organization that need the data.

2) Terms until initiation

The data gathering system of the National Meteorological Service could be established in the short term.

3) Other

Self-financing may be available.

Table 4.12.3 presents the issues, countermeasures, and terms for meteoro-hydrologic observation.

Table 4.12.3 Issues, Countermeasures and Terms Regarding Meteoro-Hydrologic Observation in Belize

No	Issue	Countermeasure	Term	Other
BZ-10	Improvement of insufficiency of the maintenance staff	Training by donors and CIMH	Short	Cooperation of donors and CIMH
BZ-11	Improvement of budget insufficiency for maintenance	Request to the central government and the ministry	Short	Negotiation with central government and the ministry
BZ-12	Capacity improvement of staffs of the meteorological service	Participation to the training program by CIMH and other donors	Short	Donor’s support
BZ-13	Database system used is developed in other country	Development of own system so that the performance of the system would be more effective	Short	Self-financing

Source: JICA Survey Team

4.12.4 List of Conceivable Projects

Table 4.12.4 demonstrates the proposed projects in Belize.

Table 4.12.4 List of Conceivable Projects in Belize

No	Term	Project Title	Component
BZ-3	Short	Road Widening Works of the Narrow Bridge Section in the Trunk Highway （Hummingbird Highway）	1) Diagnosis 2) Study on the existing plans 3) Comparative study on the widening plans 4) Design of the selected optimum plan 5) Construction planning and cost estimates 6) Construction
BZ-4	Short・Medium	Capacity Building for Erosion Management	1) Training on risk assessment, mapping, and plan formulation for the countermeasure of erosion
BZ-5	Short	Development of Countermeasures Against Water Surging and Coastal Erosion in the Coastal Zone	1) Diagnosis 2) Comparative study 3) Design for the selected optimum plan 4) Construction plan and cost estimates 5) Construction
BZ-6	Short・Medium	Disaster Mitigation Plan for Earthquake in Belize City	1) Study on the existing plans 2) Update of the hazard map for earthquake 3) Studies on evacuation route and shelter 4) Risk assessment and preparation of scenario 5) Formulation of disaster mitigation plan 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Fostering of leaders for training for disaster mitigation
BZ-7	Short・Medium	Formulation of Disaster Mitigation Plan Against Tsunami in the Coastal Zone	1) Study on the existing plans 2) Update of the hazard map for earthquake 3) Studies on evacuation route and shelter 4) Risk assessment and preparation of scenario 5) Formulation of disaster mitigation plan 6) Preparation of training materials like disaster mitigation map and evacuation training 7) Fostering of leaders for training for disaster mitigation
BZ-8	Medium・Long	Study on the Design Standard for the Disaster Mitigation Structures for Earthquake and Strong Wind	1) Study on the design concepts adopted in other countries 2) Study on the applicability of the standards adopted in other countries 3) Preparation of the proposed standard
BZ-9	Medium	Water Resources Management Plan for the Northern Inland	1) Diagnosis 2) Projection of the future water demand 3) Study on groundwater 5) Study on dams 6) Formulation of water resources management plan
BZ-12	Short	Capacity Strengthening for Maintenance of Meteorological Observation System	1) Training for meteorological observation 2) Training for maintenance of meteorological observation system

Source: JICA Survey Team

4.13 Common Problems and the Countermeasures for Several Countries

4.13.1 CDEMA

In several countries, the common issue is the non-availability of design standard for seismic and wind loads. CDEMA should organize a committee to recommend a common standard.

Issue: Determination of design standard is available for seismic load and wind load

1) Countermeasures

Among the targeted countries of the survey, few countries adopted the design standards for the estimation of seismic load, wind load, and earthquake resistance. Therefore, the design conditions depend on the designer. Different standards such as AASHTO and BS have been adopted in a country. Some government engineers have asserted the necessity of standardization.

This subject is common to several countries. CDEMA should organize a committee inviting specialists from the universities and design departments of the governments of related countries to study the applicability of the standards which are now being applied in other countries. The seismic loads may vary from an island to another. In Japan, the specific intensity is assumed beforehand for a zone. If the historical data are available in and around the areas, the load to be adopted will be estimated for the occurrence probability. The basic method is to estimate the intensity on the basis of the assumed seismic wave. The committee should discuss the applicability of each method for adoption as the standard. The wind load varies from island to island as well because there are countries where hurricane does not hit like Guyana and Suriname. Meanwhile, there are several countries where a tropical depression passes through before it develops to be a hurricane. The wind velocity differs along the stages of development of a tropical depression. Zoning is possible to estimate the probable wind velocity. These matters should be discussed in the committee to be established.

The committee should collect and assess the ongoing practices in each country. The committee should assess the standards adopted by other countries with the natural conditions. The committee should conduct the screening of the assessed standards for their applicability to the Caribbean countries. The committee should prepare guidelines and manuals which provide the standard and design method suitable to local conditions.

The existing Building Guidelines for building with ordinary height for the eastern Caribbean area should be reviewed referring to the results of the above studies.

2) Terms until initiation

Ironing out the views of each country is fundamental for standardization. It may take time and the measure will require medium or long term for its initiation.

3) Other

The design standards of several countries are more or less in similar conditions. CDEMA should organize a committee to study the standardization of the design standards for each country. It is recommendable to invite experts as observers from outside to provide advices to the study. The budget shall come from the member countries. The dispatching costs for the experts could be shouldered by donors.

4.13.2 Seismic Research Center

The Seismic Research Center is renovating the seismic monitoring system. There were already 40 renovated units of the system which comprised 60 units. Those to be renovated are the remaining 20 units.

The system is useful for the countries in the Caribbean Community (CARICOM) area and the renovation is urgently needed. However, the budgetary constraint is the impediment for the renovation. Donation of equipment by donor could be a solution. The Seismic Research Center belongs to the University of the West Indies and it should be noted that the donation is the cooperation to the university instead of the cooperation to a country.

In this respect, there is a possibility to extend cooperation for the renovation as a joint research project with a Japanese university under a scheme of the Science and Technology Research Partnership for Substantial Development (SATREPS).

CHAPTER 5 INVITATION PROGRAM AND SEMINAR IN JAPAN

5.1 Preparation of Invitation Program in Japan

(1) Schedule of Invitation Program

The participants of the invitation program are the staff from disaster-related agencies. The rainy season in the Caribbean countries starts in June. Because it is difficult to invite the participants during the rainy season, the invitation program was scheduled from 21 May to 30 May.

(2) Selection of Participants

The JICA Survey Team explained the purpose, period, and tentative schedule of the invitation program in Japan to the disaster management agency of each country during the field investigation. As part of the program development, the JICA Survey Team requested the names of the two representatives each from the disaster management agencies of the participating countries. The disaster-related agencies gave the information of the participants in the beginning of May. Ten countries gave the information of their participants except Barbados and Guyana. The disaster-related agency in Guyana sent the information of the participants, but they were not able to get approval from their government. On the other hand, the disaster-related agency in Barbados notified the difficulty of the arrangement of the participants. A total of 17 participants went to Japan. The participants of the invitation program in Japan consist of 16 persons from ten countries and one person from the Caribbean Disaster Emergency Management Agency (CDEMA). Table 5.1.1 shows the participants list for the invitation program.

Table 5.1.1 List of Participants for the Invitation Program

No.	Country	Name	Photo	Position	Organization
1	Antigua and Barbuda	Mr. Mullin/Philmore Glasford		Director	National Office of Disaster Service
2	Antigua and Barbuda	Mr. King/Colis David Kahlil		Project Manager	Ministry of Works
3	Belize	Mr. Thimbriel/Irving Laurence		Zone Engineer MOWT Central	Ministry of Works & Transport
4	Belize	Mr. Herrera/Simeon Elias		Structural Engineer	Ministry of Works & Transport
5	Dominica	Mr. Christian/Mandela Damien		Program Officer/Geologist	Office of Disaster Management
6	Grenada	Mr. Dufont Kemron Martin		Technical Officer	National Disaster Management Agency
7	Jamaica	Mr. Davis/ Clive Clifton		Director General	Office of Disaster Preparedness and Management

No.	Country	Name	Photo	Position	Organization
8	Jamaica	Ms. Gordon nee Aaron/Allison Agatha		Regional Coordinator	Office of Disaster Preparedness and Management
9	Saint Kitts and Nevis	Mr. Pemberton/Livingston Wycliffe		Leader	Ministry of Public Utility
10	Saint Kitts and Nevis	Mr. Pemberton/Deora Eifion Raoul		Director	Department of Public Works, Nevis Administration
11	Saint Lucia	Ms. Joseph/Velda Sheron		Director	National Emergency Management Organization
12	Saint Lucia	Mr. Hippolyte/Amos Leton		Engineer	Ministry of Infrastructure, Port Services and Transport
13	Saint Vincent and the Grenadines	Mr. James/Joel Marcus		Assistant Superintendent/ Deputy Fire Chief	Police Force
14	Suriname	Mr. Mohan/Satish Vimod		Deputy Director	Ministry of Public Works
15	Trinidad and Tobago	Mr. Ramroop/Stephen		Chief Executive Officer	Office of Disaster Preparedness and Management
16	Trinidad and Tobago	Ms. Ramkissoon/Candice Heema		GIS Specialist	Office of Disaster Preparedness and Management
17	CDEMA	Ms. Pierre/Donna Marie		Disaster Risk Management Specialist	Caribbean Disaster Management Agency

Source: JICA Survey Team

(3) Schedule of Invitation Program in Japan

Table 5.1.2 shows the original and final schedules of the invitation program in Japan. Initially, the Yui Landslide Prevention Project was proposed but it is difficult to arrange, so the Kamenose Landslide Prevention Project was selected.

Table 5.1.2 Schedule for Invitation Program in Japan

	Date	Schedule
1	21 May	Arrive at Japan
2	22 May	Courtesy call to Japan International Cooperation Agency (JICA) Meeting for the preparation of seminar Courtesy call to Ministry of Foreign Affairs (MOFA) Courtesy call to Ministry of Land, Infrastructure, Transportation and Tourism (MLIT) Courtesy call to World Bank Tokyo Office
3	23 May	Site visit in Tokyo Visit Tokyo Rinkai Disaster Park Moving (Tokyo to Osaka)
4	24 May	Site visit in Kyoto
5	25 May	Visit Uji River (Flood mitigation)
6	26 May	Visit Kamenose Landslide Prevention Project Visit Sayama Reservoir Moving (Osaka to Tokyo)
7	27 May	Visit Tenku Park (Underground retarding basin) Preparation of the JICA seminar material
8	28 May	Attend the JICA seminar Discussion between JICA and participants of each country
9	29 May	Discussion between JICA and participants from Belize, Dominica, Saint Lucia, and Saint Vincent and the Grenadines Site visit in Tokyo
10	30 May	Leaving from Japan

Source: JICA Survey Team

5.2 Execution of Invitation Program in Japan

Four persons, namely, two Nippon Koei staffs and two JICA training supervisors, assisted the participants for the duration of the invitation program.

5.2.1 Courtesy Call to Related Ministries/Agencies

(1) JICA Head Office

When the participants visited JICA for courtesy call, JICA explained the importance of international knowledge sharing in the disaster prevention field, visit of Japanese Prime Minister, Mr. Abe, to Trinidad and Tobago last year, and strengthening of relation between Japan and the Caribbean Community (CARICOM) countries.

The participants asked about the evacuation guidance during disasters, administrative evaluation of governance in the local government, the building code in Japan, and so on.

(2) Ministry of Foreign Affair

The Ministry of Foreign Affairs (MOFA) explained the visit of Japanese Prime Minister, Mr. Abe, to CARICOM countries last year, the history of relationship between Japan and CARICOM countries, and the further policy to strengthen the relationship. In addition, the three pillars of Japan's CARICOM policies and Japanese assistance policy are explained. The three pillars are "Cooperation towards sustainable development, including overcoming the vulnerabilities particular to small island states", "Deeping and expanding fratemal bonds of cooperation and friendship", and "Cooperation in addressing challenges of the international community".

(3) Ministry of Land, Infrastructure, Transportation and Tourism

The outline of disaster mitigation in Japan was explained. The topics that were explained were:

- Prevention of floods drastically decreased the number of deaths caused by floods,
- Past flood disasters in Japan,
- Recent disasters due to climate change,

- Importance of the establishment of the emergency operation center, and clarification of the responsibility for required actions of post-disaster, and
- Structural and non-structural countermeasures for flooding.

In the question and answer session, the participants asked about the evacuation warning criteria during floods, legal force of the evacuation order, disaster information transfer to the handicapped persons, hazards maps, evacuation facilities, countermeasures for landslide and tsunami, and so on.

(4) Disaster Risk Management Hub in Tokyo, World Bank

The importance of Japan in the World Bank was explained, and the outline of the program of the disaster risk management hub was also expounded. The following topics were explained:

To utilize Japanese technology corresponding to various disasters, and

To carry out disaster risk reduction in the developing countries by using knowledge in the world.

The participants asked the assistance of the World Bank, and requested advice for possible countermeasure against disaster and the possible plan of improvement of sustainability in the island countries.

5.2.2 Outline of Site Investigation

(1) Tokyo Rinkai Disaster Park

The disaster prevention experience learning facility is located in Tokyo Rinkai Disaster Park. The participants were able to experience how to take action during 72 hours after a large-scale earthquake.

The participants asked how to take initial action by the government prior to starting operation from the operation room to the related agencies to disaster prevention.

(2) Yodo River Museum and Flood Prevention Facilities for Yodo River in Yodo City

At the Yodo River Museum, Mr. Sakuma, the director of Yodo River Office under MLIT, explained the following topics:

- Rainfall characteristics, topographical, and geographical conditions in Japan,
- Topographic condition and characteristic of the flood damage in the Yodo River basin,
- Flood in August 2012, and
- Disaster recovery vehicle.

The participants asked about the riverbed aggradations, decreasing the sedimentation of the coast due to dam construction, design of river structures, and operation method of the pump, among others.

The participants visited the following disaster-related structures.

- Drainage canal (Yadajirou River)
- Reservoir
- Drainage pump

(3) Kamenose Landslide Prevention Project

Mr. Hosokawa, a construction officer in Yamato River Office under MLIT, explained the following topics:

- Outline and cause of Kamenose landslide
- Applied countermeasures to protect landslide, and
- Monitoring facility for displacement.

The participants visited the drainage tunnel.

The participants asked the maintenance method of the drainage pipe, monitoring method of the landslide, and the resettlement for the countermeasure of the landslide, among others.

(4) Sayama Reservoir

Mr. Hosokawa explained the historical background of the Sayama Reservoir in the Sayama Reservoir Museum. The participants visited the dike and channel which were utilized before the Edo era.

(5) Megro Tenku Park

The participants visited the underground storage facility which stored the drainage water temporarily during the floods. It was located under the Megro Tenku Park. The staffs of Sekisui Techno Modeling Co., Ltd. explained the material and construction method of the underground storage facility.

The participants asked the purpose, vertical load, sales performance, and storage volume of the underground storage facility.

5.2.3 Follow-up Seminar of Japan-CARICOM Relations

The JICA seminar titled "Follow up seminar of Japan-CARICOM Relations: Present Situation of Disaster Prevention Sector in CARICOM" was held at the Conference Room 8A, 8th Floor, Takebashi Godo Building on 28 May, 2015, 9:30 to 12:30 and 51 persons attended. It was mainly sponsored by JICA and co-organized by the Tokyo Disaster Risk Management in Tokyo Hub, World Bank, and MOFA. Table 5.2.1 shows the schedule of the seminar. 11 members of the invitation program participated in the panel discussion of the seminar.

Table 5.2.1 Schedule of Follow-up Seminar of Japan-CARICOM Relations

9:00-9:30	Registration	
9:30-9:35	Opening Speech	Vice President of JICA, KUROYANAGI Tosiyuki
9:35-9:55	Assistance to CARICOM countries from Japan	Ministry of Foreign Affairs, International Cooperation Bureau, Country Assistance Planning Division II Assistant Manager HISHIYAMA Satoru
9:55-10:10	Problems and Needs for disaster prevention sector in CARICOM Area	JICA Survey Team for Data Collection Survey on Disaster Risk Management in CARICOM Team Leader AZUMA Yasuhiro
10:10-10:25	Future prospects and activities for disaster prevention sector in JICA	JICA Global Environmental Division, Water Resources and Disaster Management Group Deputy Director AKIYAMA Shintaro
10-25-10:40	Future prospects and activities for disaster prevention sector in CARICOM area	World Bank, Global Lead for Resilience and Disaster Risk Management Niels Holm Nielsen
10:40-10:50	Break	
(1^{st} session) 10:50-11:40	Panel Discussion Present Situation and Problems of the disaster prevention sector in CARICOM area and expectation for Japan 1^{st} Session: Investment of Disaster Prevention under Public Works	Moderator： JICA Global Environmental Division, Senior Advisor BABA Hitoshi Commentator： World Bank: Global Lead for Resilience and Disaster Risk Management Niels Holm Nielsen Panelist （1^{st} session） Belize: Mr. Irving Laurence Thimbriel Zone Engineer MOWT Central,

(2nd Session) 11:40-12:30	2nd Session: Mainstreaming of Disaster Prevention beyond the Organizations	Ministry of Works and Transportation Dominica: Mr. Mandela Damien Christian Program Officer/Geologist, Office of Disaster Management Saint Christopher and Nevis Mr. Livingston Wycliffe Pemberton Director, Nevis Administration Department Saint Vincent and the Grenadines Mr. Joel Marus James Assistant Superintendent/ Deputy Fire Chief., Police Force Suriname Mr. Satish Vinod Mohan Deputy Director, Water related Civil Engineer, Ministry of Public Works Panellist Antigua and Barbuda Mr. Philmore Glasford Mullin Director, National Office of Disaster Service Grenada Mr. Kemron Martin Dufont Technical Officer, National Disaster Management Agency Jamaica Ms. Allison Agatha Gordon nee Aaron Regional Coordinator, Office of Disaster Preparedness and Management Saint Lucia Ms. Velda Sheron Joseph Director, National Emergency Management Organization Trinidad and Tobago Mr. Stephen Ramroop Chief Executive Officer, Office of Disaster Preparedness and Management CDEMA Ms. Donna Marie Pierre Disaster Risk Management Specialist

Source: JICA Survey Team

The opinions of the participants are summarized below.

Suriname (Mr. Satish Vinod Mohan)
- Landslide is not a major problem because people do not live in the landslide prone area. - Flood ➢ Necessity of a countermeasure for extreme flood event in the metropolitan area due to climate change,

➢ Strengthening the meteorological and hydrological section (data monitoring system, database system, warning system)
Saint Christopher and Nevis (Mr. Livingston Wycliffe Pemberton)
- Commercial use of the land for the developer was allowed - Develop the shelter in case of disaster, and periodical checking of the condition of the shelter by the government, - Prepare a database of related disasters, since it can be utilized in disaster risk reduction and development, - The present building standard should be revised based on the available statistical data, - To realize the strength of disasters and to quickly recover from the damages in the country, it is necessary to organize a new agency which will focus on the improvement of disaster education, development of the knowledge about disasters, and publicity of the disaster prevention plan.
Saint Vincent and the Grenadines (Mr. Joel Marcus James)
- Saint Vincent is a volcanic island. When an eruption occurs, the impact will affect the whole island. When the volcano erupted in 1902, 1970, and 1979, the nearby residents were forced to evacuate. - There is no monitoring system for volcanic and seismic activity on the island. - The schools and the churches were utilized as an evacuation area during the hurricane. The government annually checks the condition of these shelters. - More than 90% of the domestic water source is from the surface water. It cannot take the domestic water during the hurricane. - A major flood disaster occurred in the island in 2010 and 2013. In 2013, 15 people died due to the flash flood and the subsequent landslide. - Most of the bridges did not have an adequate freeboard resulting to the damage of the bridges due to the driftwood carried by the flood. - Previously, the disaster related information was not properly organized. At present, a proper data collection is started to be implemented for the future projects. - Some people moved from the seaside area to upland because they lost their houses by the coastal area due to erosion.
Dominica (Mr. Mandela Damien Christian)
- The structural countermeasures for the disaster in Dominica are designed based on the maximum record. - It is difficult to implement the new design standard due to budget limitation and technical point of view. - JICA is expected to assist in providing the knowledge of disaster risk management and the multipurpose use of the disaster prevention facilities, and design method for the structures. - The Kamenose Landslide Project is impressive because other places used a similar measure. JICA's assistance for the countermeasure against landslide is requested.
Belize（Mr. Irving Laurence Thimbriel）
- The most serious disaster is hurricane, and its magnitude has increased due to climate change. - Drought situations are occurring and especially the inland area suffer more severe situation. - The collected disaster data cannot be applied for design purpose. - The government carries out data collection to be utilized in future forecasting and design purpose.
Antigua and Barbuda (Mr. Philmore Glasford Mullin)
- Damage due to flood is frequent due to topographical condition. - A coastal management system needs to be carried out. - A warning system is needed
Grenada (Mr. Kemron Martin Dufont)
- The government concentrates on disaster data collection due to lack of data. - The intensity and frequency of hurricanes have increased.

- Education for disaster risk management is important. - There are earthquake, tsunami and volcanic disasters. - It is necessary to monitor the submarine volcano because it can cause a tsunami.
Jamaica (Ms. Allison Agatha Gordon nee Aaron)
- The disaster risk management agency works in relation to the public and private sector. The agency corroborates with the Ministry of Education and Tourism Agency. - It is necessary to share the disaster related information among the related agencies. It has to identify the tools and countermeasures for disaster risk management in the related agencies. - The development of laws for district level is insufficient. - Incorporating the disaster risk measures into law shall be considered. - Establish an early warning system of flood and tsunami countermeasure system.
Saint Lucia (Ms. Velda Sheron Joseph)
- Train the staff of the disaster-related agencies. - Educate the citizens about disaster prevention. - Assist the communities that conduct disaster prevention countermeasures. - Budget constraints and resources are severe.
Trinidad and Tobago (Mr. Stephen Ramroop)
- CDEMA has established the disaster risk management strategy in 2014. The national strategy in Trinidad and Tobago applied the CDEMA's. The Sendai framework will be incorporated in it. - Increasing the frequency of the flood and the landslide. - Involve the people in disaster risk management, and necessity of strengthening the capacity development of the people - Carry out disaster prevention meeting per month - Carry out the drainage project at the Port of Spain by IDB
CDEMA (Ms. Donna)
- Incorporate the Sendai framework to CDEMA strategy - It is necessary to confirm what kind of data is required and how to use the collected data, which will have to be utilized for the people. - Strengthening the resilience of the communities - Outline of the assistance policy by CDEMA

5.2.4 Exchange of Opinion

JICA explained the problems and countermeasures as results of the field investigation and JICA and the participants of each country also discussed after the seminar in Takebashi Godo Building on 28 May, 2015 and at JICA head office in the before noon of 29 May, 2015.

As a result of the discussion, the problems and countermeasures suggested by the JICA Survey Team were understood and agreed upon by the participants of each country.

5.3 Observation on the Invitation Program in Japan

5.3.1 Result of Questionnaire

The questionnaire for the invitation program in Japan was disseminated to the participants. A summary of the questionnaire is shown below;

Q1. Do you find the program contents appropriate for you or your organization?

←← Yes, appropriate			No, inappropriate→→
□4	□3	□2	□1
13	4	0	0

Q2. Do you find the period of the program appropriate?

☐Long	☐Appropriate	☐Short
0	12	4

No answer…1

Q3 Do you find the number of participants in the invitation program appropriate?

☐Too many	☐Appropriate	☐Too few
0	14	2

No answer…1

Q4 Were you able to learn from the experiences of other participants in the invitation program?

←← Yes, very much			No, not at all →→
☐4	☐3	☐2	☐1
7	9	1	0

Q5 Did you have enough opportunities to get direct experiences such as site visits in the invitation program?

←← Yes, enough			No, very few →→
☐4	☐3	☐2	☐1
6	9	2	0

Q6 Please describe the following questions regarding the contents of the program

Disaster Prevention Experience Learning Facility (Tokyo)

Useful	Not Useful	Others
17	0	0

Positive
Exposure to disaster risk reduction methods was interesting. Those are applicable to my country.
The methods used were simple enough that countries with limited resources can easily adopt to their own environment.
The 72 hour survival tour was the most enlightening. I was also impressed with the robust emergency operations center layout, and the operation system and procedures.
Fun and innovative way to educate people on various hazards.
The disaster prevention experience learning facility shows education is a critical part to achieve behavior change to foster a more resilient nation.
Negative
None

Yodo River Office (Flood Management)

Useful	Not Useful	Others
17	0	0

Positive
The flood control systems employed were useful. The river flow gauges placed in drains in communities with sirens was useful, and similar systems are available. This could be improved with the use of sirens used in Japanese communities for early warning.
When addressing flood management issues, it is important to have access to many examples and the Yodo River Office was a good one. It was one that can be applied to the mainland territories such as Belize, Grenada, and Suriname.
Ideas for management of flood waters. Multiple use options (irrigation, power generation,

recreation, and flood control) This shows that land management is important for flood management. Very relevant since Trinidad Tobago has a hazardous profile flood most frequently occurring and impactful hazard.
Negative
None

Yamato River Office (Landslide)

Useful	Not Useful	Others
17	0	0

Positive
Very useful, Dominica faces a similar situation on a smaller scale. This trip/visit was very resourceful and provided valuable knowledge on how to manage landslides and slope instability in Dominica. This shows that disaster management is an ongoing process, and sometimes it may take decades to achieve the goals. Political commitment, technical expertise, and finances are important in disaster risk reduction. Good example in showing how risk data is documented, managed, and applied in decision making. Structural mitigation measures were strong, and linkages could be made to local context and how these can possibly be applied to assist local situation. Innovative approach to landslide. The techniques shown in reducing the impact of landslide are very relevant and effective. The distinction between landslide and hillside collapse gave a clearer understanding of what we experience at home.
Negative
None

JICA Seminar

Useful	Not Useful	Others
17	0	0

Positive
The bringing together of the Caribbean contingent and Japanese experts was a useful exchange and interactive session. From a regional perspective, the JICA seminar provided insight on the possible collaborative efforts to enhance capacities within the regional system and in the individual participating states. Good forum for learning about other countries' experience and for feedback and perspectives from JICA and other relevant stakeholders. Exchange of ideas and best practices in other countries. Information sharing, presentations and networking created a base for future interaction and problem solving.
Negative
None

Site Inspection of Tenku Park (Sekisui)

Useful	Not Useful	Others
15	0	2

Positive
The material used to store stormwater is a good idea which may be applied in Belize. Great method for harvesting rainwater for groundwater recharge for future use. Good flood mitigation techniques which are relevant and can be applied locally, based on the local flooding problem, particularly in the cities. Exposure to new technology was exciting.
Negative
Visit was interesting, especially being exposed to new technology, but this material may not be the best solution for us.

Discussion with JICA on 28 May

Useful	Not Useful	Others
16	0	0

No answer…1

Positive
The opportunity to interact with JICA, World Bank and other funding partners is very useful. The opportunity to discuss specific country project and the way forward was greatly appreciated. Good for exchanging ideas and possible project options. Japan and CARICOM have lots of similarities in terms of hazards that both are susceptible to. CARICOM has a lot of similar challenges that Japan can provide assistance on. The discussion was brief. Dr. Ramroop and I gave clarification on our major initiatives in the country based on information previously collected when Nippon Koei visited us, and how we will be moving forward when we return. Gave an overview of the findings of the JICA's Data Collection Survey. This discussion allowed for verification of conclusion by the JICA Representative.
Negative
None

Q7 Do you think the knowledge and experience you acquired through the invitation program in Japan is useful?

A	Yes, it can be directly applied to work.	12
B	It cannot be directly applied, but it can be adaptable to work.	5
C	It cannot be directly applied or adopted, but it can be of reference to me.	0
D	No, it was not useful at all.	0

Q8 Any comments or suggestions for improvement concerning the invitation program in Japan

Comments
Where applicable, the same methodologies can be utilized in their current state. In other instances, they can still be used but will have to be modified to meet the needs in the local setting. I totally enjoyed my experience in Japan. Ensure that we can collaborate to implement the lessons learned in our countries. Diversification of the cultural site visits. Shorten sessions to allow for more time for personal use. Increased interaction with the private sector and other disaster emergency management personnel. Please don't supply lunches, but see if it is possible to give participants choice of their own

meals.

Clear objectives and scope should be shared early on with all participants in a common briefing session (i.e., prior to the trip). Many people came with differing perceptions of what would have been covered.

A session about actual cues for engineers in structures would be good.

The program in general was very relevant. The practices of the Japanese are commendable and can be replicated. However, the period was compact and there was not much time to recover.

As an engineer, more in depth exposure to the technology and methods in the field used to help with disaster risk reduction and disaster risk management may be useful.

5.3.2 Observation of Invitation Program in Japan based on Questionnaire

(1) Overall Observation of Invitation Program in Japan

1) Overall Schedule

The participants visited three site inspections and one disaster experience facility. The participants gave high points to the quality and sufficiency for all site inspections and disaster experience facility.

2) Site Visit

Twelve participants answered that it could be directly applied to work. The remaining five participants answered that it could be directly applied, but it could be modified to work.

3) Period, Number of Members and Contents

The participants answered questions on adequacy of the period, number of members, and contents. The results of these issues are as follows:

Period	Adequate - 12 persons	Short - 4 persons	No answer - 1 person
Number of Members	Adequate - 14 persons	Less - 2 persons	No answer - 1 person
Contents	Adequate - 17 persons	-	-

Most of the participants answered adequate period, number of members, and contents.

(2) Participants of Invitation Program

1) Qualification

The JICA requested the following persons to attend the invitation program in Japan:

- Manager class (1 person) and working staff (1 person) from the disaster prevention sector agencies from each country
- 1 person from CDEMA
- Twenty one people from each country and CDEMA were nominated, but 17 people visited Japan. Four people could not attend the invitation program due to following reasons:
- Guyana (2 persons): They could not get approval from the new government organization,
- The government did not allow the use of the official passport, and
- Poor physical condition during the transfer from Trinidad and Tobago to New York.

2) Willingness on the Invitation Program and Manner of Site Visit

During the program, the participants had a high motivation for the site visits and seminar. They met the starting time and asked some questions during the site visit.

(3) Circumstance of Invitation Program

1) Lodging

The participants stayed at hotels during the program. They did not rise any lodging issue.

2) Invitation Program

Most of the participants were satisfied with the program, accommodation, and the staff. They did not have any complaint.