Ministry of Public Works and
Ministry of Agriculture and Fishery
Democratic Republic of Timor-Leste

THE POST SITUATION AND DATA COLLECTION SURVEY FOR THE FLOOD COUNTERMEASURES IN DILI

Final Report

(Summary)

IMPORTANT

- The grant aid projects described in this report are based on information as of February 2022. The proposed project contents will be revised according to price and exchange rate fluctuations at the time of cost estimation in a separately conducted preparatory survey.
- None of the proposed projects described in this report are promised to be implemented.

December 2022

JAPAN INTERNATIONAL COOPERTAION AGENCY (JICA)

IDEA Consultants, Inc.

Sanyu Consultants Inc.

INGEROSEC Corporation

Exchange Rate

USD 1 = JPY 115.26

(As of February 2022)

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Abbreviations

ADB	Asia Development Bank
ADN	National Development Agency
AdP	Aqua de Portuguese
BTL	Bee Timor-Leste
CBDRM	Community-based Disaster Risk Management
CPA	Civil Protection Authority, Ministry of Interior
CVTL	Timor-Leste Red Cross
DDIUP	Dili Drainage Improvement Upgrading Project
DFAT	The Department of Foreign Affairs and Trade, Australia
DGPC	Directorate General of Civil Protection
DNGRD	National Directorate of Disaster Risk Management
DNMG	National Directorate of Meteorology and Geophysics
DNSA	National Directorate of Water Supply (Predecessor of BTL)
DRBFC	Directorate of Road, Bridge and Flood Control
EDTL	National Electricity Company
EU	European Union
EWB	Engineers Without Border (Australia)
EWS	Emergency Warning Signal
FAO	The Food and Agriculture Organization of the United Nations
FB	Facebook
GMNTV	Grupo Media Nacional TV
GoTL	Government of Timor-Leste
GPDRR	Global Platform for Disaster Risk Reduction
GSMaP	Global Satellite Mapping of. Precipitation
ICHARM	International Centre for Water Hazard and Risk Management under the auspices of UNESCO
IFAS	Integrated Flood Analysis System
IPG	Institute of Petroleum and Geology
JMA	Japan Meteorological Agency
JPY	Japanese Yen
KOIKA	Korea International Cooperation Agency
MAF	Ministry of Agriculture and Fishery
MNEC	Ministry of Foreign Affairs and Cooperation (Ministro dos Negócios Estrangeiros e Cooperação)
MoF	Ministry of Finance
MPS	Secretariat for Major Project Service
MPT	Ministry of Planning and Territory
MPW	Ministry of Public Works
NGO	Non-governmental organizations
NOAA	National Oceanic and Atmospheric Administration
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PDNA	Post Disaster Needs Assessment
SEPC	Secretary of State for Civil Protection
SMS	Short Message Service
UNDP	United Nations Development Programme
UNITAR	The United Nations Institute for Training and Research
UNRCO	The United Nations Resident Coordinator Office

UNTL/ FEST	National University of Timor Lorosae / Faculty of Engineering, Science and Technology
USAID	United States Agency for International Development
USD	United States Dollars

Chapter 1 Background and Objectives of the Survey

1.1 Background of the Survey

The Democratic Republic of Timor-Leste (hereinafter referred to as "Timor-Leste") has landslides and flooding disasters every year. Dili Municipality, the capital, has population of about 300,000 people, but its drainage facilities have not caught up with the growing urban population. In recent years, local heavy rains and extreme weather conditions have led to repeated flooding, seriously affecting the region's economic and social activities. In April 2021, heavy rains caused small rivers and drainage channels in Dili to overflow predawn, and the overflowed water far exceeded the drainage in Dili. The floods in April 2021 have killed 48 people and more than 10,000 people were displaced.[1] In addition, landslide disasters marked it difficult to travel between local cities. (Hereinafter referred to as "the floods" or "the April 2021 floods.")

The Government of Timor-Leste has sent the Government of Japan and JICA an official letter of technical cooperation to support the government's efforts for Build Back Better. In response to the official letter. JICA and the Government of Timor-Leste held a series of discussions and exchanged views on the survey and JICA and counterpart agency (Ministry of Public Works, Ministry of Agriculture and Fisheries) signed the Minutes of Meeting on August 12, 2021.

After which, the Post Situation and Data Collection Survey on Flood Management in Dili (hereinafter referred to as the Survey Team) was dispatched to Timor-Leste.

1.2 Objective of the Survey

The objective of this survey is to collect information necessary for the formulation of future cooperative projects regarding disaster-resistant urban development in Dili.

1.3 Survey Areas

- Dili Municipality (Dili*, Hera, Tasitolu, Comoro River, Bemos Water Supply System)　*"Dili" indicates the center of Dili Municipality.
- Liquica Municipality（Tibar）
- Aileu Municipality（Comoro River, Water Supply System in Bemos-Dili）
- Manatuto Municipality（Buluto Irrigation Facilities）
- Bobonaro Municipality（Maliana Irrigation Facilities）

1.4 Counterparts and Related Organizations of Timor-Leste

1.4.1 Counterparts

(1) Ministry of Public Works: MPW
- Directorate of Road, Bridge and Flood Control: DRBFC
- Bee Timor-Leste: BTL

(2) Ministry of Agriculture and Fishery: MAF
- Department of Irrigation and Water Management: DIWM

1.4.2 Partner Organization

National University of Timor-Leste: UNTL, Faculty of Engineering, Science and Technology: FEST

[1] UNEP/GCF Proposal "Enhancing Early Warning Systems to build greater resilience to hydro-meteorological hazards in Timor-Leste" (2021/07)

1.4.3 Related Organizations

(1) Ministry of Finance: MoF
(2) Ministry of Foreign Affairs and Cooperation: MNEC
(3) Secretariat for Major Project Service: MPS
(4) Civil Protection Authority: CPA (successor of Directorate General of Civil Protection (DGPC))
(5) National Authority for Water and Sanitation: ANAS
(6) National Directorate of Meteorology and Geophysics: DNMG
(7) Institute of Petroleum and Geology: IPG
(8) National Electricity Company: EDTL
(9) Municipality of Dili

1.4.4 International Organizations

(1) UN Resident Coordinator Office: UNRCO
(2) Asia Development Bank: ADB
(3) World Bank: WB
(4) United Nations Development Programme: UNDP

1.4.5 Other Donors

(1) Aqua de Portuguese: AdP
(2) Engineers Without Borders (Australia): EWB
(3) United States Agency for International Development: USAID

1.4.6 NGO/NPO

(1) Mercy Corps

1.5 Members of the Survey Team

In total 10 Japanese experts have been involved in the survey, from IDEA Consultants, Inc., Sanyu Consultants Inc. and INGEROSEC Corporation.

1.6 Work Schedule

- Inception Report: September 2021
- Progress Report: December 2021
- Interim Report: February 2022
- Supplementary survey: April 2022
- Draft Final Report: July 2022
- Final Report: August 2022

Chapter 2 Current Disaster Management System

2.1 Laws and Policies Related to Disaster Risk Management

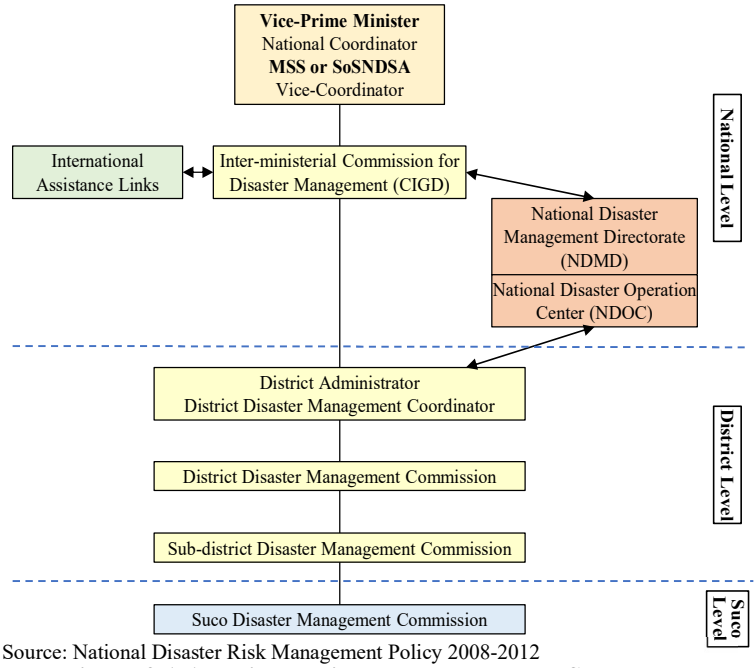
Currently, Timor-Leste has a National Disaster Risk Management Policy 2008-2012 and the newly approved Civil Protection Law No. 12/2020. An overview of these policies and laws and the major issues are described below.

(1) National Disaster Risk Management Policy (NDRMP)

The National Disaster Risk Management Policy (NDRMP) 2008-2012 was formulated in 2008 based on the Hyogo Framework for Action (2005-2015). This Policy aims to respond to the constitutional mandate to identify priorities to guide Government objectives and strategies in order to guarantee the security and safety of citizens and their property and to safeguard natural resources against natural or human-induced disasters. The policy lays out the government's vision for disaster management from the national level to the village (suco) level. It outlines a series of activities for disaster risk management, including vulnerability assessment, risk analysis, early warning system, crisis management, post-disaster survey and review, recovery and reconstruction, and disaster risk awareness.

The policy states that evacuation planning should be based on the following principles. "Suco committees, as part of their preparedness for disasters and major emergencies, should identify safe emergency shelters from floods and other hazards and safe routes to these shelters". The interviews with residents on flood disasters in this study revealed that the emergency shelters and routes to them have not been identified in Dili Municipality. Also, no one was aware that this was the role of Suco. This is an issue that needs to be addressed as soon as possible to prepare for the next flood season.

The National Disaster Management System in the Policy is shown in Figure 2.1-1. Under the policy, the National Disaster Management Directorate (NDMD, current National Directorate of Disaster Risk Management: DNGRD) was organized under the Ministry of Social Solidarity (MSS) and was responsible for coordinating and providing technical assistance for disaster risk management in Timor-Leste.



Source: National Disaster Risk Management Policy 2008-2012

Figure 2.1-1 National Disaster Management Structure

The policy is based on the Hyogo Framework for Action (2005-2015), which makes it a comprehensive disaster risk management policy. However, it is a bottom-up policy, with emphasis on community-based disaster risk management and expansion of early warning, viewing disaster management as a humanitarian issue. This is different from the current perspectives of disaster risk reduction (the direction of the Sendai Framework for Disaster Risk Reduction), which sees disaster risk reduction as a development issue and emphasizes prevention of economic loss and the importance of prior investment in disaster risk reduction. In addition, although the roles of relevant ministries and agencies are described, they do not match the current governmental and local organizations due to reorganization, and their roles and responsibilities are unclear. In order to implement efforts in line with the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR), there is an urgent need to update the National Disaster Risk Management Policy.

Based on the Decree-Law No.11/2022 of March 9, 2022, the government established the structure of

the entire civil protection system headed by Civil Protection Authority: CPA (Autoridade de Proteção Civil) as the executive entity of national scope regulating all civil protection activities (successor of Directorate General of Civil Protection: DGPC). CPA has in its President its focal point of liaison at the political level and which will make the operational, administrative, logistic and financial management of the entire civil protection system. The regional and municipal civil protection systems will be the existing deconcentrated and in the future decentralized structures in the Special Administrative Region of Oe-Cusse Ambeno (SAROA) and in each of the 13 municipalities. CPA has the following national directorates:

1) National Directorate of Firefighters
2) National Directorate of Disaster Risk Management
3) National Directorate of Security and Protection of Public Property
4) National Directorate for the Prevention of Community Conflicts
5) National Directorate of Resource Management Directorate

According to the Decree-Law No.11/2022, CPA will create Standard Operation Procedures and the National Civil Emergency Planning System within one year from the effective date of the Decree-Law.

The newly established CPA is expected to perform overall coordination of all the concerned organizations for implementation of disaster risk reduction policies of Timor-Leste.

(2) Civil Protection Law No. 12/2020)

The Civil Protection Law No. 12/2020, enacted on December 2, 2020, is the current basic law on civil protection in Timor-Leste. The objectives of the Civil Protection Law are stated as follows:

a) To prevent collective risks and the occurrence of serious accidents or disasters.
b) To diminish collective risks and limit potential effects in the event of a major accident or catastrophe
c) To rescue and assist people and animals in danger and to protect property and cultural, environmental, and high public interest values
d) To support the restoration of normal life for people in areas affected by a serious accident or catastrophe.

The civil protection activity is carried out in the following areas:

a) Survey, forecast, monitoring, evaluation and prevention of collective risks;
b) Continuous analysis of vulnerabilities in risk situations;
c) Information and training for the population;
d) Emergency action planning, to search, rescue and provide relief and assistance, as well as evacuation, accommodation and supply to the affected populations;
e) Maintaining an inventory of the resources and means available which can be mobilized at the municipal, regional, and national levels;
f) Study and dissemination of adequate forms of protection for infrastructures and buildings in general, monuments and other cultural assets, as well as natural and environmental resources;
g) Forecasting and planning actions for the restoration of communications in case of isolation of areas affected by serious accidents or catastrophes.

Based on the above d), CPA is responsible to issue evacuation orders to the people in the risk areas before disaster occurs.

Article 28 stipulates that the head of the municipality is responsible for the civil protection policy of the municipality and is obliged to take preventive, rescue, supportive and restorative actions according to the situation when a major disaster is imminent or occurs.

The National Civil Protection Council is to be represented by ranks of heads nominated by government members from the fields of defense, internal affairs, justice, finance, trade and industry, environment, public works, transportation and communication, agriculture, forest and fishery, social solidarity, health, education, and national administration. The fire service, the national defense forces, the national police, and the immigration service are also members. But there is no mention of the role of each ministry in implementing disaster risk reduction policies or coordinated efforts. One of the duties of the Council of State is to propose standards and technical norms for the formulation and operation of the Civil

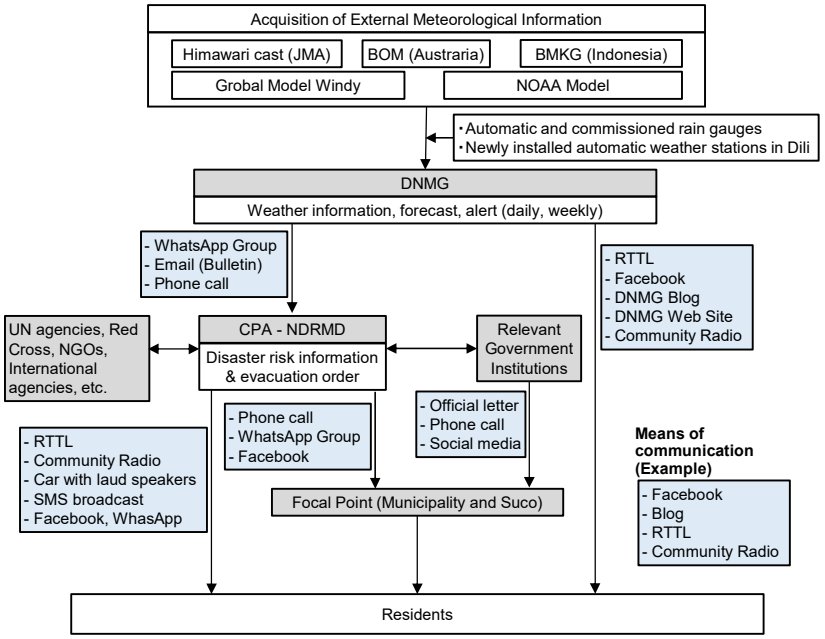
Protection Emergency Plan, but the formulation of the disaster risk reduction investment plan is not included in the mandate.

The content of the Law is mainly focused on post-disaster emergency response, with little reference to disaster risk reduction.

2.2 Disaster Information Communication

Figure 2.2-1 shows the current flow of disaster risk information and means of communication. Meteorological information from the Department of Meteorology and Geophysics (DNMG) is sent to the CPA. Disaster risk information such as evacuation orders is issued by the CPA based on the Article 4 of the Civil Protection Law No. 12/2020 directly to the contact points (Focal Points: in the case of municipality, the staff dispatched by the CPA; in the case of villages, the head of the Suco), and disseminated through social media and SMS broadcast.

A major step forward since the April 2021 flood disaster is the agreement with three mobile carriers in Timor-Leste to distribute disaster risk information via SMS broadcast. SMS broadcasts are ideal for issuing warnings because they do not require an internet connection like social media, and even older cell phones can be used to receive the disaster risk information.



Source: Prepared by JICA Survey Team based on interview survey.

Figure 2.2-1 Flow of disaster risk information and means of communication

Depending on the scale of the approaching hazard, messages that convey the potential for impact may be necessary. In Japan, expressions such as "never experienced before" or "comparable to torrential rains in 20xx" are sometimes used, but expressions that match Timor-Leste are needed to convey a sense of urgency.

2.3 Legal system on environment and social consideration (EIA) of Timor-Leste

The main laws related to environmental and social considerations in Timor-Leste and the legislative bills currently under draft are as follows.

【Environment related】

The Environmental License Law stipulates the procedure for environmental impact assessment in Timor-Leste.

According to this law, regarding categorizing of impacts of the projects, there are three categories that similar with the JICA guidelines (Table 2.3-1).

Table 2.3-1 Criteria and classification of EIA of Timor-Leste

Categorizing of impacts of the projects	Criteria of project impact assessment
Category A	Projects could have a significant negative impact
Category B	Projects could have a certain negative impact
Category C	Projects could have a negligible /slight negative impact

Source: JICA expert team

Regarding the existence of "significant negative impact" in the definition of the category, this will be determined by comprehensive evaluation such as the scale of the project site, the presence or absence of involuntary relocation of residents, and whether or not target project includes socio-economic impact. All development project planners are required to submit a project document describing the project plan to the National Directorate of Environment of the Secretary of State of Environment before implementing the project, in order to obtain an environmental license.

【Social consideration related】

In order to realize the peoples' rights that are stipulated in the Constitution and Civil Code of Timor-Leste, in 2017, the Special Regime for the Definition of Ownership of Real Estate and Expropriation for Public Utility was promulgated. However, now given the stage of the development of related laws, real estate (excluding land), are now areas for compensation.

In addition, the Government ordinance stipulates compensation targets such as plants and their acquisition prices. The replacement prices offered by Timor-Leste Government were based on market prices, and they include income tax and bank remittance fees, the same as the compensation level based on the JICA Environmental and Social Consideration Guidelines.

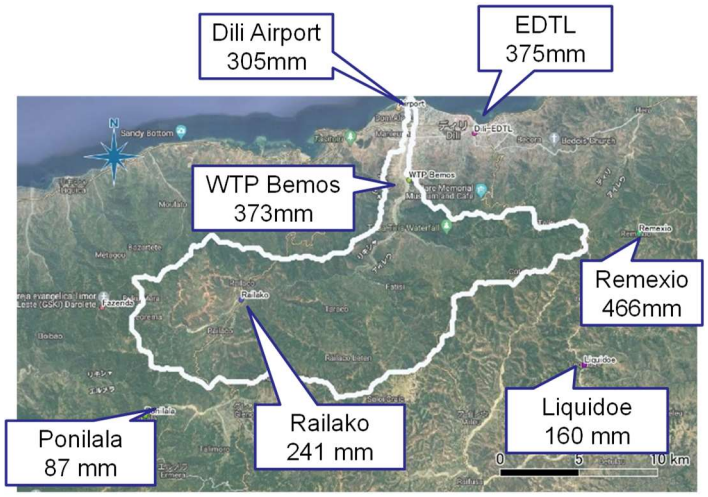
Chapter 3 Survey Results

3.1 Understanding the Mechanism of Disaster Occurrence (April 2021) and Disaster Risk Assessment

3.1.1 Evaluation of Rainfall /River Water level, and estimation of hourly rain fall

(1) Rainfall data of the April 2021 floods

Dili Airport recorded daily rainfall of 305mm on April 4th, 2021 and other rain gauge stations managed by ANAS record peak daily rainfall on April 4th (Figure 3.1-1). According to the rainfall observation in Dili conducted by UNTL for research purposes, heavy rainfall occurred at dawn on April 4th. The two-day rainfall from April 3rd-4th was 359.6mm for Beto Leste and 338.4mm for Bairro Formosa.

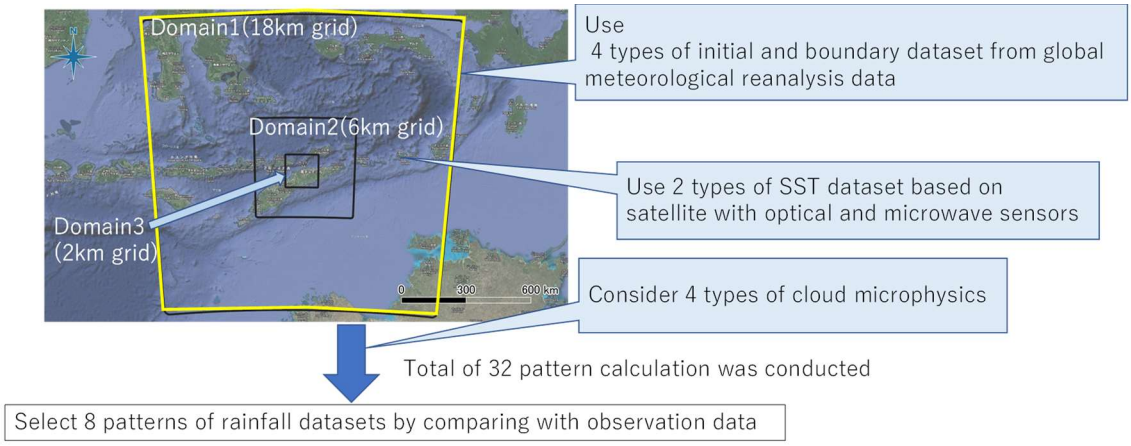


Source：ANAS, DNMG

Figure 3.1-1 Rain gauge record(daily) around the Comoro River Basin on April 4th 2021

(2) Estimation of hourly rainfall by mesoscale numerical weather prediction system WRF

To conduct runoff and flood analysis, spatio-temporal high resolution rainfall data is required. Therefore, the survey team created a multiple pattern of high-resolution rainfall dataset and evaluated them by comparing with observation data as shown in Figure 3.1-2.



Source: JICA Survey Team

Figure 3.1-2 Procedure for creating multiple high-resolution rainfall data

(3) Estimation of tide level during the April 2021 floods

There was no tide level observation data during the April 2021 floods, but the survey team conducted harmonic analysis based on the data for two years from the tide level data from May 19, 2018 to June 31, 2019 provided by APORTIL, and calculated astronomical tide level of Dili during the April 2021 floods.

It was confirmed that heavy rain occurred in the early morning of April 4th in Dili, and the astronomical tide level from 5:00-7:00am on April 4th, near the time of high-tide was 203cm-215cm. In terms of the tide height, it was thought to be 29cm-41cm. Furthermore, assuming that the tropical cyclone Seroja had a blowing effect, it is assumed that the actual tide level was higher.

3.1.2 Understanding the mechanisms of disaster occurrence (April 2021)

(1) Disaster Situation of April flood

Regarding the April 2021 floods, damage occurred in various places around Dili Municipality as shown by Figure 3.1-3.

Source：JICA Survey Team based on the materials provided by several Institutions

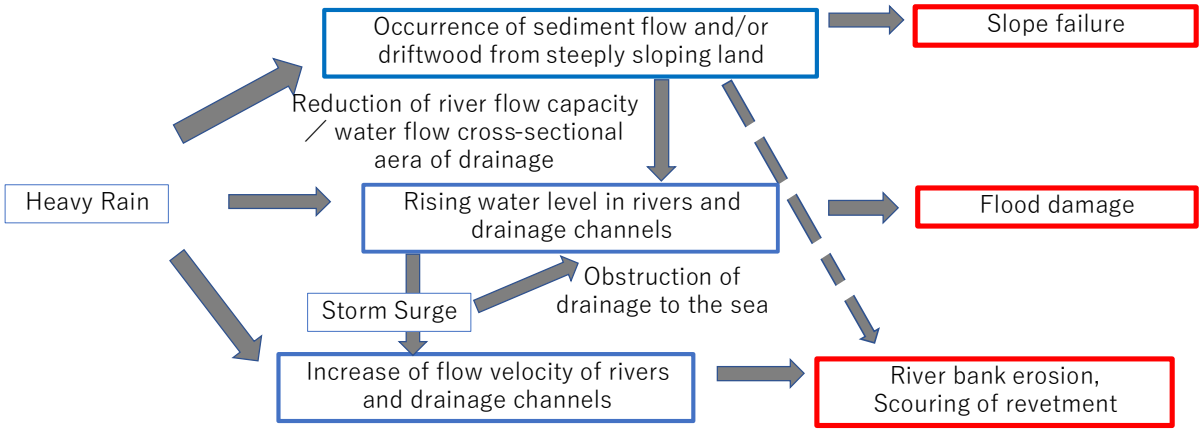
Figure 3.1-3 Damage around Dili Municipality caused by the April 2021 floods

(2) Mechanisms of disaster occurrence

The disaster occurrence mechanism of the April 2021 floods is roughly classified as shown in Figure 3.1-4.

It is assumed that sediment and water flooding occurred in the small river area of Dili during the April 2021 floods. With respect to the Comoro River, there was no overflow, but it is assumed that mudflow flowed down the river channel, which caused riverbank erosion, scouring of revetment foundation, outflow of revetment blocks and collapse of the revetment.

In the Bemos River, there was evidence that flood flow carried rocks and driftwood, which is thought to have caused enormous damage at the intake facility.



Source：JICA Survey Team

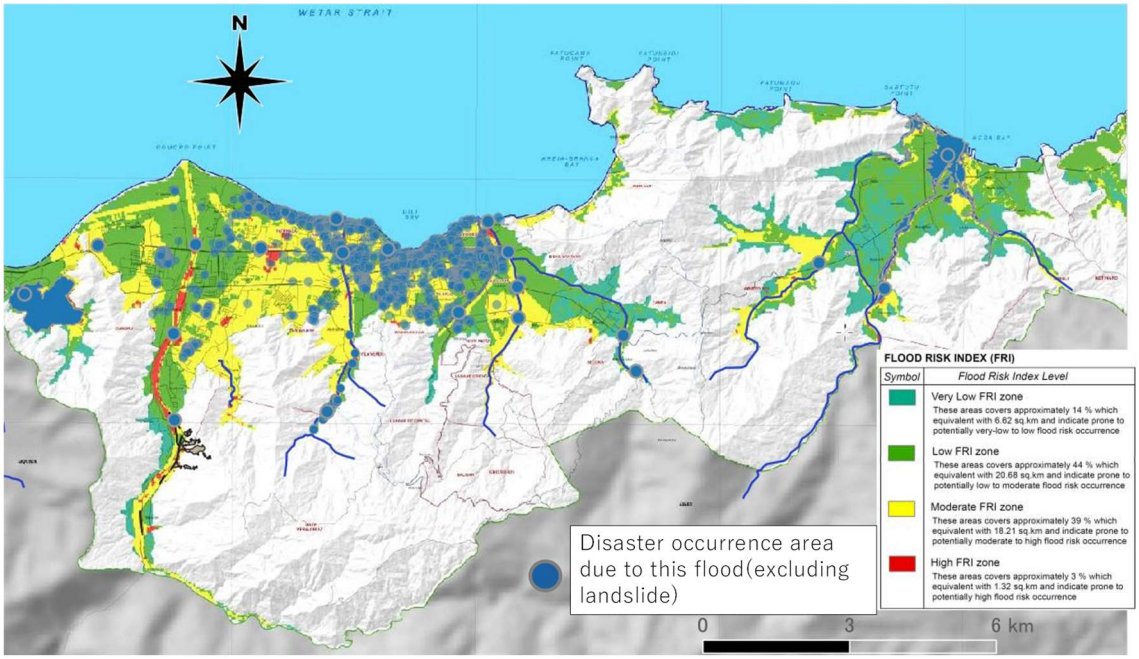
Figure 3.1-4 Disaster occurrence mechanism of the April 2021 floods

Based on these circumstances, future flood countermeasures should take into account not only

rainfall and water levels/flow rates in rivers and drainage channels, but also sediment dynamics in the watershed.

3.1.3 Analysis of disaster risk at survey area

Based on the disaster occurrence mechanism discussed in 3.1.3, a disaster risk assessment was carried out by overlaying the damage from the April 2021 floods on the existing landslide risk map and Flood risk map.



Source：JICA Survey Team based on the material provided by UNTL

Figure 3.1-5 Flood risk assessment map

Regarding the Flood Risk, it can be confirmed that the damage caused by the April 2021 floods did not necessary occur in High-Risk zone. It is presumed that the cause of the April 2021 disaster was not only through flooding but a complex combination of sediment and water flooding.

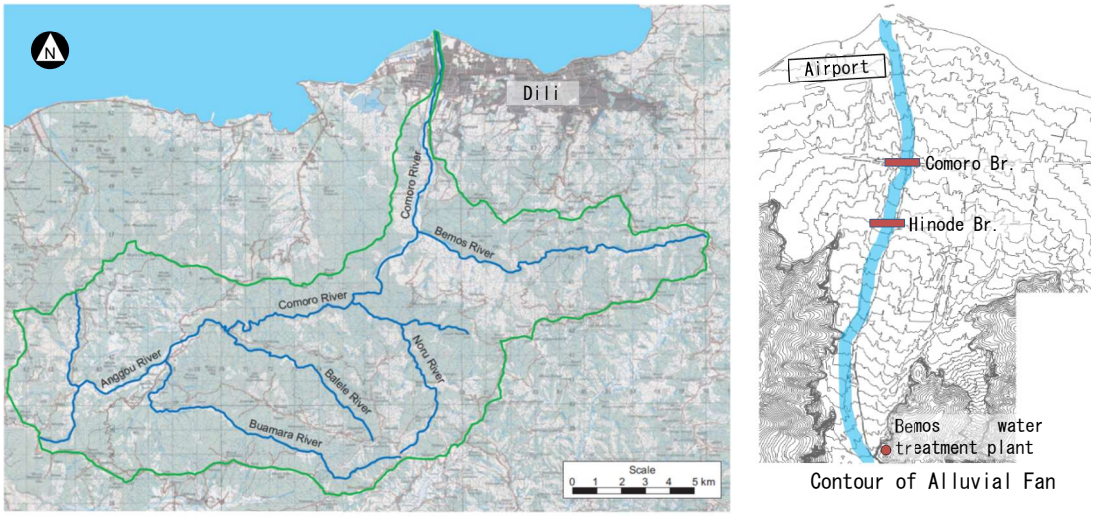
Based on the above the measures for the survey area and each facility for Build Back Better are examined in the following sections.

3.2 Study on rehabilitation plan for Comoro River

3.2.1 Outline of the Comoro River

(1) General Overview

Comoro River basin has a catchment area of 207 km2, which covers about 30 km east-west and about 4 to 8 km north-south as shown in Figure 3.2-1 (Left). Most of the river basin area is mountainous. From the west, the Anggou River, the Buamara River and the Balete River join and become the Comoro River. The Comoro River joins the Noru River and the Bemos River, which are tributaries on the right bank in the mountainous area. It then reaches the head of the alluvial fan located about 5.5 km from the river mouth and flows straight to the see. The alluvial fan has been formed by repeating flood inundation (Figure 3.2-1 (Right)). Longitudinal gradient is 1/30 in mountainous area and 1/70 for the downstream reaches from the confluence with the Noru River (14 km from the river mouth).



Source: The study team revised output of "Preparatory Survey Report on the Project for the Construction of Upriver Comoro Bridge in the Democratic Republic of Timor-Leste (2014), JICA"

Figure 3.2-1 Comoro River Basin

(2) River Management

1) River Administrator and River Law

Rivers are used by the public, and river management must be carried out properly for the purpose of preventing the occurrence of disasters such as floods and storm surges and maintaining public safety. The person/organization who has the authority and obligation to manage this river is the river administrator, but in Timor-Leste, the river administrator is not clearly defined. In addition, the river law, which stipulates river administration including the river administrator, has not been enacted. In Timor-Leste, the construction of river management facilities is carried out by DRBFC, and maintenance after construction is the role of the municipalities, but it may differ depending on the location and facility.

2) River Structures in Comoro River

Revetment: There are three types of revetments on the Comoro River, i.e., wet masonry, gabion mattress, and concrete block masonry.

Ground sill: 2 ground sills are installed at 1.69km and 3.88km from river mouth. Comoro bridge crosses the river upstream of No.1 ground sill.

Groins: There are 6 new and old groins in place over a distance of 10km from the river mouth. All the groins are located on the right bank.

3) Gravel Mining in the River

Gravel mining is actively conducted on the riverbed of the Comoro River. The Environment Bureau has authority over the provisions of the following laws and manages gravel mining by issuing environmental licenses.

- Government Decree Law No. 26/2012 4th July, Basic Law on Environment
- Government Decree Law No.5/2011 9th February, Environmental Licensing

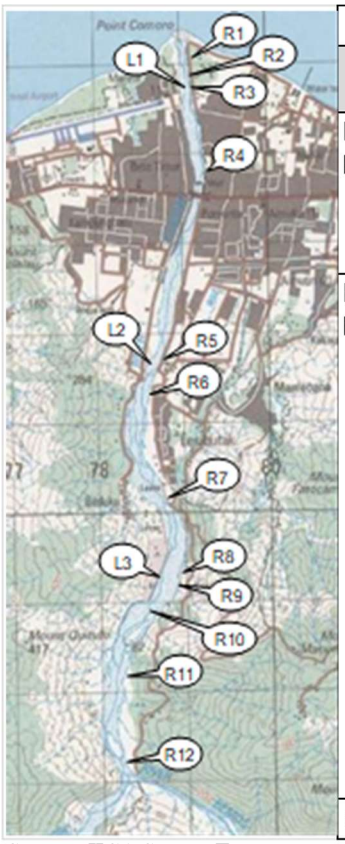
As a law related to gravel mining in rivers, there is a mining bill drafted at the time of the 7th constitution government, but the bill has not been passed until now. For this reason, gravel mining restrictions for river management are only indirectly screened for negative impacts when the environmental license mentioned above is obtained.

3.2.2 Damage assessment of the Comoro River

The damage to the Comoro River caused by the April 2021 floods can be divided into (a) damage to the revetment due to the flood flow and associated riverbank erosion, (b) washout of the foot protection blocks around the pier of the Hinode Bridge, and (c) inundation or flushing of houses in the river channel. The flood did not cause overflow from the Comoro River.

(1) Damage of bank protection works and river bank erosion

The damage to the revetment of the Comoro River from the river mouth to the upstream of the confluence with the Bemos River are shows in Figure 3.2-2. The damage to the revetment is concentrated on the right bank, and the number of damaged locations is four times that of the left bank and the length of the damaged revetments is twice that of the left bank. In particular, the revetments constructed after 2013 have been continuously damaged on the right bank (R7 to R12) upstream of 5.5km. On the other hand, on the left bank side of the same section, the road on the riverbank is cut off in the middle, so the land development is not progressing, and the revetment is limited.



Length of Damaged Bank		
	Mark	Length (m)
Left Bank	L1	460
	L2	23
	L3	374
	Total	857
Right Bank	R1	168
	R2	39
	R3	38
	R4	141
	R5	100
	R6	110
	R7	142
	R8	100
	R9	112
	R10	232
	R11	560
	R12	53
	Total	1,741
Grand-total		2,598

Source: JICA Survey Team

Figure 3.2-2 Location of Damaged Revetment

(2) Washing out of foot protection blocks

The riverbed around each pier of Hinode bridge is covered with foot protection blocks about 20m square to prevent scouring. Some foot protection blocks were washed away due to gravel mining near the piers and flood flow.

(3) Inundation and washing out of houses inside the riverbanks

In recent years, many houses have been built on high water channel or higher land in the Comoro River. During 2021 April flood, some houses have been inundated and washed away. As of October 2021, it was confirmed that new houses were being rebuilt on the sites that had been washed away.

3.2.3 Review of the present river plan of the Comoro River

A river plan for Comoro River from river mouth to 3.6km was prepared for basic design of Hinode bridge (2.6km from river mouth) in the Preparatory Survey on the Project for the Construction of Upriver Comoro Bridge (2014). In the Post Situation and Data Collection Survey for the Flood Countermeasures, this river plan is revised adding new hydrological data, and its range extended from the river mouth to the confluence with the Bemos River.

(1) Rainfall analysis

According to the Thiessen polygon delineation method, the daily rainfall on April 4th in the Comoro River basin was 279mm/day, which was the maximum rainfall historically and it corresponds to the 172 years return period rainfall for GEV.

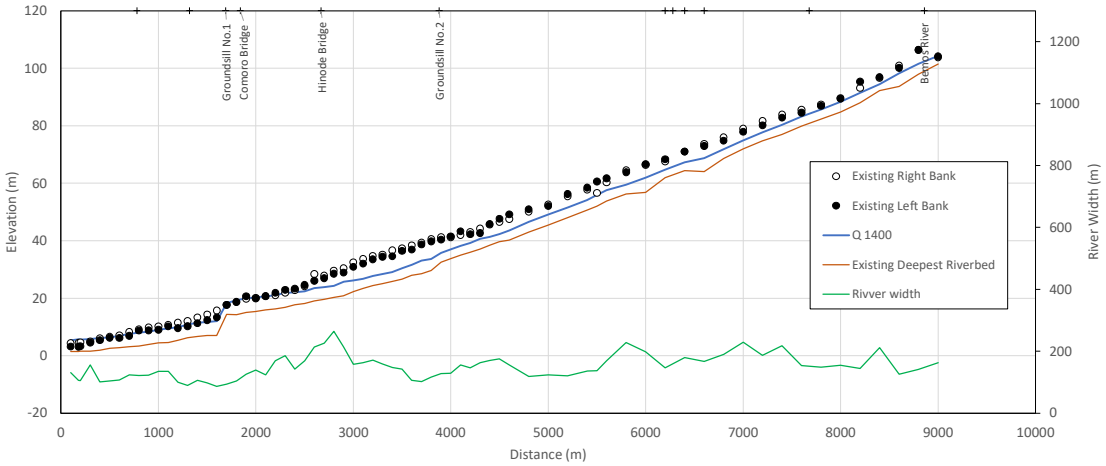
Based on this maximum rainfall in the past, JICA Survey Team proposes 292mm/day, which corresponds to the 200 years return period, as design rainfall for future disaster risk reduction.

(2) Runoff analysis

For runoff analysis, Rain-Runoff-Inundation (RRI) Model was utilized. Runoff analysis is conducted using the above design rainfall, and the peak discharge of the analysis in the downstream of the Comoro River was 1,270-1,323 m3/s. Based on this result, the design discharge was determined to be 1,320m3/s.

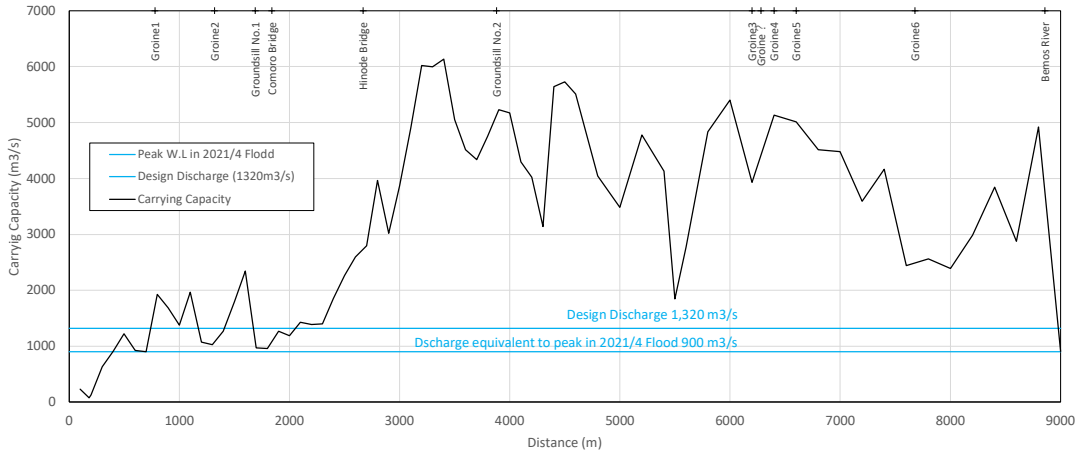
(3) Existing river condition

Figure 3.2-2 shows the existing longitudinal profile of the Comoro River prepared from cross-sections obtained by topographic survey implemented in this survey. The figure also illustrates the river width in green line and calculated water level of 1,400 m3/s. Carrying capacity of the existing river is estimated by non-uniform flow as shown in Figure 3.2-4.



Source: Survey Team

Figure 3.2-3 Longitudinal Profile



Source: Survey Team

Figure 3.2-4 Carrying Capacity of Existing Comoro River

(4) River plan

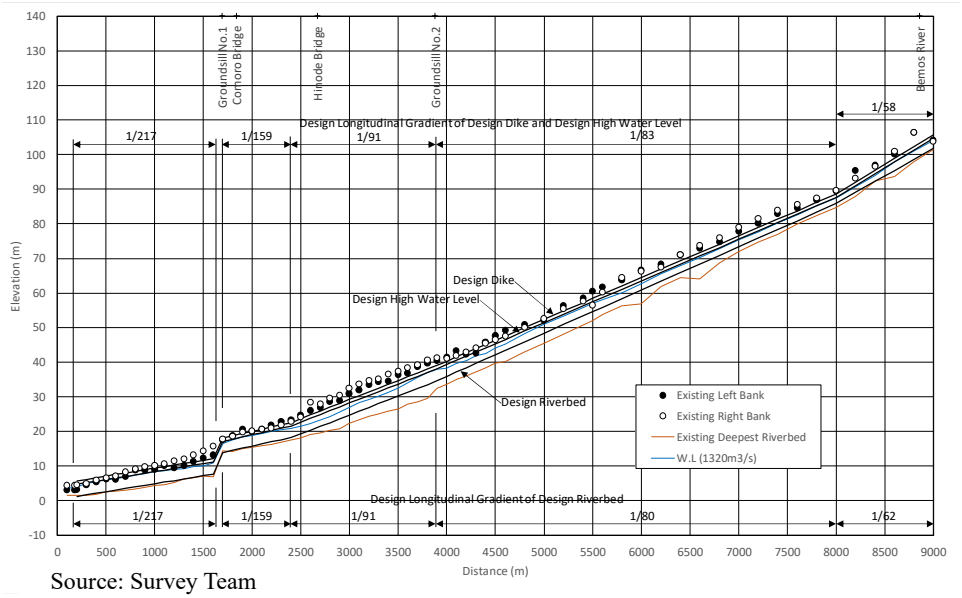
Basic concept for the design of a river plan is shown in Table 3.2-1. Based on this concept, design longitudinal profile (Figure 3.2-5), design cross section and design dike alignment are decided.

Table 3.2-1 Basic Concept of River Planning

Item	Post situation and data collection survey
Design Scale	Design scale should be safe level against 2021 April flood JICA survey team proposes 200-year return period (design discharge 1,320m3/s) because daily rainfall amount in the Comoro River basin of 2021 April flood was 172-year return period as described in "3.1.3 (2)".
Design Longitudinal Gradient	Design longitudinal gradient is determined factoring in riverbank height, surrounding ground height, etc. not only riverbed. This is because riverbed elevation is considerably affected by gravel mining.

Item	Post situation and data collection survey
Design High Water Level	Even in the April 2021 flood, no inundation from the Comoro River occurred near the river mouth where the carrying capacity was low. Based on this fact, the design high water level should be set to a height that does not exceed the existing riverbank height as much as possible.
Dike Alignment	Left bank: From the river mouth to the ground sill No.1, design dike alignment is put in the position of the existing retaining wall. For upstream of the ground sill No.1, design dike alignment is the existing riverbank decided by ground elevation. Right bank: Because the bypass of National Road No.2 is of the right bank, the position of the existing riverbank is set as the design dike alignment.

Source: Survey Team



Source: Survey Team

Figure 3.2-5 Design Longitudinal Profile

(5) Sediment Disaster Countermeasures

In the reach from 3.0km to 7.0km, the existing deepest riverbed is lower about 3m than design riverbed. Degradation of riverbed has merit that carrying capacity will be increased by cross sectional area expanded by riverbed degradation. On the other hand, it has demerit that it will cause shorten foundation depth of structures such as revetment, bridge pier, etc. In order to prevent further degradation, installation of groundsills (about 1.5m height) is recommended. It is recommended that a groundsill is installed from downstream and after confirmation of sediment accumulation upstream of the groundsill, the position of a second groundsill is studied.

3.2.4 Recommendation on river management of Comoro River

The table below summarizes the efforts necessary to properly implement river management in Timor-Leste.

Table 3.2-2 Necessary Efforts for River Management

Major Component of River Management	Necessary Efforts
1. Development of laws and standards	1) Formulation of river law, legislation of mining law 2) Formulation of operation and maintenance manuals for rivers and river structures
2. Planning	1) Formulation of river plan 2) Formulation of operation and maintenance plan 3) Formulation of gravel mining regulation plan
3. Enhancement of hydrological observation	1) Installation of rainfall/water level gauging stations 2) Improvement of hydrological observation system

4. Installing flood control facilities	1) Installation of revetments against riverbank erosion 2) Installation of groundsills against riverbed degradation
5. Practice of river management in collaboration with gravel companies and citizens	Practice of proper gravel mining based on gravel mining regulation plan
6. Improvement of operation and maintenance capacity	1) Development of organizational structure 2) Implementation of operation and maintenance (longer infrastructure life, preventive maintenance, utilization of ITC)

Source: Survey Team

3.2.5 Concept of rehabilitation of Comoro River retaining wall

(1) Concept of rehabilitation of retaining wall and the priority

Concept of rehabilitation of 15 retaining walls in Figure 3.2-2 is described in Table 3.2-2. The priority of rehabilitation is shown in the table according to the influence by damage to the critical infrastructures such as an airport, a national road bypass, etc. The damaged retaining walls should be rehabilitated promptly and surely by securing enough budget according as the priority.

Table 3.2-3 Concept of Rehabilitation of Damaged Retaining Wall and Priority

Left/ Right bank	No	Distance from river mouth	Length	Description for rehabilitation	Priority H:high M:middle L:low
Left Bank	L1	0.7km	460m	For about 200m near the runway of the airport, which is critical infrastructure, more stable type such as L-shaped retaining wall is adopted and rehabilitated on a priority basis.	H
	L2	3.8km	23m	Because it is a limited damaged, wet masonry type is adopted same as the up/downstream of it. For exposure of foundation of revetment, filling it with gravel to prevent scouring. Backland of the site is filled ground by gravel company.	L
	L3	6.3km	374m	This site was originally the land filled in the riverside and so may not be so durable against erosion. It is possible to proceed bank erosion but less property to be protected is here.	L
Right bank	R1	0.3km	168m	For this reach, new dike or elevating the riverbank are needed for the river plan. If more time is required for land acquisition in construction of design cross section, temporary rehabilitation is implemented by gabion mattress, etc. to protect a bypass road on the riverbank.	M
	R2	0.5km	39m		M
	R3	0.6km	38m		M
	R4	1.6km	141m	Revetment of 2-steps is adopted because the riverbank height is more than 7m. The site is just downstream of the groundsill No.1. Because the damage of the revetment is in danger of influencing the groundsill, the site is rehabilitated on a priority basis.	H
	R5	3.8km	100m	The middle part with 100m is damaged of gabion mattress with 570m in total. Riverbank height is about 10m, so 2-steps revetment type consisting of retaining wall (lower) and concrete block (upper) is adopted. Because the collapsed gabion pulls the neighboring proper gabions, the priority of rehabilitation is high.	H
	R6	4.1km	110m	Riverbank height is about 8m, so 2-steps revetment type consisting of retaining wall (lower) and concrete block (upper) is adopted. Collapse of riverbank expanded to the bypass road that houses exist along the road as of May 2022. Therefore, the priority of rehabilitation is high.	H
	R7	5.5km	142m	Collapse of revetment and riverbank erosion compel one	H

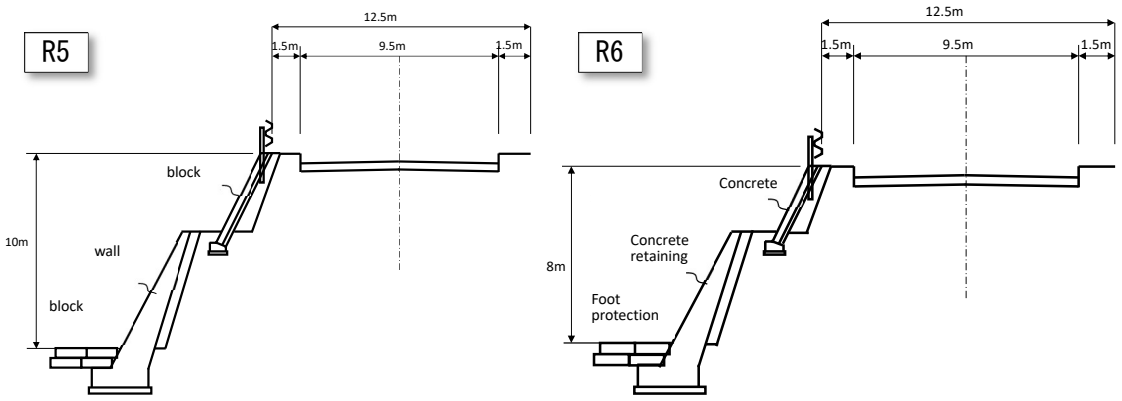
Left/ Right bank	No	Distance from river mouth	Length	Description for rehabilitation	Priority H:high M:middle L:low
				lane traffic of bypass road on the riverbank and lower its elevation. The site is rehabilitated with improvement of road drainage. Flood water directly flows to the site due to landfill inside the river just upstream of it. The priority of rehabilitation is high for maintaining the function and securing the safe traffic, but the rehabilitation needs to be implemented with dealing with the landfill (removal).	
	R8	6.3km	100m	Since R8 and R9 are in a continuous section, they are rehabilitated at the same time. Because the riverbank height is as high as 7 to 8m, 2-setps revetment structure is used. It is located on the outer side of the curved section, and 3 spurs have been installed. It is recommended that the damaged spurs are repaired and densely add new ones to mitigate the direct impact of flood flow.	M
	R9	6.5km	112m		M
	R10	6.8km	232m	Because the riverbank height is as high as 7 to 8m, 2-setps revetment structure is used. Collapse of the revetment partially extend into the bypass road on the riverbank. Therefore, the priority of rehabilitation is high.	H
	R11	7.8km	560m	Since it is a straight section of about 930m downstream from the confluence with the Bemos River, the slope of riverbank is 1:2. Gradual slope make it easier for trucks to enter the river, so it is necessary to take measures along with river management and river use restrictions.	M
	R12	6.8km	53m		M
Total			2,442m		

Source: Survey Team

(2) Study on Rehabilitation by Japan's Grant Aid

R5 (3.8km point, damage length 100m) and R6 (4.1km point, damage length 110m) will be candidates for rehabilitation by Japan's Grant Aid. The basic idea in the revetment restoration plan is as follows. Figure 3.2-6 shows the standard cross sections of the rehabilitation.

- Ensure a sufficiently safe foundation depth against scouring and lay a foot protection blocks to prevent local scouring at the foot of slope.
- A lateral strip will be installed on the revetment at regular intervals in the extension direction to insulate the revetment so that transfer or damage at one point will not spread to others.
- If the riverbank is high, a small step will be provided in the middle of the slope to stabilize the slope. However, the width of the small steps should be such as to discourage housing construction.
- The above ideas of plan and design for rehabilitation are adopt to other sites and projects.



Source: Survey Team

Figure 3.2-6 Standard Cross Section of the Rehabilitation

3.3 Study on Rehabilitation Plan of Bemos Water Supply System

(1) Damage of Bemos Water Supply System

Bemos water supply facilities are classified into 1) water intake facilities, 2) water supply facilities, and 3) water purification facilities, and it is the water intake facilities and water supply facilities that were damaged by the April 2021 floods. The water purification facility has not been directly damaged by the flood.

・ Water intake facility

The water intake facility was damaged, and the structure and revetment were damaged, and the surface was abrased and cracked.

・Water conveyance Pipe

The water conveyance Pipe was severely damaged, especially at the crossing of the river, and the pipe itself was washed away and could not function. Some other parts have also been washed away.

(2) Plan for rehabilitation of water supply facilities, including other donors

The Bemos Dili Water Supply Facility uses the Bemos River as its water source and consists of a water intake and about 7,000m of pipeline facilities. The floods caused damage to about 2,750m of pipelines from the intake works, and little flood damage was observed in the 4,000m section downstream from the third river crossing. In this section, some houses were built on top of the pipe after it was constructed, and it will be necessary to relocate the pipe in the future after increasing its diameter to meet the increased water demand and planned water volume.

Currently, restoration projects are being planned and implemented by EWB and BTL. The contents of the current plan are shown in Table 3.3-1. The section number is in accordance with the designation of EWB.

Table 3.3-1 Rehabilitation Plan for Bemos Water Supply Facility

District	Target Area	Construction	Construction Period and Construction Entity
Section 1	Intake	Restoration of damaged parts of water intake works Reinforcement work for damaged areas	Emergency response measures such as repairing the water intake gate will be implemented by BTL
Section 2	Water intake - decompression tank (About 1,360m)	Pipe installation using 315mm diameter HDPE Restoration of damaged protection wall	Mid-November 2021 -March 8, 2022 Construction by EWB
Section 3	Depressurization tank - Near the third crossing	Pipe installation using 315mm diameter HDPE	Construction scheduled to start in 2022

	(approx. 1,380m)	Restoration of damaged protection wall	Construction by BTL

Source: JICA Survey Team

As shown in Table 3.3-1, Section 2 was planned and implemented by EWB and was scheduled to be completed in March 2022, however, delays in material procurement have delayed construction progress, with completion currently scheduled for November 2022. For Section 3, the design documents have been submitted by BTL to ADN, and after approval of all design documents, BTL will start construction in 2022. These restoration works are planned to be restored to the original structure and function as per the grant project implemented by the Japanese side in 2009. In addition, not only the pipeline facilities but also the damaged protection wall will be restored.

For this reason, the Japanese side will plan the restoration work of Section 1 (intake weir) as a grant aid project.

(3) Restoration plan for water intake (section 1)

・Flood flow

Table 3.3-2 shows the flood probability years, estimated discharges, and water levels that should be adopted in the rehabilitation plan. The flood discharge is a numerical value calculated by the storage function method using eight patterns of hourly rainfall intensity data as in the case of the Comoro River. Since the water level is a guideline value calculated from the water level at the time of basic design by the uniform flow method, it is necessary to improve the accuracy through local flood traces and interviews in the next stage.

Table 3.3-2 Flow rate for Bemos water supply facility

Rainfall intensity (mm/day)	Target probability year	Intake point flow rate (m3/s)	Intake point water level (m)
126.7	9-years equivalent Adopted outline design	61.96	EL.230.00
150.0	BTL adopted	76.04	EL.230.28
228	50-years return period	260.27	EL.233.41
379	Largest ever	535.43	EL.237.21

Source: JICA Survey Team

・ Recovery plan

As with the BTL repair plan, the intake works shall be reinforced and repaired without changing the structural section of the current facility. The repair plan is summarized in Figure 3.3-1 and Table 3.3-3. The repair plan shown in Table 3.3-3 can be roughly classified into reinforcement, restoration (re-installation or replacement), and repair. Reinforcement refers to the strengthening of the structure to make it tougher, restoration refers to the restoration of the original structure, and repair refers to minor repairs such as surface repair. In the table, the reinforcement to a tougher structure applies to ①, ②, ⑤, ⑥, ⑰, ⑳, and ㉒, and the structure is less likely to be severely damaged by a flood of the same level. In this disaster, falling rocks from the top of the facility and rocks from upstream were one of the factors that caused damage to the facility. In order to prevent rock fall, the slope will be protected with concrete up to the planned water level. As for measures to prevent rocks from flowing down rivers, protection works and erosion control dams are assumed to reduce the flow of sediment. Although berms can prevent small rocks from flowing downstream, they are almost ineffective when large rocks flow downstream, as in this case, and the berms themselves are likely to be damaged, resulting in serious damage to the facilities. In addition, erosion control dams, including permeable dams, are not expected to be included in this restoration plan because of their high construction cost, the need to remove rocks after each rainy season, and the possibility of collapse depending on river flow. In the future, it will be desirable to consider a river improvement plan and implement measures for revetment and stone runoff.

Table 3.3-3 Details of improvements to the Bemos water supply facility

№	Structural Classification	Target Facilities	Damage	Reconstruction Policy	Classification
①	Water intake	Wing walls	Megalithic deposition	Extension of wing wall	Reinforcement
②				Raising of RC at the top of wing wall	Reinforcement
③				Removal of rocks and other sediments	Restoration
④		Inlet side wall	Total damage	Front wall reinstallation	Restoration
⑤				Front wall strengthen	Reinforcement
⑥				Reinforcement of gravity type retaining wall at side wall	Reinforcement
⑦				Repair of side wall above the opening (removal and restoration)	Restoration
⑧		Water Intake	Damage	Reconstruction	Restoration
⑨	Channel of approach	Slew gate	Damage	Gate replacement (including guide)	Restoration
⑩		Waterway	Step breakage	Step replacement	Restoration
⑪			Damage to the top	Reconstruction upper 50cm of side wall	Restoration
⑫			Falling lid	Reinstallation of approach channel lid	Restoration
⑬	Fixed weir	Water flow section	Wear	Re-placing high-strength concrete	Restoration
⑭		Still water pond	Stone accumulation	Sediment removal	Restoration
⑮			Drifting away (from the floor)	Re-placing of floor protection works	Restoration
⑯	Right bank revetment	Protection of Stillwater Pond	Damage	Restoration by masonry blocks	Restoration
⑰			Slope protection	Concrete up to bedrock line	Reinforcement
⑱		Top concrete	Partially damaged	Re-placing high-strength concrete	Restoration
⑲	Left bank revetment	Bank protection top edge concrete	Damage	Demolition and high strength C restoration	Restoration
⑳		Stone retaining wall at the bottom of the Stillwater pond	Partially damaged	Restoration with RC leaning retaining wall	Reinforcement
㉑		Upper level of the stairs at the Pond	Damage	Restoration by masonry	Restoration
㉒			Slope protection	Concrete up to bedrock line	Reinforcement
㉓	Whole	Whole	Crack	Epoxy injection	Maintenance
㉔			Surface deterioration	Repair with high-strength mortar	Maintenance
㉕		Basin, channel, on top of concrete	Sedimentation	Removal of rock and sand	Restoration

Source: JICA Survey Team

Source: JICA survey team
Note: The coloring indicates the position of the repair shown in table 3.3-3 and dose not classify the repair method by color coding

Figure 3.3-1: Planned renovation of the Bemos water supply facility

3.4 Buluto/Maliana irrigation facilities

(1) Flood damage of Buluto irrigation facility

Based on the interviews with the Ministry of Agriculture and Fisheries office, the follow-up project, and the field survey, the areas where the Buluto irrigation facilities were damaged by the floods in April 2021. The locations and details of the damage are as follows:

Table 3.4-1 Locations and details of damage in Buluto irrigation facilities

Locations of the damage	Details of the damage
The retaining wall at the downstream of Buluto Headworks	The 5 m RC retaining wall and about 30 m of the stone masonry on the downstream side of the right bank of the headworks collapsed.
Downstream apron of Buluto Headworks	The downstream apron of the Buluto headworks was scoured.
Main channel (embankment section)	The main canal (high embankment, rectangular canal cross section), was cracked on the concrete bottom slab at approximately 400m, causing water leakage.

Source: JICA Survey Team

(2) Flood damage of Maliana irrigation facilities

Based on the interviews with the Ministry of Agriculture and Fisheries office, the follow-up project, and the field survey, it is assumed that the Maliana irrigation facilities were damaged by past floods, and were further been damaged by the current floods in April 2021. The status of the damaged areas is as follows

Table 3.4-2 Locations and details of damage in Maliana irrigation facilities

Locations of the damage	Details of the damage
Fixed weir and downstream apron of sand sluiceway apron, administrative corridor in Maliana headworks	The fixed weir and downstream apron of sand sluiceway in Maliana headworks are damaged and worn, due to repeated flood damage.
Narrowed drainage point	During floods, the cross-section of the drainage canal that runs intersected to the main canal is insufficient, therefore drainage overflows into the main canal at that point.

Source: JICA Survey Team

(3) Buluto irrigation facility

1) The retaining wall at the downstream of Buluto Headworks

The stone masonry wall in the downstream of the headworks was damaged by the flood in April 2021. At present, gabions have been installed in the damaged masonry's sections for emergency restoration, but it is necessary to utilize the Comprehensive Grant Aid for full-scale restoration.

As a result of the comparative study, we propose the rehabilitation plan "Revetment Blocks and Scour Prevention Measures".

In this proposal, revetment blocks (1:2.0) will be constructed on the place of temporary gabions , and river protections will be laid in front of the masonry walls. The alignment will reduce the floodwater impact on the revetment.

2) River protection block at the apron downstream for the Buluto headworks

The apron downstream of the Buluto headworks has a large scour of 2~3m. This is a section where the flow is disturbed by high velocity currents during floods, and it is judged necessary to install protection blocks to cope with unpredictable upstream and downstream riverbed fluctuations in the future. The following is the calculation of the required river protection blocks.

3) Main channel (embankment section)

Since the bottom slab concrete is to be replaced with reinforced concrete, there is no risk of cracks in the bottom slab even if similar scouring occurs in the future., The repair plan "Bottom Slab Concrete Replacement (unreinforced concrete to reinforced concrete)" shall be adopted.

(4) Maliana irrigation facility

1) Maliana headworks fixed weir, sand sluiceway and administrative corridor

For sustainable operation of the headworks, it is necessary to restore the headworks fixed weirs, sand sluiceway and administrative corridor that have suffered from the repeated flood damages. Basically, the restore shall be made to the original design.

① Rehabilitation of fixed weirs

The unreinforced concrete (high strength concrete σ=35N/mm2) of the fixed weir shall be demolished and replaced with new unreinforced concrete (same high strength). The new concrete shall be fixed with anchor bars (D22*1.0m) at intervals of 0.5m. The scope of rehabilitation of the fixed weir is shown below.

② Rehabilitation of sand sluiceway

Demolish the unreinforced and reinforced concrete (high strength concrete σ=35N/mm2) downstream of the sand sluiceway and replace it with new unreinforced and reinforced concrete (same high strength).

③ Rehabilitation of administrative corridor

Backfill the scoured administrative corridor and repair with unreinforced concrete.

2) Widening of narrowed drainage

In the narrowed point of the drainage canal intersecting the main canal (STA.0+435), the drainage capacity is exceeded during floods and the canal overflows into the main canal, scouring the cross-section of the main canal.

Two (2) centrifugal reinforced concrete pipes (φ800) shall be arranged in the narrow point of the drainage canal intersecting the main canal (STA.0+435). The reason for using two (2) pipes is to allow drainage without delay when an unexpected flood amount of water flows down.

3.5 Study on drainage improvement measures for Dili and three suburbs (Tasitolu, Hera and Tibar)

In this section, the survey for the damage of the April flood and the current circumstances of drainage facilities in Dili and three suburbs (Tasitolu, Hera, and Tibar), which were severely inundated in the April flood, is given

JICA survey team conducted flood analysis by using high-resolution topographic data AW3D. Finally, the team extracted drainage measures to be implemented in each region based on these results.

3.5.1 Outline of current drainage situation for Dili and three suburbs

The survey team describe drainage characteristics of each area, including the vulnerability to heavy rain based on the topographic data called AW3D. In this summary version, only Dili's examination is described.

(1) Drainage characteristics in Dili

In the watershed of the Becora, Taibesi-Santana River, the watershed of the Lahane-Kuluhun River, and watershed of the Maloa River, flood flows down and discharge into the sea. There is no overflow from the channel. The Manleu-ana River, which is connected to a drainage channel and a river channel disappears on the way, has the topographical characteristic that the flood flows down along the west side of the Maloa River. In the western and eastern parts of the Dili low-lying area, there are no rivers that discharge directly to the sea, but flood flows pass through the area.

Depressions are concentrated mainly the Caicoli district, where flood occurs if existing drainage channels cannot be drained properly.

(2) Outline of Dili Drainage and Infrastructure Upgrading Program

The Dili Drainage and Infrastructure Upgrading Program (hereinafter referred to as "DDIUP") is planned for Dili's inland water drainage measures with Aqua de Portugal(hereinafter referred to as "AdP").

The project plans to install a total of about 70km length of drainage channels in Dili by restoring existing ones and constructing new ones. The existing drainage channel was installed with the capacity of 5-years return, period, but this project plans to install facilities with the capacity of 25 years for drainage channels (158mm/day at Dili airport 2), and 100 years for diversion channel and rivers (200mm/day at Dili airport 2) in Dili. In addition, 2 flood retention basins to help control the flow in the middle of Dili.

(3) Drainage condition around Dili Airport

Dili airport is the area where flood flow from the left bank of the Comoro River reaches. Topographically, the airport is lower than the surroundings and is prone to flooding if not properly drained.

The area around the Nicolau Lobat Roundabout (hereinafter referred to as the "Roundabout") in front of the Dili Airport entrance has a topographic shape that allows flood flow from the southeastern side, which is relatively higher in altitude, to reach. In addition, the water accumulated around the roundabout during flooding is considered to be drained from the drainage channel of the runway in the airport to the sea.

There are drainage channels that run underground in the runway, but DDIUP is planning to install new drainage channels which will bypass the runway.

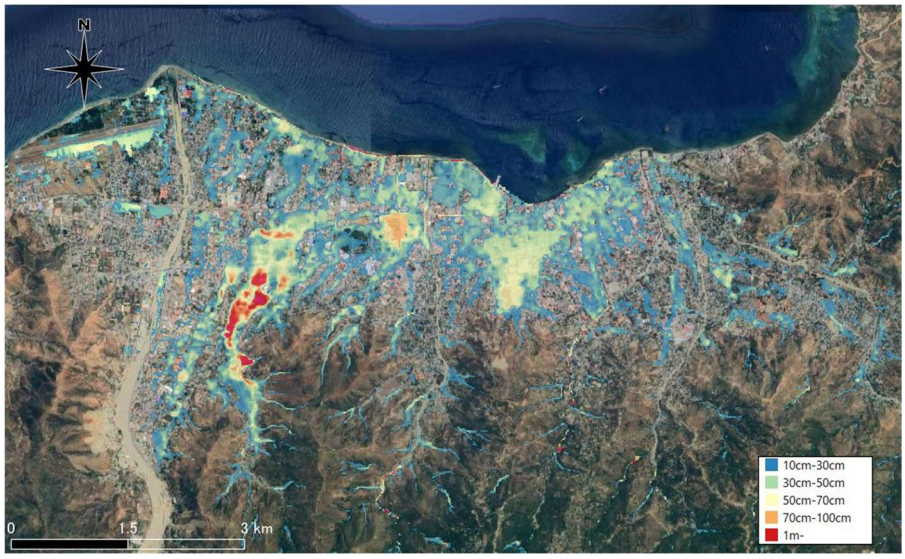
[2] Implementation of the Dili sanitation and drainage master plan -phase 2, January 2015, AdP Timor-Leste and DALAN

3.5.2 Study of flood maps and pre-evacuation plan

JICA Survey Team created flood maps for the April 2021 floods based on topographical and drainage conditions and considered a pre-evacuation plan on how to respond when flood damage occurs in the future. In this summary version, only the results of Dili's examination are described.

(1) Making flood maps for the April 2021 floods

Regarding Dili's flood map, a flood analysis was carried out by considering various small river and drainage channels referring to the pseudo-drainage channels created in 3.5.1, the drainage channel network planned by DDIUP. Figure 3.5-1 shows a map of the estimated flooded area for the April 2021 floods.



Source：JICA Survey Team

Figure 3.5-1 Flood map at the time of the April 2021 floods (Estimated results)

In the vicinity of the President's office on the west side of the Maloa River, flood depth is the greatest in both Figure 3.5-1 and the floodmarks.

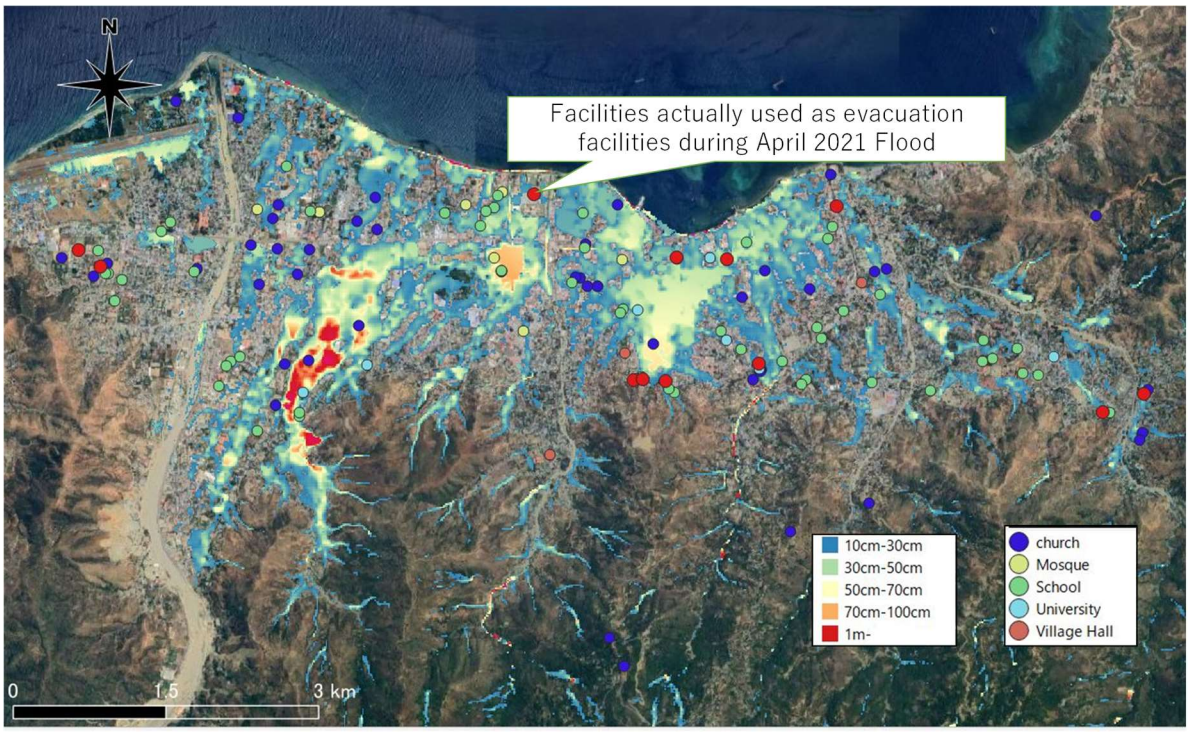
In addition to "the results of the April 2021 floods", evaluation of measures planned by DDIUP was conducted. The results indicate that the risk of flooding can be reduced by implementing measures not only for the main drainage channels covered by the DDIUP, but also for smaller drainage channels.

(2) Consideration of a pre-evacuation plan

According to JICA Survey Team's research, there are no designated evacuation facilities in the event of disaster in Timor-Leste. Therefore, JICA Survey Team first identified potential temporary evacuation places as part of a pre-evacuation plan.

Figure 3.5-2 shows the potential evacuation facilities in the vicinity of Dili overlaid on the map of the area expected to be inundated by a flood event. The red circles indicate facilities which have been used as evacuation facilities. While a number of facilities which have been used in the past are clearly insufficient, it is assumed that if other evacuation sites are to be included, the overall situation for evacuation will be improved.

However, many of the possible evacuation sites are located within the high risk flood zone. If they are to be used, it is necessary to take measures to reduce flood risk.



Source：JICA Survey Team, facilities used for evacuation during the April 2021 floods extracted from UNRCO Material

Figure 3.5-2 Distribution of potential evacuation sites in Dili with estimated flood map at the time of the April 2021 floods

3.5.3 Direction of drainage measures in Dili and three suburbs

Direction of drainage measures was considered based on disaster occurrence and on April 2021 floods (3.1.2), , the outline of the current drainage and the flood analysis results (3.5.1).

Table 3.5-2 shows the drainage improvement measures for Dili, and Table 3.5-3 shows those for the three suburbs.

Table 3.5-1 Drainage measures in Dili

Measures	Locations	Remarks and Details
Measures for sediment	Rivers in Dili	・Excavate river channels from areas that are relatively easy to access on the middle and downstream sides and areas with high risk. ・Begin sediment runoff monitoring in the rivers of urban areas to determine sediment management measures.
Replacement of bridges that intersect rivers in urban area	Rivers in Dili	・If overflows cannot be avoided due to sediment transported from upstream areas during flooding even with channel excavation, take measures to increase the water flow by removing the bridge.
Re-examination of drainage measures in the lower reaches of the Manleuana River	West of the Maloa River	・The area is flat and the existing drainage canals do not have sufficient drainage capacity. Widening of the main drainage channel is necessary.
Measures in areas with frequent flooding	① Presidential Office area ② Caicoli District	① ・Raise height of land ・Implement pump drainage to the Maloa River ② ・Consider the expanding the capacity of RB1 ・Implement natural drainage and mechanical drainage at RB3 ・Examine the possibility of increasing drainage capacity of the Maloa River with adequate considerations for resettlement

Regular monitoring and maintenance	River channels and main drainage channels in Dili	・Sediment monitoring from upstream to downstream of rivers by UAV, patrols and inspection of drainage channels ・Sediment removal before the rainy season and after flooding
Measures for flood events: installation of water flow control room	Rivers, drainage channels and retention basin in Dili	・Automatic data collection of river water level and main drainage channel water level ・Automatic monitoring of regulated pond water level, remote drainage.

Source: JICA Survey Team

Table 3.5-2 Drainage measures in three suburbs

Area		Measures
Tasitolu	Around Lake Tasitolu	・Drainage by drainage pump vehicle ・Designation as restricted residential zone
	National Road No.3	・ Raise road height
Hera	Mid and upstream of the Akanunu River and Mota-Kiik	Driftwood / soil erosion control measures ・Soil and forest management to prevent landslides ・Installation and/or maintenance of facilities such as check dams, sediment retarding basins, soil retaining wall.
	Akanunu River and Mota-Kiik	・Examination of drainage measures based on upstream/ downstream balance (setting planned drainage flow capacity for each drainage channel section, designation as restricted residential zone etc.)
Tibar	Proposed site for industrial park	Installation of revetment at the boundary of the proposed site
	Drainage channels used as road	・Examination of drainage measures based on upstream/downstream balance (setting planned drainage flow capacity for each drainage channel section etc.)

Source: JICA Survey Team

3.6 Study of rehabilitation plan by Japan's grant aid

This project will be implemented with the following 3 components under a Japan's grant aid, i.e., " The Programme for Urgent Rehabilitation of Flood Damaged Infrastructure in Timor-Leste".

- Rehabilitation plan for Comoro River Retaining wall
- Rehabilitation plan for Bemos Water Supply System
- Rehabilitation plan for Buluto/Maliana Irrigation Facilities

"Project Descriptions and estimated project cost for the Grant Aid Plan" and "Planned implementing schedule of the Grant Aid", as of February 2022, are given in the following tables.

It is expected that the scope of the Programme will be reconsidered at the time of project cost estimation by the preparatory survey of the Programme, in consideration with price escalation as well as exchange rate of Japanese Yen.

Table 3.6-1 Descriptions and estimated project cost for the Grant Aid Plan

A. Construction cost

Component（Implementing agencies）	Outline of the component	Description of the work	Estimated Cost	Remarks
1． Rehabilitation plan for Comoro River Retaining wall 【MPW-DRBFC】	・ Urgent rehabilitation for retaining wall will be constructed at the most dangerous places which collapsed during the April 2021floods., . ・ This work will be a pilot project, and the technology will be transferred to other restoration works to be carried out by Timor-Leste side.	① Rehabilitation of Retaining walls R5（110m）and R6(120m) ② Bypass National Road No. 2（at retaining wall R5、R6、total about 230m）	About ****** JPY	
2． Rehabilitation plan for Bemos Water Supply System 【MPW-BTL】	・ The existing water intake facilities have collapsed due to the April 2021 floods, and it cannot be operated safely. ・ Emergency restoration of facilities that are particularly severely damaged, and reinforcement against future flooding.	① Rehabilitation of Intake facilities (water intake gate, pond, waterway, etc.) ② More resilient structural reinforcement against floods	About ****** JPY	・ Australia support plan is in progress (repair of water channel pit). Take note of overlapping support. ・ Temporary road construction is required.
3． Rehabilitation plan for Buluto/Maliana Irrigation Facilities 【MAF-DIWM】	・ Due to the April 2021 floods, damage is spreading to the deteriorated parts of existing facilities. ・ Repair and restore the facilities.	A. Buluto Irrigation Facility ① The masonry wall downstream of the headworks will be rehabilitated. ② River protection block at the apron downstream for the headworks will be constructed. ③ The bottom slab concrete in the main canal will be rehabilitated	About ****** JPY	Including the stone masonry walls which were rehabilitated under the follow-up grant aid.
		B. Maliana Irrigation Scheme ① Rehabilitation of the Maliana headworks ② Rehabilitation of the drainage		
		Total	About ****** JPY	

B. Consulting services

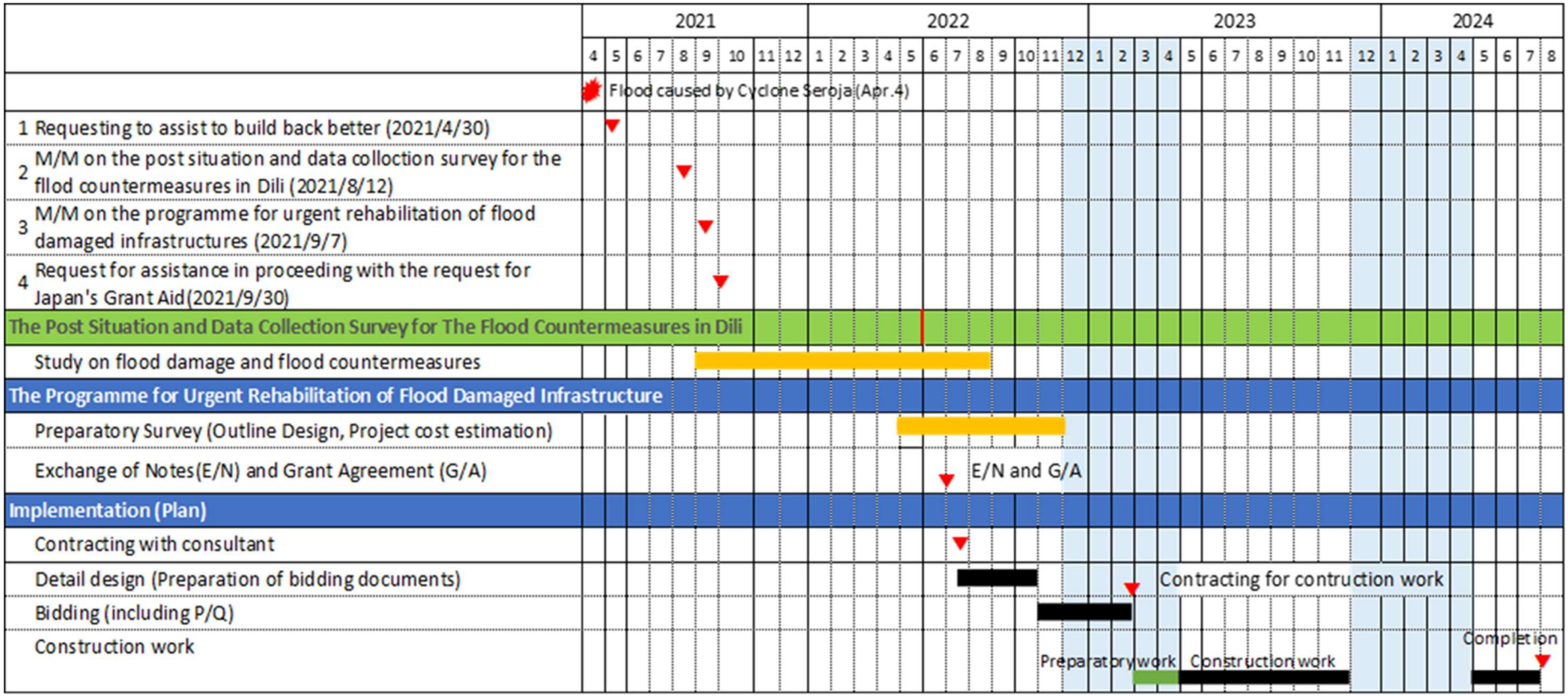
Component (implementing agencies)	Outline of the component	Description of the work	Estimated Cost	Remarks
Consultant Fee 【MPW-DRBFC)】 【MPW-BTL】 【MAF-DIWM】	・ Detailed design and construction supervision	① Detailed design (Preparation of Tender Documents) ② Tendering support ③ Construction contract support ④ Construction supervision	About ****** JPY	

C. Grand Total of the Project (A+B): ***** JPY**

Source：JICA Survey Team

Remarks: This table was prepared as of February 2022. It is expected that the scope of the project will be reconsidered at the time of project cost estimation by the preparatory survey of the Programme, in consideration with price escalation as well as exchange rate of Japanese Yen.

Table 3.6-2 Planned Implementation Schedule of the Grant Aid Project



Source: JICA Survey Team
Remarks: This construction schedule was prepared based on the information as of February 2022. The schedule will be revised at the time of preparatory survey of the Programme.

The main points that Timor-Leste side should pay particular attention to in implementing this project (Undertakings) are as follows:

(1) General Items

1) Organization of Implementing Agencies

a) Representative ministry of executing agencies.: Ministry of Public Works (MPW)
b) Executing agencies: Refer to Table 3.6-3.

Table 3.6-3 Executing agencies for the Project

Department Name	Activity / Role	Primary component
Ministry of Public Works/ Directorate of Road, Bridge and Flood Control (MPW-DRBFC)	・ Representative implementing agency on the Timor-Leste side ・ Overall management of the project ・ Coordination with all related organizations ・ Implementation management of the primary component	・ Rehabilitation plan for Comoro River Retaining wall
Ministry of Public Works／Bee Timor-Leste （MPW-BTL）	・ Implementing agency on the Timor-Leste side ・ Cooperation with the representative implementing agency ・ Implementation management of the primary component	・ Rehabilitation plan for Bemos Water Supply System
Ministry of Agriculture and Fishery／Department of Irrigation and Water Management) （MAF-DIWM）	・ Implementing agency on the Timor-Leste side ・ Cooperation with the representative implementing agency ・ Implementation management of the primary component	・ Rehabilitation plan for Buluto/Maliana Irrigation Facilities

Source：Preparatory survey of the Programme

2) Establishment and Operation of Coordinating Committee for the Project

The Government of Timor-Leste shall establish a coordinating Committee for the Programme (hereinafter referred to as “the Committee”) in order to discuss any matter, at the Programme level.

Table 3.6-4 Committee for the Programme

Item	Description	Remarks
1. Members of Committee	・ Ministry of Foreign Affairs and Cooperation ・ Ministry of Finance (MoF) ・ MPW-DRBFC ・ MPW-BTL ・ MAF-DIWM ・ Representative(s) of JICA Timor-Leste Office	Ministry of Finance and MPW-DRBFC shall be Co-chair.
2. Observers of the Committee	・ Representative(s) of Embassy of Japan	
3. Meetings	・ Regular meeting of the Committee shall be held in Timor-Leste semiannually	Other meetings may be held upon request of either JICA or the Recipient whenever JICA deems it necessary to call such meetings
3. Terms of Reference	① to confirm an implementation schedule for the Programme for the smooth and effective disbursement of the Japanese Grant (hereinafter referred to as “the Grant”); ② to discuss modifications to the Programme, including modifications of the allocation of the Grant for the Subprojects; ③ to identify problems that may delay the implementation of the Programme or the disbursement of the Grant, and to explore solutions to such problems.	

	④ to exchange views on publicity related to the Programme; and ⑤ to discuss any other matters that may arise from or in connection with the G/A.	

Source: Preparatory survey of the Programme

3) Undertaking of Agreement and contract document

① Exchange of Notes (E/N) and Grant Aid Agreement (G/A)	Signer
・E/N	Embassy of Japan ― Ministry of Foreign Affairs and Cooperation
・G/A	JICA ― Ministry of Finance
② Banking Arrangement (B/A) and Authorization to Pay (A/P)	Signer
・B/A (One time about JPY ******)	MoF
・A/P (Nine times total about JPY ******)	MoF
・Customs duty, tax, etc. (about JPY ******)	MoF (Consignee of imported goods and materials is MoF.)
③ Contracts	Signer
・Contract for Consulting Services (One contract for three sub-components)	MPW (witness by MAF)
・Contract for Construction (One contract for three sub-components)	MPW (witness by MAF)

Source: Preparatory survey of the Programme

4) Undertaking of contract management

MPW, as the representative ministry of executing agencies, in coordinating with the executing agencies, will issue the necessary contractual documents for the Project, such as signature of contracts, approval letters for design documents, contracts, modification of the contract, etc., in cooperation with related agencies.

5) Coordination with other donors, etc.

6) Appointment of dedicated counterparts and technical transfer

(2) Banking Arrangement

1) Opening Bank Account

2) Banking Commission

(3) Tax Exemption

1) Tax exemption for the good of the project

2) Entry permit, tax exemption for Japanese physical persons and/or physical persons of third countries

MPW, as a representative ministry of the executing agencies, will undertake the following permissions through related agencies:

- To accord Japanese physical persons and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work.

(4) Construction Supervision

1) Obtaining approval of the project plan for environmental and social considerations

2) Securing the temporary construction sites

3) Traffic control for the Rehabilitation plan for Comoro River Retaining wall

4) Restrictions on water flow for Rehabilitation plan for Buluto/Maliana Irrigation Facilities

Chapter 4 Recommendations for disaster risk reduction

4.1 Importance to promote investment in disaster risk reduction

In the past, Japan also suffered from large-scale floods caused by typhoons almost every year, often resulting in thousands of casualties. In recent years, however, the number of flood victims has been reduced to a range of tens to hundreds. This has been achieved through continuous investment in disaster risk reduction.

Figure 4.1-1 shows the disaster risk management cycle. In many developing countries, a large amount of budget is spent on repeated disasters, response and recovery, and they are stuck in a vicious cycle of disaster and poverty. Instead of spending money on disaster response and recovery in the right half of the disaster management cycle, more money should be invested in disaster risk reduction (reinforcement (build back better), prevention /mitigation and preparedness) as shown on left hand side of the diagram.

Source: JICA

Figure 4.1-1 Disaster Risk Management Cycle

4.2 To make the capital Dili a "Safe, Resilient and Attractive City"

In order for the capital Dili to further develop in the future as a destination for visiting tourists and various private companies, it must become a "Safe, Resilient, and Attractive City". To this end, various measures for "disaster risk reduction" must be implemented as described in 4.1 above. Key measures include: 1) Improving flood management systems; 2) Strengthening the critical infrastructures; 3) Enhancement of hydrological and meteorological observations; 4) Promotion of urban planning; 5) Development of legal systems for urban planning, river management, forest conservation, land use, and disaster risk reduction; and 6) Capacity development for DRR. Figure 4.2-1 shows a conceptual image of "Dili, a Safe, Resilient, and Attractive City. It is important to establish a cooperative framework among the Civil Protection Authority (CPA), the Ministry of Finance, and the Ministry of Public Works to promote the "Safe, Resilient and Attractive City" concept.

Source: JICA Survey Team

Figure 4.2-1 Measures to make Dili a "Safe, Resilient and Attractive City"

Table 4.2-1 shows various disaster risk reduction measures and progress toward realizing the concept, making Dili a "Safe, Resilient, and Attractive City". Some of the proposed measures shown here are already being implemented and others are planned to be implemented in the future. However, there are also many important measures that have not yet been implemented. It is expected that the Government of Timor-Leste will define the responsible ministries, and systematically implement them in collaboration with the development partners in the future.

Table 4.2-1 Measures required to be implemented to make Dili a "Safe, Resilient and Attractive City"

Sector	Measures	Current Status
1. Flood management	**①Flood Risk Analysis**	
	1.1 Comoro River basin	Implemented in this survey (JICA)
	1.2 **Flood risk analyses for other river basins**	**Required to be implemented**
	②River Management Planning	
	2.1 Dili and surrounding areas	Proposed for future project (Japan's Technical Assistance)
	③Rehabilitation of the Comoro River retaining walls	
	3.1 Emergency Rehabilitation of the selected part	Japan's grant aid is assumed.
	3.2 **Rehabilitation of the Comoro River retaining walls at the remaining damaged part**	**Required to be implemented**
	④Forest (Catchment Area) Management and Conservation	
	4.1 Forest (catchment areas) management and conservation	In progress (GoTL, JICA, EU/GIZ, WB, FAO)
	④ Drainage improvement to mitigate inland floods	
	5.1 **Drainage improvement in Dili**	**Required to be implemented**
	⑥Retention basin development to mitigate inland floods	
	6.1 **Retention basin development in Dili to mitigate inland floods**	**Required to be implemented**
	⑦Enhancement of heavy equipment for DRR and recovery	
	7.1 Enhancement of heavy equipment for disaster risk reduction and recovery	Japan's grant aid is assumed.
2. Strengthening critical infrastructure	**⑧Rehabilitation of Irrigation Facilities**	
	8.1 Buluto/ Maliana emergency rehabilitation	Japan's grant aid is assumed.
	8.2 **Rehabilitation of other damaged irrigation facilities**	**Required to be implemented**
	⑨Rehabilitation of water supply facilities	
	9.1 Bemos WTP emergency rehabilitation	Japan's grant aid is assumed.
	9.2 **Rehabilitation of other damaged water supply facilities**	**Required to be implemented**
	⑩Flood-resistant road structures	
	10.1 **Rehabilitation and reinforcement of roads and bridges against flooding**	**Required to be implemented**
	⑪Development of ports and airports	
	11.1 Development and improvement of ports and airports	In progress (GoTL, JICA, ADB, DFAT)
	⑫DRR strengthened hospitals, government buildings, schools, etc.	
	12.1 **Development/ reinforcement for flood and earthquake resistant buildings**	**Required to be implemented**
3. Enhancement of meteorological and terrestrial observation	**⑬Development of flood early warning systems**	
	13.1 In selected river basins	In progress (Mercy Corp (KOICA), UNTL (JICA), UNEP (GCF))
	13.2 **Development of flood early warning systems for other river basins**	**Required to be implemented**
	⑭Nationwide automatic hydrometeorological observation system	
	14.1 **Development of nationwide automatic hydrometeorological observation system**	**Required to be implemented**

	⑮Earthquake observation	
	15.1 Human resources development for seismology, earthquake engineering and tsunami disaster mitigation	In progress (JICA)
	⑯Strengthening tide level observation	
	16.1 **Strengthening tide level observation**	**Required to be implemented**
4. Urban Planning	**⑰Updating of Dili urban masterplan**	
	17.1 Updating of Dili urban masterplan	In progress (GoTL, JICA)
	⑱Preparation of flood hazard map	
	18.1 Flood hazard map for Dili and suburb areas	In progress (GoTL, this study (JICA))
5. Improvement of laws and institutions	**⑲Urban planning related law**	
	19.1 Laws and regulations for urban planning	In progress (GoTL, JICA)
	⑳Land property related law	
	20.1 Laws and regulations for land property	In progress (GoTL, JICA)
	㉑Forest management roadmap	
	21.1 Reduction of forest degradation and deforestation by applying the CBNRM approach	In progress (GoTL, JICA)
	㉒River management related law	
	22.1 Formulation of river management related laws and regulations	Proposed for future project (JICA)
	㉓Update of Disaster Risk Management Policy 2008	
	23.1 Updating of the Disaster Risk Management Policy 2008	In progress (UNDP/ CPA)
	㉔Development of Disaster Risk Reduction Investment Plan	
	24.1 **Development of Disaster Risk Reduction Investment Plan**	**Required to be implemented**
6. Capacity development for disaster risk reduction	**㉕Capacity development for disaster risk management (development of the disaster response plan)**	
	25.1 Capacity development for disaster risk management (development of the disaster response plan)	In progress (UN CADRI, IOM (Japan, USAID))
	㉖Table-top disaster exercise (simulation training)	
	26.1 Table-top exercise for disaster response involving all the line ministries and NGOs	In progress (Australia)
	㉗Evacuation drills	
	27.1 Training of Community-based Disaster Risk Management including evacuation drills	In progress (CVTL, IOM (Japan, USAID), NGOs)
	㉘ Establishment of Disaster Learning Center	
	28.1 **Establishment of Disaster Learning Center**	**Required to be implemented**
	㉙ Establishment of Disaster Research Institute	
	29.1 **Establishment of Disaster Research Institute**	**Required to be implemented**

Note: **The measures in red** indicate those required to be implemented by the Timor-Leste government and/or with the development partners. Red squares indicate higher priority measures.

Source: JICA Survey Team