Republic of Mozambique
Post Cyclone Idai Reconstruction Cabinet
(GREPOC)
Ministry of State Administration and Public Services
(MAEFP)

REPUBLIC OF MOZAMBIQUE

PROJECT ON STRENGTHENING RESILIENCE IN CYCLONE IDAI AFFECTED AREA

FINAL REPORT

September 2023

Japan International Cooperation Agency

Pacific Consultants Co., Ltd.
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Abbreviation

AfDB	African Development Bank
AIAS	Water Infrastructure and Sanitation Administration (Administração de Infraestruturas de Água e Saneamento)
ANEP	National Authority for Vocational Education
BBB	Build Back Better
BMRRP	Beira Municipal Recovery and Resilience Plan
CCP	Fisheries Community Committee (Comité Comunitário das Pescas)
CEGRC	School Disaster Management Committee (Comité Escolar de Gestão do Risco de Calamidades)
CENACARTA	National Cartography and Remote Sensing Centre (Centro Nacional de Cartografia e Teledatação)
CENOE	National Center of Emergency Operation (Centro Nacional Operativo de Emergência)
CFS	Health Training Center (Centro de Formação de Saúde)
CFM	Railways and Ports of Mozambique (Caminhos de Ferro de Moçambique)
CGM	Market Management Committee (Comite de Gestao do Mercado)
CLGRD	Local Disaster Managemenet Committee (Comités Locais de Gestão do Risco de Desastres)
CMB	Beira City Council (Conselho Municipal da Beira)
COE	Emergency Operation Center (Centro Operativo de Emergência)
CPP	Coastal Protection Project
CTDGC	District Technical Council for Disaster Management (Conselho Técnico District de Gestão de Calamidades)
CTPGC	Provincial Technical Council for Disaster Management (Conselho Técnico Provincial de Gestão de Calamidades)
DIEE	Directorate of School Infrastructure and Equipment (Direcção de Infraestruturas e Equipamentos Escolares)
DIG	Disaster Imagination Game
DPE	Directorate of Education of Sofala (Direcção da Educação de Sofala)
DPEDHS	Directorate of Education and Human Development of Sofala (Direcção da Educação e Desenvolvimento Humano de Sofala)
DPSS	Directorate of Health of Sofala (Direcção da Saúde de Sofala)
ECW	Education Cannot Wait
ECMWF	European Centre for Medium-Range Weather Forecasts

EIA	Environmental Impact Assessment
EPC	Complete Primary School (Escola Primária Completa)
ESG	General High School (Escola Secundária Geral)
EU	European Union
GACOR	The INGD Coordination Office for Reconstruction (Gabinete de Coordenação da Reconstrução)
GEBCO	General Bathymetric Chart of the Oceans
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GRC	Disaster Management (Gestão do Risco de Calamidades)
GREPOC	Post Cyclone Idai Reconstruction Cabinet (Gabinete de Reconstrução Pós-Ciclone Idai)
GTZ	Gesellschaft fur Technishe Zusammenarbeit
HAI	Health Alliance International
ICS	Institute of Health Sciences (Instituto de Ciências de Saúde)
IICB	Industrial and Commercial Institute of Beira
IFLOMA	Forest Industries of Manica (Industrias Florestais De Manica)
IFPELAC	Instittue of Professional Training and Labor Studies Alberto Cassimo (Instituto de Formação Profissional e Estudos Laborais Alberto Cassimo)
INAHINA	National Institute of Hydrography and Navigation (Instituto Nacional de Hidrografia e Navegação)
INAM	National Institute of Meteorology (Instituto Nacional de Meteorologia)
INGD	National Institue for Disaster Management
INE	National Statistical Institute (Instituto Nacional de Estatística)
KfW	Kreditanstalt für Wiederaufbau Bankengruppe
LEM	Engineering Laboratory of Mozambique (Laboratório de Engenharia de Moçambique)
MAEFP	Ministry of State Administration and Public Services (Ministério da Administração Estatal e Função Pública)
MINEC	Ministry of Foreign Affairs and Cooperation (Ministério dos Negócios Estrangeiros e Cooperação)
MINEDH	Ministry of Education and Human Development (Ministério da Educação e Desenvolvimento Humano)
MISAU	Ministry of Health (Ministerio da Saúde)
MITADER	Ministry of Land, Environment and Rural Development (Ministério da Terra, Ambiente e Desenvolvimento Rural)

MOPHRH	Ministry of Public Works, Housing and Water Resources (Ministério das Obras Públicas, Habitação e Recursos Hídricos)
MSF	Médecins Sans Frontière
MTA	Ministry of Land and Environment (Ministério da Terra e Ambiente)
NOAA	National Oceanic and Atmospheric Administration (Administração Nacional Oceânica e Amosférica)
PDNA	Post Disaster Needs Assessment
PEU	Urban Structure Plan (Plano de Estrutura Urbana)
PGU	General Urbanization Plan (Plano Geral de Urbanização)
PPU	Partial Urbanization Plan (Plano Parcial de Urbanização)
PWJ	Peace Winds Japan
RVO	The Netherlands Enterprise Agency
SANS	South African National Standards
SEJE	Secretary of State for Youth and Development (Secretaria de Estado da Juventude e Emprego)
SPT	Standard Penetration Test
UEM	Eduardo Mondlane University (Universidade Edurado Mondlane)
UNHCR	Office of the United Nations High Commissioner for Refugees
UN-HABITAT	United Nations Human Settlements Programme
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WB	World Bank
WHO	World Health Organization
WWTP	Waste Water Treatment Plant

CHAPTER1 Project Outline

1.1 Project Background

Tropical Cyclone Idai made landfall near Beira City in Sofala Province, central Mozambique during the night of March 14 to 15, 2019. Cyclone Idai brought torrential rains, strong winds and wreaking havoc across Sofala, Zambezia, Manica, and Inhambane Provinces. The impact of Cyclone Idai has been devastating, resulting in over 600 deaths and more than 1,600 injuries. Additionally approximately 240,000 houses were damaged by the Cyclone[1]. Among the affected areas, Beira City in Sofala Province suffered significant devastation, including the destruction of various public facilities, including schools.

The Mozambican government launched search and rescue operations with cooperation from the international community centering on the National Institute for Disaster Management (hereinafter referred to as “INGC”). Subsequently, the INGC established the Post Cyclone Idai Reconstruction Cabinet (hereinafter referred to as “GREPOC”) and the Ministry of Public Works, Housing and Water Resources and has taken the initiative in understanding the damage status and conducting Post Disaster Needs Assessment (hereinafter referred to as “PDNA”) for the formulation of reconstruction plans.

Simultaneously, Beira Municipality took action by developing the Beira Municipal Rehabilitation and Resilience Plan (hereinafter referred to as “BMRRP”), with support from the Netherlands government, UN-HABITAT and other organizations. This plan outlines the strategic direction for rehabilitation efforts in Beira city. The BMRRP was released at the International Donor’s Conference held in Beira city from May 31 to June 1, 2019. During this conference, the Mozambican government appealed to the international community to provide recovery and reconstruction assistance in line with the BMRRP.

In response to the disaster, JICA immediately sent emergency aid supplies and dispatched the Japan Disaster Relief Team to the affected areas. JICA also sent a study team for a need’s assessment from April 18 to 28, 2019, to assess the extent of the damage in the devastated regions. The JICA study team held meetings with other donors as well as related ministries and agencies to discuss future recovery and reconstruction assistance. Based on the PDNA and the needs assessment study, etc., the Mozambican government officially requested technical cooperation from the Japanese government to support the formulation of reconstruction plans. This project aims to assist the Mozambican government formulate relevant reconstruction plans, implement a post-disaster rehabilitation approach “Build Back Better” (hereinafter referred to as “BBB”) which has been adopted in the “Sendai Framework for Disaster Risk Reduction 2015 - 2030,” and form a society more resilient to disasters.

1 Based on the Post Disaster Needs Assessment (PDNA), May 2019. It is the latest officially published value as of March 2020.

1.2 Project Objective

This project focuses on supporting the development and implementation of action plans for reconstruction efforts in response to the damages caused by Cyclone Idai, aiming to promote the smooth implementation of rehabilitation projects and the formation of a disaster-resilient society.

1.3 Project Outline

(1) Expected Output of This Project

Output 1: Disaster risk assessment and hazard map creation

1) Analyze disaster status
2) Conduct trace surveys, etc.
3) Implement risk assessment related to natural disasters like cyclones, storm surges, floods, etc.
4) Assist Beira Municipality to create the hazard map
5) Develop reference manual for hazard map creation

Output 2: Production of the BMRRP-related action plan based on the hazard map

6) Review the BMRRP and related regulations
7) Assist the formulation of action plans in the following areas of the BMRRP
    - Land use plan
    - Infrastructure recovery and resilience plan
    - Public facility recovery and resilience plan
      *Including recovery and resilience assistance for public facilities through the pilot project.
    - Action plans in the case of a disaster (including evacuation plans)
    - Livelihood recovery plan (Pilot Project for the Resilience of Fish Market)
8) Capacity development of counterparts (hereinafter referred to as “C/Ps”) through the above activities

(2) Target Region

Beira City, Sofala Province (649km^2)

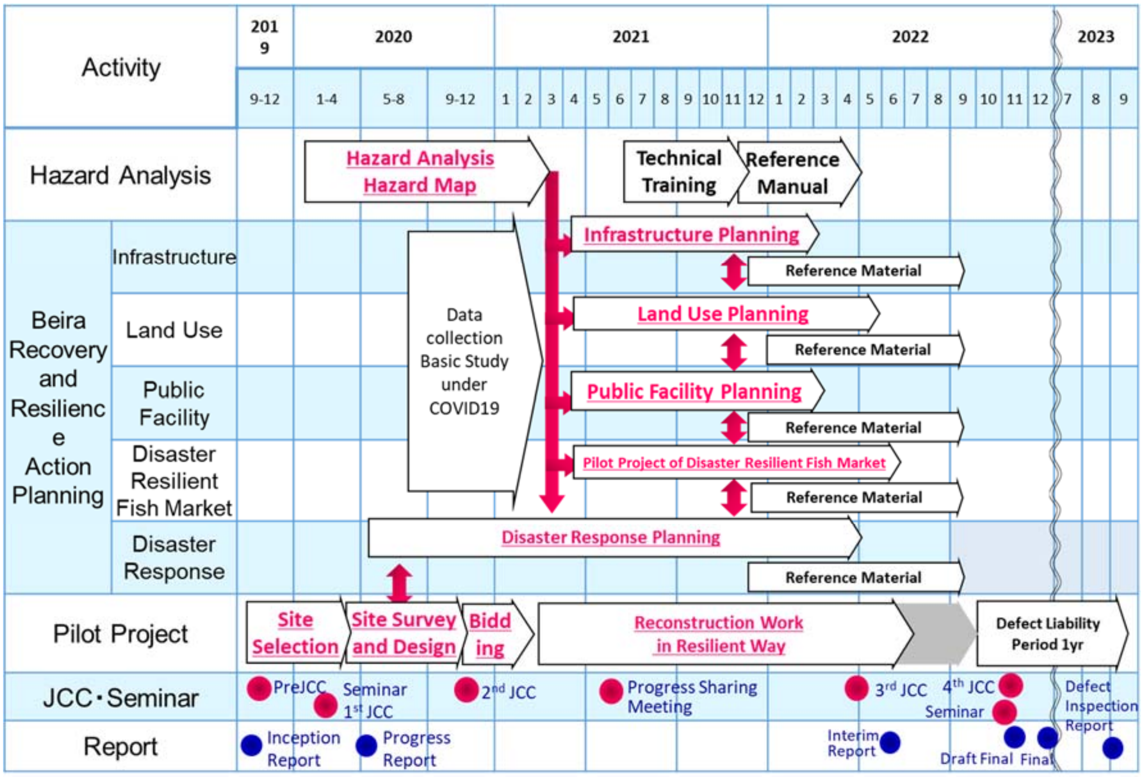
(3) Project Schedule

1) Execution Period

September 2019 to March 2024 (54 months)

- Includes the defect reliability period for the recovery and resilience assistance for public facilities through the pilot project.
- The revision of the Record of Discussion (RD) was finalized in September 2022 and the project period was revised until March 2024.

2) Schedule outline



Source：JICA Project Team

Figure 1-1 Schedule Outline

(4) Government Ministries and Organizations Responsible for This Project

The following organizations serve as main C/Ps. The Ministry of State Administration and Public Services (MAEFP) and the GREPOC work as a contact organization to coordinate the entire project.

Table 1-1 Counterpart Organization

Organization		Role in this project	Contact organization
C/Ps	Post Cyclone Idai Reconstruction Cabinet (GREPOC)	- Overall coordination for the reconstruction project	○
	Ministry of State Administration and Public Services (MAEFP)	- Coordination between the local government and the central government such as ministries	○
	National Institute for Disaster Management (INGD)	- Coordination with related organizations - Modeling of hazard map utilization - Technological assistance to province/city/community	○
	Ministry of Public Works, Housing and Water Resources (MOPHRH)	- Infrastructure rehabilitation/ reconstruction construction planning assistance	
	Ministry of Education and Human Development (MINEDH)	- Execution assistance for the pilot project (activities for schools in Beira City)	
	Ministry of Health (MISAU)	- Coordination related to assistance to medical institutions	
	Ministry of Foreign Affairs and Cooperation (MINEC)	- Coordination with other donors	
	Ministry for Land and Environment (MTA)	- Community development, land use and assistance for reconstruction planning	
	Beira Municipality	- Execution plan formulation for rehabilitation/resilience planning, etc. - Pilot project execution - Planning for land use, etc.	

Source: JICA Project Team

CHAPTER2 Disaster Risk Assessment and Hazard Map Preparation

2.1 Damage Analysis through Site Surveys

2.1.1 Confirmation of Infrastructure Damage

(1) Storm Surge

In the coastal area of Beira City, there are several sections where seawalls and walls are installed along the coast as a storm surge countermeasure. Some sections were affected by Cyclone Idai (See Figure 2-1), and the damage situation is summarized below. Figure 2-2 illustrates the damage mechanism of coastal facilities.

1) Damage of Seawalls

- There was no evidence of storm surge overflowing the seawall from the results of the site survey and interviews.
- In most cases, parapet parts were damaged by the effect of high waves due to strong winds during Cyclone Idai (Photos B and H).
- In particular, there is no joint bar between the parapet and the main body, and therefore damage occurred at the seam between the seawall and the parapet part (Photo H).
- There are areas where roads are installed behind the seawalls. In some areas with severely damaged seawalls, the damage was expanded to the road pavement (Photo B).
- Several seawalls being hollowed out due to suction was observed in the base section of the seawall (revetment) (Photo G). Hollowing-out may have proceeded for a long time and advanced further by high waves from the cyclones.
- Beira City has some old seawalls in the coastal area. These seawalls function properly as there is a market in front of them so that no waves or storm surges affect it directly (Photo D).

2) Other Facilities

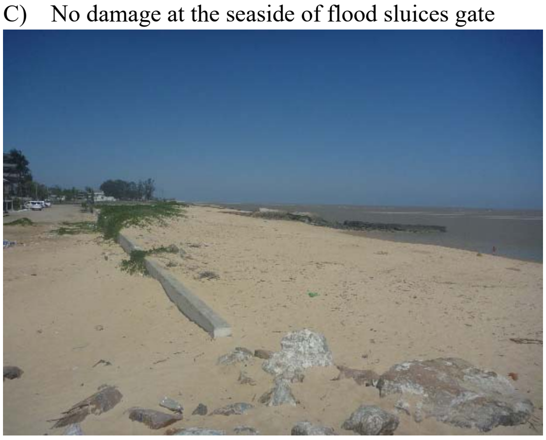
- Coastal erosion has occurred due to high waves at several locations (Photo A). The coastal area in Beira City has been remarkably affected by drift sand over the years. Since the Portuguese colonial era, many jetties had been installed to reduce its erosion (Photo E).
- In particular, the jetties are remarkably deteriorated. It is assumed that damage has occurred before Cyclone Idai. The waves during Cyclone Idai could have exacerbated the damage (Photo E).
- There is no significant damage to the river jetty at the estuary (Photo F) and the seaside facility of the floodgate (Photo C).

A) Coastal erosion at the lighthouse

B) Damages of the seawall and coastal road

C) No damage at the seaside of flood sluices gate

D) No damage to the old seawalls



E) Groins: deterioration and damage due to strong waves

F) No damage to the jetty at the estuary

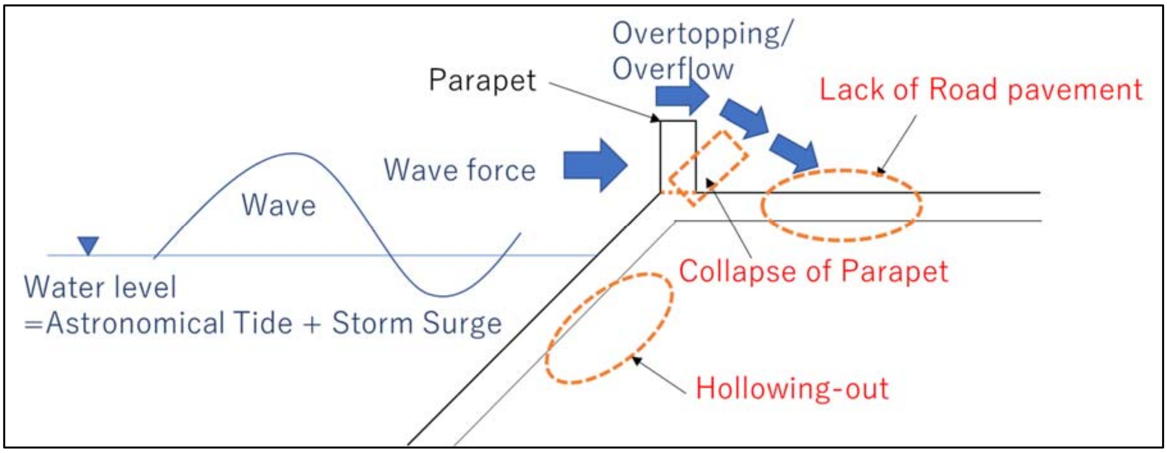
G) Hollowing-out in seawall

H) Damage of parapet near the port

Source: JICA Project Team

Source: JICA Project Team

Figure 2-1 Locations of Damaged Coastal Facilities for Storm Surge Measure

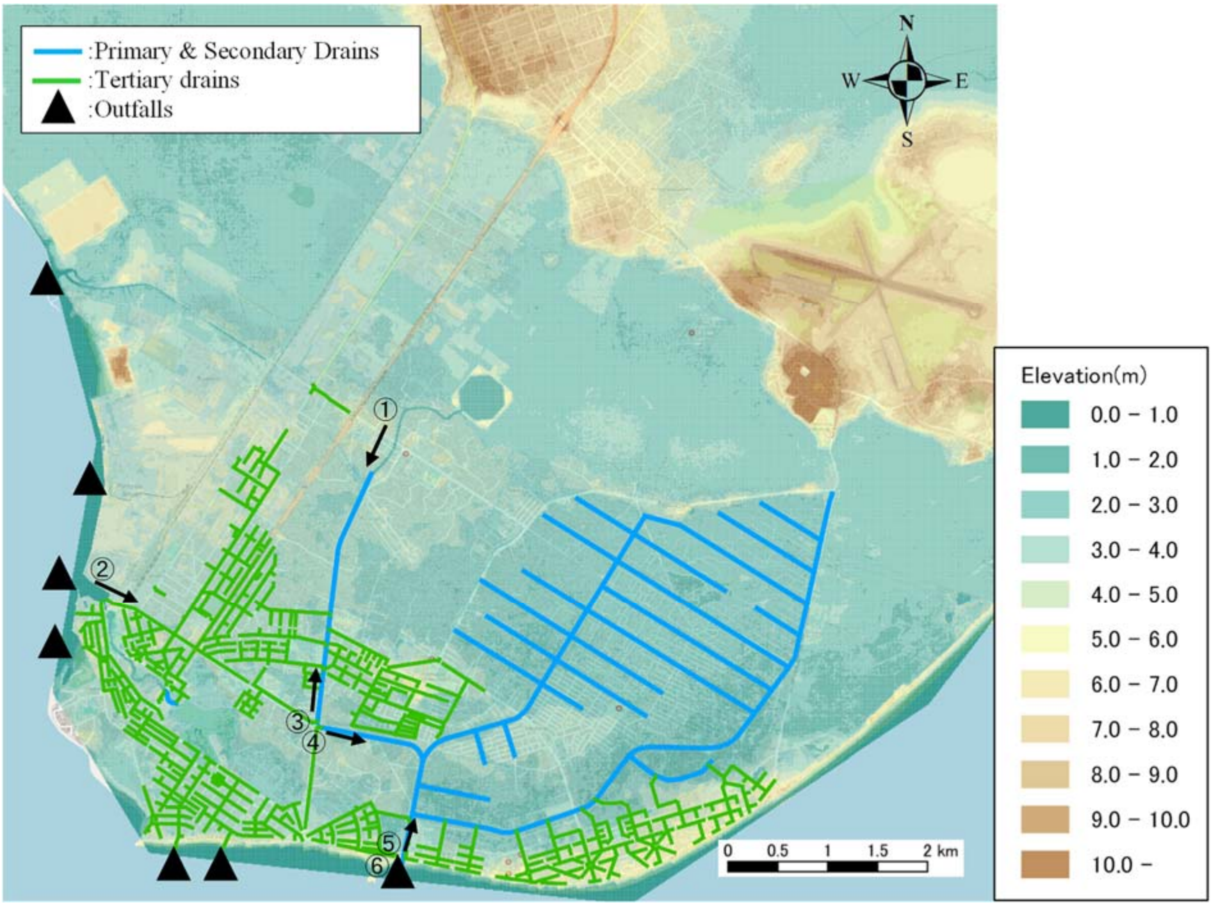


Source: JICA Project Team

Figure 2-2 Image of Coastal Facility Damage Mechanism

(2) Drainage

The damage situation was analyzed based on the site survey on December 8, 2019, and the BMRRP (Beira Municipal Recovery and Resilience Plan). Figure 2-3 shows the drainage network map of Beira City. Photos (1) to (6) in the Figure indicate the position and direction that they were taken on December 8, 2019.



Source: JICA Project Team

Figure 2-3 Drainage Network in Beira City

- On December 8, 2019, the site survey was conducted focusing on the open channel network (primary and secondary drainage, as shown in Figure 2−3). As a result, it was found that there was no structural damage, such as the open channel network and water gate caused by Cyclone Idai. On the other hand, there were some cracks in the open channel.
- Also, there was no deformation and damage of the revetment for the river, of which estuary is located in the southwest (Photo (2)).


(1) No damage to the channel


(2) No damage to the embankment deformation due to the revetment with gabion


(3) No damage to the open channel


(4) No damage to the open channel

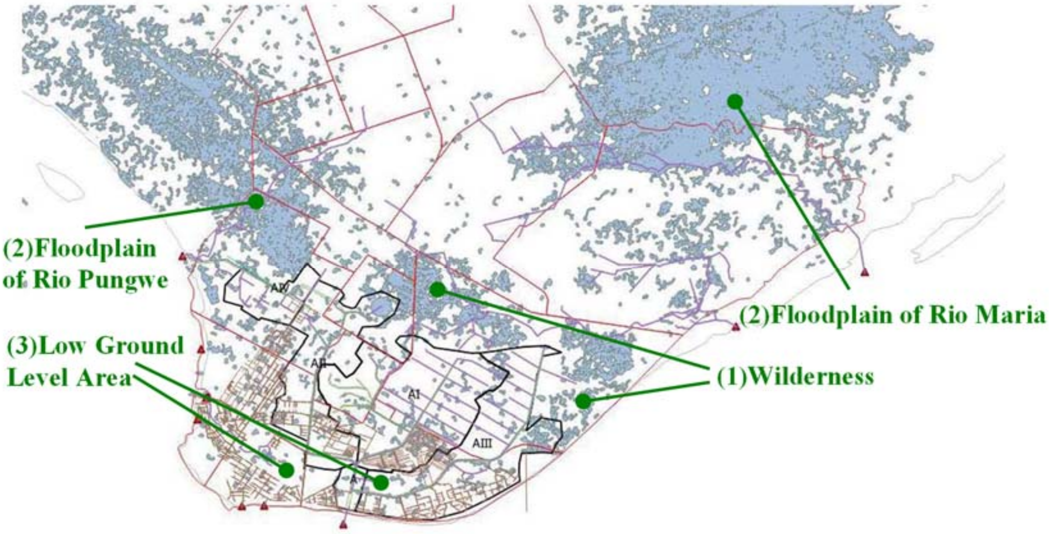

(5) No damage to the open channel around the upstream section of the watergate


(6) No damage to the watergate facilities

Source: JICA Project Team

Figure 2-4 shows the historical inundation map at Cyclone Idai.

- It indicates that there is almost no inundation area in Beira City. The inundation areas are as follows; (1) a wilderness area, (2) a depression area (drainage basin) which is lower than the surrounding ground level and a floodplain of a river, and (3) an area with the existing drainage channel that is not adequately functioned.
- According to the interviews with local residents during the site survey in December 2019, there was no inundation in the primary and secondary drainages and around these drainages.
- Meanwhile, the inundation occurred in the southwestern part and the area with no legal construction requirements based on the interviews with local residents.



Source: BMRRP Volume2, page95

Figure 2-4 Historical Inundation Map at Cyclone Idai

(3) Road

The damage caused by Cyclone Idai was mainly by storms. Thus, there was no serious damage to road structures such as a fallen bridge. But the following damages occurred throughout Beira City.

- Lost road shoulder and sidewalk functions due to collapsed coastal protection structures.
- Fallen trees and electric poles by strong winds, and pavements damages caused by these.
- Pavement damages caused by heavy vehicles and equipment which were used to remove fallen trees.

1) Lost road shoulder functions due to collapsed coastal protection structures

Storm surges resulted in the collapse of coastal protection and pavement edge block structures. The subgrade and its base were exposed and scoured due to the disruption of the protection basement, which serve as an earth retaining structure. As a result, road shoulders and sidewalks were damaged and partially lost. More than 1m road area was lost in some places, which could cause accidents such as falling of passing vehicles. Based on an interview with a municipal engineering official on recovery status, easy repair work, such as patting, had already been carried out. But there was no prospect for repairing such large-scale damage. Both tentative measures for immediate recovery and comprehensive restoration are necessary to ensure safety.


Damaged concrete block


Loss of road shoulder due to collapsed coastal protection


Damaged shoulder and sidewalk due to collapsed coastal protection


Lost road shoulder due to collapsed coastal protection

Source: JICA Project Team

2) Fallen trees and electric poles by strong winds and pavements damages

Due to the cyclone, numerous fallen trees and electric poles was observed, which hindered the progress of emergency recovery work. Although the fallen trees had already been removed at the site visit of the JICA Project Team, there were many traces of fallen trees even in the traffic circle throughout the city, which is expected to have a considerable impact on traffic structure. Furthermore, raised tree roots had caused damage to pavements in many locations.

At Inhamizuwa and Chingussura.
Many fallen trees were thrown away at the pilot project sites.

Only tree basin remains at the intersection.

Source: JICA Project Team

3) Pavement damages caused by heavy vehicles to remove fallen trees

Many heavy vehicles and equipment were used to remove the trees. Based on interviews with a municipal engineering official and the BMRRP, pavements were damaged by the load of the heavy equipment. Damages, including potholes and cracks, were observed throughout the city as a result of the field survey.

At Avenida 24.
There were some potholes.

At Inhamizuwa and Chingussura.
Many pavement surface areas were lost due to the deteriorated pavement.

Source: JICA Project Team

As the pavement in Beira City is not flat, the proper drainage gradient cannot be secured, and stagnant water was caused across the city during the rainfall. It is considered that pavement degradation is progressing chronically due to the presence of stagnant water, in addition to the effect of recovery work to remove fallen trees. The inadequate flat structure is deemed to be caused by insufficient compaction at construction work and inappropriate design work or improper use of materials.

Situation during rainfall on Feb.12.
Stagnant water was observed in many places across the city

Pothole. The base and subbase were not found.
The pavement surface might be constructed on the grand directly.

Source: JICA Project Team

2.1.2 Data Collection on Topographic Information, Ground Level, Land Use Situation, Precipitation, Sea Tide/Ocean Surface Water Level and Hydrometeorology

(1) Topographic Information

The following topographic information data was obtained in the field survey.

Table 2-1 Collected topographic information

Collected Information	Information Source	Data Type
Digital Topographic Map (1/5000)	CENACARTA	Shapefile
Digital Topographic Map (1/25000)	CENACARTA	Shapefile
Control point, Benchmark information	Beira Municipality	Excel file
Ortho images	WB	TIFF file

Source: JICA Project Team

Source: CENACARTA

Figure 2-5 Existing Digital Topographic Map 1/5000

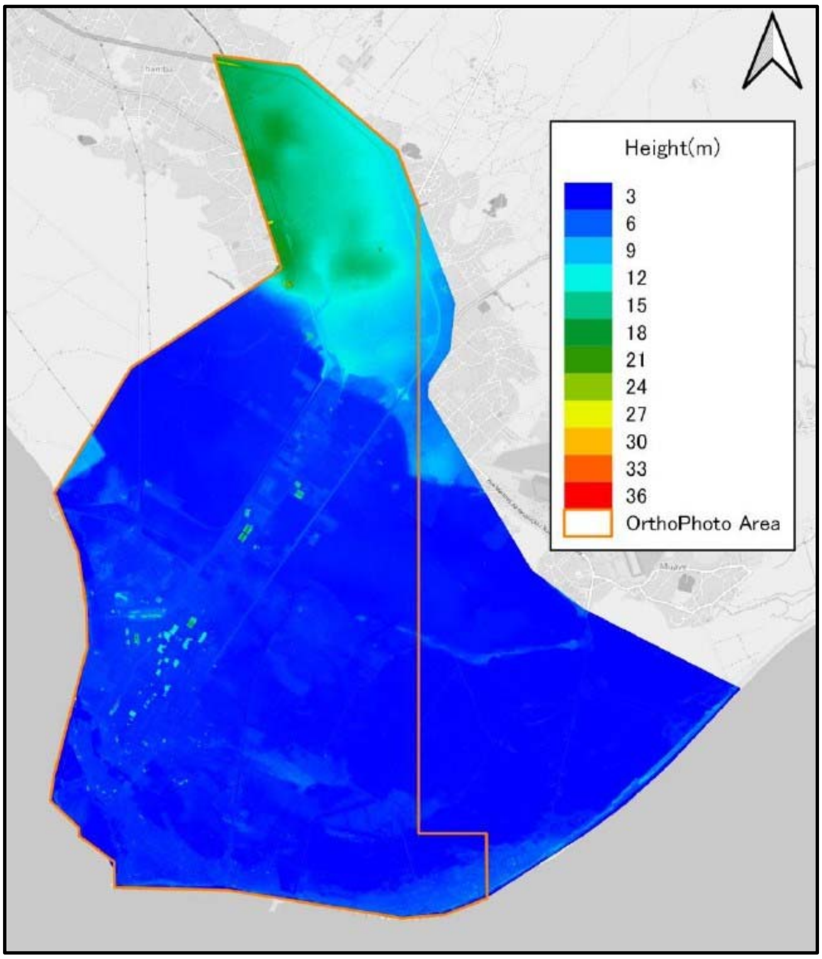
(2) Ground Level Data

The following elevation data were gathered in the field survey.

Table 2-2 Collected Elevation Data

Collected Information	Information Source	Data Type
Digital Elevation Model	WB	Text file (X, Y, Z)

Source: JICA Project Team



Source：JICA Project Team, based on data from WB

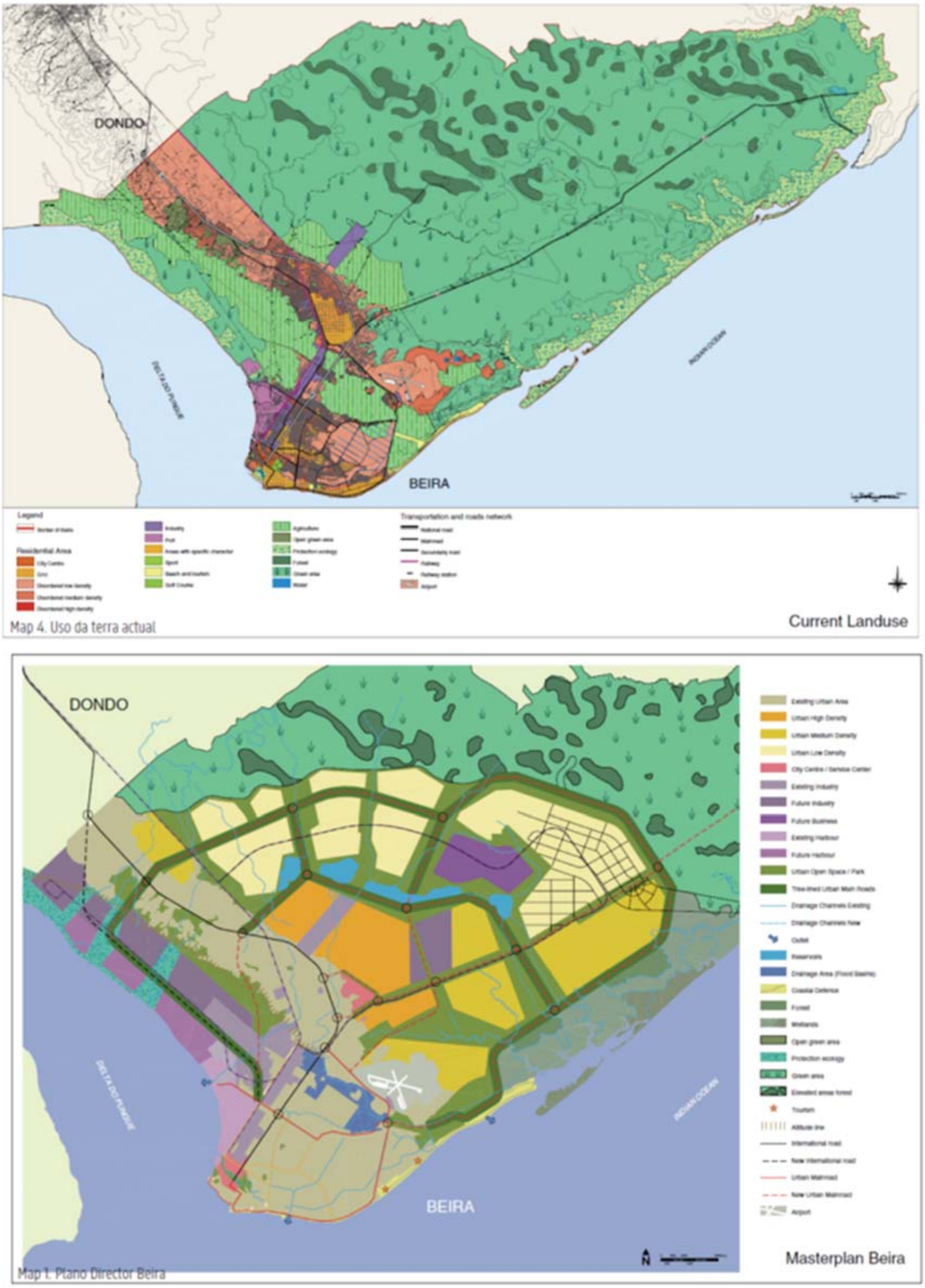
Figure 2-6 Existing Digital Elevation Model

(3) Land Use

Considering the future land use in Beira City, even though the Beira Urban Master Plan 2035 (Plano Director Beira 2035) was formulated with support from international organizations, including the Netherlands government in 2013, the plan is not legally stipulated. The BMRRP describes a future land use plan, which is updated based on the Master Plan. To make the plan legally effective by April 2020, the Ministry of Land and Environment (MTA) asked consultants to formulate the Beira City Urban Structure Plan together with the Beira Municipality. The Urban Structure Plan is a 10-year comprehensive urban plan from 2020 to 2030, including land use planning.

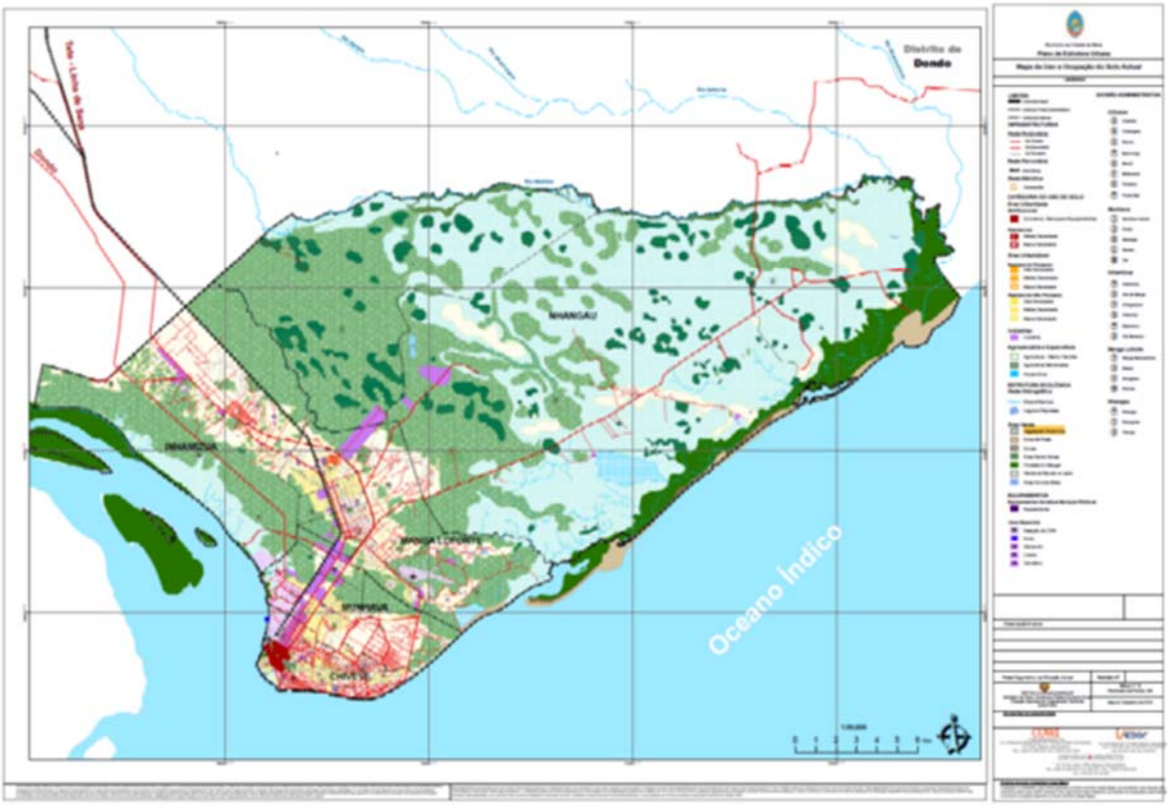
Shapefiles and other data on the Urban Structure Plan have been collected by the JICA Project Team. However, the land use plan in the Urban Structure Plan does not fully cover hazard analysis on storm surges, as being carried out in this project.

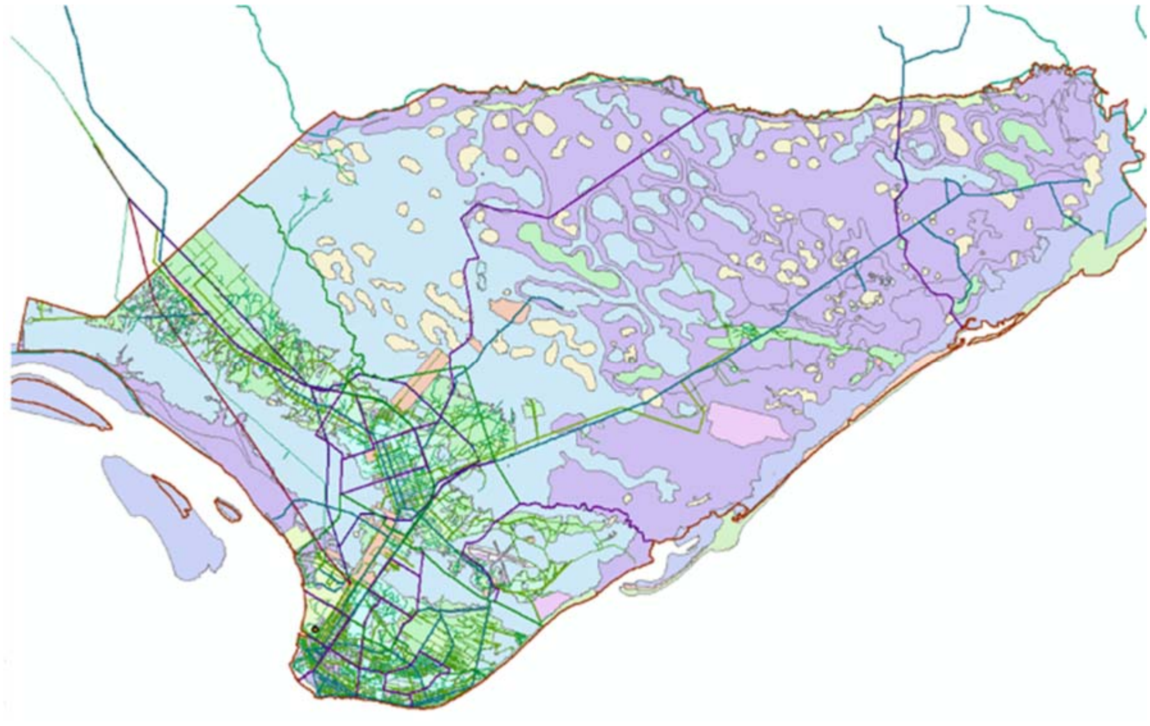
The following figures show the current land use and the planned one in Beira City. In this project, land use plans, which contribute to disaster risk reduction and management, will be studied and proposed based on the inundation simulation result, the hazard analysis, and existing land use plans.



Source: PLANO DIRECTOR BEIRA 2035 (2013)

Figure 2-7 Current Land Use Situation (upper) and Land Use Plan (lower) in Beira Urban Master Plan 2035





Source：MTA (Draft Urban Structure Plan)

Figure 2-8 Land Use Plan in Draft Urban Structure Plan (upper) and GIS Data (lower)

(4) Precipitation and Hydrology Data

The available precipitation data was collected from records maintained by the National Institute of Meteorology (INAM) in the vicinity of Beira City. The data primarily originates from a single weather observation station situated at the Beira International Airport, serving as the designated station for aviation weather observations in the Beira City area.

All the existing meteorological observation data at the Beira International Airport were paper documents and stored for 20 years from 2000 to 2019 (as of December 2019). The observation were conducted using the widely used Synop method. Consequently, the existing precipitation data is only on a daily basis with no hourly data. Additionally, the daily precipitation records were recorded from 09:00 to 09:00 the following day, rather than following the conventional 00:00 to 24:00 time frame.

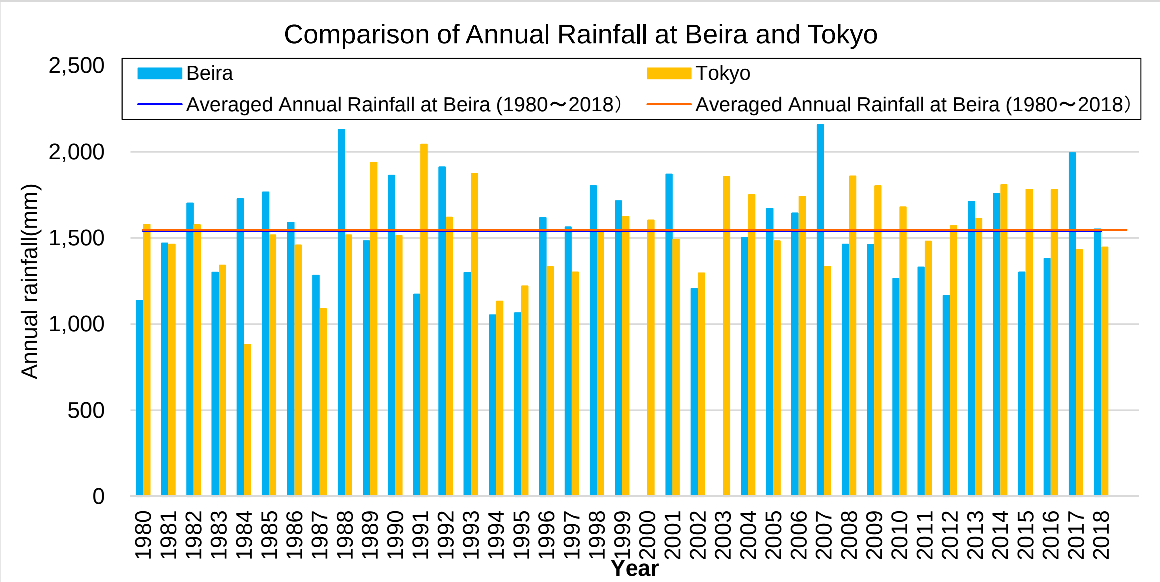
Table 2-3 Outline of INAM Precipitation Rainfall Observation

Location	Beira International Airport
Observation Type	Synop
Period	From 1980 to 2019 (Monthly Precipitation Data) From 2000 to 2019 (Daily Precipitation Data)
Data Type	Daily and Monthly Precipitation

Source: JICA Project Team

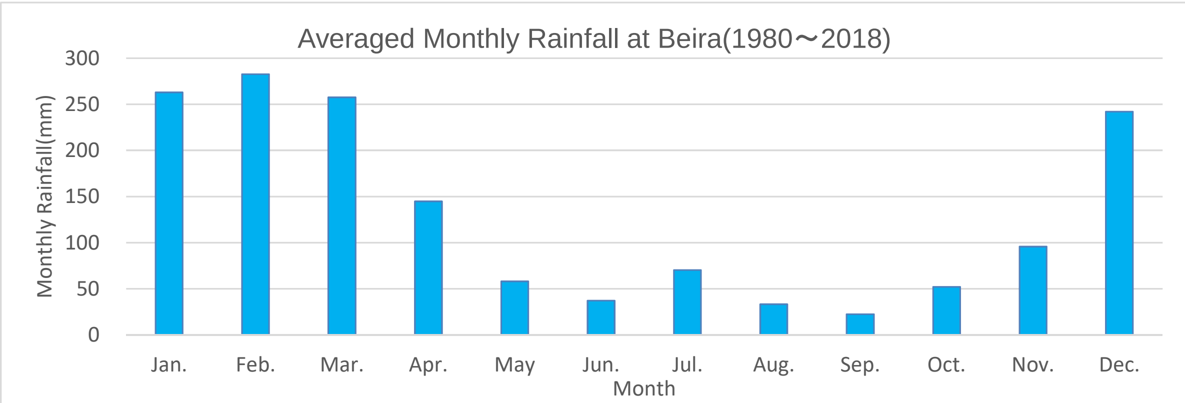
The annual rainfall in Japan (Tokyo) is used for a comparison with that of Beira City in order to understand the general rainfall situation in Beira City. The data of Japan (Tokyo) is AMeDAS data observed by the Japan Meteorological Agency.

- The average annual precipitation between Beira City and Tokyo is almost the same for 39 years from 1980 to 2018 (Mozambique: 1,542 mm, Tokyo: 1,547 mm). (See Figure 2-9)
- The average monthly precipitation in Beira City shows that the dry season is from May to October, and the rainy season is from November to April (See Figure 2-10).



Source: INAM and JMA

Figure 2-9 Comparison of Annual Precipitation in Beira and Tokyo



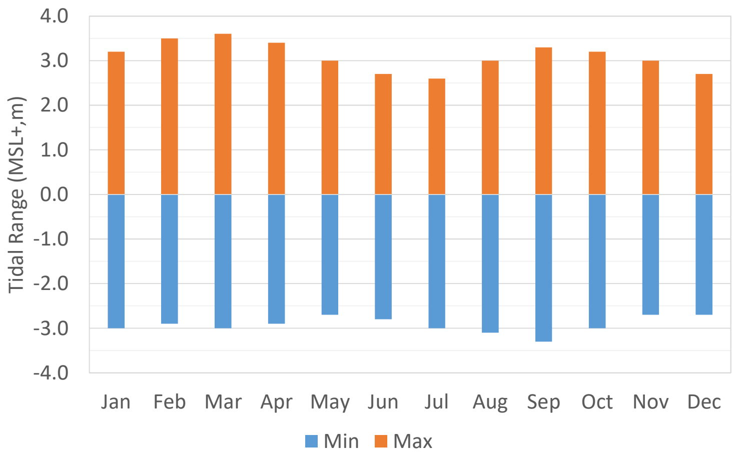
Source: INAM and JICA Project Team

Figure 2-10 Averaged Monthly Precipitation in Beira (1980 - 2018)

(5) Sea Tide/Sea Surface Water Level Data

The National Institute of Hydrography and Navigation (hereinafter referred to as INAHIANA) conducts observations on sea tide/sea surface water level in Mozambique. The station observes tide levels at a point (19 ° 49'.4S, 34 ° 50'.0E) near the Beira Port. According to the interview surveys, the observation data is recorded only in the period from 1995 to 1999, from 2001 to 2003, for 2009, for 2010 and from March 2014 to June 2014, which do not cover continuous observation (data has not yet received). Therefore, the statistical probability analysis could not be performed because of data limitation.

Thus, another method (e.g., probability of cyclone intensity) should be used to estimate the probability intensity of the target hazard. Also, estimated astronomical tide data for 2019 was collected, and the following figure shows the highest and lowest tides for each month. The highest tide is MSL + 3.6 m in March.



Source: INAHINA and JICA Project Team

Figure 2-11 Monthly Tidal Range at Observation Station at the Beira Port (2019)

2.1.3 Confirmation on Areas and Scales Affected by Natural Disasters such as Past Cyclones, Storm Surges, and Floods

(1) Storm Surges in Past Cyclones

No large-scale inundation damage has occurred in Beira City at the past cyclones. In the previous study (Alberto: Estudo numérico de marés meteorológicas na costa de Moçambique, 2017), the occurrence of storm surge deviations was examined in the cases of Bonita (1995) and Lesette (1997).

Table 2-4 Storm Surge Record due to Past Cyclones

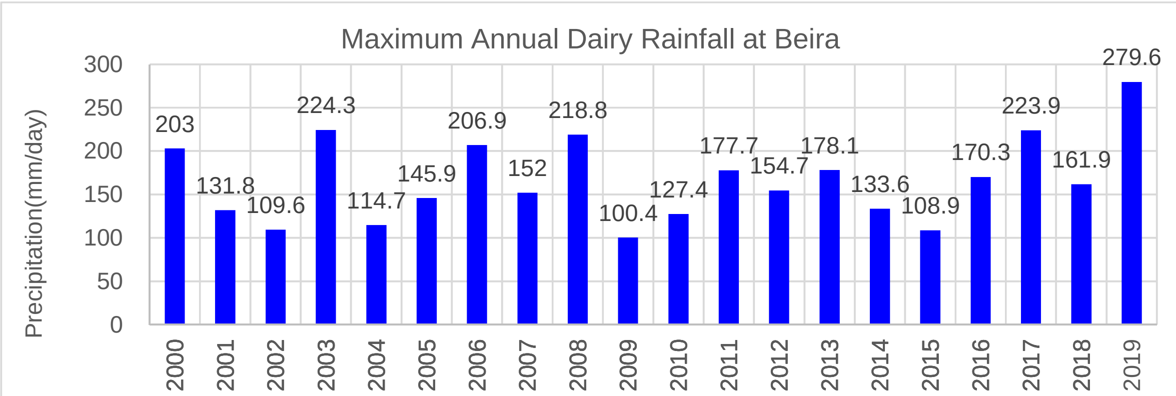
Cyclone	Storm Surge	Comment
Bonita (1995)	0.58 m	Estimated by Alberto 2017
Lesette (1997)	0.73 m	Estimated by Alberto 2017
Idai (2019)	?	To be estimated in this study

Source: JICA Project Team

(2) Precipitation Scale in Past Cyclones

The annual maximum daily rainfall is shown in Figure 2-12, observed by INAM at the Beira International Airport. This information indicates as follows:

- The maximum daily rainfall from 2000 to 2019 is 279.6 mm/day (February 18, 2019, Cyclone Desmond).
- The maximum daily rainfall during Cyclone Idai is 219.6 mm/day (March 14, 2019).



Source: INAM and JICA Project Team

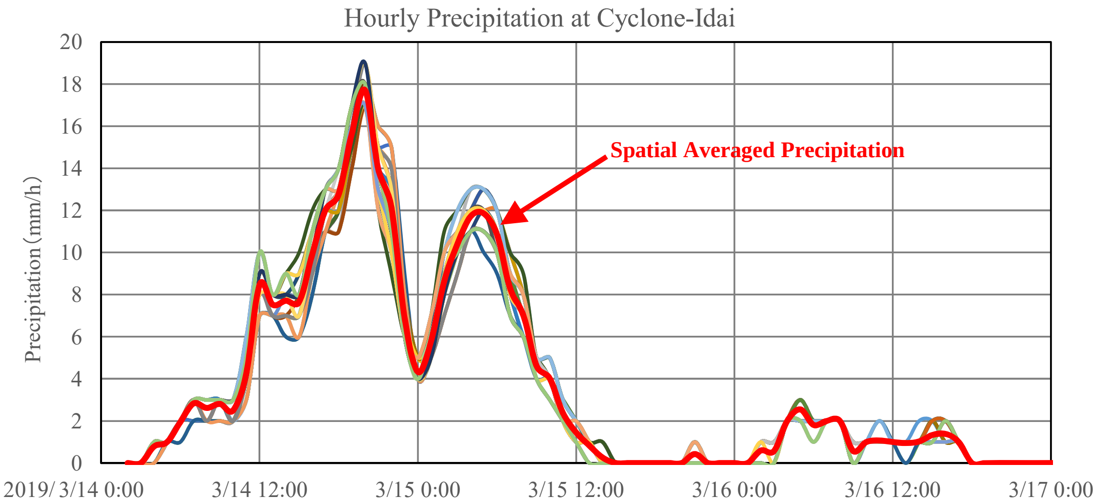
Figure 2-12 Maximum Annual Daily Rainfall in Beira

Also, spatiotemporal data of precipitation has been organized and analyzed for Cyclone Idai, the major disaster in 2019, based on data released from the European Centre for Medium-Range Weather Forecasts (hereinafter referred to as ECMWF). The following information is gained:

- To organize and analyze spatiotemporal data for precipitation in the area, clarify the temporal and spatial variation of rainfall around Beira City, the hourly rainfall precipitation arranged on the red grid points was collected by ECMWF data (See Figure 2-13). Furthermore, Figure 2-14 shows the chronological changes in the hyetograph of the average precipitation rainfall at all 42 grid points.
- As shown in Figure 2-14, the rainfall at any grid point starts and stops at almost the same time, which means that there is virtually no time difference in the rainfall in the area around Beira City. On the other hand, there is almost no spatial change in the area around Beira City, since the rainfall on all grid points indicates the same hourly rainfall.
- Also, it suggests that the rainfall continued for about one day from 12:00 March 14 to 12:00 March 15, and the maximum hourly precipitation is less than 20 mm/hr.
- When evaluating the predicted disaster scale in Beira City, as described later, the rainfall duration is approximately one day, and the spatial distribution for precipitation is uniform with no need in considering spatial distribution. As a reference, the maximum hourly precipitation is recognized at less than 20 mm/hour in the scale of Cyclone Idai.

Source: ECMWF and JICA Project Team

Figure 2-13 Location of the Grid Points in ECMWF Precipitation Data



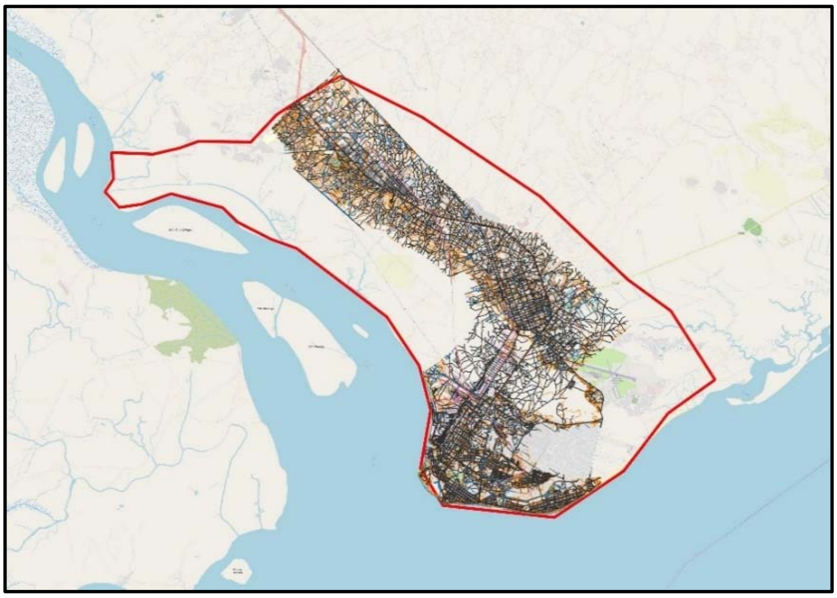
Source: ECMWF and JICA Project Team

Figure 2-14 Chronological Change of Average Precipitation on All 42 Grid Points

2.2 Digital Topographic Map Production

2.2.1 Collected Existing Data

The existing data obtained during the field survey were confirmed. Digital topographic maps and digital elevation models have not satisfied survey standards. It was also found that they did not cover the target area under this project.



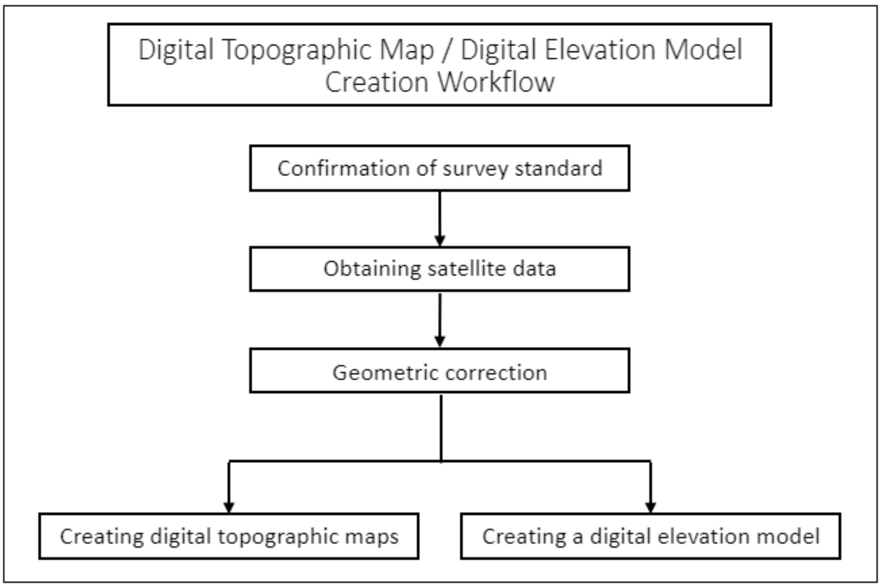
Source: CENACARTA and JICA Project Team

Figure 2-15 Existing Digital Topographic Map Area

2.2.2 Digital Topographic Map Production

After examining the collected data, the JICA Project Team prepared digital topographic maps and digital elevation models to create hazard maps covering the target area under this project. During the field survey conducted in December 2019, Beira Municipality Mayor and Beira Municipality C/Ps asked to include the river zone on the east side as a target range. Thus, the range of digital topographic map is expanded to an eastward direction. The survey standards are as follows:

- Map Projection UTM Zone36S
- Ellipsoid WGS84
- Geoid model EGM2008



Source: JICA Project Team

Figure 2-16 Digital Topographic Map Creation Procedure Flow

(1) Purchase of Satellite Data

AW3D data was purchased to create a digital topographic map and digital elevation model covering the target area. The specifications for the purchased data are as follows.

Satellite: WorldView Satellite, etc. (DigitalGlobe)

Product type: AW3D Enhanced Terrain Model and AW3D Orthoimages

Resolution: 0.5 m

Data type: GeoTIFF (Terrain data), TIFF (Ortho image)

Source: JICA Project Team

Figure 2-17 AW3D Orthoimage

(2) Geometric Correction

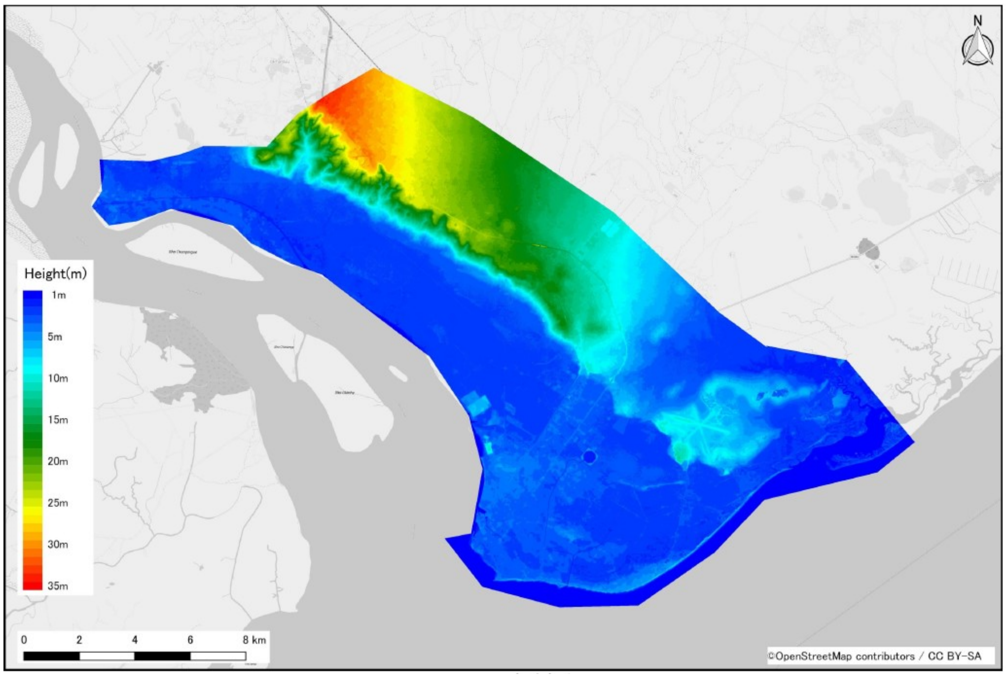
For the purchased image data and topographic data to satisfy the survey standards, a specific point on the image was set onsite as a Ground Control Point (GCP), and X, Y, Z coordinates were given for geometric correction.

Source: JICA Project Team

Figure 2-18 Ground Control Point Survey

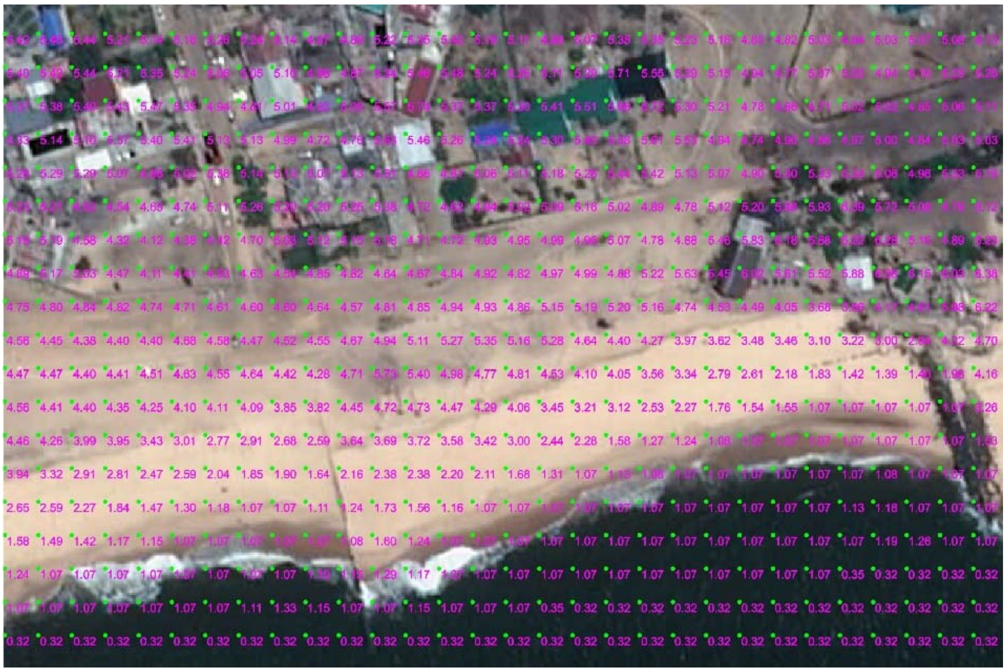
(3) Digital Elevation Model (DEM) Production

Topographic data with geometric correction was converted to a 10m mesh elevation model (Shapefile) for hazard analysis.



Source: JICA Project Team

Figure 2-19 Digital Elevation Model

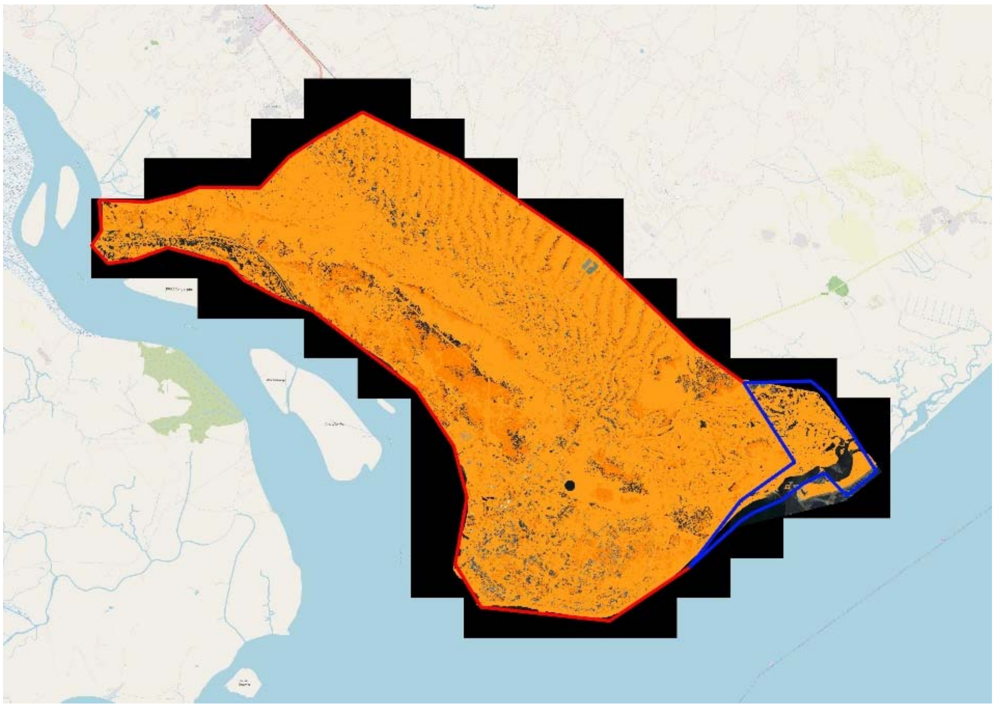


Source: JICA Project Team

Figure 2-20 Sample of Digital Elevation Model Sample (Expanded Sample)

(4) Digital Topographic Map (Orthophoto Map) Production

By using topographic data with geometric correction, the 1m interval contour lines were created. The digital topographic map (Orthophoto Map) was produced by superimposing contour lines on the orthoimage.



Source: JICA Project Team

Figure 2-21 Orthophoto Map

Source: JICA Project Team

Figure 2-22 Sample of Orthophoto Map Sample: 1/5000

2.3 Investigation on Target Disaster Scale

2.3.1 Concept of Target Disaster Scale Related to Storm Surge

(1) Procedures of Cyclone Hazard Analysis

The cyclone hazard analysis is conducted to set target hazards, with the following procedures:

i) Collect observation data of cyclones (track, central pressure, etc.)

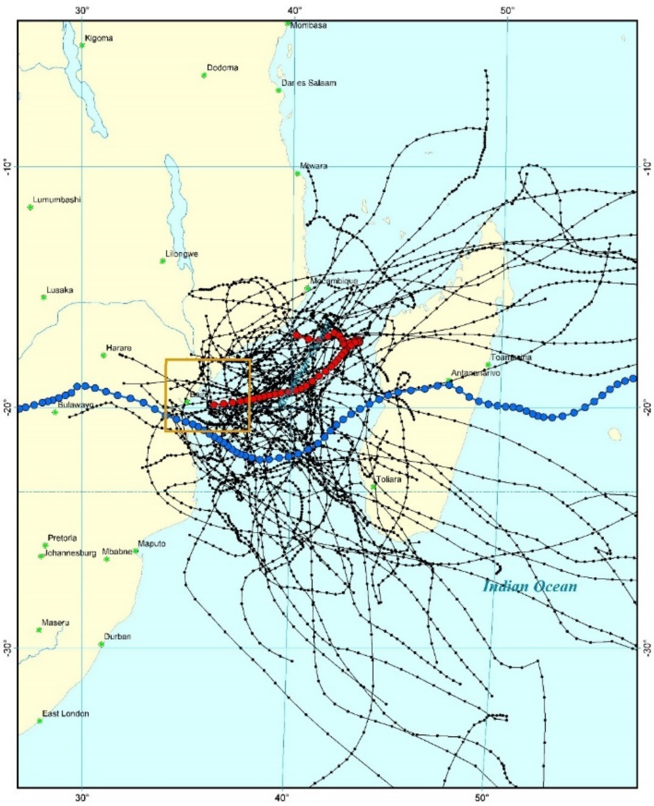
ii) Choose cyclones which passed the vicinity of Beira City

iii) Analyze the characteristics of the chosen cyclones (central pressure, moving speed. etc.)

iv) Conduct probability statistics analysis to estimate the return periods of the past cyclones

(2) Selection of Target Cyclones

Past cyclones that passed the vicinity of Beira City were extracted from the cyclone database by the National Oceanic and Atmospheric Administration (hereinafter referred to as NOAA). In total, 25 cyclone cases were selected from the observation data recorded since 1951. The red line in Figure 3-28 shows Cyclone Idai, and the blue line shows Cyclone Eline. These are the remarkable cyclones in Beira City.

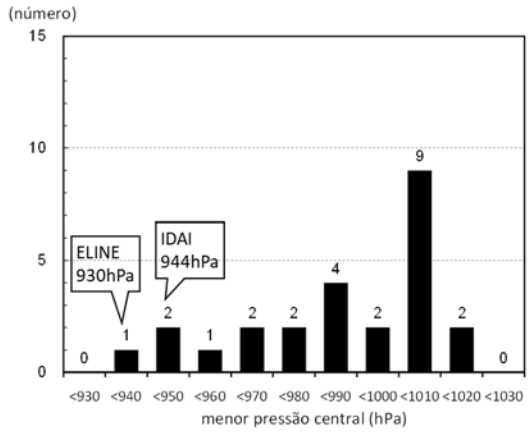


Source: NOAA and JICA Project Team

Figure 2-23 Cyclone Tracks in the Vicinity of Beira City

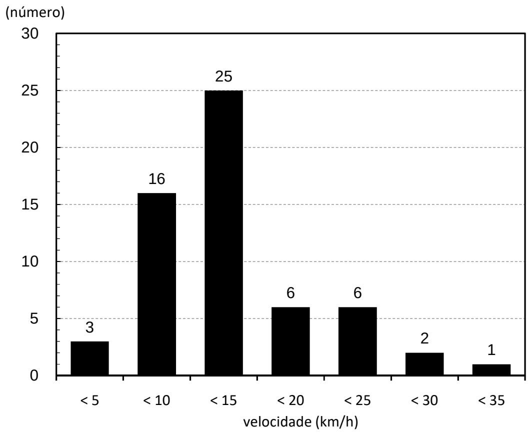
(3) Cyclone Characteristics

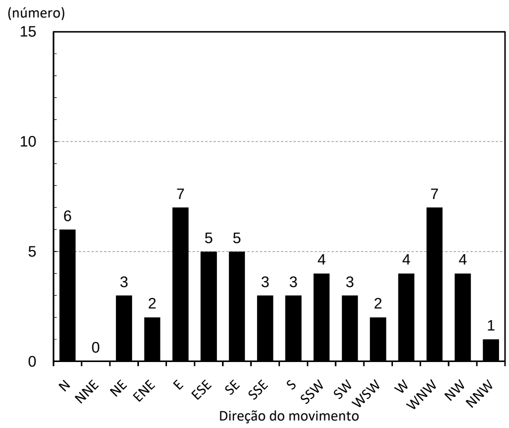
The appearance frequency distribution of central cyclone pressure, moving speed, and direction as cyclone characteristics were analyzed (See Figure 2-24 and Figure 2-25).



Source: JICA Project Team

Figure 2-24 Histogram of Past Cyclones' Central Pressure in Beira City





Source: JICA Project Team

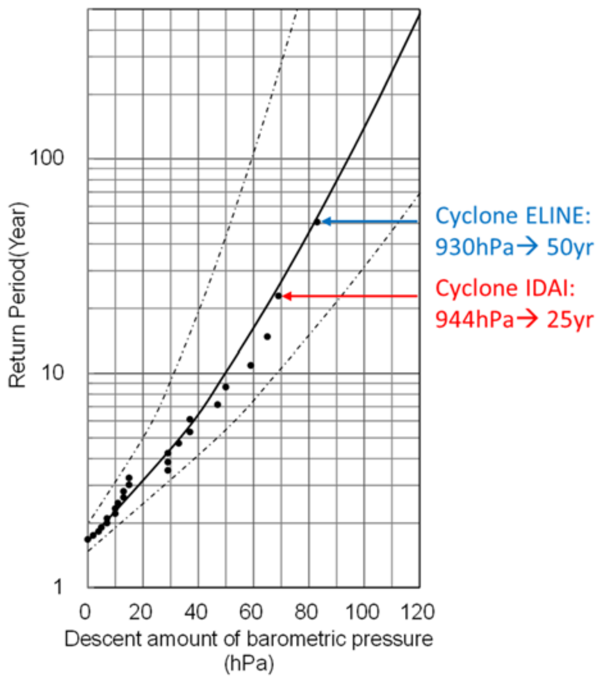
Figure 2-25 Histograms of Past Cyclones' Moving Speed (left) and Moving Direction (right) in Beira City

The characteristics are summarized as follows.

- Central pressure for Eline (2000) was the lowest with 930 hPa, and that for Idai was the 2nd lowest with 944 hPa (967 hPa at the time when the cyclone moved closest to Beira City).
- Moving speeds in most cases are less than 15 km/h, which is a very slow speed compared to typhoons near Japan. Therefore, the effect of storm surge continues for a long time (one day or more).
- The moving direction has no remarkable characteristics, which indicate that cyclones can attack Beira City from all directions.

(4) Probability Analysis of Cyclone

The storm surge deviation consists of two effects: a suction effect due to a lower air pressure depression and a wind drift effect due to strong wind. Since both effects are greatly affected by a decrease in the central pressure of the cyclone, the project team performed a statistical probability analysis on a decrease in the central pressure of the selected cyclones and estimated the return periods of the past cyclones. The estimation results are shown in Figure 2-26. It indicates that the return period of Cyclone Eline (2000) is about 50 years, and that of Cyclone Idai (2019) is about 25 years.



Source: JICA Project Team

Figure 2-26 Results of Probability Analysis (Central Pressure of Cyclone)

(5) Identification of Target Cyclone

This study extracted actual cyclones that passed around Beira City in the past, analyzed their characteristics, and performed the statistical analysis. Based on these results, two cyclones are set as target cyclones by the following reasons:

- The two cyclones occurred in the vicinity of Beira City in the past, and the cyclones may attack the city again in the future.
- They are the largest cyclones with the lowest central pressure among the cyclones that have occurred in the vicinity of Beira City.
- The probability scale ranges from several to five decades, which is not an unrealistically long period (the actual occurrence probability might be much longer, depending on the cyclone course and tide level during its approach).

Table 2-5 Target Disaster: Cyclone

Cyclone	Central Pressure	Notes
Idai (2019)	944 hPa	
Eline (2000)	930 hPa	The lowest central pressure since1951

Source: JICA Project Team

2.3.2 Inspection of Probable Flood Disaster Scale

Target disaster needs to be identified in the process of evaluating risks and producing hazard maps. Therefore, rainfall intensity was estimated, based on rainfall data observed by INAM around Beira City. The probable flood disaster scale is estimated with the following procedure:
Collect and organize meteorological and hydrological data

(1) Calculate flood concentration time

(2) Set design rainfall duration

(3) Set design rainfall

(4) Set design rainfall temporal pattern

(1) Collection and Evaluation of Meteorological and Hydrological Data

Refer to “2.1.3 (2) Precipitation Scale in Past Cyclones”.

(2) Calculation of Flood Concentration Time

In Japan, Kraven, uniform flow rate method, and Doken formula are used to calculate flood concentration-time for small and medium-size rivers with less than 50 km^2 in the basin area. Among them, the Kraven formula is mostly adopted. In the Kraven formula, the concentration-time is set at 30 minutes for mountain watershed, 20 minutes for steep slope area, and 30 minutes for the area with the developed sewer system.

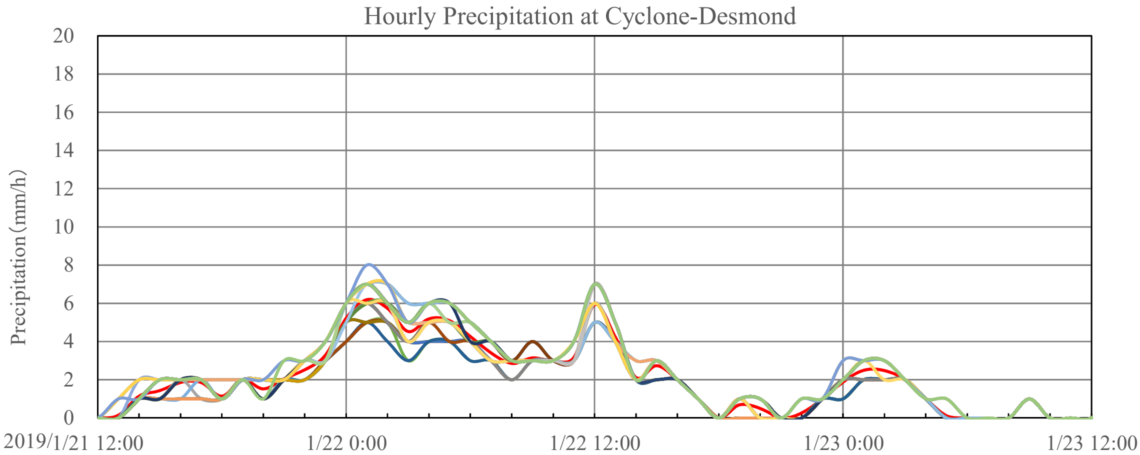
As Beira City is not categorized as a steep area, and it has the areas with developed sewer systems, Beira City’s concentration-time is set at 30 minutes.

(3) Setup of Design Rainfall Duration

In Japan, for small and medium-sized rivers with a basin area of less than 50km^2, the duration of major floods that have been recorded are investigated based on the actual significant floods.

In this study, the design rainfall duration was evaluated based on the same method as in Japan. In fact, the design rainfall duration was assessed with the data from Cyclone Desmond and Cyclone Idai, which were recognized as famous flood events and were available for hourly rainfall data (Figure 2-27 and Figure 2-14).

- If the hourly rainfall is set at 2 mm/hr for the rainfall starting and ending points, the threshold rainfall intensity of starting and stopping rainfall is set 2mm/hr, the rainfall durations for in Cyclone Desmond and Cyclone Idai are almost one day, as shown in Figure 2-27 and Figure 2-14.
- Therefore, the design rainfall duration in Beira City can be set to one day (24 hours).
- On the other hand, the total rainfall of Cyclone Desmond is minimal in Figure 2-12, compared with that of the ordinary ground rain gauge observation results as shown in Figure 2-27 (the total ground observation value of the ordinary rain gauge is 279.6 mm/day and, that of ECMWF data is approximately 65 mm/day in ECMWF data). Therefore, the data of Cyclone Desmond can be used for studying rainfall duration but not for studying the rainfall total or rainfall intensity formula.



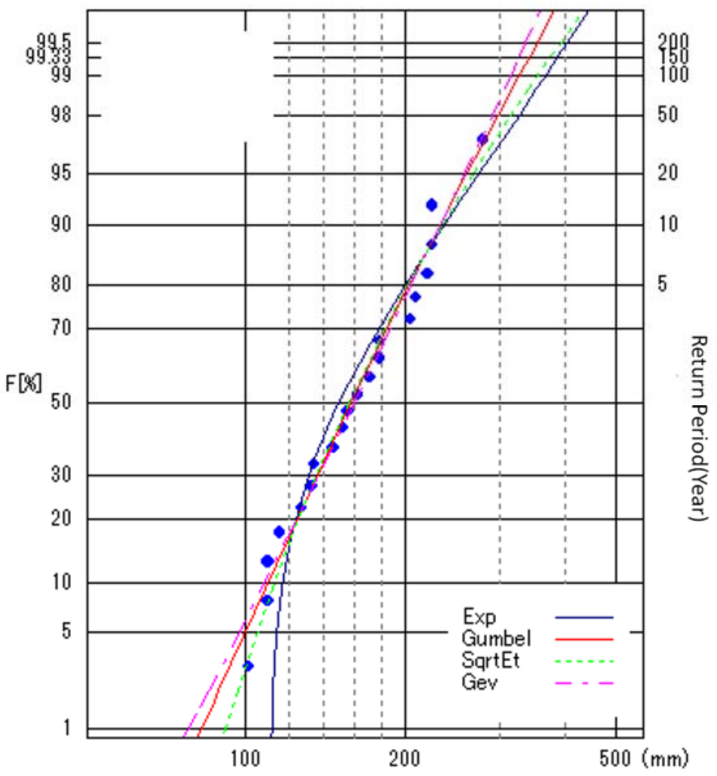
Source: ECMWF and JICA Project Team

Figure 2-27 Hyetograph in Beira City at Cyclone Desmond

(4) Setup of Design Rainfall

The annual maximum daily rainfall data for about 20 years from 2000 to November 2019 were collected and statistically analyzed using a probability distribution model. The relationship between the return period and the rainfall probability was as shown in Figure 2-28. The figure shows as follows:

- The maximum daily rainfall was 279.6 mm/day (February 18, 2019, Cyclone Desmond), as shown in Figure 2-10. The maximum daily rainfall at Cyclone Idai was 219.6 mm/day (March 14, 2019).
- Figure 2-28 and Table 2-6 show the relationship between the return period and the rainfall probability. In this case, three kinds of probability distribution models (Gumbel method, Sqrt-Et method and, GEV method) are shown as standard models in Japan, and the Gumbel method used as the standard in Japan is adopted.
- These results indicate that the rainfall probability for Cyclone Desmond is around a 1-in-30-year return period and that for Cyclone Idai is less than a 1-in-10-year return period.



Source: JICA Project Team

Figure 2-28 Rainfall Probability Analysis Results in Beira City

Table 2-6 Relationship between Return Period and Probable Rainfall

Items		Yearly Maximum Daily Precipitation (mm/day)		
Method of Rainfall Probability Analysis		Gumbel	Sqrt-Et	GEV
Number of Samples		20	20	20
Maximum of Daily Precipitation		279.6	279.6	279.6
Rain Probability	**2-yr**	157.8	155.6	159.4
	3-yr	179.1	176.5	181.0
	5-yr	202.9	201.2	204.4
	10-yr	232.8	234.4	232.6
	20-yr	261.4	268.3	258.7
	30-yr	277.9	288.7	273.2
	50-yr	298.5	315.3	290.9
	80-yr	317.3	340.6	306.6
	100-yr	326.3	352.8	313.9
	150-yr	342.5	375.6	327.0
	200-yr	354.0	392.2	336.1

Source: JICA Project Team

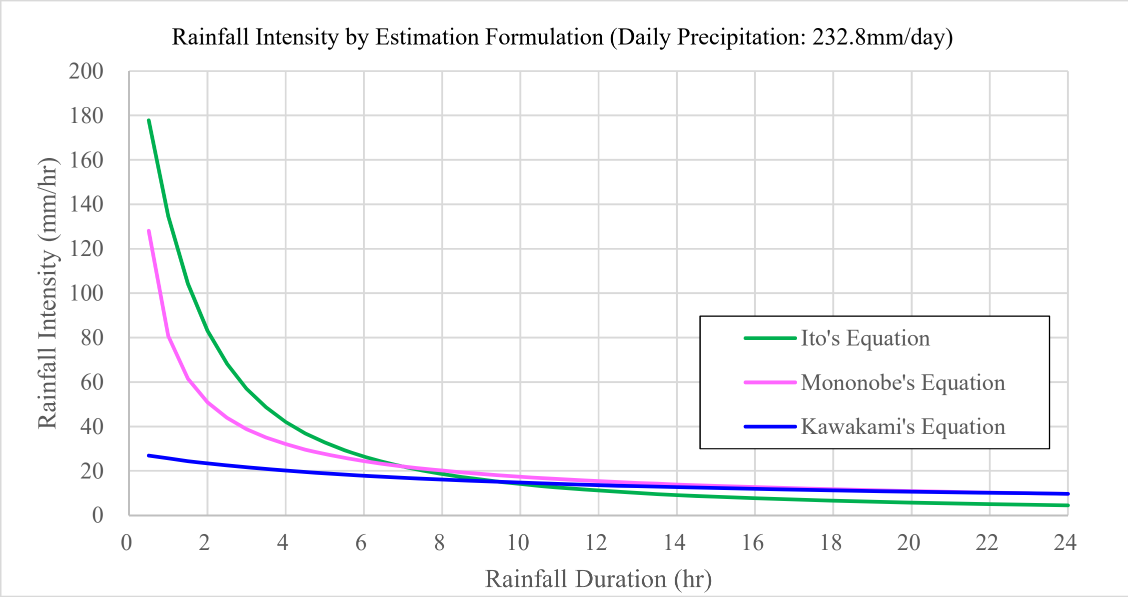
There are three equations for estimating rainfall intensity from daily rainfall, that are, Ito, Mononobe, and Kawakami equations as follows:

Ito equation: $r_t = \frac{R_{24}}{24}\left(\frac{34.7}{t^{1.35}+1.5}\right)$, Mononobe equation: $r_t = \frac{R_{24}}{24}\left(\frac{24}{t}\right)^{2/3}$,

Kawakami equation: $r_t = \frac{R_{24}}{24}\left(\frac{30}{t+6}\right)$

where, r_t is rainfall intensity (mm/hr), R_{24} is 24-hour daily rainfall (mm), t is rainfall duration (hr), respectively. The Mononobe equation is usually used as the standard equation for small and medium-rivers in Japan. Figure 2-29 shows the rainfall intensity under 232.8 mm/day rainfall conditions equivalent to Cyclone Idai rainfall (219.6 mm / day).

These results show that the short-time maximum rainfall intensity estimated by Mononobe and Ito equations is significantly larger than that of actual observation data. In contrast, the short-time maximum rainfall intensity estimated by Kawakami equation is almost the same as that of actual observation data for Cyclone Idai). Therefore, the Kawakami equation is adopted.



Source: JICA Project Team

Figure 2-29 Calculation of Rainfall Intensity by Three Equations (Daily Rainfall Equivalent to that of Cyclone Idai)

With the above rainfall probability analysis results, the design rainfall is set in this project. The design rainfall needs to be set to satisfy the following objectives in this project.

- Produce a hazard map which is used to develop evacuation plans
- Support the formulation of recovery/resilience plans for infrastructure (drainage)

Table 2-7 shows how to consider inland water hazard maps and design rainfall setup for drainage design in Japan and other countries. Thus, for creating hazard maps of Beira City, it is desirable to target Cyclone Desmond, which caused one of the largest rainfalls in history. Besides, for drainage design, Beira City could target a 5-year to 10-year return period rainfall of Cyclone Idai, However, since through the discussion with the related C/Ps the project team decided not to consider the design for drainage, thus the project did not set the target for the drainage design

Table 2-7 Set up of Design Rainfall

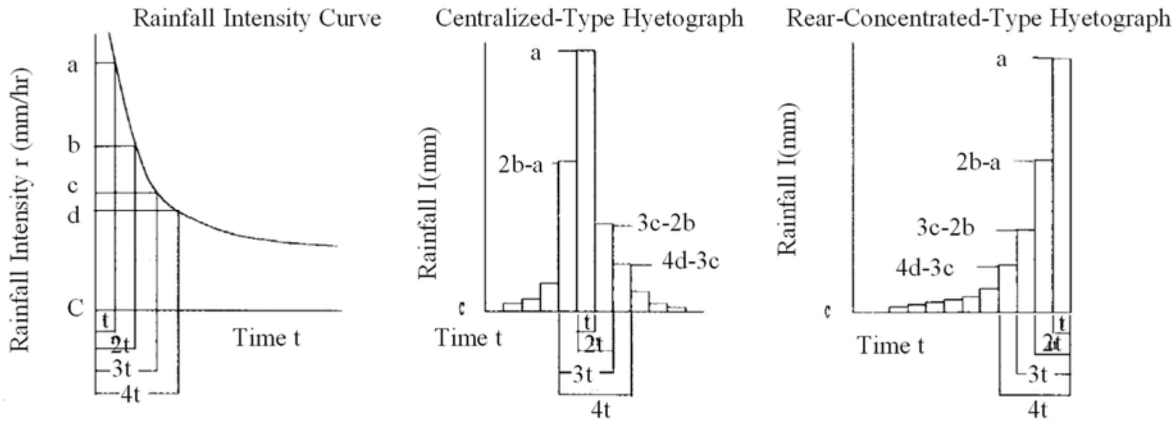
	Inland Inundation Analysis	**Drainage Design**
Japan	・Maximum Rainfall in the Target Area ・Large Rainfall in Other Near Areas ・Target Rainfall of River Flood Hazard Map	5-yr to 10-yr
Other Countries	Reference: River Flood Hazard Map 50-yr or 100-yr in the Philippines	15-yr in the Philippines 5-yr in the United Kingdom

Source: JICA Project Team

(5) Setup of Design Rainfall Temporal Distribution

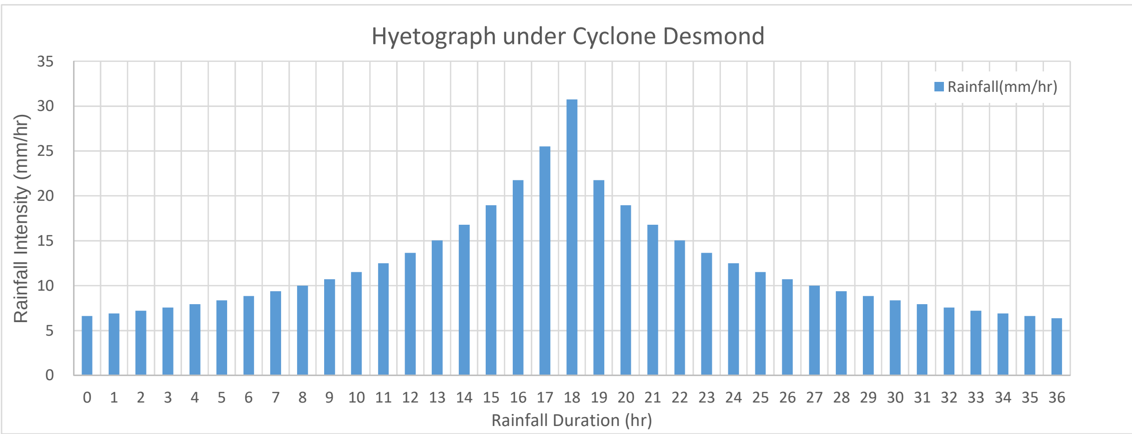
In Japan, centralized-type or rear concentrated-type hyetographs (Figure 2-30) will be adopted for small and medium-rivers having a catchment area with less than 50 km^2, based on the actual hyetographs. The design hyetograph setup is also evaluated.

- Based on rainfall hyetographs of well-known floods (Cyclones Desmond and Idai), the centralized type hyetograph was adopted as a design hyetograph type.
- For Cyclone Idai, the hyetograph from ECMWF data is used. For Cyclone Desmond, which has the largest rainfall scale in the past and is for creating the hazard map, the hyetograph is created based on this method (See Figure 2-31).



Source: River Plan Guideline for Middle and Small Rivers, JICE

Figure 2-30 Method of Creating Design Hyetograph from Rainfall Intensity Formula



Source: JICA Project Team

Figure 2-31 Hyetograph under Cyclone Desmond Condition

2.4 Disaster Risk Assessment Related to Storm Surge and Flood

2.4.1 Storm Surge Simulation for Cyclone and Storm Surge

(1) Calculation Method

This study adopted the model from the "Guideline for Hazard Map Preparation in Possible Storm Surge Inundation Areas" in Japan. This model includes the motion equation and the continuity equation as fundamental equations using non-linear long-wave theory. The model also incorporates various effects into the vertically integrated shallow water theory. Please refer to the guideline for the basic formula and details.

(2) Calculation Conditions

Table 2-8 shows the calculation conditions of cyclone and storm surge simulation at cyclone. Nautical Chart was obtained from INAHINA and reflected on bathymetric data. The calculation domain is as shown in Table 2-9 and Figure 2-32, and the 1st largest domain was set to include Madagascar Island, and the smallest domain up to the 4th area was modeled and nested with a 1/3 size of smaller mesh size than others.

Table 2-8 Calculation Conditions of Cyclone Simulation

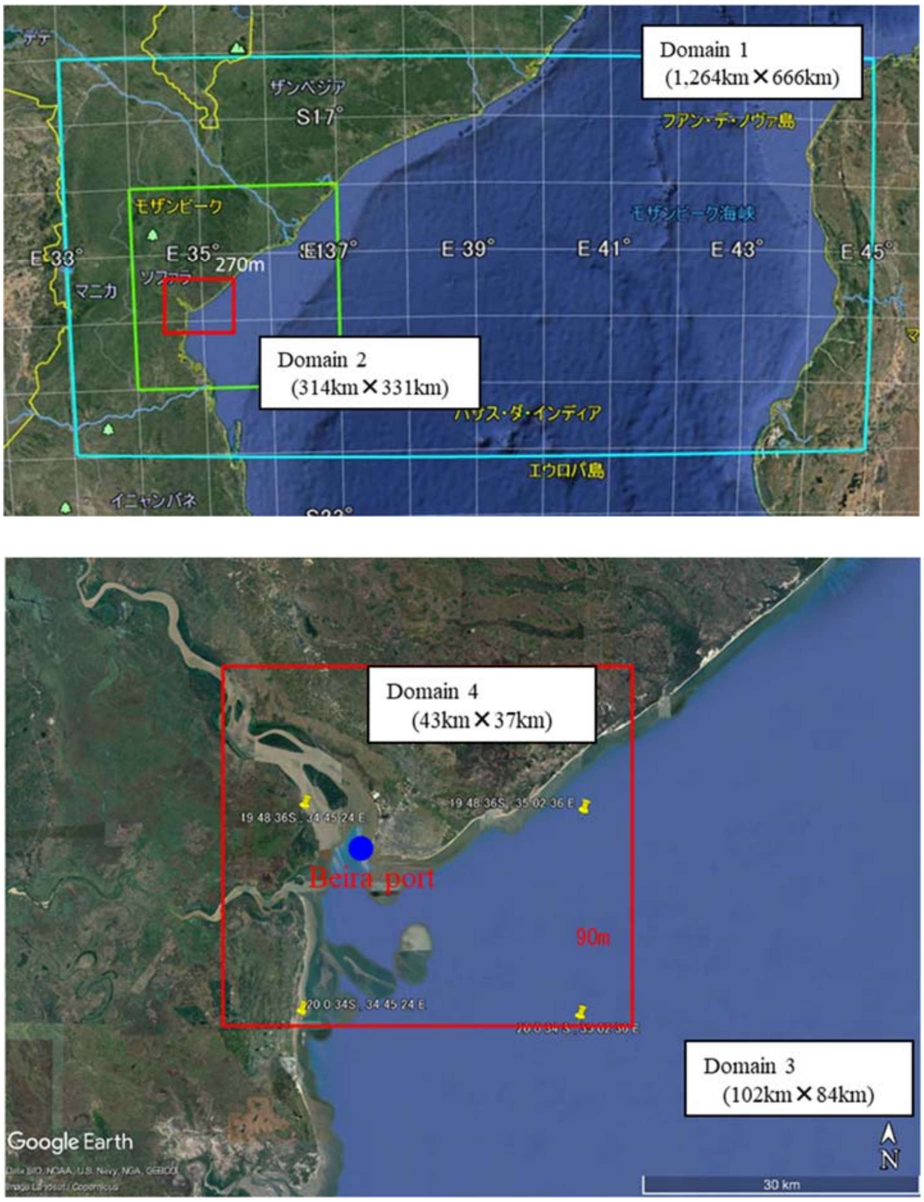
Item	Setting	Comments
Cyclone track	ECMWF data/Best Track	
Central pressure	ECMWF data/Best Track	
Wind data	ECMWF data/Myers method	
Bathymetry	GEBCO 30 sec Nautical chart (Beira port)	Offshore Nearshore
Tide	Case 1: MSL+1.3m Case 2: MSL+3.6m	At Idai At spring high tide

Source: JICA Project Team

Table 2-9 Calculation Domains of Cyclone Simulation

Domain	Domain Size	Mesh Size
1	1,264 km × 666 km	Δx=2,430m
2	314 km × 331 km	Δx=810m
3	102 km × 84 km	Δx=270m
4	43 km × 37 km	Δx=90m

Source: JICA Project Team

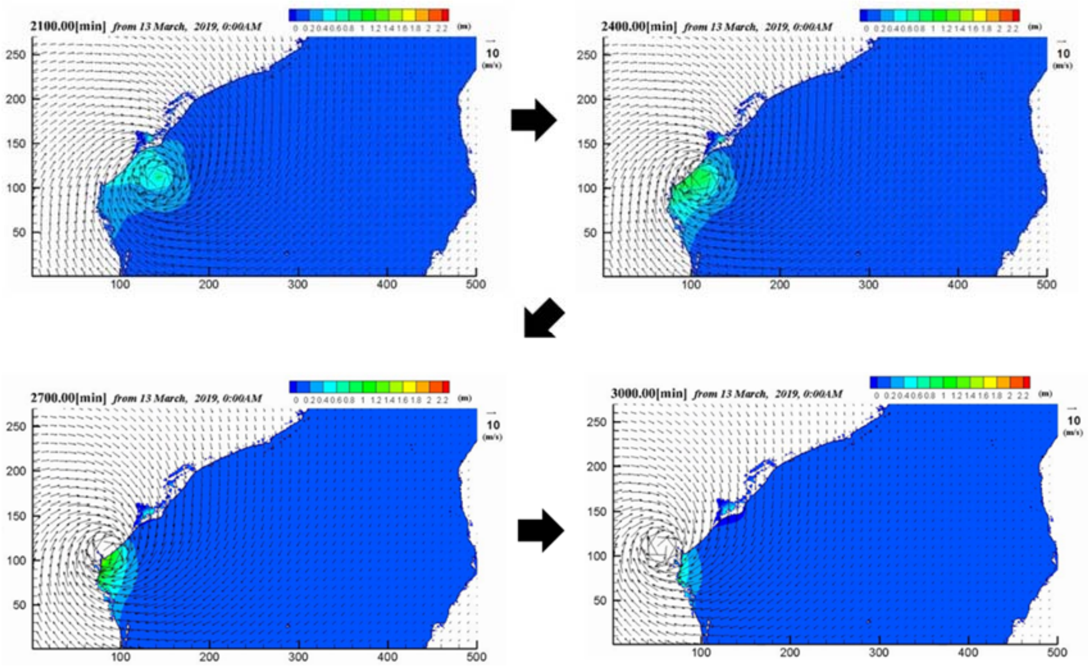


Source: JICA Project Team

Figure 2-32 Calculation Domains of Storm Surge Simulation

(3) Simulation of Cyclone Idai

To simulate the storm surge associated with Cyclone Idai, the best track data available until March 14 was utilized. Since there were no track data available for subsequent days, the cyclone tracks for Cyclone Idai were set by estimating the central location from the pressure distribution map of the mesoscale meteorological analysis data of ECMWF. The central pressure before or after landing was set as 967 hPa after landing, based on the ECMWF data. Figure 2-33 shows snapshots of the storm surge deviation distribution as calculation results. The maximum storm surge deviation was about 1.8 m near the Beira Port.



Source: JICA Project Team

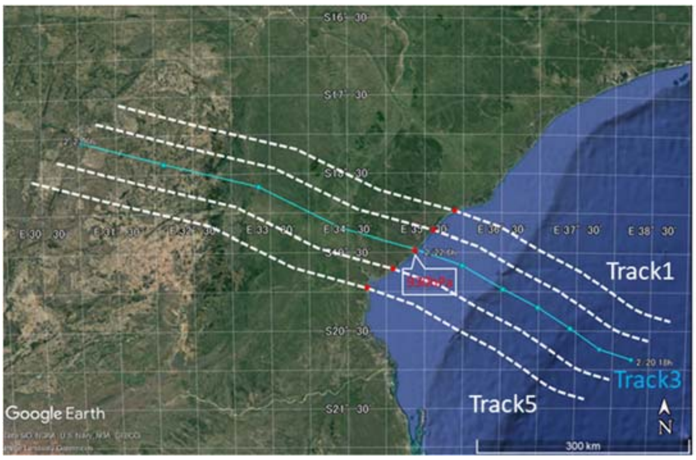
Figure 2-33 Snapshots of Simulation Results for Cyclone Idai

(4) Simulation of Cyclone Eline

1) Parallel Shifted Courses of Cyclone Eline

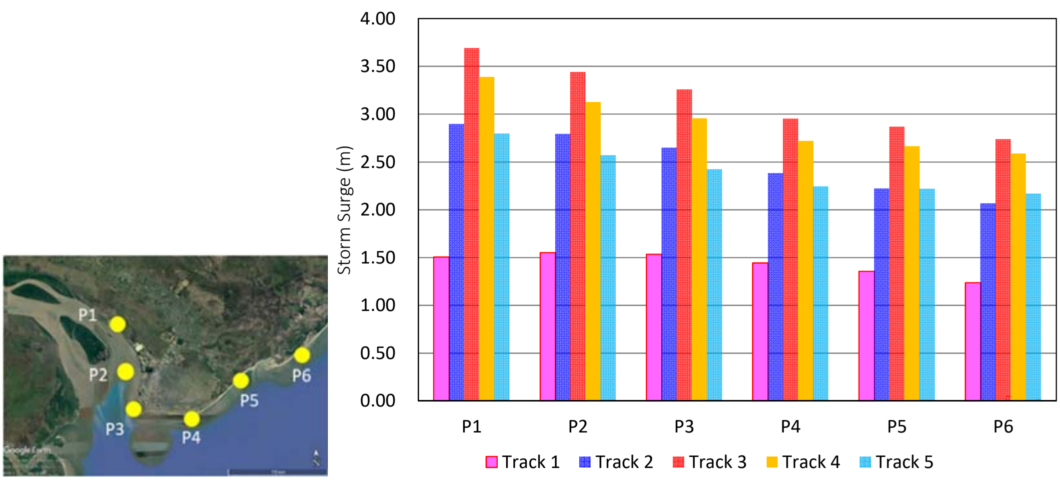
Because the Cyclone Eline passed 100 to 200 km south of Beira City, no storm surge occurred in Beira City at that time. For the possible disaster cases, this study sets five courses in which Cyclone Eline was moved in parallel at every 0.25 ° (See Figure 2-34, Tracks 1 to 5) and examined which course generates the most substantial storm surge deviation.

Figure 2-35 shows the maximum storm surge deviation for each course as a calculation result. From the Figure, it can be seen that Track 3 passing to the north of Beira City has the maximum storm surge deviation at each monitoring point. It was also found that the course passing to the north of Beira City is a dangerous course.



Source: JICA Project Team

Figure 2-34 Five Possible Parallel Shifted Courses of Cyclone Eline

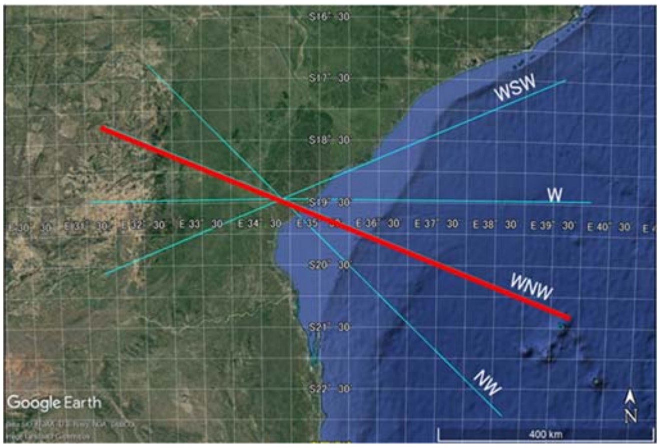


Source: JICA Project Team

Figure 2-35 Results of Maximum Strom Surge Deviation (Parallel Shifted Courses of Cyclone Eline)

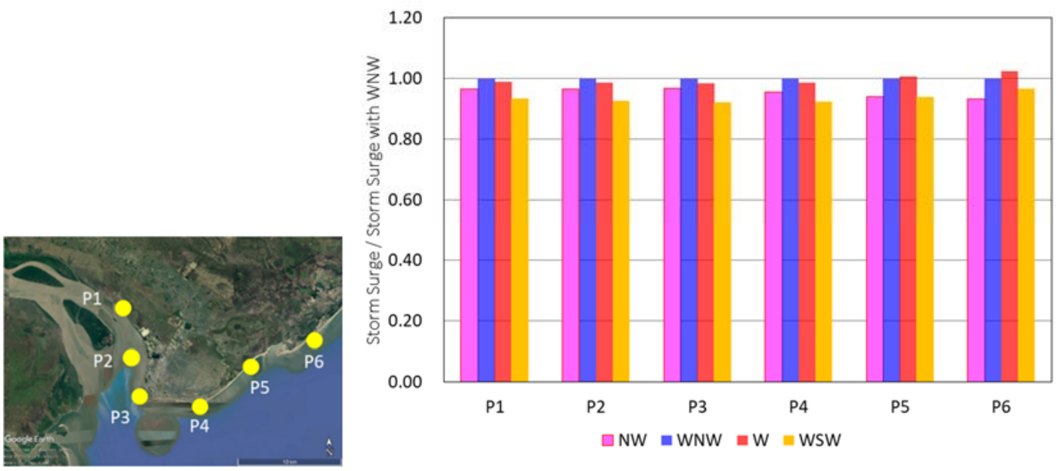
2) Rotation Course Simulation of Cyclone Eline

Because of the characteristic of Beira City, cyclones can hit from all directions. Therefore, four possible rotated courses with directions of WSW, W, WNW (Cyclone Eline's original course), and NW were marked as the severest course of parallel shifted courses of Eline (Figure 2-36). Figure 2-37 shows the results of the maximum storm surge deviation on each rotation course, which are normalized with the storm surge deviation at the WNW original course. Except for monitor point P6, Cyclone Eline's original course (WNW) causes the most substantial storm surge deviation. Therefore, if Eline is set as a predicted disaster, the cyclone conditions are adopted at the original Eline course by shifting northward to pass to the north of Beira City.



Source: JICA Project Team

Figure 2-36 Four Possible Courses of Rotated Cyclone Eline

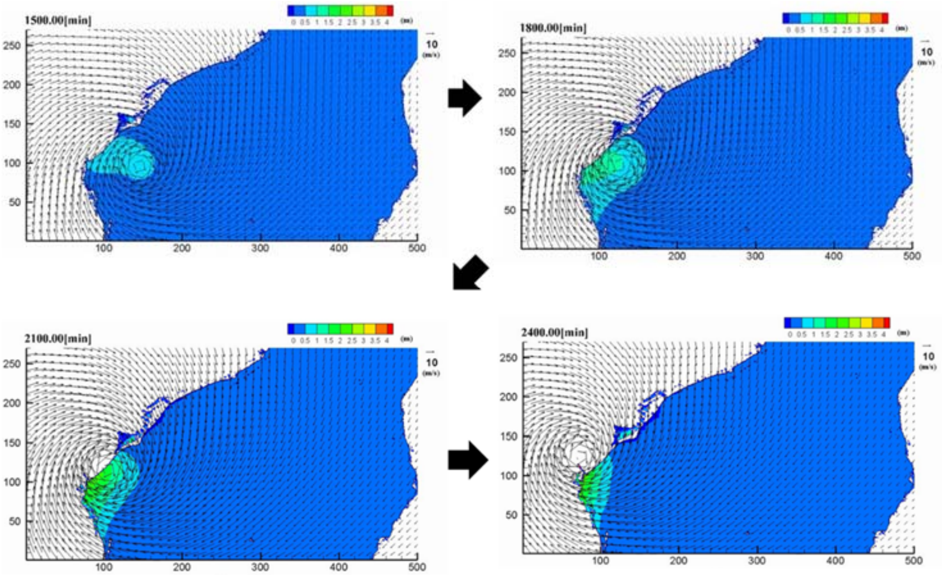


Source: JICA Project Team

Figure 2-37 Results of Maximum Strom Surge Deviation (Rotated Courses for Eline)

3) Simulation of Cyclone Eline Course in Worst-Case Scenario

Figure 2-38 shows the snapshots of storm surge deviation as calculation results caused by Cyclone Eline on a course that generates the most significant storm surge deviation in Beira City. As a result of the calculation, the maximum storm surge deviation is about 3.4 m.



Source: JICA Project Team

Figure 2-38 Snapshots of Storm Surge Simulation Results for Cyclone Eline

2.4.2 Inundation Simulation

(1) Calculation Cases

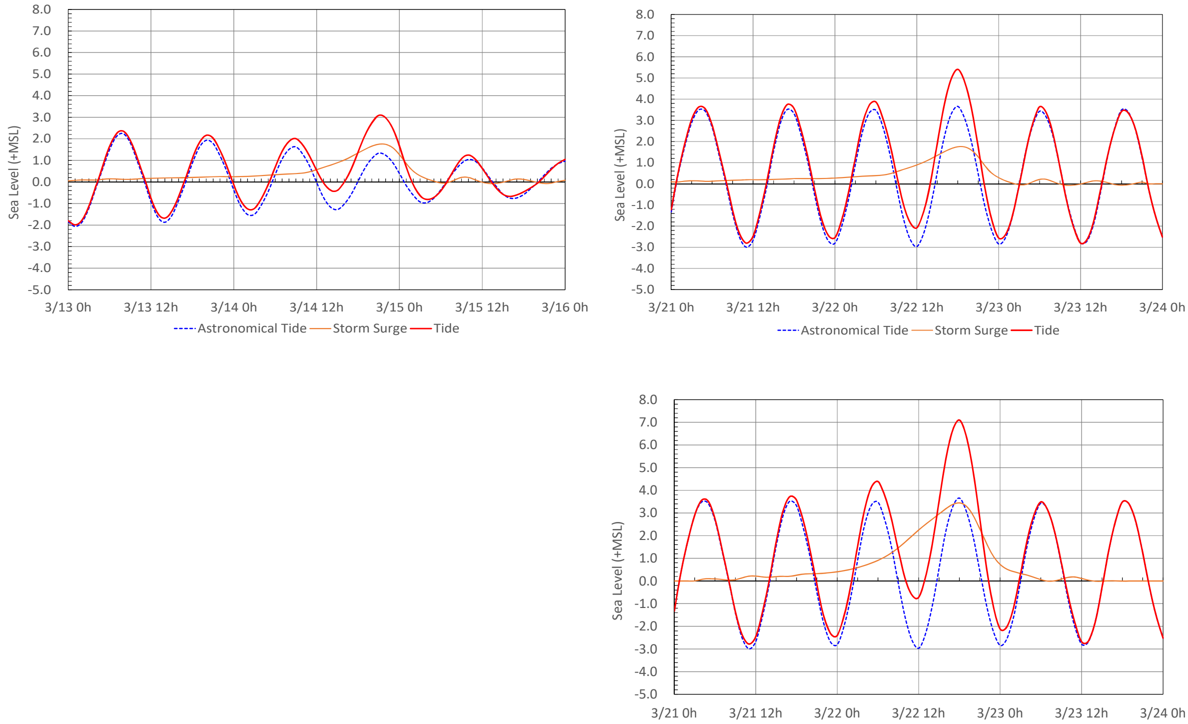
The following eight cases of inundation simulations were performed for the basic study of hazard maps. These cases include two cyclones (Idai and Eline), with two kinds of tide levels during Idai and Spring High Tide, and two types of rainfalls during Idai and Desmond (January 2019). Eight cases in total are set by combining respective features. Details are shown in Table 2-10.
(Top left: Idai with Idai tide, Top right: Idai with Spring High Tide, Bottom right: Eline with Spring High Tide)
Figure 2-39 shows the tide curves for each calculation case. It indicates that the difference of the blue-lined astronomical tide is remarkably large at approximately 2.3 m between the tide at Idai attacking and the Spring High Tide, which came one week after Idai.
Table 2-11 compares the maximum tide values in each case except for the cases of only with no rainfall (i.e., cases 1-3 and 3-3).

Case 1 is based on the assumption that the Cyclone Idai arrives at Spring High Tide, Case 2 is based on the assumption that the Cyclone Eline arrives at Spring High Tide, and Case 3 is based on a worst-case scenario of Cyclone Eline arriving at Spring High Tide. In each case, to check the effects of storm surge and rainfall, two cases were calculated, one considering only tides and the other considering only rainfall.

Table 2-10 Calculation Cases of Inundation Simulation

Case	Cyclone	Tide	Rainfall
1-1	Idai (967 hPa @Beira)	During Idai (MSL+1.3m)	During Idai (220 mm/day)
1-2			-
1-3		-	During Idai (220 mm/day)
2-1		Spring High Tide (MSL+3.6m)	During Idai (220 mm/day)
2-2			-
3-1	Eline (930 hPa @Beira)	Spring High Tide (MSL+3.6m)	During Desmond (280 mm/day)
3-2			-
3-3		-	During Desmond (280 mm/day)

Source: JICA Project Team



Source: JICA Project Team

(Top left: Idai with Idai tide, Top right: Idai with Spring High Tide, Bottom right: Eline with Spring High Tide)

Figure 2-39 Tide Curve for Inundation Simulation

Table 2-11 Summary of Maximum Tide Level in Each Inundation Simulation

Case	Maximum Storm Surge	Maximum Astronomical Tide	Maximum Water Level
1-1	**1.8 m**	**MSL+1.3 m**	MSL+3.1 m
1-2			
2-1		**MSL+3.6 m**	MSL+5.4 m
2-2			
3-1	**3.4 m**		MSL+7.1 m
3-2			

Source: JICA Project Team

(2) Simulation Results

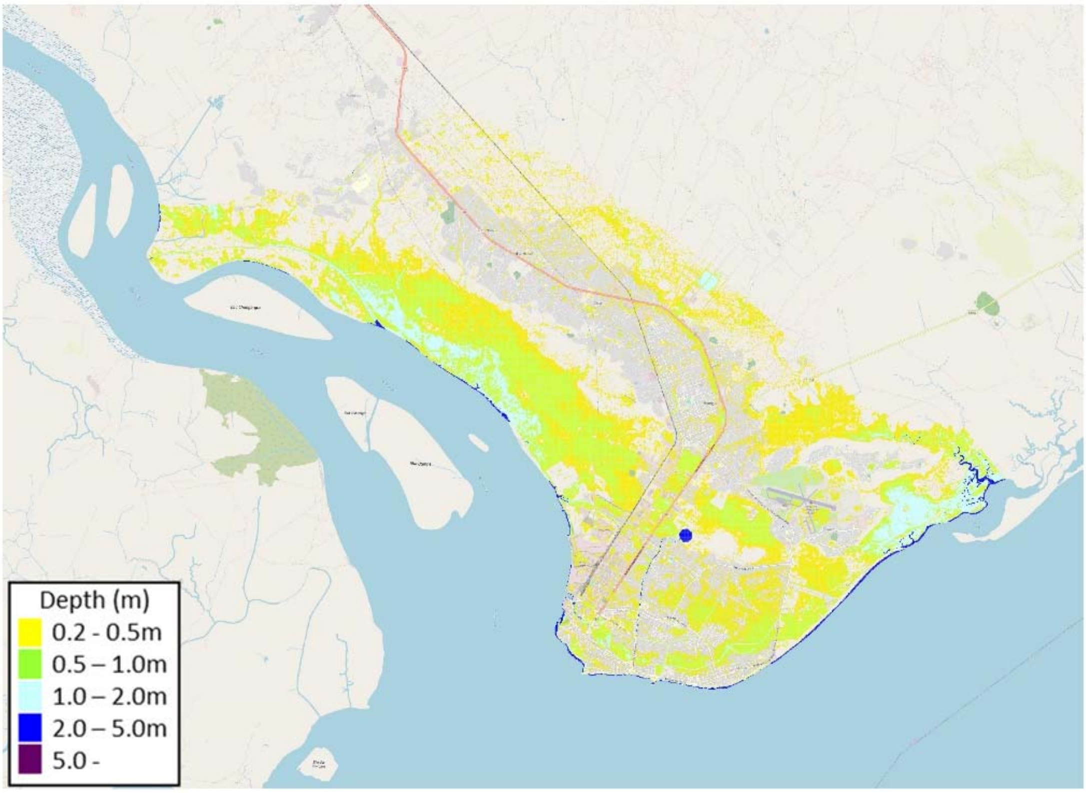
The simulation results of maximum inundation depth distributions for eight cases are shown in from Figure 2-40 to Figure 2-43. Also, Table 2-12 summarizes the inundation conditions for eight cases of simulation results.

Table 2-12 Summary of Inundation Conditions

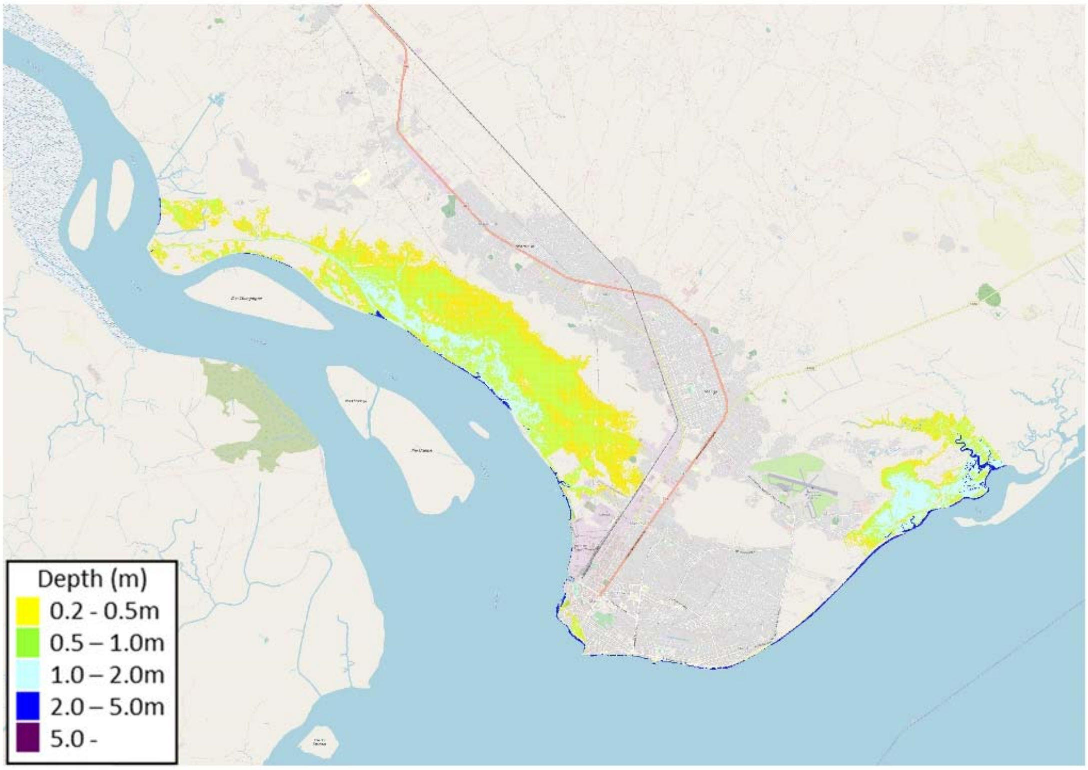
Case	Cyclone	Tide	Rainfall	Inundation
1-1	Idai	During Idai	During Idai	• The inundation area in urban areas due to storm surge is quite limited, and the inundation depth is less than 0.5 m. • A wide range of inundation is caused due to rainfall. Although inundation depths in most areas are less than 0.5 m, they range from 0.5 m to 1 m in some areas 0.5-1 m.
1-2			-	
1-3		-	During Idai	
2-1		Spring High Tide	During Idai	• Inundation caused by storm surge occurs on a large-scale in the urban area with, and the inundation depth is about 0.5 m to 2 m. • Inundation due to rainfall occurs on the upper side of the hill. Compared with the inundation range with storm surge, the inundation depth is less than 0.5 m in many areas. The inundation level is relatively lower than that of storm surge.
2-2			--	
3-1	Eline		During Desmond	• In large-scale urban areas, flooding has occurred due to storm surges, where areas have a depth of 2 m or deeper of inundation in most areas. • Inundation due to rainfall occurred on the upper side of the hill, and the extent and depth of inundation are greater than that of Idai. However, the inundation level is relatively lower than that of the storm surge.
3-2			-	
3-3		-	During Desmond	

Source: JICA Project Team

Case 1-1 Cyclone Idai, Tide: During Idai, With Rainfall



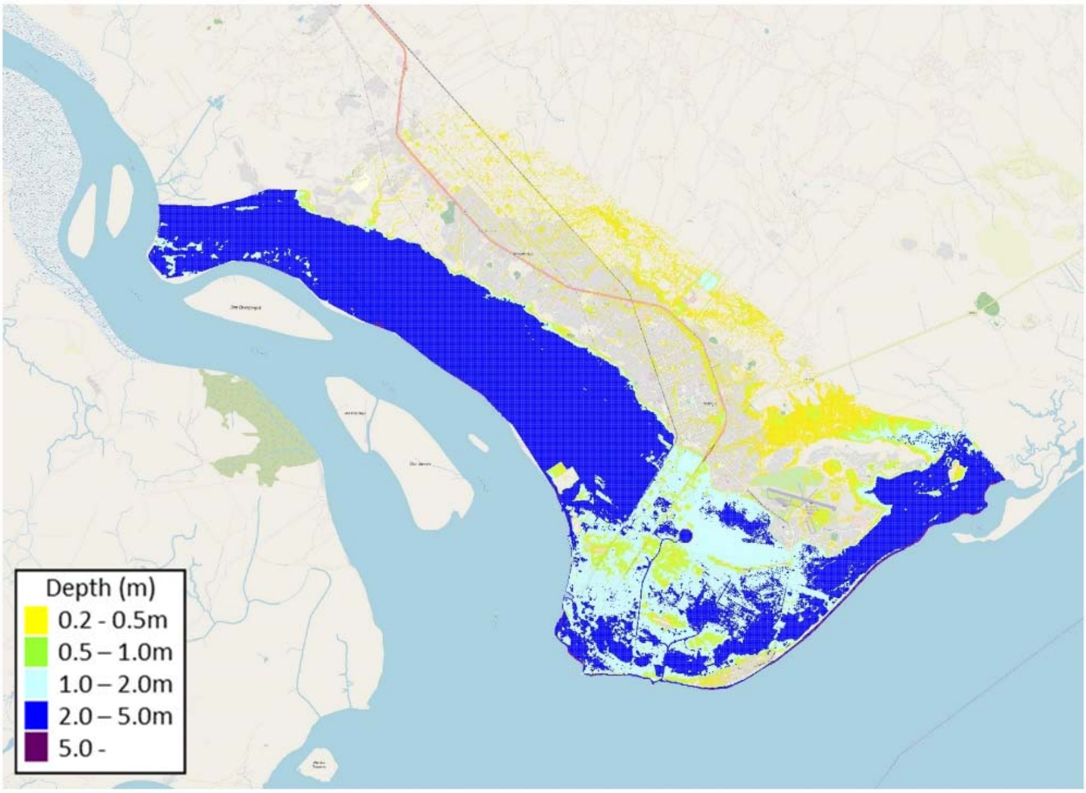
Case 1-2 Cyclone Idai, Tide: During Idai, Without Rainfall



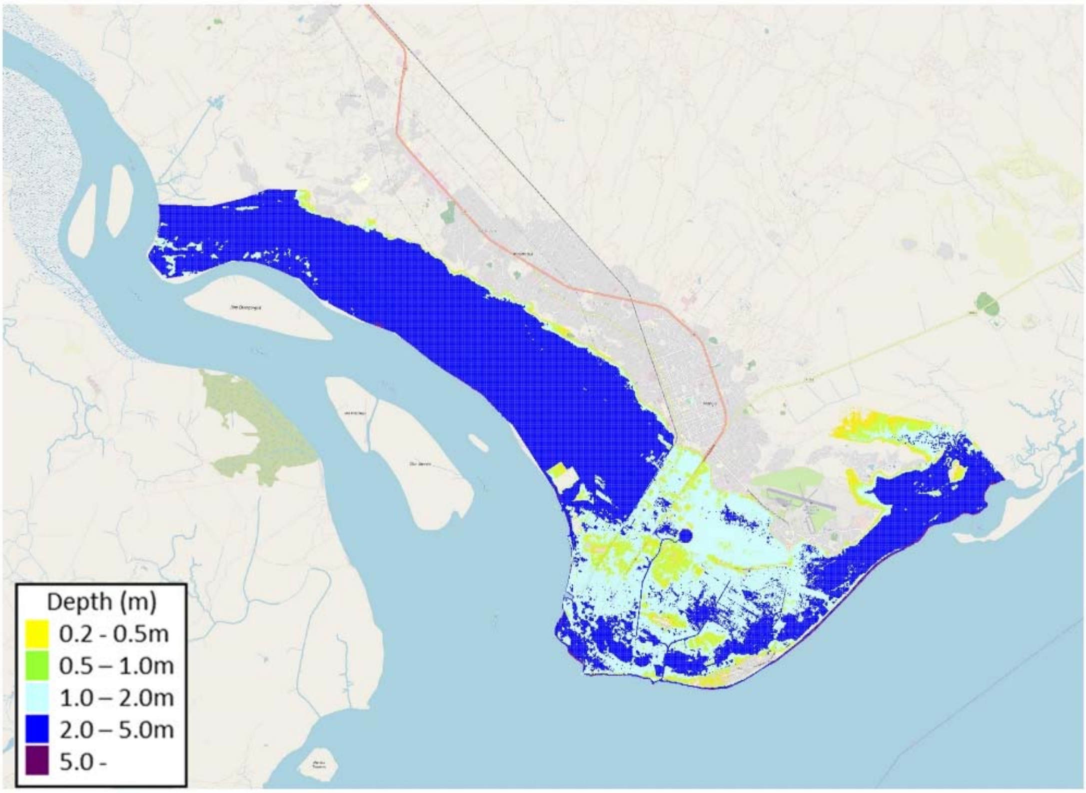
Source: JICA Project Team

Figure 2-40 Maximum Inundation Depth Distribution (Case 1: During Idai)

Case 2-1 Cyclone Idai, Tide: Spring High Tide, With Rainfall



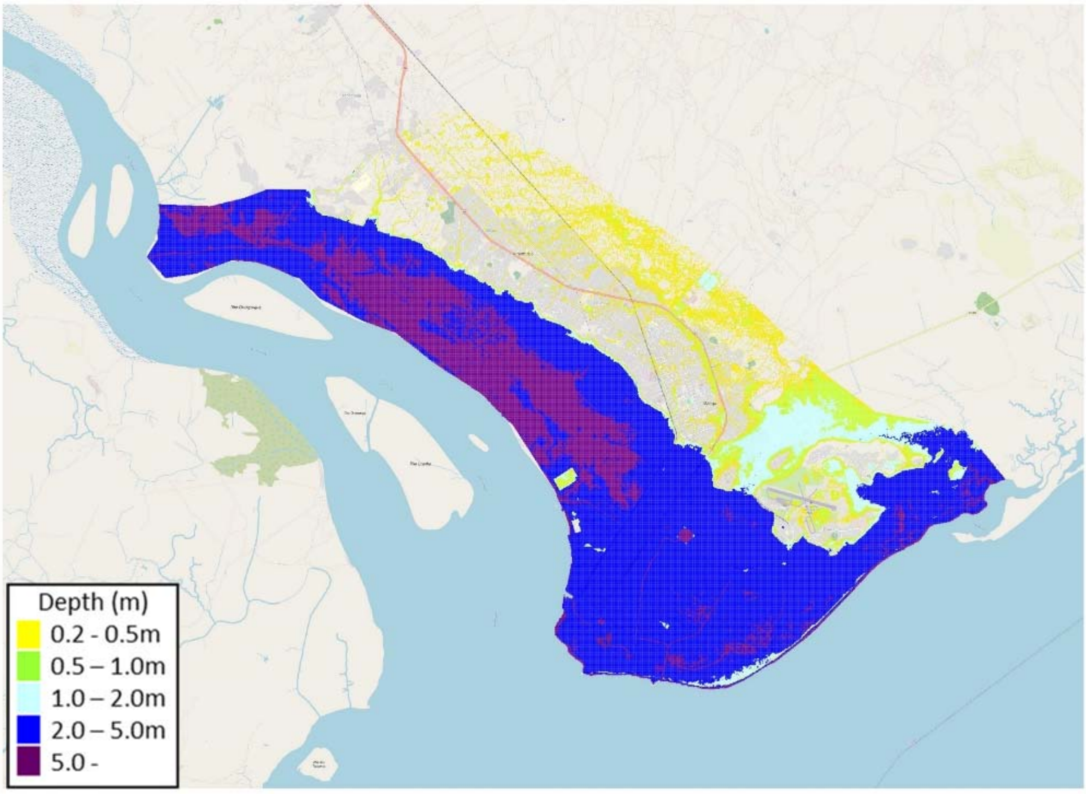
Case 2-2 Cyclone Idai, Tide: Spring High Tide, Without Rainfall



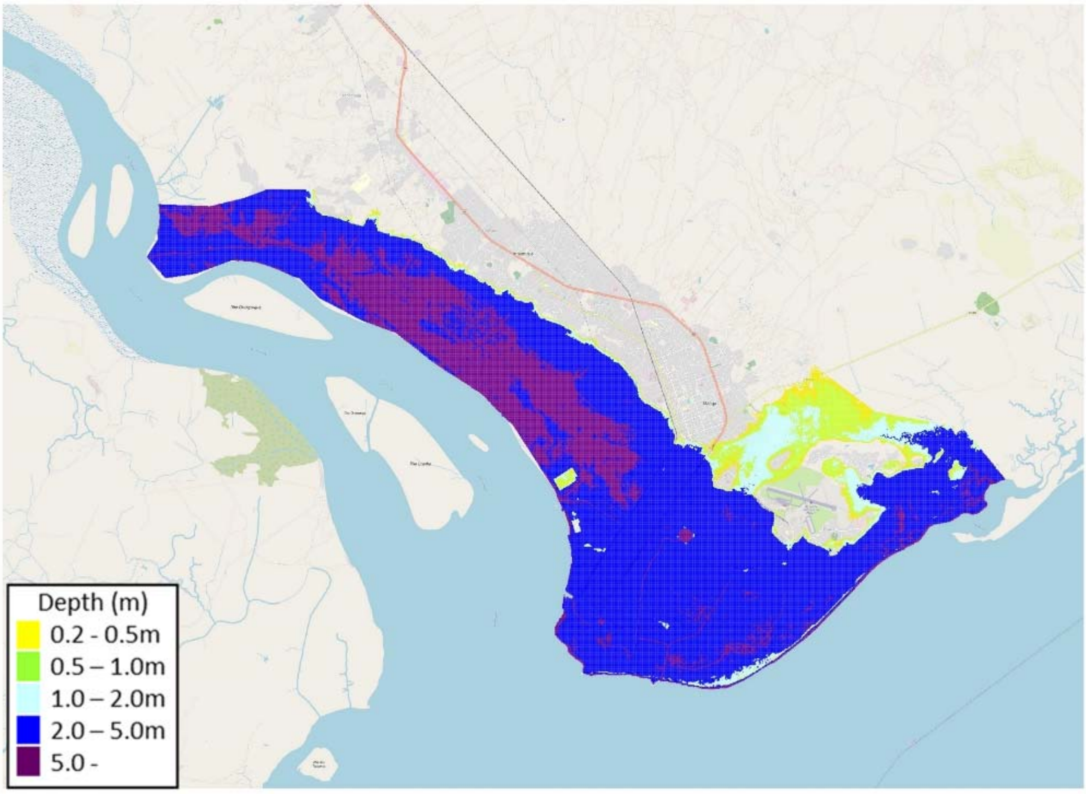
Source: JICA Project Team

Figure 2-41 Maximum Inundation Depth Distribution (Case 2: Cyclone Idai with Spring High Tide)

Case 3-1 Cyclone Eline, Tide: Spring High Tide, With Rainfall



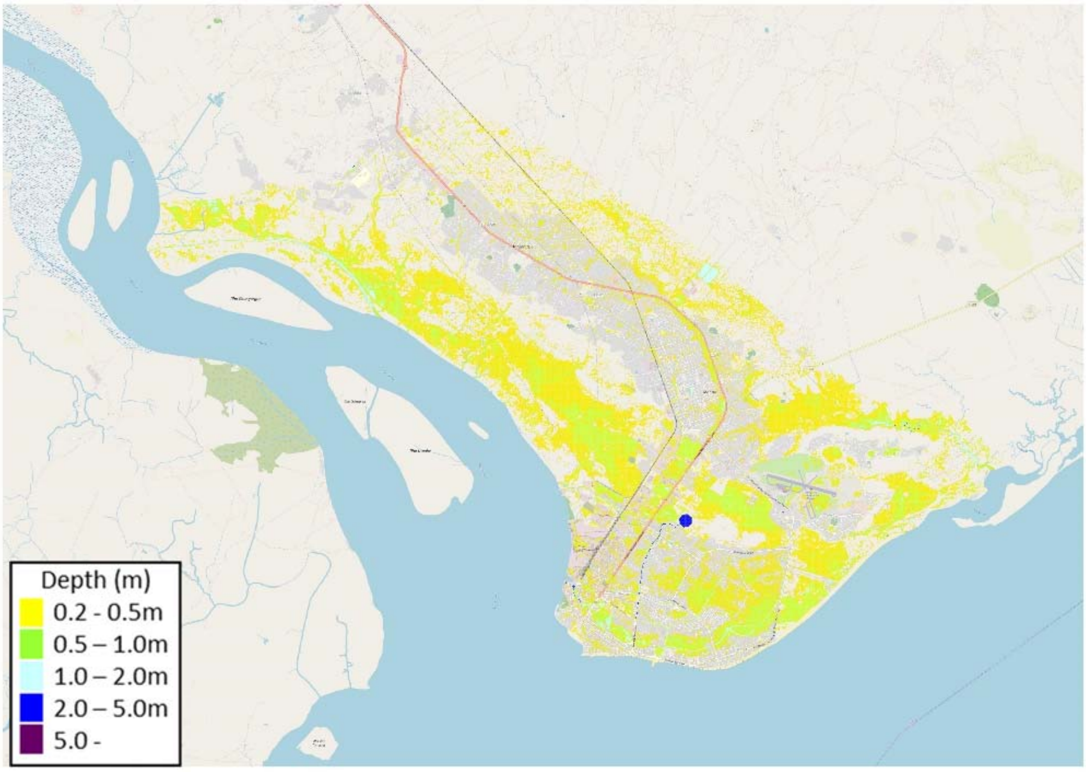
Case 3-2 Cyclone Eline, Tide: Spring High Tide, Without Rainfall



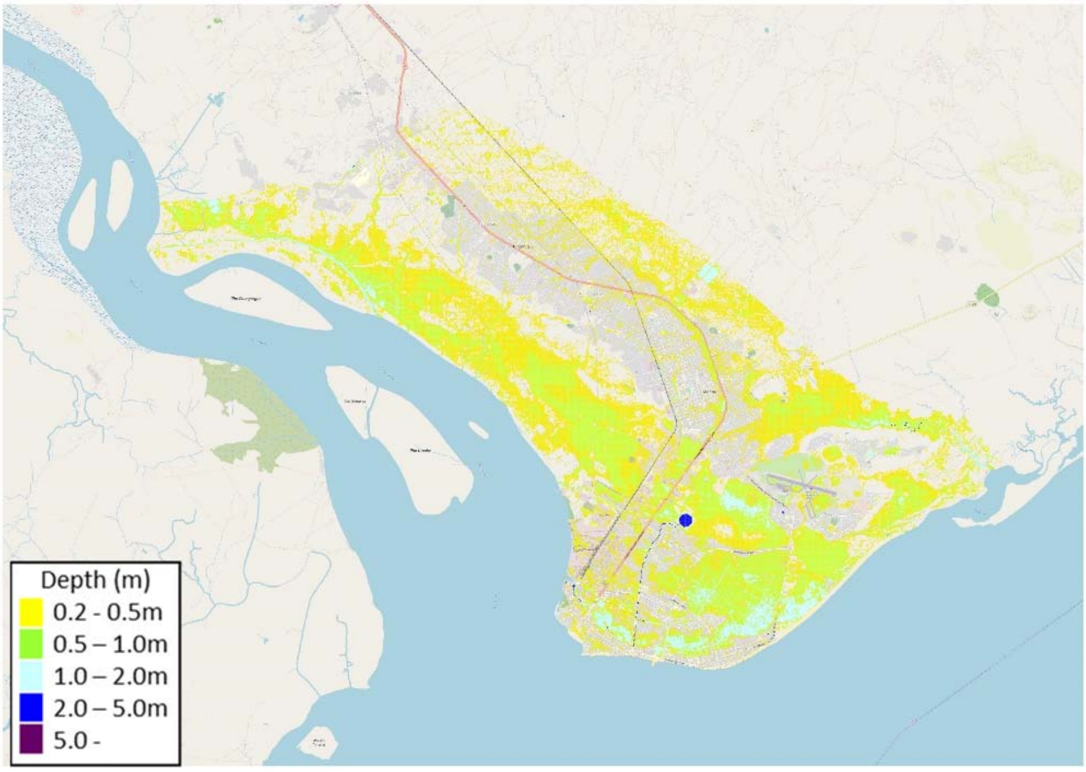
Source: JICA Project Team

Figure 2-42 Maximum Inundation Depth Distribution
(Case 3: Cyclone Eline with Spring High Tide)

Case 1-3 Only rainfall during Cyclone Idai



Case 3-3 Only rainfall during Cyclone Desmond



Source: JICA Project Team

Figure 2-43 Maximum Inundation Depth Distribution (Only Rainfall, Top: Case 1-3, Bottom: Case 3-3)

2.4.3 Finalization of the Target Disaster

At the first JCC meeting on February 12, 2020, the following basic concepts were approved for assumed disaster scenarios:

- Hazard maps will be based on observation records from past notable cyclones and rainfall events.
- As the hazard map authorization organization, INGD/CENOE will approve the hazard map.

The return period of each external force in this study is as follows. With regard to tidal levels, a probability assessment cannot be performed because continuous tidal level observations have not been conducted in the vicinity of Beira. Therefore, the results of a previously conducted probability assessment by the Netherlands Enterprise Agency (RVO) for hypothetical cyclones for 10,000 years was referred.

Table 2-13 Return Period for Each External Force

Cyclone	Return Period: Cyclone (Center Pressure)		Return Period: Rainfall	
IDAI (2019)	967hPa	25 yrs.	220mm/day	10 yrs.
ELINE (2000)	930hPa	50 yrs.	(Not Beira)	
DESMOND (2019)	1000hPa	2 yrs.	280mm/day	30 yrs.

Hazard	Maximum Storm Surge	Maximum Astronomical Tide	Maximum Water Level	Return Period
IDAI	**1.8 m**	**MSL+1.3 m**	MSL+3.1 m	< 1 yr.
IDAI + Spring High Tide	**1.8 m**	**MSL+3.6 m**	**MSL+5.4 m**	**200-300** yrs.
ELINE + Spring High Tide	**3.4 m**	**MSL+3.6 m**	MSL+7.1 m	> 1000 yrs.
Reference: Previous study by RVO			*MSL+6 m*	*1000 yrs.*

Source: JICA Project Team

The return period for each of the eight cases is shown below. Based on the results of this review, discussions were held with Beira and central government entities such as the National Center for Emergency Operation (CENOE), and the following was decided at the second JCC meeting in November 2020.

In the Case 1, even though it represents and actual disaster event, the calculated return period is about 10 years, when only the storm surge and rainfall are considered and is not suitable for a hazard map to be utilized for various future planning studies. On the other hand, Case 3 (Cyclone Eline + Spring High Tide) represents a worst-case scenario but due to Mozambique's underdeveloped disaster prevention infrastructure and the challenging financial situation of the country and based on the fact that appropriate evacuation plan has not yet been formulated this case was considered to be overwhelming to plan necessary actions. . So as a first step, Case 2 (Cyclone Idai-Spring High Tide) will be adopted for use in the various related plans.

Table 2-14 Return Period for Each Case

Case	Cyclone	Tide	Rainfall	Return Period
1-1	Idai (967hPa)	During Idai (MSL+1.3m)	During Idai (220mm/day)	< 1 yr.
1-2			-	< 1 yr.
1-3		-	During Idai (220mm/day)	10 yrs.
2-1		Spring High Tide (MSL+3.6m)	During Idai (220mm/day)	200 – 300 yrs.
2-2			-	200 – 300 yrs.
3-1	ELINE (930hPa)	Spring High Tide (MSL+3.6m)	During Desmond (280mm/day)	More than 1000 yrs.
3-2			-	More than 1000 yrs.
3-3		-	During Desmond (280mm/day)	30 yrs.

Source: JICA Project Team

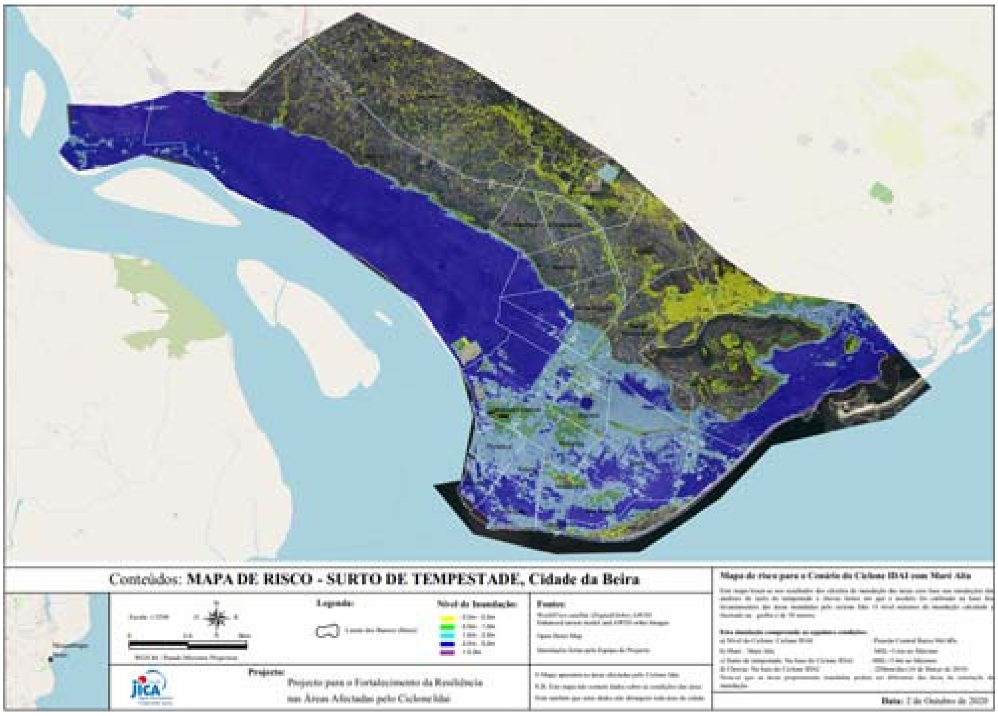
The disaster scenarios were shared not only with counterparts but also with major donors (World Bank, Netherlands government, etc.) at the second JCC meeting in November 2020. The World Bank and the Netherlands government have plans to implement intervention on costal protection and drainage improvements in Beira, and it was decided to incorporate this study into that plan.

2.5 Assistance for Hazard Map Preparation

Based on the above considerations, the JICA Project Team will support hazard map production
for storm surge and rainfall in Beira City. As mentioned above, discussions were held with Beira and the central government regarding hazard map content. The content was finalized by the National Institute for Disaster Management (INGD) and CENOE in November 2020.

2.5.1 Hazard Map Handover Ceremony

In May 2021, a hazard map handover ceremony was held, and the hazard map shown in Figure 2-44 was handed over to the Government of Mozambique and the City of Beira. The handover ceremony is shown in Figure 2-45.



Source: JICA Project Team

Figure 2-44 Published hazard map

Sources: (Left) JICA Project Team, (Right) Facebook

Figure 2-45 Hazard map handover ceremony (left) and the handover to Beira City

2.5.2 Technical Training

In addition to technology transfer through discussions on hazard map preparation with Beira and CENOE, two technical training sessions were held to strengthen capacity for hazard map preparation.

(1) The 1st Technical Training

The first technical training session was held as follows, with the core content shown below. For further details, please refer to the training report.

- Training periods: Thursday, December 5, 2019 (Maputo), and Tuesday, December 10 to Thursday, 12 2019 (Beira)
- Number of trainees: Six in Maputo (CENOE staff), 31 in Beira (Beira municipal Council (CMB) and INGD Sofala officials)
- Purpose of training: The trainees should understand the importance of hazard map preparation and its usage after understanding the process of preparing topographic maps and targeting hazards types in Beira City

Table 2-15 Outline of the 1st Technical Training

Date	Time	Contents	Lecture
Maputo: December 5, 2019 Beira: December 10, 2019 *Conducted the same program in different location	09:00-09:10	Outline of this project	Mr. Ito
	09:10-10:20	GIS/Digital Mapping	Mr. Kamimura
	10:20-10:45	Break	
	10:45-11:45	Hazard analysis on storm surge disaster	Dr. Kumagai
	11:45-12:15	Utilization of hazard map and Land-use/ Evacuation planning	Mr. Ito
	12:15-12:45	Question & Answer	
Beira: December 11, 2019	10:00-12:00	Field practice of watermark survey of storm surge disaster	Dr. Kumagai
	12:00-13:30	Lunch break	
	13:30-14:00	Explanation of watermark survey of storm surge disaster Question & Answer	Dr. Kumagai
Beira: December 12, 2019	10:00-11:00	Outline of drainage planning and introduction of practical inland flood measures	Dr. Yamasaki
	11:00-11:20	Break	
	11:20-11:50	Outline of a survey on elevation, cross-section, profile in river	Mr. Kamimura
	11:50-12:10	Additional lecture on watermark survey	Dr. Kumagai
	12:10-13:10	Lunch break	
	13:10-13:40	Explain and fill out the questionnaire	
	13:40-14:00	Question & Answer	

Source: JICA Project Team

Overview of GIS/topographical mapping
(Maputo, Dec. 5)

Overview of storm surge hazards/hazard analysis
(Beira, Dec. 10)

Overview of land use planning/evacuation planning
(Beira, Dec. 10)

Practical training for storm surge trace surveys
(Beira, Dec. 11)

Source: JICA Project Team

Figure 2-46 Photo from the first practical training session for storm surge trace surveys

(2) Second Technical Training Session

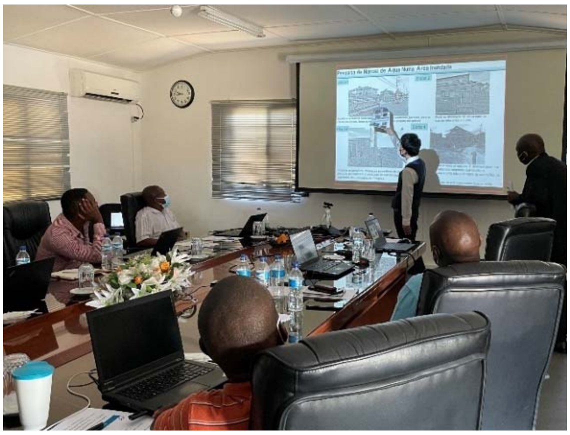
The second technical training session was held as follows, with the core content shown below. For further details, please refer to the training report.

- Training period: November 2–5, 2021 (Maputo)
- Number of trainees 20 in (CMB official, Maputo Province staff, CENOE official, INGD provincial official)
- Location: CENOE conference room
- Purpose of training: For CENOE, conduct training on the skills required for the creation of hazard maps that will be need by Mozambique in the future

Table 2-16 Schedule and Contents of Second Training Session

Date	Time	Content	Instructor
Nov. 2, 2021 (Tue)	09:00–10:00	Introduction	Dr. Daiki Tsujio
	10:00–12:00	Analysis of damage situation through trace surveys, etc. (storm surge)	
	12:00–13:00	Lunch	
	13:00–15:00	Analysis of damage situation through trace surveys, etc. (river/urban flooding)	Dr. Yusuke Yamasaki
	13:00–14:00	(1) Trace surveys for flooding (river) and urban flooding	
	14:00–15:00	(2) Identification of flooded areas from satellite data	
Nov. 3, 2021 (Wed)	9:00–12:00	Hazard analysis (high tides)	Dr. Daiki Tsujio
	9:00–9:45	(1) Overview of high tides	
	9:45–10:30	(2) Relationship to tide levels	
	10:30–10:40	Coffee break	
	10:40–12:00	(3) High tide analysis	Dr. Daiki Tsujio
	12:00–13:00	Lunch	
	13:00–15:00	Hazard analysis (urban flooding)	Dr. Yusuke Yamasaki
	13:00–14:00	(1) Cyclone sampling and characteristics analysis	
	14:00–15:00	(2) Precipitation data analysis	
Nov. 4, 2021 (Thu)	9:00–12:00	Hazard map preparation (high tide)	Dr. Daiki Tsujio
	9:00–9:45	(1) Hazard map preparation methods	
	9:45–10:30	(2) Calculating inundations	
	10:30–10:40	Coffee break	
	10:40–12:00	(3) Display of results	Dr. Daiki Tsujio
	12:00–13:00	Lunch	
	13:00–15:30	Hazard map preparation (river/urban floods)	Dr. Yusuke Yamasaki
	14:30–15:30	(3) Display of results	
Nov. 5, 2021 (Fri)	9:00–12:00	Hazard map formulation	Dr. Yusuke Yamasaki
	9:00–9:45	(1) Items to be displayed	
	9:45-10:30	(2) Inundation depth, scale	
	10:30–10:40	Coffee break	
	10:40–11:15	(3) Displaying evacuation sites and evacuation routes	Dr. Yusuke Yamasaki
	11:15-12:00	(4) Publication of map and how to use it	
	12:00–13:00	Lunch	
	13:00–15:00	Review, feedback	Dr. Daiki Tsujio

Source: JICA Project Team



Day 1: Analysis of damage through trace surveys, etc.
(storm surge)
(Maputo, November 2)

Day 3: Hazard map formulation
(Maputo, November 4)

Day 4: Hazard map preparation
(Maputo, November 5)

Day 4: Commemorative photo of training session participants (including online participants)
(Maputo, November 5)

Source: JICA Project Team

Figure 2-47 Photos from the second training session for hazard map formulation

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2.6 Collaboration with Other Donors

Collaboration with other donors is essential for hazard analysis and hazard map production. In particular, the World Bank (hereinafter referred to as WB) and the Netherlands government plan to implement the following coastal protection and drainage improvement projects in Beira.

Project: Coastal Protection & Drainage Improvement in Beira

From 2020: F/S and Environmental Impact Assessment (delayed for about one year)

From 2023: Detailed Design (for about one year)

From 2023: Construction (until 2026)

From the beginning of this project, we have continued discussions with other donors, such as the WB and the Netherlands government. According to the Netherlands government, the basic data and results of the hazard map studied in this project will be referenced to the F/S and environmental impact assessment on the Coastal Protection Project.

In addition, in the CPP project the comments indicated by the JICA project team regarding the direction of inundation and the necessity to implement countermeasures against the inundation caused from Maria river, the location of the coastal protection intervention was updated. Since the project team continuously made communication with WB and Netherlands project form the planning stage of the project it has contributed to the CPP project. The details of the input are mentioned in Chapter 3.

2.7 Reference Material Production for Hazard Map

Reference material describing the method and process of hazard map preparation was prepared so that the knowledge and experience of the response to the current disaster can be appropriately used for future disasters not only in Beira but throughout Mozambique.

In the hazard map formulation by the C/P institutions in Mozambique, it is considered that the C/P will need to manage the procurement process of the consultants to conduct the formulation. Therefore, the reference manual material was made by taking into account the process for the C/P institutions to conduct the procurement and progress management of the hazard map formulation process.

For the second training session, the original materials on which the reference document is based were explained. Comments from the relevant organizations on the Mozambican side were also reflected in the final reference document. An overview of the reference document is provided below.

Table 2-17 Overview of Reference Materials Used for the Hazard Map Formulation

Objectives	To understand the contents and methods of digital mapping, hazard analysis, and hazard map To expand the target area of hazard map based on the method for Beira	
Contents of Refence Material		
Chapter 1	Outline of Hazard Map Procedures	1st Technical Training
Chapter 2	GIS/Digital Mapping	1st Technical Training
Chapter 3	Damage situation analysis from flood marks (Storm surge/River flooding and urban flooding	2nd Technical Training
Chapter 4	Hazard Analysis: Storm Surge/Flooding	2nd Technical Training
Chapter 5	Hazard Map Formulation: Storm Surge/Flooding	2nd Technical Training
Chapter 6	Utilization of Hazard Map/Evacuation plan	2nd Technical Training

Source: JICA Project Team

CHAPTER3 Support for Formulating Infrastructure Recovery and Reconstruction Plans

3.1 Steps of consideration for infrastructure recovery and reconstruction plan

In the project, considerations for infrastructure recovery and reconstruction were conducted in three sectors: storm surge countermeasures, drainage, and roads. The selection of these sectors was based on a review of the Beira Municipal Rehabilitation and Resilience Plan (BMRRP), which highlighted the major disasters in the area, including inundation from storm surge and flooding in low-lying areas. To address these issues, countermeasures against storm surge and drainage were identified as crucial. Furthermore, the BMRRP also emphasized the significance of repairing degraded roads along the coastline and the need to ensure road infrastructure for effective evacuation. As a result, the road sector was added to the project scope to address these concerns. Firstly, survey to confirm the current situation of the infrastructure for each sector in Beira city was conducted to determine the extent of damage and identify support needs. Secondly, existing implementation plans of counter measures in each sector by international donors for recovery and reconstruction was reviewed. Thirdly, based on the current plan and the situation in Beira, additional counter measures to be considered were considered with regard to measures needed to eliminate residual risks and to strengthen resilience. The flow of studies in each sector is summarized in the table below. The consideration was conducted by utilizing the hazard map prepared by the project, and in addition, the JICA project team have communicated and exchanged opinion and information frequently with the World Bank, the Netherlands government, and other donors who are implementing project in the target sector in Beira city.

Table 3-1 Needs of Recovery and Rehabilitation for Each Target Sector

Sector	Steps of Consideration			
	Current Situation and Needs for Support	Review of Existing Counter Measures	Coordination with related organizations	Additional items to be considered
Coastal Protection	・ Damage to sea wall ・ Damage to other coastal facilities	・ BMRRP ・ Details of support by WB and Netherlands government	・ Discussions with CMB, AIAS, WB, Invest International (formerly RVO)	・ Measures against flooding from the river to the east of Beira city central area ・ Countermeasures against flooding of the western wetland
Drainage	・ Current drainage network ・ Occurrence of inundation, including outside the scope of the hazard map			・ Consideration was not done as a result of discussions with AIAS and CMB
Roads	・ Damage to coastal roads ・ Damage to road pavement	・ BMRRP ・ Beira Port Access Road	・ Consultation with CMB, MOPHRH and AfDB	・ Measures to strengthen the road and road network in Beira city ・ Road heightening of Beira Port access road.

Source: JICA Project Team

One of the most notable achievements of the project was that the inputs made by the project were included in the WB and Netherlands government joint-funded project to prevent inflow from the sea caused by storm surges from the river to the east of Beira city central area.

Based on the results of the hazard map formulated in this project, the simulation showed that implementing countermeasures to prevent inflow from the eastern river side would effectively reduce the extent of inundation in the city. The project team shared the results of the simulation with WB and Invest International (formerly RVO), a Netherlands government related institution for international aid and support. As a result, the additional countermeasures to prevent inflows from the eastern river side was included in the plan of the intervention.

3.2 Analysis of the Damage Situation and the Reconstruction Needs of Target Sectors

As mentioned above, countermeasures against storm surge, drainage, and roads were selected as target sectors. The damage situation in each sector is summarized in "2.1 Analysis of the Damage Situation and the Reconstruction Needs of Target Sectors ".

Table 3-2 summarizes the needs of each sector.

Table 3-2 Needs of Recovery and Rehabilitation for Each Target Sector

Sector	Related organizations	Needs
Coastal Protection	Beira Municipality AIAS, WB, RVO	- The current sea wall has deteriorated remarkably and is structurally vulnerable since there are no joint bars. - The World Bank/Netherlands government have plans to jointly build a sea wall planned to be by 2026. - It is therefore necessary to consider additional necessary measures after the completion of this plan.
Drainage	Beira Municipality AIAS, WB, RVO	- There is a plan to implement the second phase of a drainage improvement plan (jointly funded by WB and the Netherlands government) planned to be by 2026. - The Phase 2 project will cover the low land area in the urban area of Beira city, and will not cover the area at the east of Beira city where also inundation is happening. Therefore, there are needs for drainage projects to be implemented in these areas.
Road Infrastructure	Beira Municipality, MOPHRH, AfDB	- There is a high need for road reconstruction. It has been pointed out that the importance of road planning that corresponds to evacuation plans and land use plans is particularly important. - AfDB is planning road rehabilitation projects (between Beira City to Zambezia Province) over the next four years. - There is a high need to consider coastal roads and port access roads, and a plan that is linked to the hazard map is required.

Source: JICA Project Team

3.3 Review of BMRRP and Related Laws and Regulations for the Infrastructure Recovery and Reconstruction Plan

3.3.1 Storm Surge

The review will be conducted based on the BMRRP Volume2. The details are as the following.

a) Outline

Regarding storm surge countermeasures, the report proposes the recovery of seawalls, coastal roads, and beach areas. Although it does not describe restoration structure details, the improved dune system is presumed for beach area recovery. Also, the report suggests that the old seawall line should be utilized, and a seawall line should be installed along the coastline for the tide barrier in the estuary section. This proposal is closely related to future land use in this area. For the next step, the JICA Project Team will review these ideas based on the hazard map results.

Figure C.24: Two routes for protecting the city of Beira against hazards from sea.

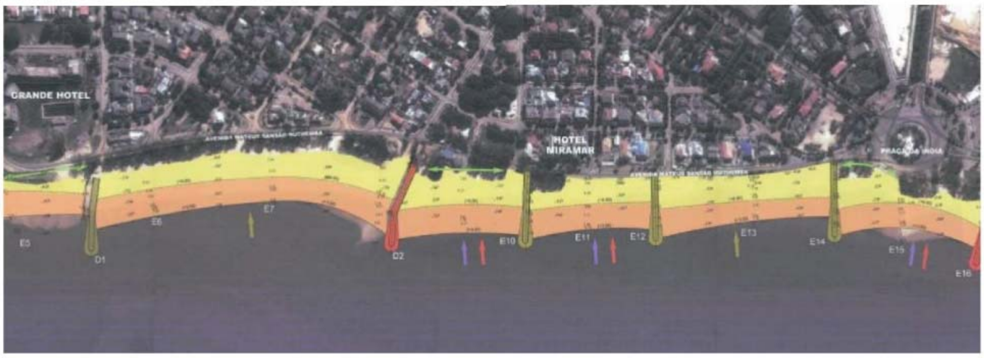


Figure C.23: Redesigned coastal protection scheme with higher and wider dune area and reinforced groynes (Source: [Consulmar, 2012])

Source: BMRRP Volume2, Annex C

Figure 3-1 Recovery and Reconstruction Plan of Storm Surge Measures and Coastal Protection in the BMRRP

b) Items considered in the project

Based on the results of the BMRRP, the following points should be noted in conducting the consideration in the project

- The policy is to recover the beach area as a Dune system, but while Dune is very beneficial system as an ecosystem, it is vulnerable to wave action, and a structure to prevent the inundation by storm surge shall be proposed to fundamentally change the way of preventing inundation from the sea.
- Regarding the selection of a seawall line at the mouth of the river, it is necessary to discuss the future land use with residents and to consider feasible seawall or coastal protection measures through a consensus-building process with the residents.
- Based on the results of the hazard map analysis in this project, it is necessary to consider measures against inundation caused by storm surge from the east river side, from the Beira port area, and from the west wetlands area, in addition to the current embankments at the river mouth and shoreline.

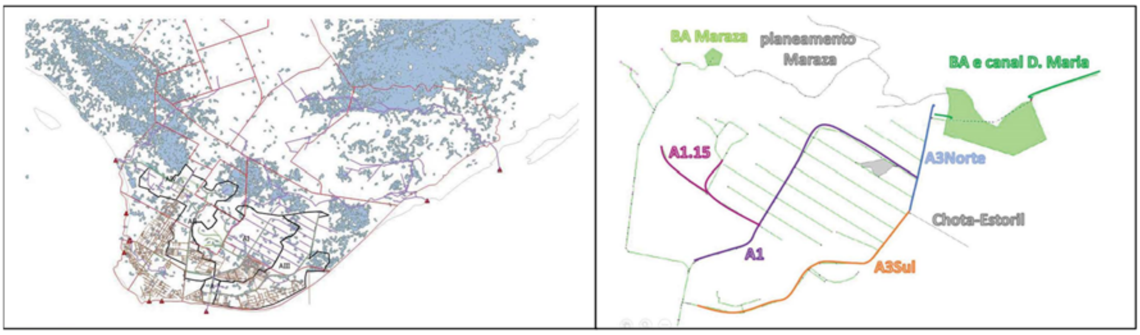
Based on the result of the BMRRP, the WB and the former RVO are conducting a detailed study simultaneously with this project, and the additional proposals considered in this project is described in the next section.

3.3.2 Drainage

The review will be conducted based on the BMRRP Volume2. The details are as below.

a) Outline

The BMRRP report proposes the upgraded drainage network and installation of retention ponds. Although it does not describe details of the upgraded drainage network, the meaning of "upgrade" is presumed to be the flow capacity improvement. The report also suggests that a retention pond should be installed on the east side, which is considered as a countermeasure against inundation in the eastern area based on the inundation map at Cyclone Idai.



Source: BMRRP Volume2, page95 and page100

Figure 3-2 Historical Inundation Map at Cyclone Idai and Recovery and Reconstruction Plan of Drainage Network

b) Items considered in the project

Based on the results of the BMRRP, the following points should be noted in conducting the consideration in the project

- Inundation conditions caused by rain in the urban center of Beira will be reduced by the development of the primary and secondary drainage network described in BMRRP.
- There is also a need to develop drainage system on the east side of the city, as residential are frequently flooded in the east low-lying areas of Beira city.
- Hazard maps have not been prepared to describe the actual inundation situation in the low-lying areas east of the urban area of Beira city. Therefore, in order to consider drainage system to be implemented in the area, it is necessary to confirm the details of the actual inundation situation as well as the Detail Plan for the urban planning of residential areas.

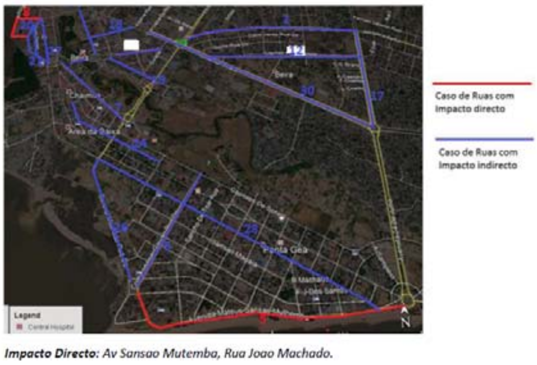
Based on the result of the BMRRP, the WB and the former RVO are conducting a detailed study simultaneously with this project and locations and specifications of the drainage system will be determined. Therefore, based on the result of the discussion among WB, the former RVO and the relevant C/P institutions such as AIAS and CMB, it was decided not to consider any additional countermeasure for drainage in the relevant districts to avoid duplication and confusion to the public. The status of consultations with relevant institutions are described in the next section.

3.3.3 Road

This section describes the policy for proposal in this project considering the review result of related plan/law and. In the road section, “(1) BMRRP” and “(2) Study on Beira Port Access Road” are reviewed. The proposal based on this section are describes in 3.6

(1) BMRRP

BMRRP proposed three items: “Recovery of damaged road”, “Elevation of airport road” and “Re-plantation of fallen tree”



Source：BMRRP Volume2、page159

Figure 3-3 Recovery Route Proposed in BMRRP

1) Recovery of damaged road

a) Outline

BMRRP selected the roads project to be recovered. The selection of project road was carried out considering the degree of damage, community activities, land utilization along the road and economic impact.

b) Items considered in the project

Although project road was selected, specific recovery plan was not described. Therefore, this project proposes the recommendation for the road plan to improve the disaster resistance considering "2.1 Damage Analysis through Site Surveys". The proposals are described in 3.6.

Source：Scoping study at pre-feasibility level for Beira’s long term coastal protection and flood preparedness. Final Report September 2018 page43

Figure 3-4 Elevation of Airport Road

2) Elevation of Airport Road

a) Outline

BMRRP proposed the elevation of the airport roads in order to realize the smooth evacuation activities during inundation. Reference value of elevation is about 1m.

b) Items considered in the project

Elevation of roads in inundation areas is an effective solution to secure evacuation routes and reducing inundation areas. However, it is necessary to consider an overlapping effect with other measures. As described in 3.4, area around the road is avoided inundating by developing coastal protection (Stretch 4: Macuti lighthouse - Rio Maria) so that elevation of this airport road is unnecessary.

In 3.3.1 (2), it is recommended that Beira port access road to be function as coastal protection. In this project, outline design of Beira port access road with function of coastal protection is studied in 3.6.3

3) Re-plantation of fallen tree

a) Outline

Re-plantation of tress fallen by the strong winds of Cyclone Ida was proposed. According to municipal estimates, 2,600 trees were fallen, and 2,500 trees should be re-plated.

b) Items considered in the project

Trees is important for providing a good urban environment. On the other hand, according to an interview with Beira municipality, maintenance work has not been carried due to lack of financial resources. If re-plantation is carried out without maintenance work, tress will be the future disaster risk. Therefore, this project recommends the formulation of maintenance and management system of trees. It is described in 3.6.2.

(2) Study on Beira Port Access Road

a) Outline

The Beira Port Access Road and development industrial area in the western part of Beira City was proposed in the Beira City Master Plan 2035. Feasibility study was carried out by Netherland finance. However, at present, Beira municipality is the implementation organization and are looking for donors.

Source： Beira City Master Plan 2035

Figure 3-5 Route of Beira Port Access Road

b) Items considered in the project

Recently, Japan is challenging to developing the resilience road network for disaster with redundancy (securing multiple emergency transportation routes) for road closer caused by disasters and accidents. The Beira port access road is expected to be a second arterial road to realize redundancy road network in Beira City, where National Road No. 6 is the only arterial road. In addition, according to the hazard analysis results described in 3.4 it is expected to function as a coastal protection.

On the other hand, the current plan for Beira Port Access Road does not consider disaster risk. Therefore, in this project, based on the hazard analysis, the road plan with disaster resistance is proposed in 3.6.

3.4 Support for Formulating Coastal Protection Infrastructure Reconstruction Plans

3.4.1 Overview of Infrastructure Reconstruction Plan Support for Coastal Protection Measures

With regard to measures, the flow shown in Figure 3-6 will be followed to support the formulation of an infrastructure recovery plan.

Data Collection for Existing Plans and Related Information

↓

Setting a Target Level for Storm Surge Countermeasures

↓

Setting a Target Area for Storm Surge Countermeasures

↓

Basic Structure of Storm Surge Countermeasures

↓

Implementation Strategy

↓

Rough Estimation of Storm Surge Countermeasures Costs

Source: JICA Project Team

Figure 3-6 Flow of infrastructure reconstruction plan formulation for sea wall countermeasures

3.4.2 Data Collection and Organization for Existing and Related Plans

The existing and related plans for coastal protection in Beira are the Coastal Protection Project (CPP) preparation studies for Beira Mozambique, shown below. This project is co-financed by the World Bank and the Netherlands government.

The CPP is studying the most appropriate coastal protection countermeasures for each of the following four areas.

- Stretch 1: Port of Beira - Rio Chiveve outlet
- Stretch 2: Rio Chiveve outlet - Ponta-Gêa
- Stretch 3: Ponta-Gêa - Macuti lighthouse
- Stretch 4: Macuti lighthouse - Rio Maria

Figure 2-1: Beira project area with 4 distinguished coastal stretches

Source: Coastal Protection Project Beira feasibility report Nov 5, 2021

Figure 3-7 Location map for CCP study

As one example under consideration, Figure 3-8 shows a standard cross-sectional view of Stretch 3. The CPP compared and studied each stretch in this way, with public meetings to explain the project to residents, and the optimal proposal has been selected for each stretch.

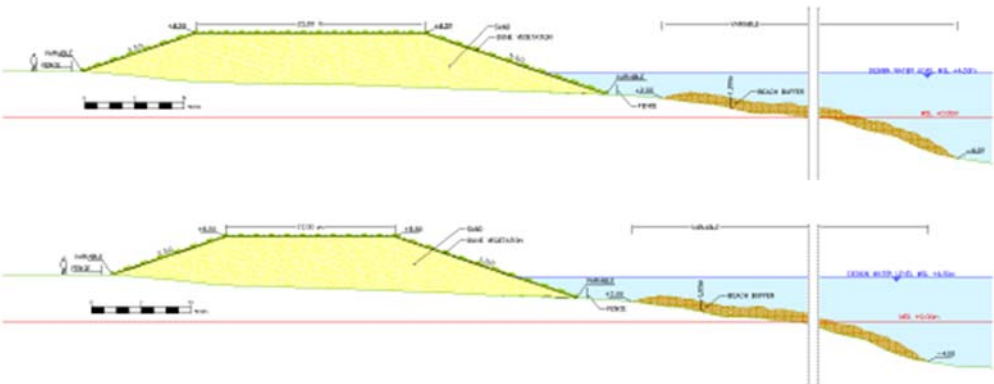


Figure 6-5: Typical cross-sections of the dune design. Top figure: east, bottom figure: west and central

Source: Coastal Protection Project, Beira feasibility report 05 Nov 2021

Figure 3-8 Standard cross-section of Stretch 3

CPP initially considered stretches 1 to 4, but then divided the four stretches into 10 sections according to countermeasures and selected the optimal plan for each section. The final CPP countermeasure’s location map is shown in Figure 3-9. Stretches 1–4 and 6 are sea wall structures and Stretches 5 and 7–10 are coastal embankment structures. Since future port expansion plans have not yet been finalized and the inundation area is quite limited, for the time being non-structural measures such as evacuation plans, and early warnings will be implemented rather than structural measures according to the interview result to the respondent of WB and the Netherlands Government.

Figure 1: Overview of proposed package of site-specific structural measures for the Beira coastal protection program

Source: Coastal Protection Project, Beira feasibility report Nov. 5, 2021

Figure 3-9 Location map for determined countermeasures

3.4.3 Setting Target Levels for Coastal Protection Measures

A target external force level needs to be established; in the case of seawalls, the main external forces include tides and waves. The CPP uses the 50-year probability value as the external force, which is consistent with Japanese standards. The inundation area for a 50-year probability storm surge is shown in Table 3-3, not considering the presence or absence of climate change.

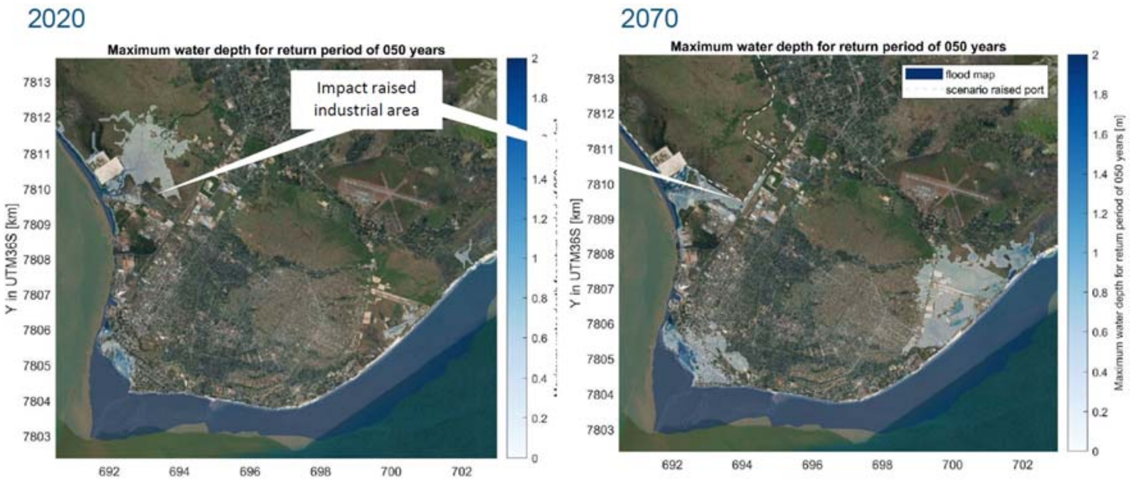
Table 3-3 Applicable External Forces by Stretch

Table 2-1: Hydraulic conditions for 1:50 per year design event

	S1***	S2		S3			S4
		S2 North	S2 South	S3 West	S3 Central	S3 East	S4**
Water level (m+MSL)	4.3	4.5	4.5	4.5	4.5	4.5	4.5
$H_{m0,\,max}$ (m)*	N/A	1.2	2.0	2.2	2.5	3.1	3.2
$T_{p,\,max}$ (s)*	N/A	11.1	11.5	11.9	12.4	12.7	12.8
$h_{,max}$ (MSL +m)*	4.3	4.5	4.5	4.5	4.5	4.5	4.5
Design wave angle (°)	N/A	45	45	45	45	0	0
$H_{m0,max}$ (m) + 10%	N/A	1.3	2.3	2.5	2.7	3.4	3.5
$T_{p,max}$ (s) + 10%	N/A	12.2	12.6	13.1	13.6	14.0	14.0

* Please note that the presented H_{m0}, h_{max} and $T_{p,max}$ have been determined independently (without any correlation). This is a conservative choice. In reality the maximum h, H_{m0} and T_p will not occur at the same time.
** For more inland design alternative only depth limited waves can occur. The wave height in that case can be calculated using the design condition for the local water depth and multiplied by a breaker parameter of 0.55 for irregular waves (Source: (The Rock Manual, 2007)).
*** For this stretch no waves apply since all alternatives are located inland where waves have no influence.

Source: Coastal Protection Project Beira feasibility report 05 Nov 2021



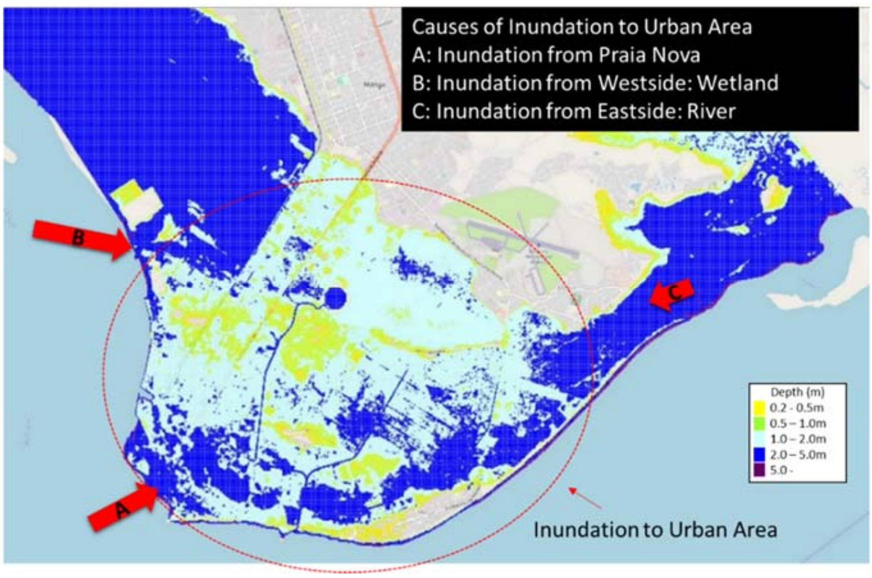
Source: CPP Beira Mozambique Broad Stakeholder Consultation meeting #3, Sept. 8, 2021

Figure 3-10 Map of estimated inundation zones based on 50-year probabilities (left: 2020, right: 2070)

3.4.4 Setting Target areas for Coastal Protection Measures

In order to select the necessary areas for measures, it is necessary to identify the factors that contribute to inundation caused by storm surge. Based on a review of the hazard map, the following three factors were identified as contributing to the inundation of central Beira.

A. Inundation from Praia Nova
B. Inundation from the westside wetlands
C. Inundation from the eastside river

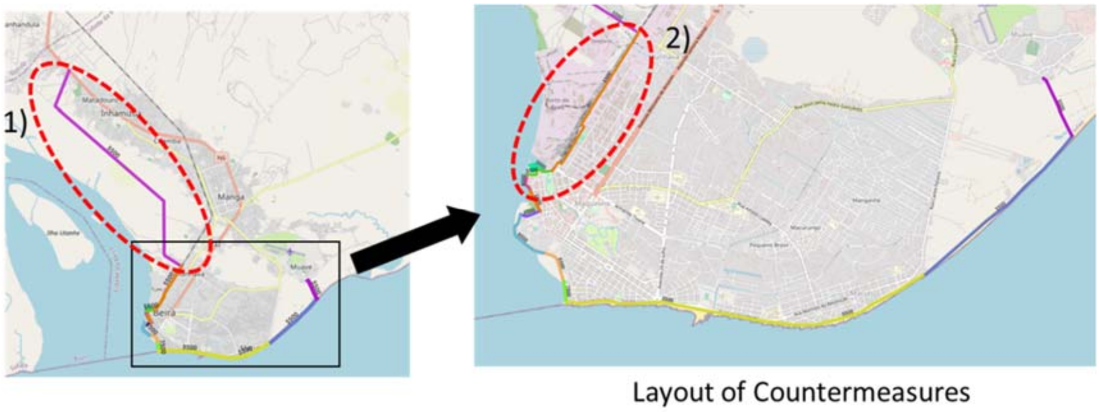


Source: JICA Project Team

Figure 3-11 Storm surge inundation factors in Beira

Since it was decided as part of consultations with related organizations that the CPP would not implement measures in the port area, it was noted that inundation countermeasures for factors A and C would be effective, but there was no such expectation for factor B. The CPP is effective in thoroughly preventing inundation from factor B for a 50-year probability external force, but not for a probability event of 200–300 years as targeted in this project’s hazard map. Therefore, the following two additional measures were considered in addition to the CPP measures.

1) Port access road that functions as coastal protection (see Road section)
2) Coastal Protection to connect the port and access road



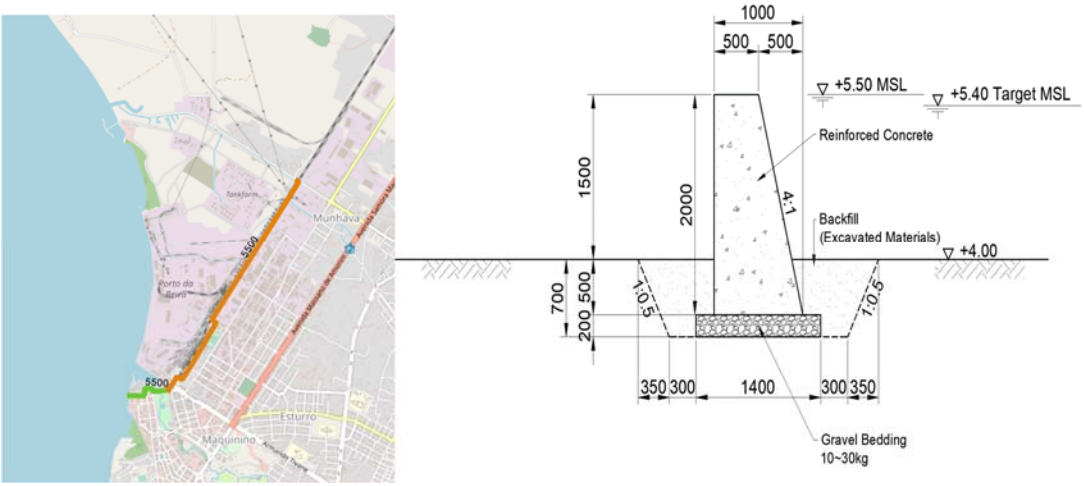
Source: JICA Project Team

Figure 3-12 Layout of additional sea wall measures

3.4.5 Basic Structure of Coastal Protection Measures

The basic structure of the proposed coastal protection measures is described in detail in the road planning section below for 1) the port access road and 2) in an example cross section for the sea wall connecting Beira Port and the access road. Since there is no space available in the target section due to the existing residential and commercial buildings and railroad tracks, an upright wall has been adopted to minimize the impact area. It should be noted that the details should be redesigned during the implementation phase.
For the additional sea wall proposal, it should also be noted that at least the following issues should be addressed for implementation.

- Ensuring consistency with the expansion plans for the Port of Beira
- Handling of train rails and intersection points such as railroad crossings



Source: JICA Project Team

Figure 3-13 Example of Coastal Protection basic structure

3.4.6 Implementation Plan for Coastal Protection Measures

When considering the implementation of sea wall measures, it is necessary to verify their effectiveness. In addition to the effectiveness of the measures, it is also necessary to understand the constraints. Therefore, the inundation simulation conducted in the hazard map study was used to analyze the inundation situation after the implementation of structural measures. The following two cases were subjected to calculations.

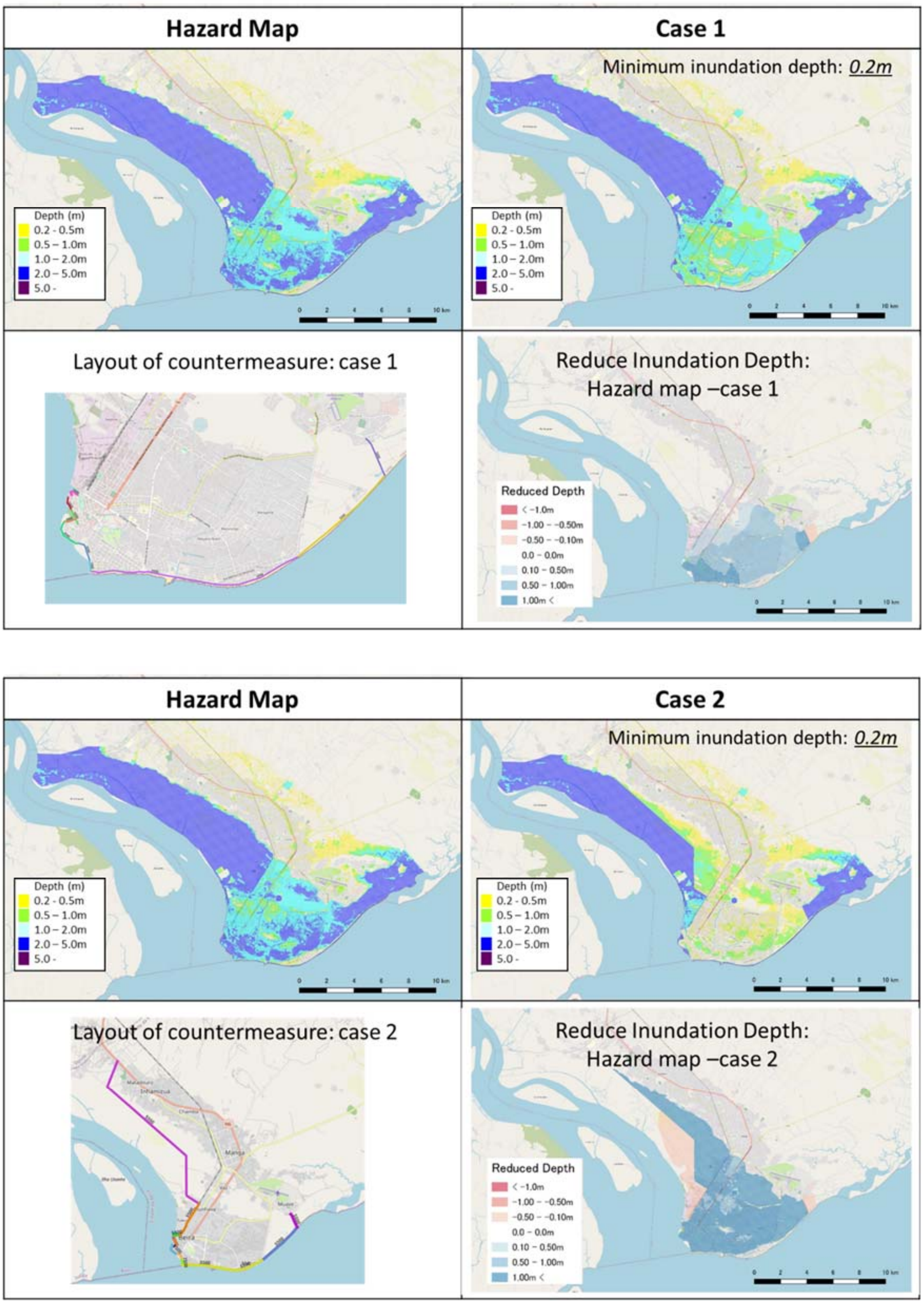
- Case 1 Coastal Protection Project (CPP) Study of AIAS funded by WB and ROV
- Case 2 Future Development Plan Case 1 + port access road and connections

The external force conditions are the same as those used for the hazard map but are reiterated below as follows.

- Cyclone level: Cyclone Idai :Lowest Center Pressure 944 hPa
- Tide: Spring High Tide :MSL+3.6m at Maximum
- Storm surge: induced by Cyclone Idai :MSL+5.4m at Maximum
- Rainfall: induced by Cyclone Idai :220mm/day (March 14, 2019)

The calculation results for Case 1 and 2 are shown in Figure 3-14. For each case, the upper left is the hazard map (maximum inundation depth distribution without countermeasures), the lower left is the location map of structural countermeasures, the upper right is the maximum inundation depth distribution after structural countermeasures, and the lower right is the reduced maximum inundation depth.

From the results, Case 1 (CPP) can reduce the inundation depth in central Beira in terms of hazard map levels, but the scope of inundation remains the same as before. Case 2 can further reduce most of the inundation in the city center.



Source: JICA Project Team

Figure 3-14 Inundation simulation after sea wall measures for Case 1 and Case 2

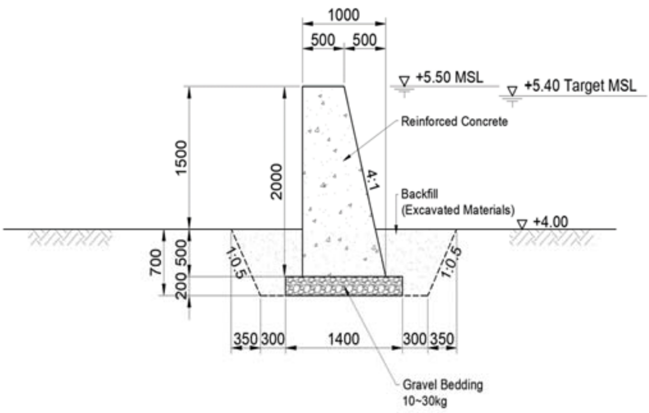
3.4.7 Calculation of Estimated Construction Costs for Coastal Protection Measures

Estimated construction costs for coastal protection proposed in an addition to the CPP was calculated. It should be noted that the unit cost used is an example based on the current assumptions, and detailed studies will be required in the future when implementing the project.

Based on the results of this study, the estimated construction cost for the 3.6 km of additional sea wall is approximately USD 5 million. This estimate is based on the average cross-section multiplied by the extension, and detailed studies on the optimal locations for measures, optimal structural cross-section, etc. will be required before implementation.

Table 3-4 Estimated construction costs for coastal protection measures

Coastal Protection



Pay Item	Spec.	Quantity	Unit	Rate (US$)	Amount (US$/m)	Remark
1 Excavation		1.65	m3/m	3.30	5.43	
2 Crushed Stone	10~30kg	0.28	m3/m	22.00	6.16	
3 Crushed Stone Levelling	t=20cm	1.40	m2/m	5.50	7.70	
4 Rebar for Reinforced Concrete Block	Grade 60	0.12	ton/m	1,375.00	165.00	
5 Formwork for Reinforced Concrete Block		4.31	m2/m	35.20	151.77	
6 Concrete for Reinforced Concrete Block	C30	1.50	m3/m	187.00	280.50	
7 Construction Joint		0.15	m2/m	18.57	2.79	
8 Backfilling	Excavated Materials	0.90	m3/m	5.50	4.93	
Subtotal (/m)				US$	624.27	
Length				m	3,600.00	
Cost	Direct Cost			Million US$	2.25	
	In-Direct Cost	100	%	Million US$	2.25	
	Subtotal			Million US$	4.49	
	Consultant fee	10	%	Million US$	0.45	
Total Cost				Million US$	4.95	

Source: JICA Project Team

3.5 Support for Developing Drainage Infrastructure Recovery Plans

3.5.1 Overview of Drainage Infrastructure Rehabilitation Support

Support for the development of a drainage infrastructure rehabilitation plan was not implemented in this project for the following reasons.

At the start of this project, the infrastructure rehabilitation plan for drainage was intended to support the second phase of the drainage improvement plan co-financed by the World Bank and the Netherlands government as shown in Figure 3-15, and to verify the effectiveness of the plan through inundation analysis. However, due to a delay in the schedule of that plan due to COVID-19, the feasibility study results that were expected to be delivered in May–June 2022, and AIAS and CMB's opinion that the JICA survey team conducting its own drainage channel plan would cause confusion, this project will not provide assistance in developing a drainage infrastructure rehabilitation plan within the scope of the World Bank/Netherlands government plan (Figure 3-15).

Source: CPP Beira Mozambique Broad Stakeholder Consultation meeting #3, September 2021.

Figure 3-15 Latest drainage plan co-financed by World Bank/ Netherlands government (draft)

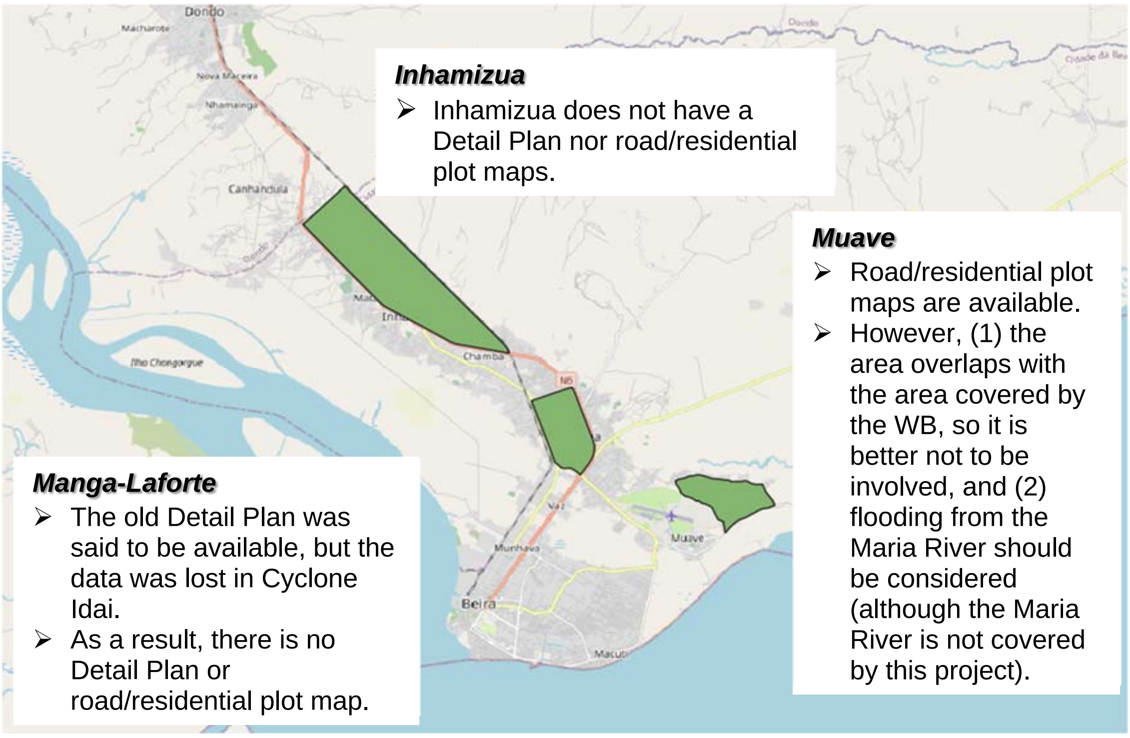
3.5.2 Consideration of Drainage Plans for Other Areas

As noted above, this project has confirmed that it will not provide assistance in developing a drainage infrastructure rehabilitation plan in the areas shown in Figure 3-15. On the other hand, we received a request for drainage plans for three areas of high interest to CMB (Muave, Manga-Loforte, and Inhamizua, see Figure 3-16). However, we confirmed with CMB that it would be difficult to consider a new drainage plan within the current project for the following reasons.

- Inhamizua district: As of March 2022, the district does not have a detail plan for urban planning, nor a plot plan for roads and housing.
- Manga-Loforte district: It was reported that the district had an old detail plan for urban planning, but

the data was lost in Cyclone Idai and there is no new plan as of March 2022.

- Muave district: Although there is a road and residential plot plan, it is not desirable to consider it within this project because (1) it overlaps with the drainage improvement plan of the World Bank and Netherlands government, and (2) consideration needs to be given to flooding, etc. from Rio Maria.



Source: JICA Project Team

Figure 3-16 Three districts requiring wastewater infrastructure development

On the other hand, as of March 2022 no other donor support has been decided for the three areas shown in Figure 3-16. so, it would be promising to provide new drainage infrastructure support to these three areas after this project and the World Bank/ Netherlands government drainage improvement plan.

3.6 Support for Developing Road Infrastructure Recovery Plans

3.6.1 Outline

The proposed measures are categorized into "Residential road" and "Arterial road". For "Residential road" recommendations are made for road structure planning and maintenance systems to enhance the capacity for disaster resistance, considering the damage caused by Cyclone Idai. For "Arterial roads" a recommendation is made for the Beira port access road to establish a resilient arterial road network, guided by the analysis of the hazard map.

3.6.2 Residential Road for Strengthening Disaster Resilience

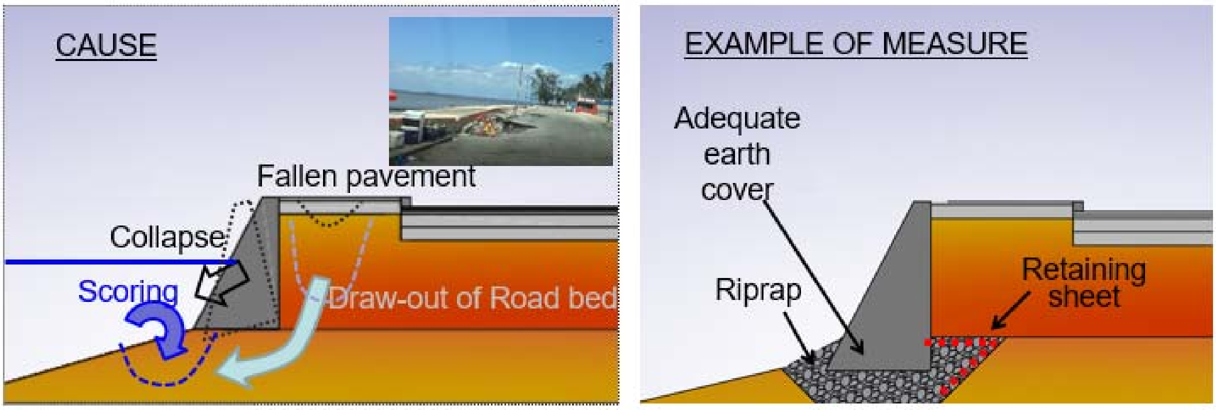
As described in 2.1, disaster risks are following 3 items; "(1) Lost road shoulder functions due to collapsed coastal protection structures", "(2) Fallen trees and electric poles by strong winds, and pavements damages caused by these", and "(3) Pavement damages caused by heavy vehicles to remove fallen trees". This section describes the measures against above items.

(1) Measures against lost road shoulder functions due to collapsed coastal protection structures

The primary cause of lost road shoulder is probably collapse of coastal protection by scouring of ground and washing out of the embankment.

Therefore, recovery plan for coastal road shall be studied with strengthening the coastal protection. The example of measure against scouring and wash out are replacement the foundation ground with riprap, ensuring sufficient earth covering and installation retaining sheet.

The figure below shows the cause of lost road shoulder and its measure.



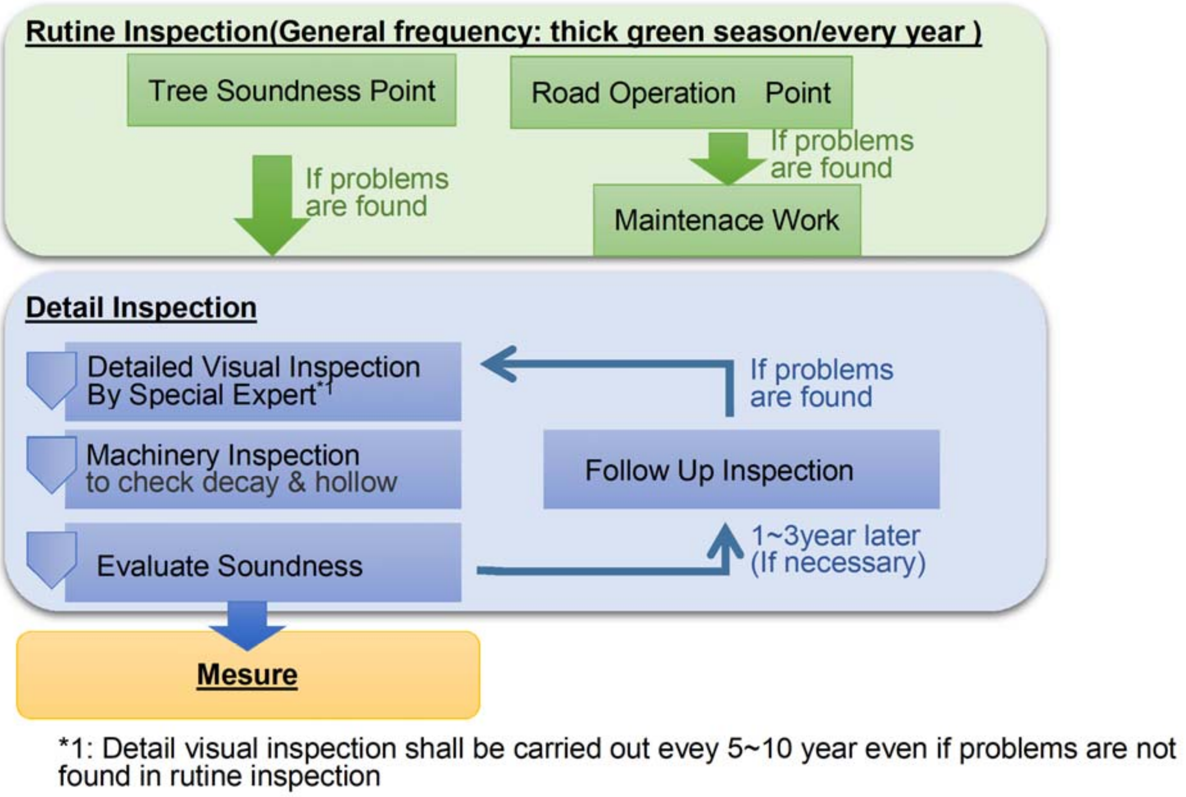
Source: JICA Project Team

Figure 3-17 Cause of Lost Road Shoulder and It's Measure.

(2) Fallen trees and electric poles by strong winds, and pavements damages caused by these

The cause of fallen trees is not only strong wind by cyclone, but also weakened durability of trees due to decay and damage, etc. Therefore, to avoid the fallen trees, maintaining the durability by appropriate inspection and maintenance work.

Following figure shows the inspection flow in Tokyo metropolitan city. In the Tokyo metropolitan city, city engineer carries out tree inspections during the growing season. If problem/damage is found, detail inspection is carried out by specialists with special equipment. To implement in Beira, it is necessary to build a realistic system considering financial and human resources. In addition, if it is difficult to cover entire road network, prioritization route shall be selected such as important transportation routes and evacuation routes.

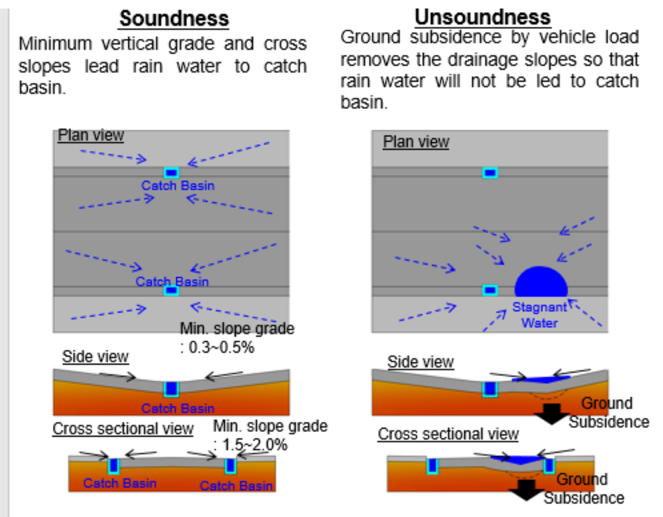


Source : Tree inspection guideline 2021, Edited by JICA Project Team

Figure 3-18 Inspection Flow in Tokyo Metropolitan City

(3) Pavement damages caused by heavy vehicles to remove fallen trees

It is necessary to apply highly durable pavement as a measure against pavement damage by heavy vehicle. However, the more important thing to maintain durability for a long period of time eliminate causes of early deterioration such as stagnant water and luck of drainage facility. The stagnant water is caused by inadequate vertical/cross slope to drain the road surface water is lost by ground subsidence. The cause of this subsidence is thought to be insufficient strength of the roadbed/subgrade and insufficient compaction during construction. Therefore, it is desirable to improve the pavement capacity, develop drainage facilities, and carry out repairs under appropriate design and construction quality control.



Source: JICA Project Team

Figure 3-19 Mechanism of Stagnant Water

(4) Additional Proposal 1: Guidance for Evacuation Route

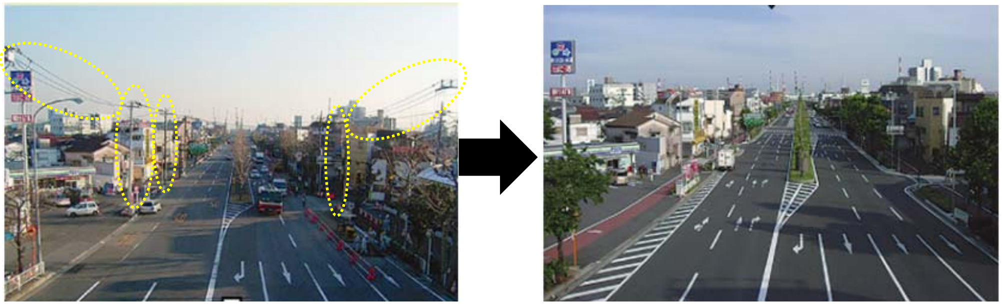
In past disasters in Japan, one of the factors which is increasing the number of victims in past disaster is that people cannot carried out evacuation activity because they do not know the evacuation site and route. From this experience, easy understanding guidance is provided in disaster risk area

Source: JICA Project Team

Figure 3-20 Guidance of Evacuation Route

(5) Additional Proposal 2: Guidance for Evacuation Route: Removal of Electric Pole

In past earthquakes in Japan, collapsed electric poles which close roads cause the delay for evacuation activities and transportation of supplies. From this experience, efforts are being made to eliminate utility poles along emergency transportation routes. In the same as Japan experience Beira municipality has risk for fallen trees and the collapsed electric poles to cause delay for emergency activities. The removal of electric poles from evacuation routes is recommended for enhancing the disaster.



Source: Ministry of Land, Infrastructure, Transport and Tourism HP

Figure 3-21 Removal of Electric Pole

3.6.3 Arterial Road

(1) Action in Japan

1) Redundancy

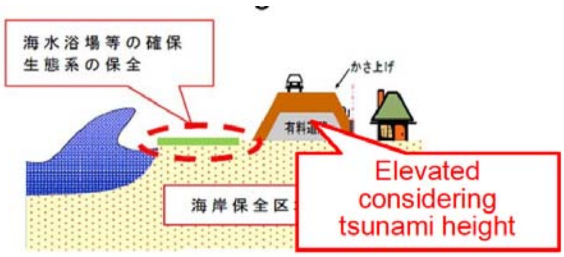
In the Great East Japan Earthquake, the west side road functioned as a transportation route for emergency goods instead of east side road closed by disaster. From this experience, Japan challenges the formation of a network that ensures redundancy (multiple access route).

Source： Ministry of Land, Infrastructure, Transport and Tourism HP

Figure 3-22 Redundancy in the Great East Japan Earthquake

2) Resistant Structure for Disaster

In the Great East Japan Earthquake, roads with high embankments functioned as a seawall to present tsunami. In addition, elevated road function as evacuation is from the Tsunami by running up from the slope to the embanked road. From this experience, elevation of roads in consideration of water disaster risk. The step is installed for elevated road to function as evacuation route.



Source: Chiba prefecture

Figure 3-23 Example of Kujukuri-Road,Chiba

(2) Recommendation in Beira

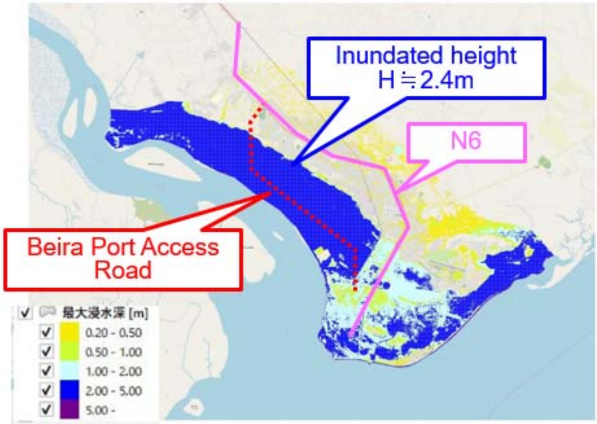
To enhance disaster resistance, it is recommended to develop Beira Port Access Road. The reason is as follows.

- Currently, National Road No. 6 is the only trunk road in Beira City. Redundancy will be ensured by the development of the road.
- It is expected to function as a coastal protection for the western wetlands where industrial area is planned in the Beira Master Plan.

1) Case Study on Beira Port Access Road

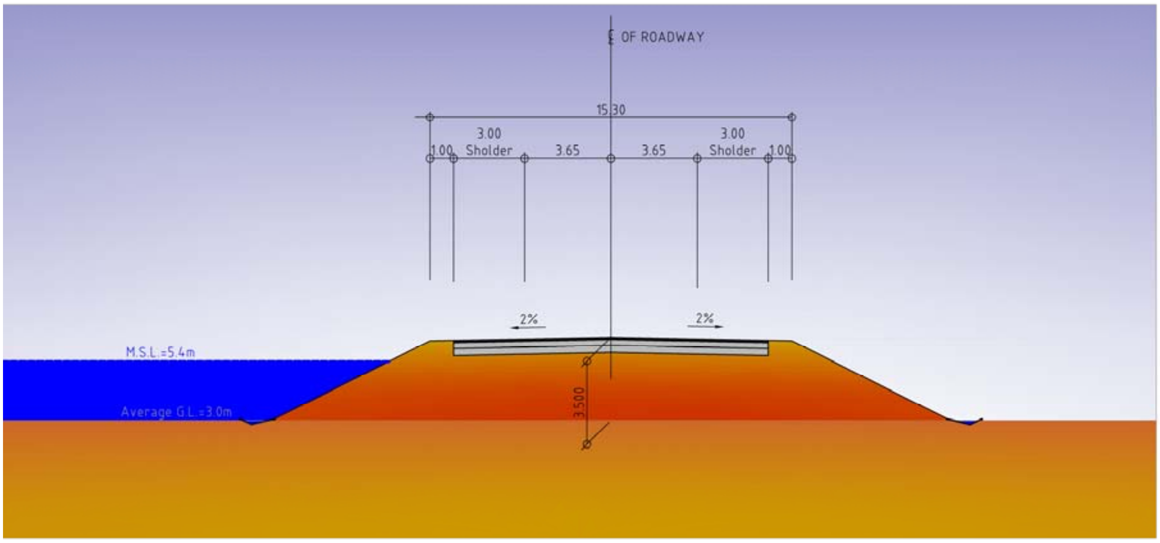
According to the hazard analysis, the area along the Beira Port Access Road is predicted to be inundated with the depth of about 2.4m. It is necessary to determine the road structure based on this inundation.

A schematic cross section is shown below. Considering the durability of the pavement, bottom of subbase should be higher than flooded height. Therefore, it is desirable that the design embankment height is about 3.5m.



Source: JICA Project Team

Figure 3-24 Route of Beira Port Access Road and Inundation Height



Source: JICA Project Team

Figure 3-25 Proposed Schematic Cross Section

Based on the cross-sectional plan above, a project cost was estimated. The results are shown in the table below. The estimated project cost is MZN 2.7 billion (direct dost). The cost should be reviewed on the implementation stage.

Table 3-5 Rough Estimation Cost for the Beira Port Access Road

				1JPY＝	502.21	MZN	(May 2022)
	Units	Units cost	Quontity/m	Units/m	ength（m)	Construction cost（JPY)	Construction cost（MZN)
embanmkment	m3	4,000	70	280,000	13000	3,640,000,000	1,828,044,400,000
Paveme	m 2	5,000	13	66,500		864,500,000	434,160,545,000
Draignage	m	6,000	2	12,000		156,000,000	78,344,760,000
Sloe formuaitio	m	1,000	1	1,000		13,000,000	6,528,730,000
Soft soil treatm	L.S.	673,985,813	-	-		700,000,000	351,547,000,000
					Tota	5,373,500,000	2,698,625,435,000

Source: JICA Project Team

3.7 Development of Reference Materials for Infrastructure Recovery and Reconstruction

Based on the above considerations, we will create materials that can be referred to for other cases. An outline is provided in the next table.

Table 3-6 Outline of Reference Materials for Infrastructure Recover and Reconstruction

Item	Content
Title	Reference Materials for Resilient Infrastructural Planning
Applicable Organizations/Persons	AIAS and ANE of MOPHRH, GREPOC and Beira City Council (CMB)
Purpose	For the staff of the target organizations to understand the points and knowledge regarding the development of more resilient infrastructure from an overview of the recovery and reconstruction of Beira's infrastructure.
Main Content	An overview of infrastructure recovery and reconstruction projects in Beira, targeting two sectors (roads and storm surge countermeasures), proposals for projects that are assumed effective from the perspective of strengthening resilience, and commentary on points when considering projects.

Source: JICA Project Team

Currently, the Table of Contents structure is as follows.

CHAPTER1 Reference Material of Storm Surge Planning

- 1.1 Outline of the Reference Material
- 1.2 Data Collection of Existing Plan and Related Information
- 1.3 Setting Target Level of Storm Surge Countermeasure
- 1.4 Setting Target Area of Storm Surge Countermeasure
- 1.5 Basic Structure of Storm Surge Countermeasure
- 1.6 Strategy of Implementation
- 1.7 Rough Estimation of Storm Surge Countermeasure

CHAPTER2 Reference Material of Road Planning

- 2.1 Outline of the Reference Material
- 2.2 Disaster Risk and Measures for Residential Road
  - 2.2.1 Storm surge
  - 2.2.2 Strong wind
  - 2.2.3 Pavement damages caused by heavy vehicles to remove fallen trees
  - 2.2.4 Additional Proposal 1: Guidance for Evacuation Route
  - 2.2.5 Additional Proposal 2: Guidance for Evacuation Route: Removal of Electric Pole
- 2.3 Arterial Road Plan Considering the Disaster
  - 2.3.1 Redundancy
  - 2.3.2 Resistant Structure for Disaster

CHAPTER4 Support for Formulating Land Use Plan

4.1 Land Use Planning in Mozambique

4.1.1 Land Use Planning in Urban Planning System

Decree No. 23/2008 stipulates land use planning for spatial planning and urban planning in Mozambique. As a general rule, spatial plans are prepared in Districts or Municipalities. Since Beira has a Municipal body, the regulations for Municipalities are applied.

In the Municipality, as a general rule, the Structure Plan is created as a master plan, followed by the General Urbanization Plan, (Partial Urbanization Plan), and Detail Plan. These plans are created by the Municipality and approved by the Municipality Assembly. The central government does not have the authority to approve it; MTA only "ratifies" it as a part of procedure. The Structure Plan indicates the direction of future urbanization but does not have legally binding force regarding land use. The General Urbanization Plan, on the other hand, is prepared as a legally binding land use plan. A partial urbanization plan may be prepared in a municipality with a large built-up area, which is not the case of Beira City.

In addition to those stipulated in Decree No. 23/2008 under the jurisdiction of MTA, there is a Detail Plan under the jurisdiction of the Ministry of Public Works and Housing. The Detail Plan is not a regulatory guidance for the existing urban area, but a plan drawing for the residential land development project and is prepared by the Municipality. In addition, the Municipality will be the implementing body for the public housing land development projects based on these Detail Plans.

Table 4-1 Outline of Land Use Plan according to Decree No. 23/2008

ARTICLE 4 (Levels of intervention and land planning instruments)	5. At the municipal level, land planning instruments are as follows: a. Urban Structure Plan (PEU); b. General Urbanization Plan (PGU); c. Partial Urbanization Plan (PPU); d. The Detailed Plan

Source: Excerpt from Decree No. 23/2008

4.1.2 Handling by Disaster Prevention System

The land use plan is also stipulated in the system of disaster prevention measures. Article 31 of Law No. 15/2014 required that the classification of risk areas be defined as a spatial plan.

Table 4-2 Outline of Land Use Plan according to Law No. 15/2014

ARTICLE 31 (Risk areas)	1. Spatial planning shall define the areas with risk of disasters. 2. Disaster risk areas shall be classified in zones with high risk, medium risk, and low risk. 3. The construction of housing in high-risk areas is prohibited. 4. Placement of construction and housing banning signs in zone areas.

Source: Excerpt from Law No. 15/2014

Since Law No.10/2020 of August 24th has come into force, the provision concerning the precautionary spatial division of risk areas, which was in Article 31 of the 2014 law, has been deleted. The new law stipulates the designation of risk areas only after the taking place of disasters.

4.1.3 Issues related to Laws and Regulations

From the viewpoint of DRRM, the following can be pointed out as institutional problems related to land use planning.

- In both DRRM and city planning systems, there are no definitions or development requirements related to preventive hazard maps and risk maps.
- There is no provision for coordination, such as cross-referencing of spatial planning in the city planning system and land use planning in the DRRM system.

In response to this situation, improvement of laws and regulations through collaboration between DRRM and the urban planning sectors is required. At present, MTA is preparing to review the Land Policy, which provides the foundation of land use policies, and the necessity of introducing hazard maps and risk maps into the spatial planning system is being recognized and discussed.

4.2 Preparation of Risk Maps

A set of risk maps was created as a method of incorporating the perspective of DRRM in urban planning. Since the difference between hazard maps and risk maps is not clearly defined in Mozambique, JICA Expert Team explained the purpose and significance of each map to GREPOC, MTA, and Beira City, and agreed on the necessity of developing risk maps.

4.2.1 Classification of Hazard Map Results

Based on the hazard maps discussed in Chapter 2, we ranked the flood heights and created a hazard map rank chart, especially considering the construction method of buildings in Beira. This will be the basis for creating a risk map, which will be described later. The concept of ranking is as follows.

(0) 0-0.2m, little risk

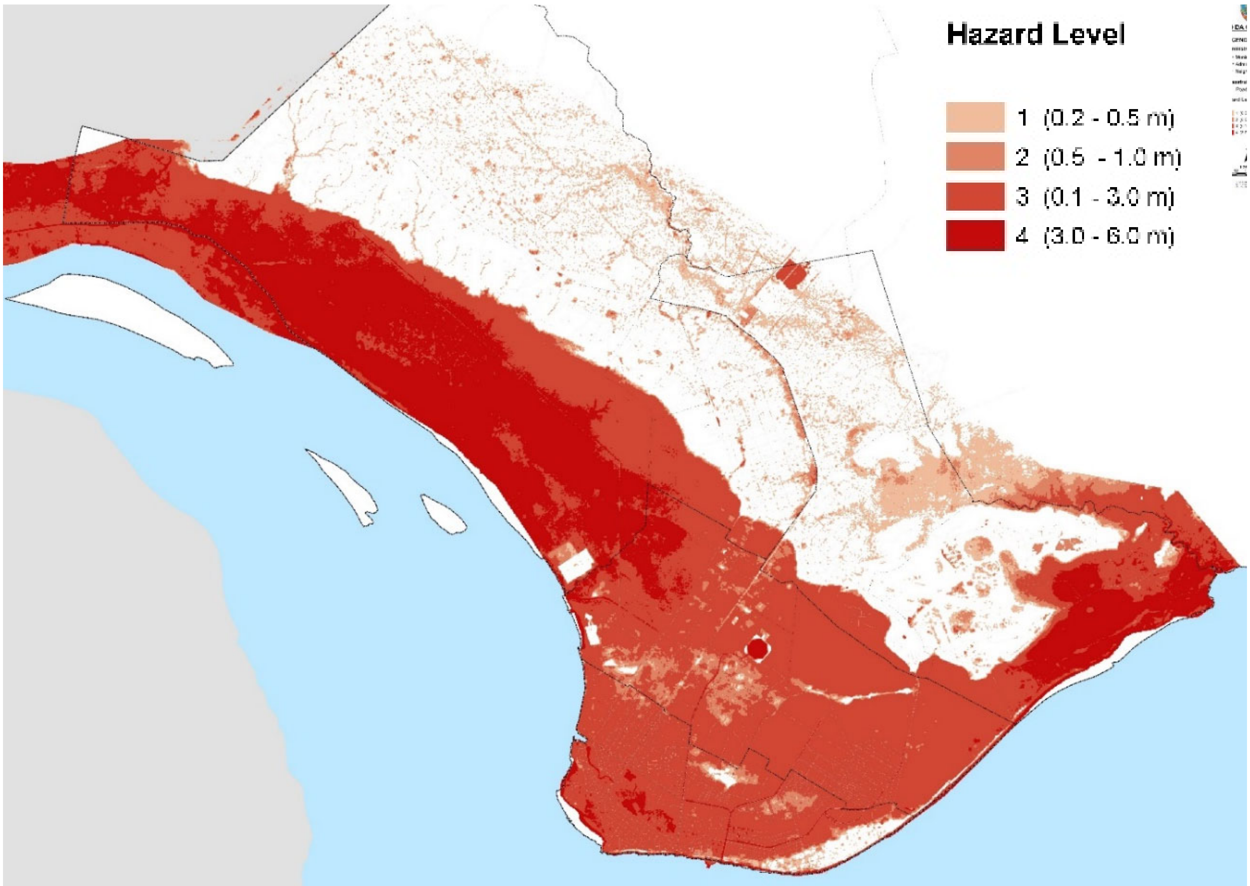
(1) 0.2-0.5m, corresponding to a small urban flood on the first floor of a dwelling facility. Goods and people can be evacuated

(2) 0.5 to 1.2m floods up to half the height of the dwelling facility, making it difficult for vehicles to move, but allowing people to evacuate to the upper floors or top of the dwelling facility

(3) 1.2 to 3.0m, equivalent to a flood that covers the entire height of a house, and in the case of a one-story house, residents can take refuge only to the roof top

(4) At 3.0 to 6.0m, a one-story house is completely submerged in water, which corresponds to a very dangerous situation.

Figure 4-1 shows the hazard rank map and the area corresponding to the above water depth classification.



Hazard Level	Influenced Area (ha)	Share of the Influenced Area (%)
1 (0.2-0.5m)	1 745	8.5%
2 (0.5-1.2m)	1 287	6.3%
3 (1.2-3.0m)	6 153	30.1%
4 (3.0-6.0m)	3 522	17.2%

Note: The Area covers 20,466 ha corresponding to the hazard map coverage area, which is 31.88% of the entire area (64,20 ha) of Beira City.

Source: JICA Project Team

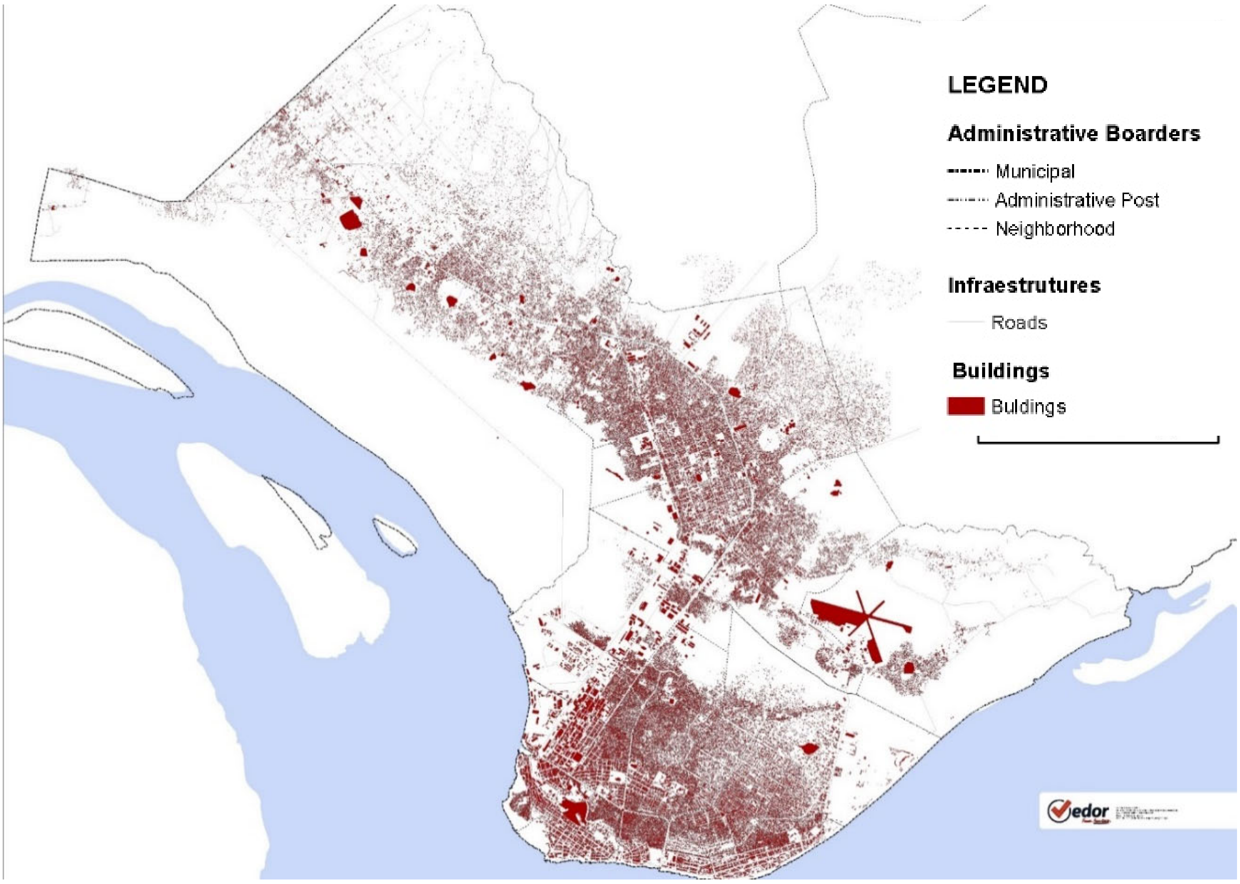
Figure 4-1 Classification of Hazard Map Results

4.2.2 Creation of Socio-economic and Human Activity Maps

After ranking the hazard map results, a base map was created for the assessment of socio-economic and human activities by asset and population distribution. The creation was performed based on the following procedure.

(1) Step 1 - Mapping Existing Buildings

Mapping of existing buildings was carried out using the software QGis and ArcGis. For these mappings, high-resolution satellite imagery was used to visualize all buildings within the municipality. Subsequently, for objects that can be called "buildings", vector data was created based on aerial photographs, and mapping was carried out in hierarchical order from the center with the highest population density to the district with the lowest population density. Figure 4-2 shows the distribution of buildings.



Source: JICA Project Team

Figure 4-2 Distribution of Buildings

(2) Step 2 – Building Identification

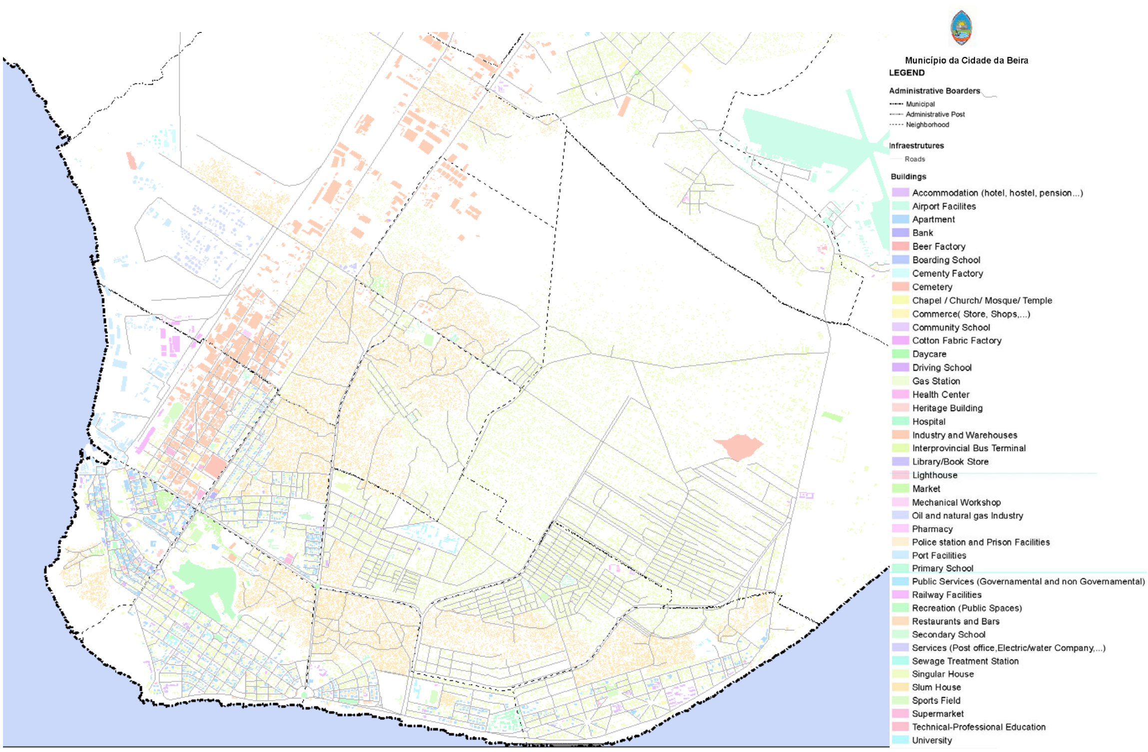
Building identification was carried out using available information from sources such as Google Maps, result of INE's surveys, and field survey by the JICA Project Team. Similar to building mapping, building identification started from where most of the city's equipment and services were located. Attributes were input in parallel with the identification of each building. Table 4-3 shows the attribute categories used to identify buildings.

In addition, as shown in Figure 4-3, identification of infrastructure are made simultaneously.

Table 4-3 Attributes employed in Building Database

	List of Bulding Attributes
1	Slum House
2	Singular House
3	Apartament
4	Bank
5	Library/Book Store
6	Commerce (stores, shops...)
7	Sports field
8	Cementy Factory
9	Beer Factory
32	Industry and warehouses
19	Gas station
10	Cemetery
11	Chapel /Church/Mosque/Temple
12	Daycare
13	Primary school
14	Secondary school
15	University
16	Techical-Vocational Education
17	Community School
18	Driving School
20	Pharmacy
21	Services (Post office,Electric/water Company,
22	Recreation (public spaces)
23	Public Services (Governamental and non Governamental)
24	Health Center
25	Hospital
26	Accommodation (hotel, hostel, pension...)
27	Railway Facilities
28	Port Facilities
29	Lighthouse
30	Police station and Prison Facilities
31	Airport Facilites
33	Supermarket
34	Market
35	heritage building
37	Interprovincial Bus Terminal
38	Mechanical Workshop
39	Restaurants and Bars
40	Sewage Treatment Station

Source: JICA Project Team

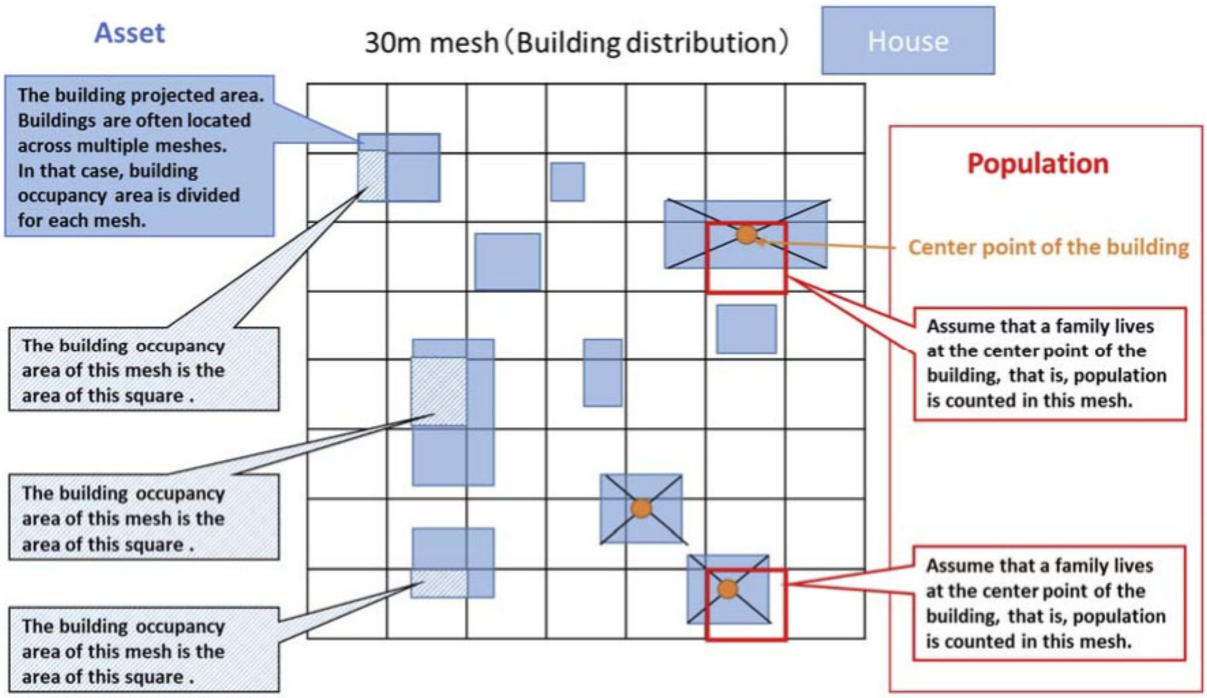


Source: JICA Project Team

Figure 4-3 Distribution of Infrastructure

(3) Step 3 - Rasterization

Based on the vector data of population and assets, the data was rasterized. The population and distribution of the property was taken on a 30m grid which is equal to the hazard map grid.

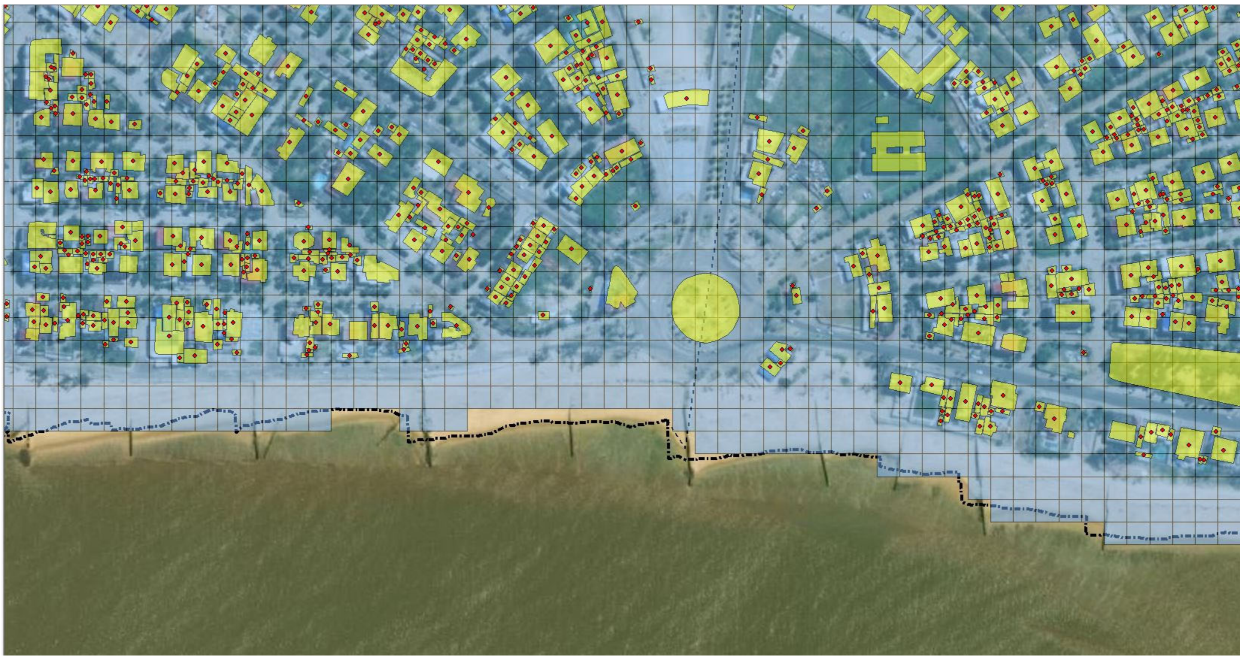


Source: JICA Project Team

Figure 4-4 Procedure for creating raster data related to population and assets

a) Population

- Identified single-storey and two-storey buildings (one-storey and two-storey buildings were assumed to be dwellings facilities).
- Defined the center point of the identified building. House polygons were converted to points based on the building mapping mentioned above (Figure 4-4). This represents the population distribution. Only dettached houses, slum houses and apartments are considered as dwelling facilities.
- Provided the number of people per househol to each point. According to the census produced by the National Institute of Statistics (INE), the number of household members in Mozambique was about 4.4 people, but is effectively defined as equivalent to 5 people according to the survey by the JICA Project Team. Thus set a value of 5 people/housholed. After defining the number of households and the number of apartments per building, the total population was estimated as shown in Table 4-4.
- After calculating the estimated total population, it was compared with the INE statistical total population and confirmed that there was no significant difference.



Source: JICA Project Team

Figure 4-5 Conversion to Point Data from Vector Data on Buildings

Table 4-4 Setting of the Number of Household Members in Small-scale Housing

OBJECTID	Attributes	Obs	Nr_Household	Nr_Apart	Nr_People
1	Apartment		5	10	50
4	Apartment		5	10	50
5	Apartment		5	10	50
6	Apartment		5	10	50
7	Apartment		5	10	50
8	Slum House		5	1	5
9	Apartment		5	10	50
10	Apartment		5	10	50

Source: JICA Project Team

b) Assets

- For each vector shape showing the foot print of building, the number of floors of each building was estimated based on aerial photographs, interviews to Beira City officials, and the Team stuff living in Beira (Table 4-5).
- Based on this, the floor area of each building is calculated considering the building area and number of stories of each building. For example, three times the projected area for 3 floors. Separately, the occupied area of buildings included in each mesh is calculated.
- The value of the building varies depending on the type of building, namely: residential (500usd/m2), office (1000usd/m2), and apartments (1250usd/m2). These values have not been officially defined by the ministry responsible for these data, and thus, have been extrapolated from prices on the construction market in Mozambique.

Table 4-5 Various attributes of buildings on vector data

Attributes	Obs	Num_Piso	Area_Polig	Num_Aparta	Cost_m2	Area_m2	Build_Area	Cost_Esti
Apartment		4	1658.08	12	1250	276.347	1105	1381250
Restaurants and Bars		1	27.6662	0	500	27.6662	28	14000
Restaurants and Bars		1	346.764	0	500	346.764	347	173500
Apartment		3	1718.06	6	1250	286.344	859	1073750
Apartment		3	1367.51	12	1250	227.919	684	855000
Apartment		3	1574.57	12	1250	262.428	787	983750
Apartment		3	2392.74	12	1250	398.79	1196	1495000
Slum House		1	51.0724	1	500	51.0724	51	25500
Apartment		3	940.608	12	1250	156.768	470	587500
Apartment		4	878.712	12	1250	146.452	586	732500
Apartment		3	798.18	12	1250	133.03	399	498750
Apartment		4	871.59	12	1250	145.265	581	726250
Apartment		3	877.518	12	1250	146.253	439	548750
Apartment		4	655.92	12	1250	109.32	437	546250
Apartment		3	2146.31	12	1250	357.718	1073	1341250
Apartment		4	1244.35	12	1250	207.392	830	1037500
Apartment		4	2978.6	12	1250	496.434	1986	2482500
Apartment		3	1399.71	12	1250	233.285	700	875000
Apartment		4	1565.03	12	1250	260.839	1043	1303750
Apartment		2	1567.64	2	1250	261.273	523	653750
Singular House	More Than One Floor	3	547.488	1	500	182.496	547	273500
Apartment		2	1142.22	2	1250	285.554	571	713750
Singular House	More Than One Floor	2	511.936	1	500	255.968	512	256000
Singular House	More Than One Floor	2	587.552	1	500	293.776	588	294000
Singular House	More Than One Floor	2	647.684	1	500	323.842	648	324000
Singular House	More Than One Floor	2	367.136	1	500	183.568	367	183500
Singular House		3	854.133	1	500	284.711	854	427000
Singular House		2	133.461	1	500	66.7306	133	66500
Singular House	More Than One Floor	3	488.838	1	500	162.946	489	244500
Singular House	More Than One Floor	3	451.572	1	500	150.524	452	226000
Singular House	More Than One Floor	3	426.846	1	500	142.282	427	213500
Singular House	More Than One Floor	3	332.46	1	500	110.82	332	166000

Source: JICA Project Team

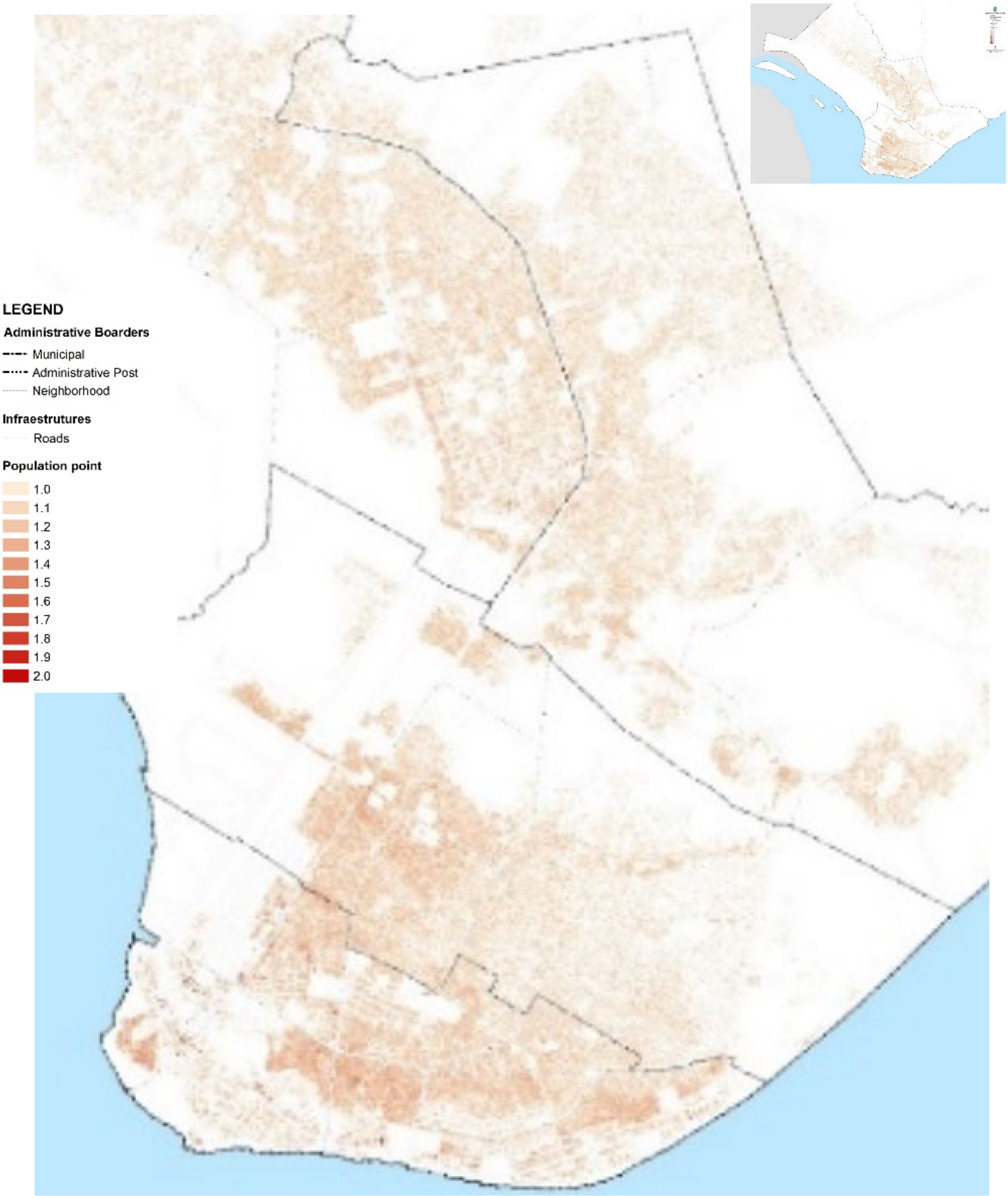
(4) Step 4 - Creation of Population Distribution Map

Based on the population calculation for each mesh, a population distribution map was created using the divisions shown in Table 4-6. Since this table is the basis for creating a risk map, risk points are used as indicators instead of simple population density. For example, if the value is zero (0), no one lives there at this point, and thus, considered as no risk. On the other hand, a place with a resident gives risk points from 1.0 to 2.0 depending on the number of people.

Table 4-6 Risk Point Classification based on Mesh Population

Population	Score	Notes
0	0.0	Zero risk if there is no person living
5	0.1	Risk will be calculated if there is a single person living
5＜n≦10	0.2	
10＜n≦20	0.3	
20＜n≦30	0.4	
30＜n≦40	0.5	
40＜n≦50	0.6	
50＜n≦60	0.7	
60＜n≦70	0.8	
70＜n≦80	0.9	
80＜n≦100	1.0	
100＜n	2.0	"2.0" points for the maximum score

Source: JICA Project Team



Source: JICA Project Team

Figure 4-6 Population Distribution by Risk Points

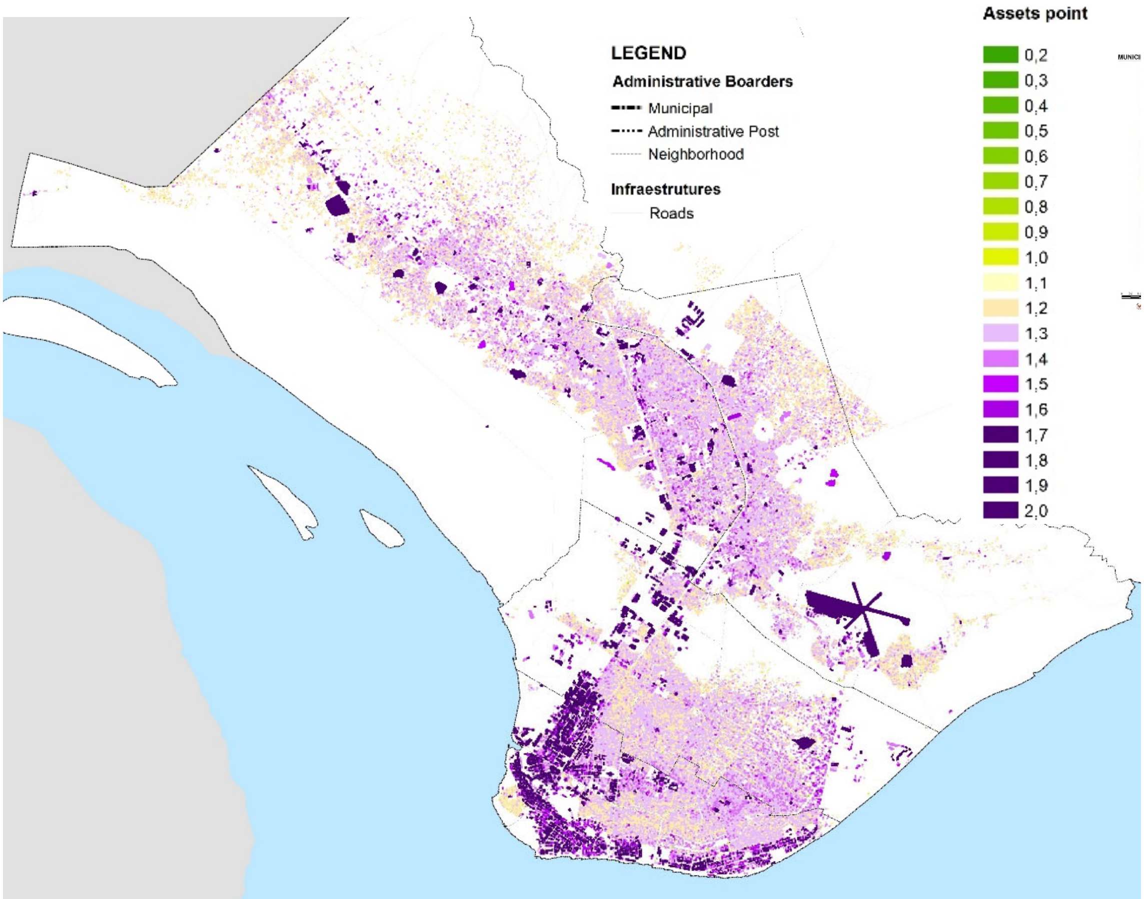
(5) Step 5 - Create Asset Distribution Map

After calculating the asset distribution of each mesh, the asset value of each mesh was calculated based on risk points as well as population.

Table 4-7 Risk Point Classification based on Mesh Asset Prices

Asset Value (Million MT)	Score	Notes
0	0.0	Zero risk in case of no buildings
0＜n≦1000	0.1	
1000＜n≦2000	0.2	
2000＜n≦3000	0.3	
3000＜n≦4000	0.4	
4000＜n≦5000	0.5	
5000＜n≦6000	0.6	
6000＜n≦7000	0.7	
7000＜n≦8000	0.8	
8000＜n≦9000	0.9	
9000＜n≦10000	1.0	
10000＜n≦20000	1.1	
20000＜n≦50000	1.2	
50000＜n≦100000	1.3	
100000＜n≦200000	1.4	
200000＜n≦300000	1.5	
300000＜n≦400000	1.6	
400000＜n≦500000	1.7	
500000＜n≦700000	1.8	
700000＜n≦1000000	1.9	
1000000＜n	2.0	"2.0" points for the maximum score

Source: JICA Project Team

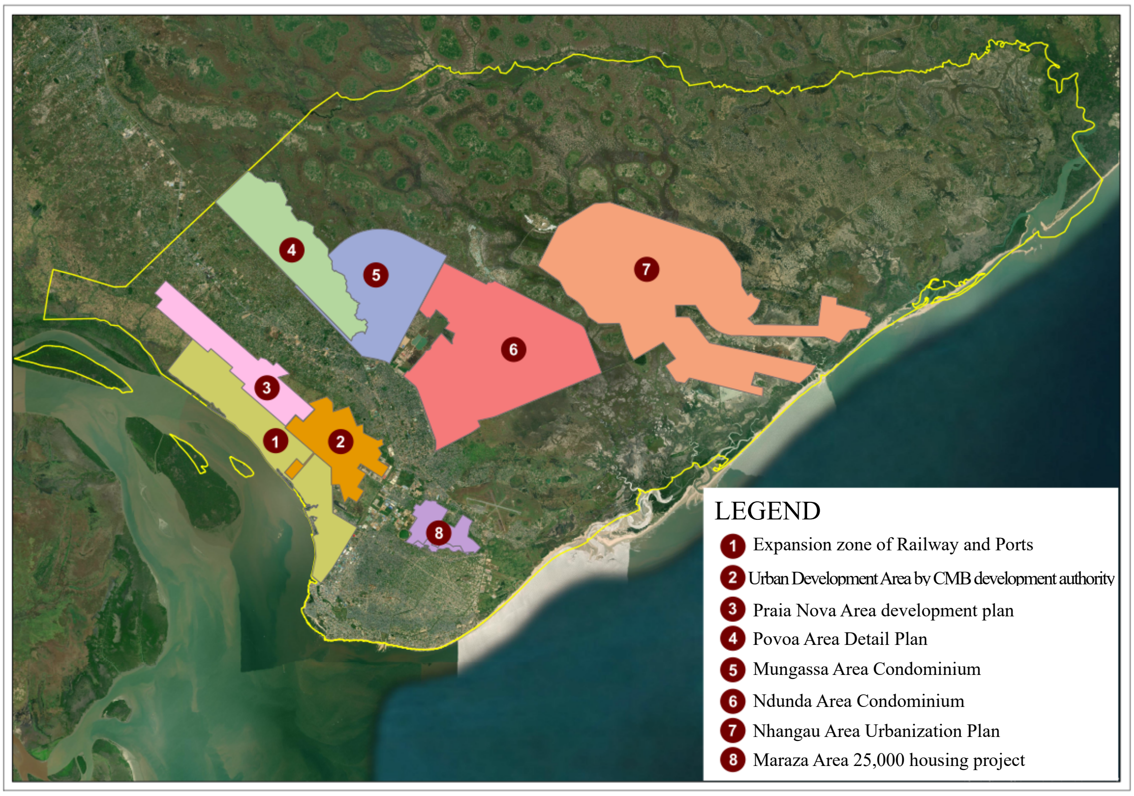


Source: JICA Project Team

Figure 4-7 Asset Distribution by Risk Points

(6) Step 6 – Organize GIS data on existing urban development plans

All existing urban development plans such as Structure Plan, General Urbanization Plan, Partial Urbanization Plan, Detail Plans, and Relocation Plan, that are underway in Beira City were collected and converted into data as shown in Figure 4-8.



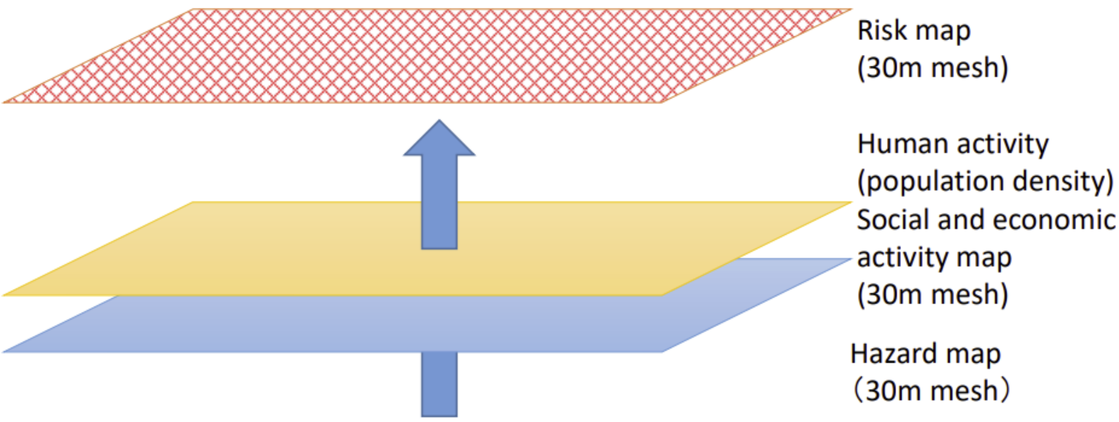
Source: JICA Project Team

Figure 4-8 Distribution of Ongoing Urban Planning and Projects in Beira City

4.2.3 Formulation of Risk Map

A series of risk maps was created taking into account all the data generated in the above phases.

The final risk level is calculated by multiplying the hazard level, population points and wealth points, as shown in Table 4-9. In the risk classification, there is no risk of life and no loss of property in uninhabited areas. On the other hand, when people live, there are more risks than the danger level shown in the hazard map. Risk maps are formulated to assess these factors.



Source: JICA Project Team

Figure 4-9 Image of the 30m mesh Risk Map Formulation

The basic policy for calculating risk points is shown below.

a) Population risk points

The formula for calculating risk points when no one lives is as follows:

RLp = HL (4.0 ≥ HL points ≥ 1.0) x 0 = 0

RLp = 0.0

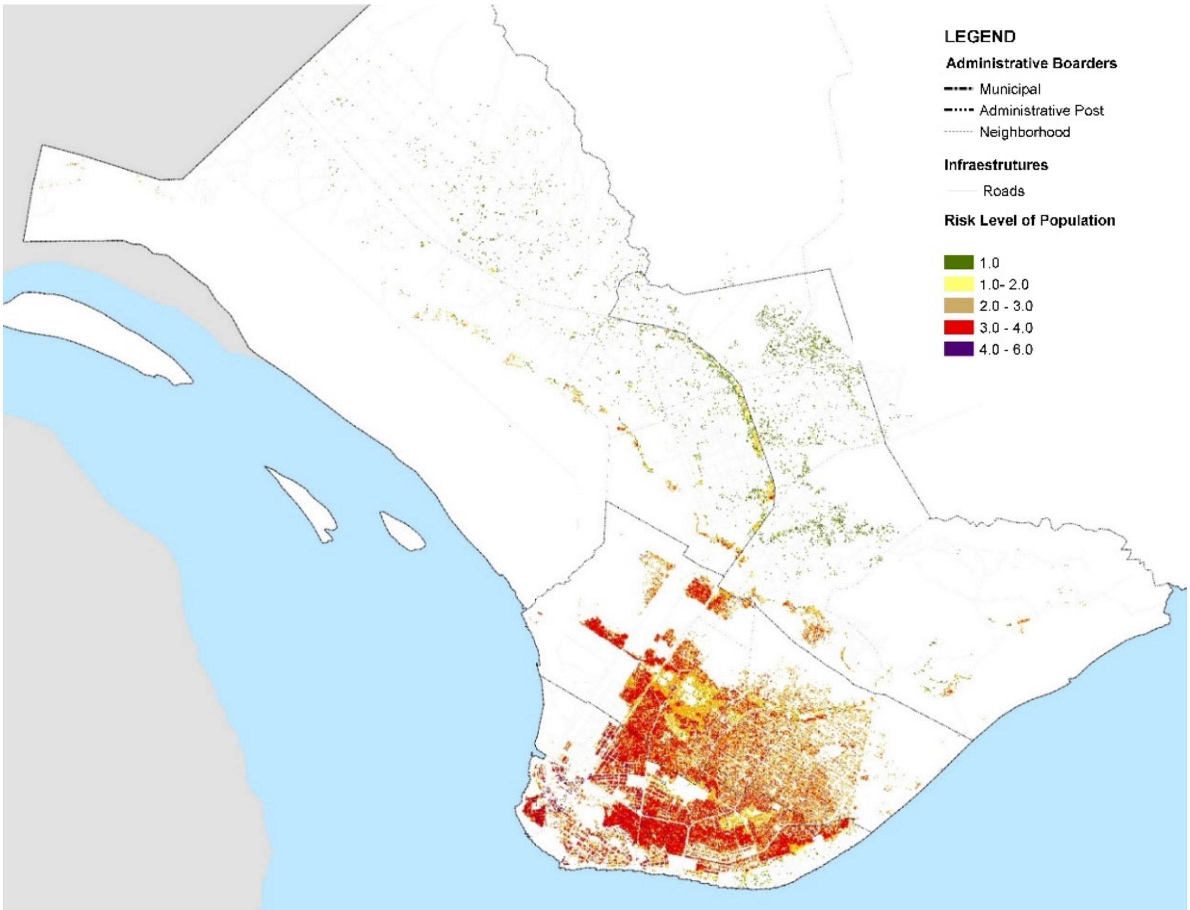
Risk points increase in places where many people live. The formula for calculating risk points in these cases is as follows.

RLp = HL (4.0 ≥ HL points ≥ 1.0) × (2.0 ≥ population points ≥ 1.0)

8.0≧RLp≧1.0

Note) RLp is population risk level, HL is hazard level

The human life risk map is presented below.



Source: JICA Project Team

Figure 4-10 Human Life Risk Map

b) Asset Risk Points

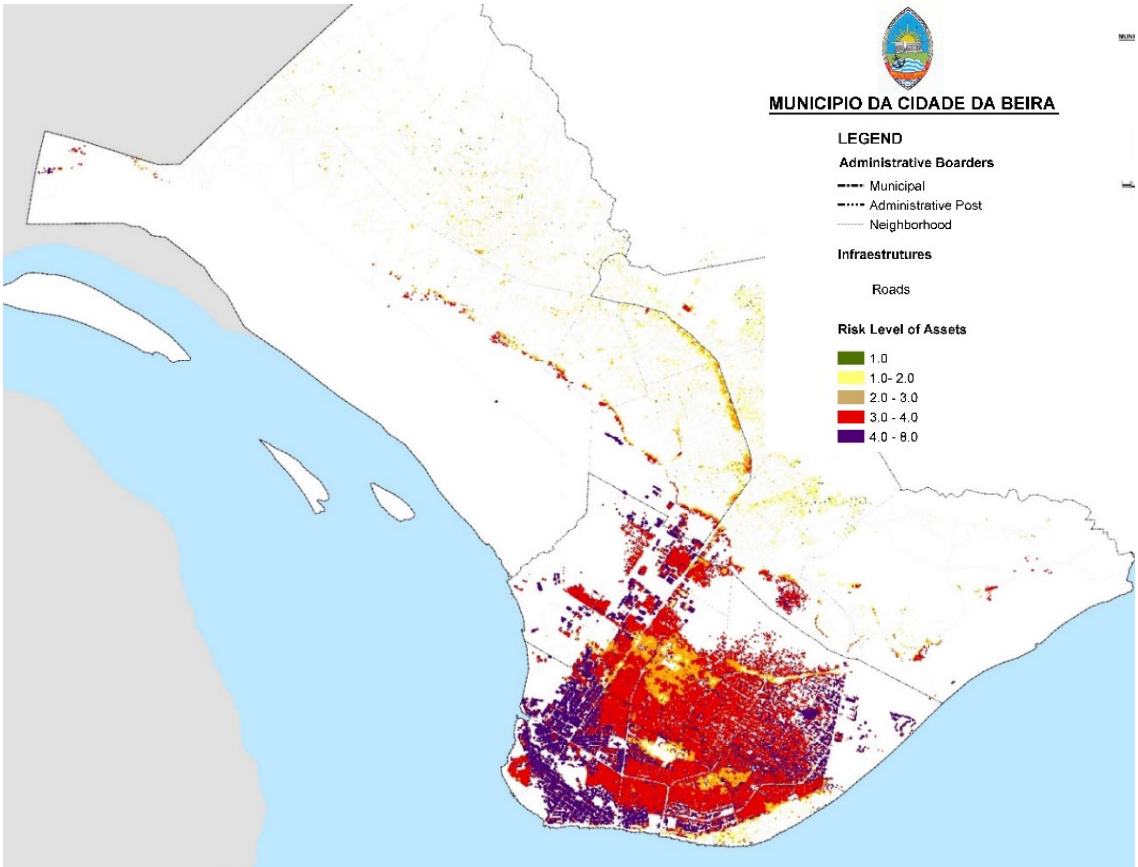
The formula for calculating asset risk points is:

$$RLa = HL\ (4.0 \geq \text{HL Points} \geq 1.0) \times (2.0 \geq \text{Asset Points} \geq 0.0)$$

$$8.0 \geqq RLp \geqq 0.0$$

Note) RLa is asset risk level, HL is hazard level

The asset risk map is presented below.



Source: JICA Project Team

Figure 4-11 Asset Risk Map

c) Total Risk Points

The sum of risk points for population and assets is the sum of risk level points, which is calculated using the following formula.

RLt = RLp + Rla

where RLt is the total risk level point

Table 4-8 Calculation of Total Risk Level Points

Hazard Score①	Population score②	Asset Score③	Risk point (①×②) ＋ (①×③)
4	0.0 ~ 2.0	0.0 ~ 2.0	0.0 ~ 16.0
3			0.0 ~ 12.0
2			0.0 ~ 8.0
1			0.0 ~ 4.0

Source: JICA Project Team

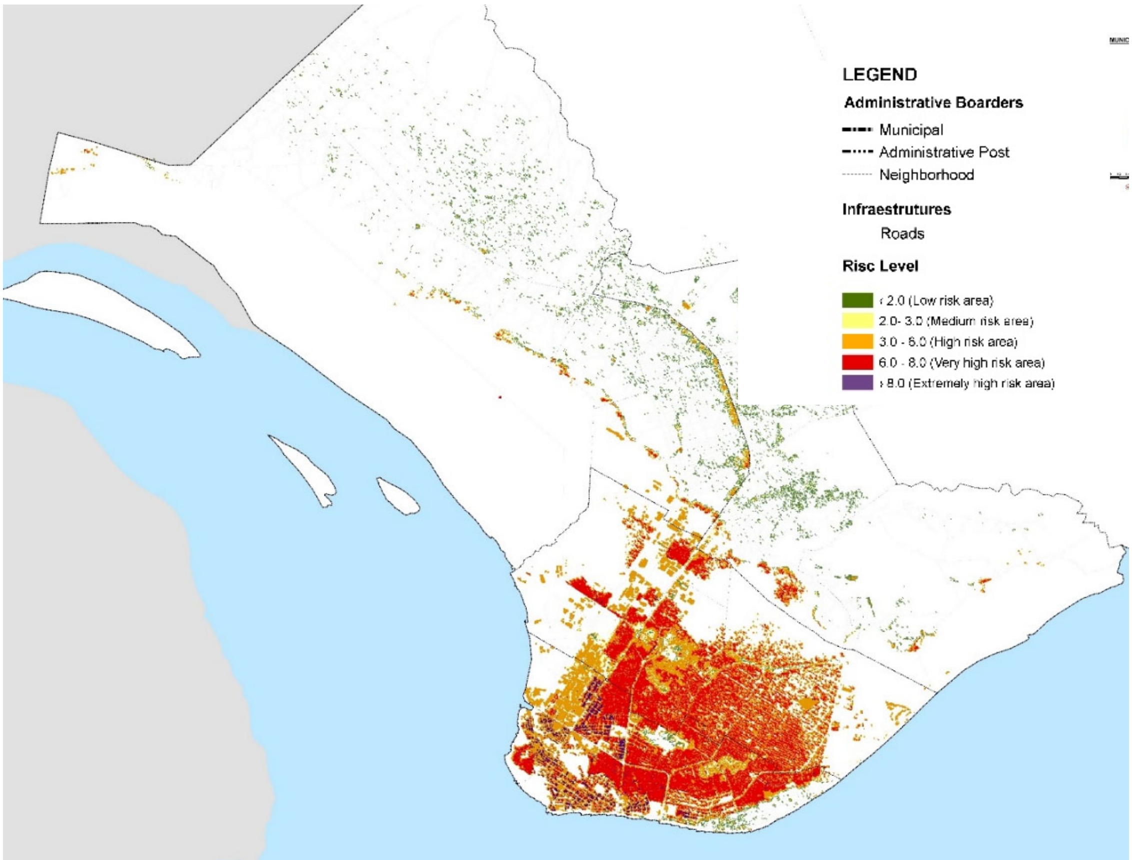
Based on the above risk point calculation method, risk levels are classified as shown in the table below.

Table 4-9 Risk Level Classification Criteria

Risk point	BG hazard level	Description
Above 8	Extremely high	Extremely high risk area
6- 8	Very high	Very high risk area
3- 6	High	High risk area
2- 3	Medium	Medium risk area
Under 2.0	Low	Low risk area

Source: JICA Project Team

Based on the above, the figure below was formulated the risk map that represents the total risk.



Source: JICA Project Team

Figure 4-12 Comprehensive Risk Map

This figure shows the state of damage for the dangers shown on the hazard map. Table 4-10 shows the estimated scale of damage calculated based on the risk map.

Table 4-10 Assumed Scale of Damage based on Risk Map

Risk Level	Area Affected (%) *	Affected population	Affected assets	Affected Asset Value (USD)
Low risk level	2.4%	36 060	7 769	424 928 995
Medium risk area	1.6%	25 905	6 080	272 289 740
High risk area	7.1%	163 290	36 449	3 056 576 850
Very high risk area	5.1%	210 870	45 510	1 636 883 000
Most high risk area	0.5%	18 970	2 674	661 807 000

*Note: The analysis presented is for 20,466 ha (31.88%) of the 64,200ha area of Beira City, which is subject to hazard mapping.

Source: JICA Project Team

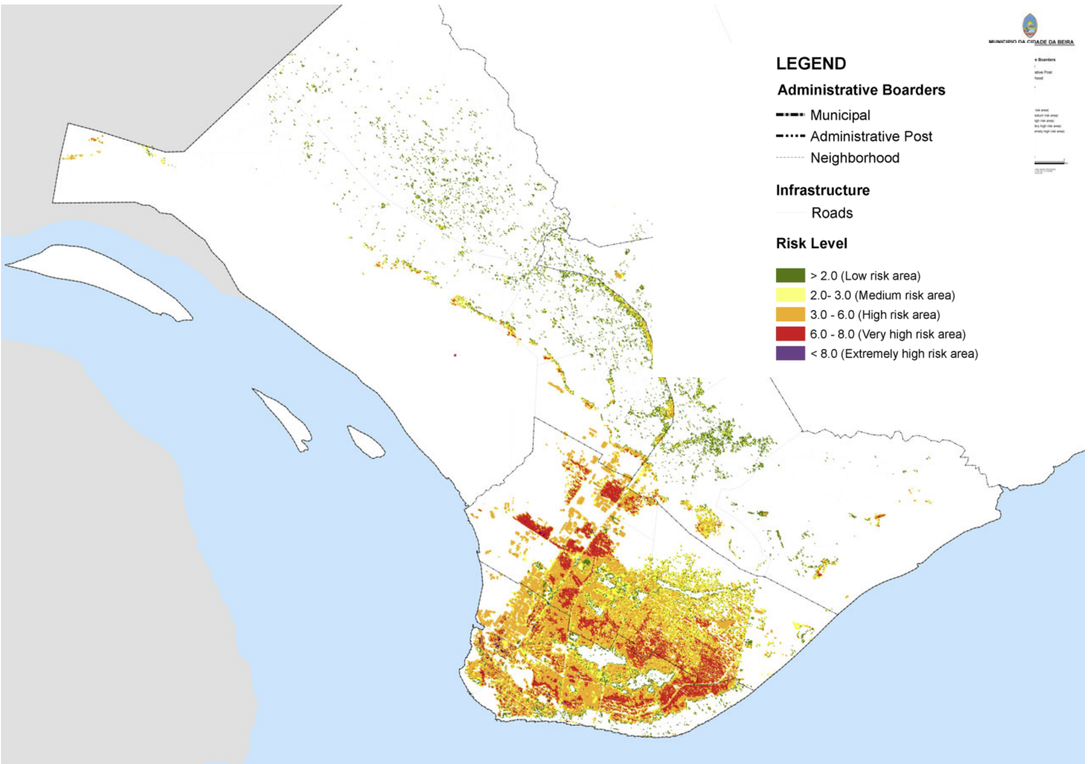
4.3 Assessment of Risk Mitigation by Physical Mitigation Measures

In order to evaluate the damage risk reduction effect by the infrastructure development plan presented in Chapter 3, and to understand its effectiveness and limitation levels, the following two flood control were examined based on the hazard maps created for each case.

Case 1: Measures proposed by the Coastal Protection Project (CPP)

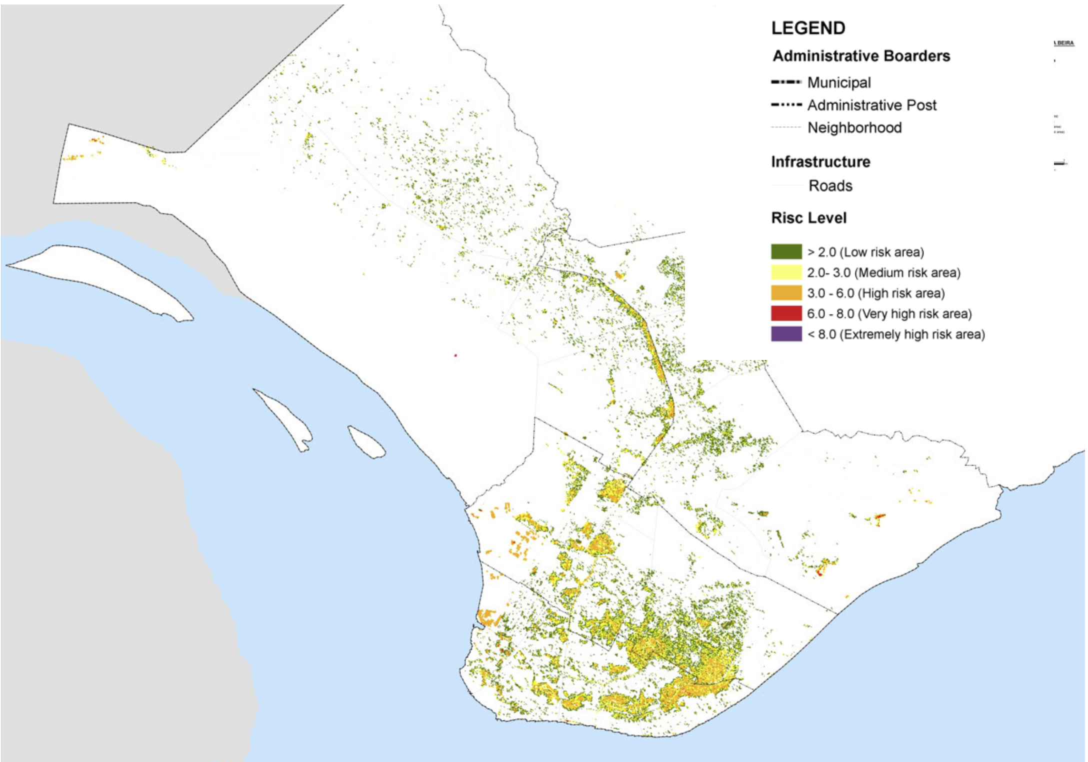
Case 2: Port access road over Case 1

Based on these simulations, a hazard map for each countermeasure was created, in accordance with the process shown in Section 4.2. The risk maps for Cases 1 and 2 show how much the magnitude of risk can be reduced in areas where countermeasures are effective (risk reduction effects). These maps can be used to assess the economic and human damages to which the city of Beira is exposed.
The figures below show the results for each case. In the future, we plan to calculate the scale of damage related to these cases.



Source: JICA Project Team

Figure 4-13 Risk Map based on Case 1



Source: JICA Project Team

Figure 4-14 Risk Map based on Case 2

Table 4-11 shows a comparison of the estimated scale of damage in each of the above cases.

Table 4-11 Estimated Scale of Damage by Case of Physical Mitigation Measures

	Case 0				Case 1				Case 2			
Risk Level	Affected Area (%)*	Affected population (000 Persons)	Affected assets (Num)	Affected Asset Value (Million USD)	Affected Area (%)*	Affected population (000 Persons)	Affected assets (Num)	Affected Asset Value (Million USD)	Affected Area (%)*	Affected population (000 Persons)	Affected assets (Num)	Affected Asset Value (Million USD)
Low risk	2.40%	36.1	7.769	424.9	3.10%	50.7	11.189.	630.	4.80%	91.345.	19.698.	1.102.5
Medium risk	1.60%	25.9	6.080	272.3	3.10%	71.2	16.804.	723.7	2.10%	53.700.	11.657.	484.2
High risk	7.10%	163.3	36.449	3.056.6	7.50%	226.6	48.686.	3.311.0	1.70%	41.030.	8.926.	489.0
Very high risk	5.10%	210.9	45.510	1.636.9	2.10%	74.3	15.379.	795.3	0.03%	0.615	96	11.9
Most high risk	0.50%	19.0	2.674	661.8	0.10%	2.6	279	92.7	0.00%	0.025	10	1.2

*Note: The analysis presented is for 20,466 ha (31.88%) of the 64,200 ha area of Beira City, which is subject to hazard mapping.

Source: JICA Project Team

CHAPTER5 Assistance for Public Facility Recovery and Rehabilitation planning

5.1 The Context of Project

5.1.1 Relevant laws and regulations

(1) The roles of Beira City Council

The role of the Beira City council (CMB) - the local government that has jurisdiction over the area of city of Beira - is stipulated in Article 8 of Decree 6/2018 (March 8, 2018) to provide the following wide-ranging administrative services. In addition, regarding this decree and complementary decrees, CMB will provide social services according to its financial resources and respects cooperation with other public institutions (Provincial authorities, etc.). Article 8 Is defined as follows:

Table 5-1 The roles of CMB

Article 8 (Attribution)
Attribution to local governments respects each group's unique, standard and specific interests.

a) Regional economic and social development;
b) Environment, basic sanitation, quality of life;
c) Supply of public goods;
d) Health;
e) Education;
f) Culture, leisure, sports;
g) District-based autonomy;
h) Urban development, construction administration, and housing maintenance.

Source: Article 8 of Decree 6/2018

(2) The role of GREPOC

Post Cyclone Reconstruction Office (GREPOC) is an organization established under the Minister of Public Works and Water Resources (MOPHRH) to ensure damage and loss assessment, reconstruction program preparation, and supervision and coordination of each program. Then, it is delegated to the GREPOC of autonomy and the technical decision to carry out the roles effectively and efficiently. The roles are stipulated in the following table.

Table 5-2 The roles of GREPOC

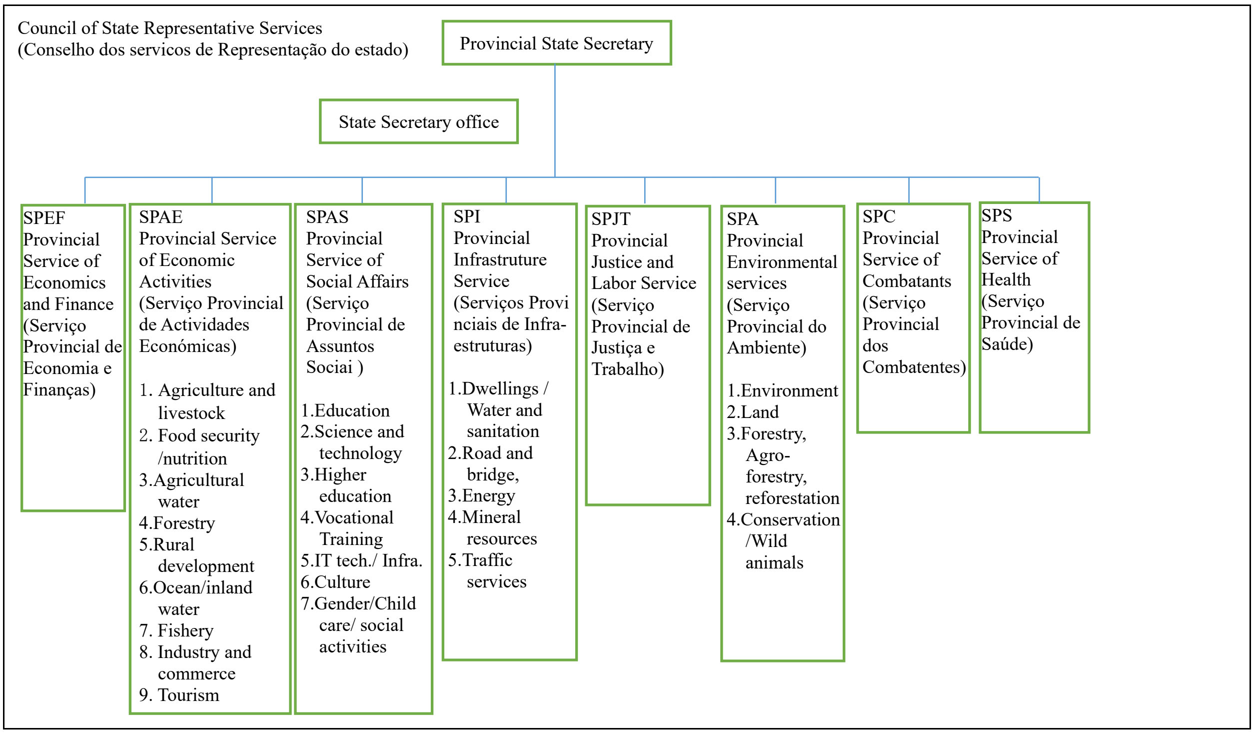
a)	Prepare internationally recognized loss and damage assessment methods in consultation with ministries, central agencies and local governments.
b)	Assess damages and losses in collaboration with ministries, central agencies, states, districts, local governments, development cooperation partners and civil society.
c)	Prepare a post-cyclone Idai reconstruction program with the participation of various stakeholders.
d)	Organise fund-raising events for post-cyclone reconstruction in Mozambique, collaborating with development cooperation partners and other stakeholders.
e)	Utilise the funds allocated to reconstruction and reconstruction projects with cooperating partners and citizens.
f)	Refine the project aimed at implementing the Idai reconstruction program after the cyclone.
g)	Oversee the contracting and management of construction contracts, the supply of goods, and the provision of services for post-cyclone Idai reconstruction and restoration activities.
h)	Prepare a progress report on the activities of the Idai Reconstruction Program after the cyclone and submit it to the government and partners.
i)	Submit the interim and final assessment report of the post-cyclone Idai reconstruction program to the government.
j)	Conduct an independent annual audit of the program and share each report with governments and partners.

Source: Article 2 and 3, Decree 26/2019

(3) The roles of provincial level administrative authorities (Council of State Representation Services, and Provincial Government)

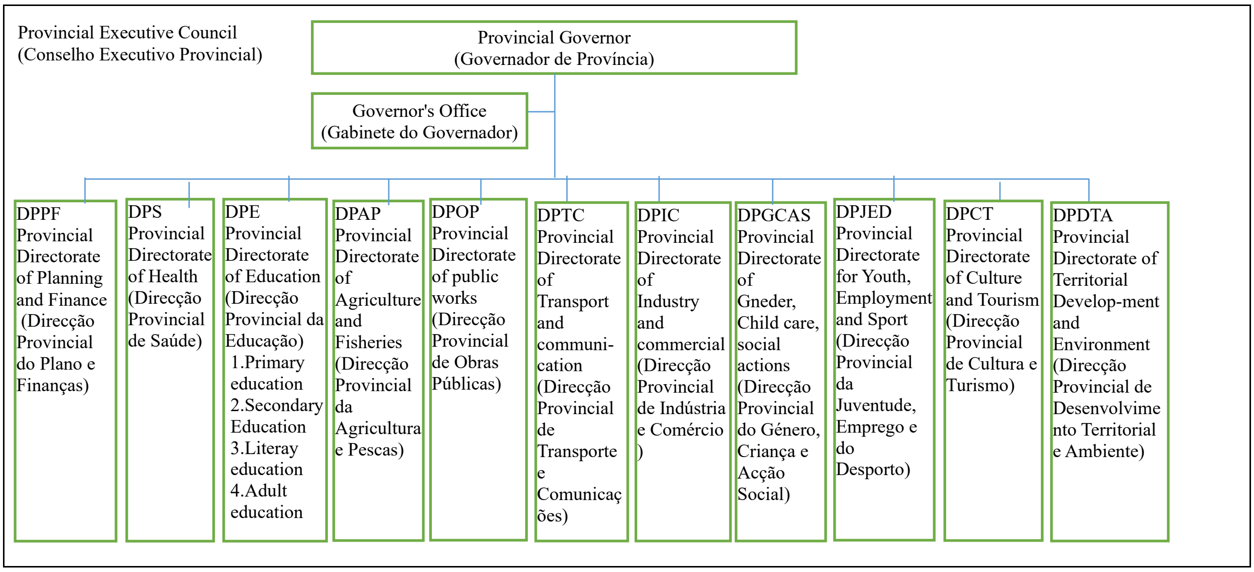
The establishment of the Council of State Representation Services was institutionalised by Law No. 4/2019 (May 31, 2019). reflecting on this, the roles which the Provincial Government had controlled were divided and then some roles were transferred to the Council of State Representation Services).

The roles and the organisational structure of both authorities are shown, respectively, in the following tables.



Source JICA Project Team created based on the decree 63/2020: August 7, 2020

Figure 5-1 Organization chart of the Council of State representative Services



Source JICA Project Team created based on the decree 64/2020: August 7, 2020

Figure 5-2 Organization chart of the Council of State representative Services

Table 5-3 Authority of State Secretary and Provincial Governor (Decrees 63/2020 and 64/2020)

	State Secretary	Provincial Governor
Relevant Laws	By Law 7/2019 (May 30), which indicates the establishment of the State Secretary System, the role and authority of the State Secretary System were revised by Decree 63/2020 (August 7). Decree 5/2020 (February 10) and Decree 16/2020 (April 30), which indicate the provisions, were repealed accordingly.	In line with Law 4/2019 (March 31), which provided for the governorship system, Decree 64/2020 (dated 28th July 2020) amends the roles and powers of the governorate system and sets forth. The previous provisions of Decree No. 2/2020 (8 January) and Decree 15/2020 (15 January) were repealed.
Appointment, Selection	Appointed by the President	Selected by Direct election
Budget	National account	Budget is approved by provincial assembly
Appointment right	Proposes a director of provincial services to the competent minister	Appoints provincial directors and the Provincial assembly approves
Annual plan Budget plan	Develop / implement / report state budget plans for areas represented by the state	Propose a provincial budget plan for the provincial decentralized administration to the provincial council, and disburse and report on the provincial budget execution
Supervision	Supervise the provincial services; Supervise state secretary services in districts, administrative post, Neighbourhood and communities	Supervise provincial directorates
Report	Submit quarterly reports of state service activities to the President through the Minister in charge	Submit quarterly plans and budgets to the provincial council
International Cooperation	implement in the province, actions and activities of international cooperation, within the framework of the materialization of the foreign policy and international cooperation strategy	monitor the design and implementation of activities of international cooperation agents in the province, in the areas of their competence.
Emergency	Communicate promptly with competent authorities and make administrative decisions essential to the public interest. Determine disaster prevention or rescue measures in the event of a major accident or disaster. Appoint security forces, such as the military or police, in cooperation with the governor	Decide on disaster countermeasures in cooperation with the state secretary of state
Social order	Propose required interventions and measures for public safety	
Personnel	Manage personnel for the state secretary service	Manage personnel for civil servants of state departments. The appointment requires the approval of the respective Ministers
Education, Health	Propose construction of schools/health facilities outside the jurisdiction of the provincial government jurisdiction	Propose the construction of primary health facilities and primary/secondary schools; Ensure adult literacy education; Appoint head school principals of primary and secondary schools; Proposal to the minister for appointment of higher education institutes
National event	Direct State national events in the province	
Community participation	Promote community participation in State socio-economic and cultural planning	

	State Secretary	Provincial Governor
Land right (DUAT) and land use	Participate in land supervision; Comment on the area for conservation; Participate in the land development plan; Comments on applications for over 1.000 ha land use; Comment on the issuance of DUAT subject to central government application	Manage land according to the relevant laws; Issue DUAT; Issue the license for provincial decentralized administration; Issue the registration and use rights of buildings; Issue orders to vacate the facility according to relevant laws
Water body	Comment on ocean/water development; Comment on the applications for the concession for the use of ocean/water	Permit small-scale freshwater aquaculture
Power supply	Secure concession permits for medium and low voltage power generation/distribution	
Road	Secure the construction, extension and maintenance of the national road network outside of the jurisdiction of the provincial government	
		Issue special licenses for partially protected areas

Source: Decrees 63/2020 and 64/2020

Accordingly, regarding the education sector, it is mainly focused on Basic education in this project. Hence the relevant authority is the DPES of the Provincial government. Regarding the health sector, this project mainly focuses on health science institutes for training health personnel, so the relevant authority is SPSS, respectively.

5.2 Related Plans and Strategies

5.2.1 Plans related to reconstruction and development of Beira City

(1) Beira 2035

In Beira, more comprehensive planned urban development has been required due to the widespread unplanned residential area without proper infrastructure, land-use conflicts, and the prospect of increased resettlement costs for future development.

In this background, the Beira 2035 was published in 2013. While Beira 2035 was examined, it considers the lessons learnt from the points that deviated from reality and unforeseen in the Beira-Dondo structural Plan issued in 1999. Then Beira 2035 indicates the direction of development, which was examined from a broad and medium- to long-term perspective, to flexibly respond to the future context in examining the detailed plans afterwards.

Beira 2035 focuses on urban infrastructures such as ports, roads, and public sewers. Regarding infrastructure related to natural disaster prevention, coastal protection and public sewer network are examined as measures against floods and storm surges.

(2) Beira Municipal Recovery and Resilience Plan (BMRRP)

BMRRP was examined and compiled by the 'Taskforce Rebuild Beira 2019' formed on March 22, 2019, under the guidance of the City of Beira with three key partners: the Dutch Government, the United Nations Habitat and the Shelter Program, after the Cyclone Idai.

The methodology applied to developing this plan is examined, referring to the reconstruction plan for St. Martin, damaged by Hurricane Irma, created by the World Bank and the Dutch government in 2018. in this, “losses in terms of social, economic and environmental damages were calculated from economic flow and overall macroeconomic impacts, using available information” [1].

Regarding the reconstruction plan, it was examined from mainly four aspects - Physical, governance, capacity building, and Economic, in consideration of the timeframe divided into three - short-term (~ 1 year), medium-term (~ 3 years), long-term (~ 5 years). Regarding facilities covered by the reconstruction plan, it focuses on nine[2] among fourteen categories under the management of CMB, and then 65% of 176 facilities affected by the Cyclone Idai were evaluated. The total required cost for renovation was estimated to be 12,310,000 USD accordingly.

Table 5-4 The rate of damage and required recovery/reconstruction period

			Required period for renovation		
Severe damage	60%		Short-term: (Emergency)	Essential facilities for the operation of the municipality of Beira that are severely damaged	50%
Intermediate damage	25%		Mid-term:	Facilities that, despite being damaged, continue functioning.	23%
				Facilities with significant damage but less critical for public services or out of use.	22%
Light damage	15%		Long-term:	Completely destroyed facilities that need to be rebuilt but require further consideration/elaboration regarding their function	5%

Source: BMRRP Vol.2 pp60,62

1 WB (2018), ‘ Sint Maarten National Recovery and Resilience Plan – a Roadmap to Building Back Better

2 A: (1. Residential area, 2. Expansion of residential area), B: Public facilities under the city, C. Revetment, D. Public sewer system, E. Sanitation, F. Solid waste management, G. Roads, H. Environmental infrastructure, I. Economic activity

(3) Preliminary Diagnostic Report of the City of Beira (Relatório Preliminar de Diagnóstico da Cidade da Beira)

This plan examined the structural plan of the city of Beira based on Article 42 of the Regulations of the Spatial Planning Act, focusing on the purposes[3] of the Urban Structural Plan (PEU) and the unique characteristics of the city of Beira. Then it was compiled in October 2019.

Table 5-5 Specific Objectives of PEU

The definition of the primary structure of accessibility networks within the municipal territory and its links with the district, provincial and national network;
The establishment of significant systems to control surface water runoff and the principles that should govern the progressive implementation of these systems;
The definition of solid waste treatment systems and the areas for their reception and processing;
Establishing the principles for the construction and location of cemeteries in the urban area;
The definition of the network of multifunctional structuring activity centres and their distribution in the municipal territory;
The establishment of general principles and parameters for the use of public space;
The establishment of general principles to which the circulation of public and private means of automobile transport must obey and the progressive creation of pedestrianized areas in the areas of tertiary and residential activities;
The integration of spatial planning and planning into the perspective of increasing urban resilience in the face of the increasingly growing phenomena resulting from climate change; and
The compatibility and incorporation of strategic documents produced by the Municipality of the City of Beira in light of the legislation that governs Spatial Planning in Mozambique.

Source: Preliminary Diagnostic Report of the City of Beira

3 ›Establish the principles of environmental sustainability, the main access networks connecting municipalities, within each municipality, the priorities of urban development, and the general parameters that guide the occupation of the territory of that municipality. ›Elimination of social asymmetries and privileges in the choice of distribution sites for infrastructure networks, services, and social facilities. ›Definition of principles and models of local government land use planning

5.2.2 Education Sector

(1) The current situation and strategic plans of Education sector in Mozambique

The "Government Five-year Programme 2020-2024" (hereinafter "PQG") sets out three priorities, among three, the education sector development which contributes to human resources is set as a priority 1, and its development target objectives by 2024 are indicated.

Table 5-6 The priorities of PQG, and strategic objective of education sector

Priority I Develop Human Capital and Social Justice Priority II Expand access and improve the quality of health services Priority III Promoting the participation of the Society, especially the youth, in socio-cultural, sporting and economic activities. Priority IV Promoting gender equality and equity, Social Inclusion and protection of the most vulnerable segments of the population			
Deliverables		Baseline year 2019	Target year 2024
1	The net enrolment rate in Grade 1 at age 6	93%	98%
2	The gross enrolment rate of 1st Cycle Secondary Education (ESG1)	30%	43%
3	The proportion of students who develop the skills required for the 1st cycle of Primary Education (including reading, writing and arithmetic)	4.9% (2016)	20%
4	The participation rate of non-literate youth and adults aged 15 and over in Formal and Non-Formal Adult Education programs, by sex	5%	10%
5	The gross rate of completion of 1st cycle Secondary Education (ESG1)	15% (2018)	35%
6	% of youth and adults achieving proficiency in functional literacy and numeracy	-	50.0%
7	% of teachers with specific pedagogical training	95%	100%
8	% of teachers who benefit from in-service training sessions	55%	95%
9	The parity between the province with the highest and lowest performance in student-to-teacher ratio, public primary education	0.65	0.95

Source: PQG pp382-(3~5)

As for the overall education system, due to the revision of the Education Law[4], the school education is gradually shifted from the 7-3-2 system (primary education course 7 years: first half 5 years + second half 2 years, lower secondary education 3 years, and upper secondary education 2years) to the 6-3-3 system. Then this transition is scheduled to be fully completed by 2023.

The situation of basic education in Mozambique has been steadily improving in quantity, with the gross enrolment rate (GER) of primary education (EP1+2) reaching 109.00% (national average: 2020).

On the other hand, the quality[5] of education has become a significant issue to be improved. Reflecting on this, in addition to improving the quality of education, the Mozambique government setting the following strategic goals in the 'Education Strategy Plan (ESP) 2020-2029' and making efforts to improve the situation.

4 Lei n.º 18/2018 de 28 de Dezembro

5 The percentage of 3rd grade elementary school students who meet the academic standards in the National Achievement Survey (2016) is 4.9% in the session of "reading and writing" and 7.7% in the session of "calculation" (from JICA: curriculum dissemination project for the new school education system project pre-evaluation sheet).

Table 5-7 The principal objectives of the Education Strategic Plan (2020～2029)

1.	Ensuring inclusion and equity in access, participation and retention.
2.	Ensuring the quality of learning.
3.	Ensure transparent, participatory, efficient and effective governance

Source: ESP 2020～2029 P36

Regarding educational facilities, based on the development goals of PQG, the annual Socio-Economic Plan (PES) set out the objective to construct 1,355 classrooms (2020) and 1,100 classrooms (2021) for primary education. As it is for primary education, 20 schools (2020) and 13 schools (2021) are set as an objective for lower secondary education (ESG1). However, the implementation status in 2020 is only 551 classrooms for primary education (69 classrooms in Sofala Province) and 12 classrooms for secondary education (0 in Sofala Province). However, in addition to these, as part of efforts to return students to school during the COVID-19 emergency declaration, the government rehabilitated 667 secondary schools and 15 teacher training institutions, repaired toilets at 262 schools and built new toilets at 134 schools. Water supply systems were maintained for 45 schools and teacher training institutions.

In addition, under the supervision of GREPOC, a total of 1,643 classrooms were planned to be renovated, and 104 classrooms to be constructed using external funds in 2021[6]. By 2022, a total of 1,143 classrooms in total have been renovated/constructed. In Sofala Province, classrooms were newly constructed: 80 by UNDP, 3 by the Tzu-Chi foundation, and 10 by JICA at Macurrungo Primary School (EPC)[7]. It has been reported that as of 2022, 3,162 classrooms out of the total 4,745 classrooms damaged by Cyclone Idai and Kenneth have been funded for rehabilitation or construction[8].

5.2.3 Health Sector

(1) The current health situation and strategic plans of Health sector in Mozambique

Various health indicators in Mozambique stay below the average of those in Sub-Saharan African countries, such as the infant mortality rate is 54.77 / 1,000 births (2019) is the lowest among neighbouring countries[9]. Under these circumstances, Mozambique published the "National Development Strategy 2015-2035", aiming to improve health and social protection standards in the pillar of human capital development. In addition, among PQG, the development of the health sector, which contributes to human resources, is set as priority 1.

6 Proposta de Plano de Actividades 2021 para Implementação do PREPOC
7 Letter from the GREPOC on March 21, 2023
8 Letter from the GREPOC on March 21, 2023
9 WHO World Health Data Platform 2019, UNICEF Data Warehouse 2019；World Bank, World Development Indicators database 2019

Table 5-8 The strategic objective of health sector

Deliverables	Baseline year 2019	Target year 2024
Institutional deliveries increased by % to reduce morbidity and mortality through expansion and improvement of the quality of genecology and reproductive health care.	87%	91%
Inpatient Maternal Mortality (per 100,000)	89.3	65.7
Increasing the number of people undergoing antiretroviral therapy (ART) to treat and prevent the spread of HIV-SIDA	86,920 (Child), 1,125,642 (Adult)	141,154 (Child), 1,852,390 (Adult)
Dissemination of preventive measures (household insecticide sprays, and insecticide-treated mosquito nets) to reduce malaria morbidity and mortality.	85% (1.126.579)	85% (4.831.008)
	90%	1,537,802 (95%)
Improving the health and quality of life of children under 5 by increasing the number of children fully immunized	94%	(96%) 1,001,405
Increasing screening rates for cervical cancer among women aged 25-54 to reduce the burden of non-communicable diseases (NCDs)	22%	1,574,355 (30%)
Improving access to and provision of basic and specialized services in health care facilities, and improving the ability to provide medicines and specialized/diagnostic equipment	2 (HCM: HCQ)	4 Central Hospitals
	0	7 Provincial Hospitals*
(Availability of pharmaceuticals at medical facilities)	70%	90%
(Availability of MRI (magnetic resonance imaging))	1 (HC Maputo)	3 Central Hospitals**
Collaboration and Complementarity between Traditional and Alternative Medicine and Conventional Medicine Enhanced in Primary Health Care	24,435 (practitioners of traditional and alternative medicine)	30,544
Increase in doctors per 100,000 population (foreign doctors + Mozambican National doctors)	113.3	170.5
Increase in the number of specialists in order to provide high-quality medical services to the public	670	935
* Lichinga, Pemba,Chimoio, Tete, Inhambane, Xai-Xai, Matola **Maputo, Quelimane, Beira, Nampula		

Source: PQG pp382-(3,4,7)

The Ministry of Health has been making efforts to improve medical services to achieve these policy goals and the goals of the SDGs, extending the Health Sector Strategic Plan (PESS) 2014-2019 for five years. In this strategy, the objectives to be achieved are indicated as follows.

Table 5-9 Strategic objectives of Health Sector Strategic Plan (PESS)

1. Increase access and use of health care services; 2. Improve the quality of services provided; 3. Reduce geographic disparities between social groups in terms of access and use of services; 4. Increase efficiency in the provision of services and resource use; 5. Strengthen sector partnerships on the basis of mutual respect; 6. Increase transparency and accountability in public resource use; 7. Strengthen the Mozambican health system.

Source : Health Sector Strategic Plan (PESS) 2014-2019 (English ver.) p13

The president announced the initiative (February 2019) to achieve the strategic goals, especially 3 and 4, and showed the direction to develop a district hospital per district. Then, in the PQG, an objective is to build and renovate 31 hospitals. According to PES, around 4 to 10 health facilities are to be built annually in recent years[10]. Regarding Sofala province, the general hospital in Buzi district is one of these that will be developed in 2021.

In addition, considering the damage to facilities caused by natural disasters in recent years, the Ministry of Health, with the support of UN-HABITAT, has been working with the Ministry of Health's Facilities Bureau to develop guidelines for the resilience of facilities during disaster recovery and construction[11]. (December 2020)

5.3 Damage and Needs analysis for public facility recovery and rehabilitation planning

Cyclone Idai caused severe physical damage in addition to casualties reported in PDNA. The estimated cost for recovery/reconstruction of such damage loss, including public facilities, in the four provinces - Sofala, Manica, Tete, and Zambezia - reached 2.9 billion USD.

Public facilities are various; however, the recovery/reconstruction of those in all sectors and dwellings is under the authority of GREPOC, which the Ministers' Council established on April 11, 2019. Then, the target reconstruction period of GREPOC was set for five years.

The role of GREPOC is to coordinate reconstruction activities divided according to the time frame. (1) After the disaster, prepare a matrix form (recording what is damaged and what is needed) for PDNA. (2) After starting PDNA, consider plans to meet the required needs. Within the recovery/rehabilitation plans, GREPOC requires meeting the technical requirements for facilities' resilience. (3) After considering the plan, coordinate the implementing partners and financing. (4) In implementing each plan, the executing partners (Incl. donors) report to the competent ministry, and the competent ministry summarises the implementation status and submits it to GREPOC. GREPOC supervises the overall progress based on this information. If necessary, GREPOC also provides direct technical assistance and monitoring.

Recovery/rehabilitation menus examined according to the needs confirmed through (2) above require fulfilling the specifications related to facility resilience shown in the catalogue published by MINEDH[12]. However, regarding facility specifications, GREPOC respects them of respective ministries in principle. Health facilities, as an example, MISAU has been examining facility specifications to be met for attaining resilience[13]. Hence these specifications will have been applied to the construction or rehabilitation of the health facilities. In GREPOC, specifications are set for housing projects, and three prototype designs have

10 Listed by confirmation of each year's PES
11 UN-Habitat, with the support of the Government of Canada, is implementing "Safer Hospitals: Post-Disaster Reconstruction and Construction Guidelines on Safer and Gender Sensitive Health Facilities in Mozambique". https://unhabitat.org/canadasupports-un-habitat-to-design-resilient-and-inclusive-hospitals-in-mozambique（Accessed on July 26, 2021）
12 Hearing survey to GREPOC (Feb. 2020), and then the specification of MINEDH became a Ministerial decree (June 2021)
13 Hearing survey to SPSS (May 2021)

been examined by UNDP/UN-Habitat and Eduardo Mondlane University. one of these prototypes was applied to the houses for resettlement in the peri-urban area[14]. In addition, the cost for the planned menus was estimated with the technical support of UN-HABITAT, Mozambique Institute of Engineering (LEM), and Eduardo Mondlane University (UEM). However, GREPOC will not implement the facility recovery/rehabilitation with its budget. Therefore, the financial source for implementing the recovery/rehabilitation projects will be the investment budget of donors or the line ministries.

GREPOC announced a bid to establish the "OPERATION Room" on its website in February 2020[15]. This room was intended to provide assistance menus that reflect the confirmed needs and the status of the menus under implementation. It appears that the progress of relevant activities related to the "OPERATION Room" was posted on the web, although it may not have been fully covered as of April 2022.

The recovery/rehabilitation needs for the facilities are described in the next chapter. Firstly, we focus on the facilities likely to be utilised as evacuation centres through recovery under the jurisdiction of CMB and DPES. Secondly, we focus on the facilities, under the management of SPSS and DPSS, for providing medical services to the casualties in natural disasters.

5.3.1 CMB's facilities

(1) Damages on CMB's Facilities

In BMMRP, the number of damaged CMB's public facilities reached 176, according to the assessment done by SDU Beira[16] with the support of the Holland government. This assessment classified the damaged facilities into the following five types. However, since the entire facility has not been assessed on-site, the same facility type was evaluated as having the equivalent damage. After that, the cost of recovery/rehabilitation was summarised according to the category of facility use[17].

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14 Resettlement area: Mutua, Savane and Mandruze-2 financed by UNDP, and Gwaragwara by Red Cross, according to the hearing survey to GREPOC (May 2021)

15 Ditto 2

16 SDU Beira is a private limited company (sociedade anonima), currently 100% owned by the Municipality of Beira. SDU Beira S.A has full support from Netherlands, through Netherlands Enterprise agency (RVO). SDU Beira renovated municipal facilities, especially for post-administrativo and Bairro level public services, after Idai.

17 1：Administrative service (CMB, Department), 2: Administrative service (Post–administrativo office), 3: Administrative services (Bairro office), 4: Health post, 5: Residence, 6: Water supply facilities, 7:Pool, 8:Market, 9:Community Centre,
10: Parks, gardens, roundabouts, 11: Football field, 12: Cemeteries, 13: Leased Properties, 14：School. In BMMRP, the cost for renovation of facilities is estimated for the mainly the categories more related to social service delivery among all

Regarding facility damage, it is assessed as follows: category1:50%; Category2:23%; Category3:22%; Category4:5%. As more than 70% of the buildings reportedly were damaged on their roofs and roof frames, we may assume that strengthening roof parts is indispensable for preparedness for natural disasters.

Table 5-10 Category damage costs per m2 roof surface

Category	Damages	Damage cost	Ratio	Target period
Category1	One floor building, roof completely destroyed, Severe infiltration damage, Severe Damage to door and window frames, Severe Damage to electrical and hydraulic installations	21,600 MT/m2	50%	In 1 year
Category2	Ground floor building, roof completely destroyed, Severe infiltration damage, Severe Damage to door and window frames, Severe Damage to electrical and hydraulic installations	15,000 MT/m2	23%	In 3 years
Category3	Complete new roof sheets, repairs on the roof structure, Average infiltration damage, damage to door and window frames, damage to the electrical and hydraulic installation	10,650 MT/m2	22%	
Category4	Partial replacement (< 50%) of roof sheets, minor repair of the roof structure, Minor infiltration damage, Minor damage to doors and windows, Minor Damage to electrical and hydraulic installation	5,440 MT/m2	5%	In 5 years
Category5	Partial replacement (< 25%), roof sheets. No repair on the roof structure, Minor infiltration damage, and Minor damage to doors and windows. Minor Damage electrical	2,925 MT/m2	—	—

Source： BMRRP Vol 2 Sector report. P62

Table 5-11 Total estimated Damage to municipal buildings and facilities (Unit: USD)

Facility category	Damage
1. Municipal services and departments	2,552,201
2. Neighbourhood posts	637,420
3. Residential	1,201,803
4. Sanitary buildings	347,820
5. Markets	1,277,484
6. Community centres	159.984
7. Rented out	1,693,918
8. Schools (municipality)	228,625
9. Health centres (municipality)	190,745
Total:	8,290,000
MT/USD rate is 64.0. VAT excluded. 10% contingencies and 10% engineering included	

Source： BMRRP Vol. 2 - Sector Reports, P60

(2) Recovery and Rehabilitation needs

The facility evaluation list puts recovery/reconstruction needs on each facility. Then CMB planned and implemented recovery and renovation, reflecting the priority, and also selected candidate sites to meet the requirements of donors who wish to support public facility rehabilitation. As is the same, candidate sites for the pilot project of ARPOC were selected from this list.

As of August 2020, 60 facilities out of 190 were renovated or scheduled to be renovated. As of May 2021, the number stayed almost the same –63– due to additional damages caused by Cyclones: Chalane (2020) and Eloise (2021). Accordingly, there is still much need for facility rehabilitation[18].

18 The facility list of CMB (as of August 2020, May 2021)

In the background of the enormous damage caused by this disaster, a budget plan for reconstruction from 2019 to 2024 is prepared for the facilities under the jurisdiction of CMB, divided into eight major categories with an estimated 892 million US dollars in total.

[1] Coastal protection (WB/Netherland/KfW), [2] Municipal Sewerage (WB・Netherland), [3] Public health facilities (EU/Netherland), [4] Waste proposal (UNDP), [5] Road, [6] Residence and residential area (Netherland/UK), [7] Municipal administrative facilities for public services (Netherland), [8] Economic measures (WB/Netherland/EU) [19]。
Among these, [6] residence and residential areas account for 31% of the total, followed by [8] economic measures at 23% and [2] public health facilities at 22%. Regarding [7] Municipal administrative facilities, which are likely to be used as emergency evacuation sites and shelters through renovation, it accounted for 2% in total, and it is estimated that 13,755,000 US $ is required.

Among 7, all Bairro offices, including the Chingussura Bairro office located in one of the ARPOC pilot project sites, were already renovated by SDU-Beira in August 2020.

5.3.2 Education Facilities

(1) Damages to Education Facilities

The damage to educational facilities in Mozambique by Cyclone Idai reached 3,504 classrooms[20] in 1,380 schools[21]. Of these, 2,713 classrooms in 340 schools, the most severe damage reported are in Sofala province where the city of Beira locates, and also 237,186 students were affected[22]. As for the city of Beira, 714 classrooms in 64 out of 66 public elementary and junior high schools were damaged. Furthermore, reportedly, 1,675 classrooms[23] in Sofala province (values in Beira city are unknown) were damaged by Cyclone Chalane and Eloise, which landed in December 2020 and January 2021 after Cyclone Idai.

(2) Repair and Rehabilitation needs

The rehabilitation of the educational environment in Sofala Province, including the city of Beira, has been coordinated by the 'Education Cluster' led by DPEDHS, UNICEF and Save the Children. The Cluster also has played a significant role in formulating the "Preparation, Response, and Restoration Strategy (2020-2029) in the Education Sector in Emergency Situations" together with MINEDH.

Facility renovation assistance is also one of the items coordinated by the Cluster. The list indicating the

19 ( ) Indicates the leading donors in the project implementation and funding list (Matriz Priorização e Clarificação de Projectões r4 (plenária)) provided by the CMB Infrastructure department Officer (September 2019).
20 UN-Habitat News and Press Release (18 Mar 2020) reported 1,380 schools were damaged, and 382,717 students and 9,616 teachers were affected.
21 INGC Cyclone IDAI Overview data
22 PLAN International (2019), 'Rapid School Needs Assessment Report – Beira and Buzi Districts, Sofala Province Cyclone IDAI Response' by Momo Manasseh & Oketa Denis
23 Mozambique Eloise Response: EIE Coordination Group / Education Cluster Factsheet Reporting of Activities from Jan.1 2021 to April 30, 2021

affected schools and earmarks by donors has been shared with the cluster members to avoid duplication of donor assistance and improve the efficiency of each donor's activities. Accordingly, the ARPOC pilot project school sites were selected after confirming that the school had no donor support from the list.

Numerous NGOs, including UNICEF and KfW, have planned or implemented assistance programs for facility renovation. In Beira City, support has been confirmed for 36 out of the 66 damaged public primary and secondary schools as of October 2019. Additionally, in December 2019, Education Cannot Wait (ECW) announced the renovation of 54 classrooms in six primary and secondary schools[24]. UN-Habitat has also set a goal to renovate 275 classrooms and establish 150 new classrooms as of March 2020[25]. The assistance of facility renovation is not uniform, from the temporary classroom installation to the existing classrooms rehabilitation or new classroom construction. Among all, especially in providing temporary classrooms, COSACA[26] has played a significant role at many schools in Sofala Province, including Beira, reflecting the urgent need to secure providing an educational environment even in the rainy season starting from October or November 2019.

Regarding facility rehabilitation and new construction, various donors have played roles. In the case of rehabilitation by donors, MINEDH requires them to meet the specifications of primary schools' resilient standard design and specifications (in October 2021, it became a ministerial decree as provisions for resilient facility planning[27]). However, some of the facilities renovated by donors did not fulfil the requirement, just like a makeshift measure of installing temporal roof sheets. So, DPEDHS, with the support of MINEDH DIEE, gave contractors guidance and supervision to make facilities resilient through rehabilitation[28].

Although DPEDHS has jurisdiction over educational facilities in Sofala Province, including Beira city, it is hard for DPEDHS to meet the needs from short-term to long-term due to the severe damages caused by the cyclone mentioned above[29]. Therefore, DPEDHS intends to promote the acquisition of support donors by submitting the list of damaged schools not yet earmarked by any donor to GREPOC, which centrally controls the whole reconstruction plan, after GREPOC becomes fully functional in 2020[30].

Recovery is still underway with the support of many organisations, even after the facilities requiring rehabilitation increased by Cyclone Chalane and Cyclone Eloise. However, it is reported that there are still 183 classrooms[31] with no prospect of rehabilitation (as of June 2021). Furthermore, as a measure against

24 From the documents provided by UNICEF (December 2019)
25 UN-Habitat News and Press Release 18 Mar 2020
26 COSACA is a consortium established by CARE International, Save the Children and OXFAM in 2007. In the case of the activities after Cyclone IDAI, CARE International undertakes temporally classroom installation, and Save the Children undertakes assistance for recovering the learning environment such as supplying learning materials
27 Hearing survey to the technical officer in the infrastructure department, DPEDH (May 2021)
28 Hearing survey to DPEDHS (October 2019)
29 In the 2019 Socio-Economic Plan (Plano Economico Social (PES) 2019), the number of classrooms in the construction plans nationwide is 766 for primary and 225 for secondary education, which is about 1,000 in total. This number is far less than 3,504 of the classrooms damaged by the disaster.
30 Hearing survey to DPEDHS (October 2019)
31 Retrieved from the statistics provided by DPES (June 2021)

Covid-19, securing a social distance of 1.5m or more and the limited capacity - 25 people/classroom - are enforced[32]. Hence, the facility demands to ensure the educational environment is further increasing.

5.3.3 Health facilities

(1) Damages caused to Health Facilities

The casualties caused by the Cyclone Idai were 602 dead and more than 1,641 injured. Furthermore, physical damage to medical institutions, transportation and communication networks, and access became difficult in wide-area flood areas. As a result, the facility became malfunctioned. It reported that 173 facilities under MISAU and DPSS in Sofala Province have 4 destroyed facilities and 63 partially damaged[33], mainly the roof[34].

Under these circumstances, the health cluster required miscellaneous assistance: emergency treatment for injured people after a disaster, continuous provision of medical services, and support for preventing infectious diseases such as cholera and malaria. Reflecting this, and in addition to DPSS, international organisations and NGOs provided medical assistance at existing health facilities and the emergency medical posts established by "Doctors Without Borders" (MSF), International Red Cross (IRC), etc.

In this way, emergency medical services are more prioritised in the health sector, but the continuous medical services supply shall be a prerequisite from a longer-term perspective. The renovation of facilities, regarded as a long-term measure, is mainly carried out by DPSS[35] but with limited support[36] from FHI360, Health Alliance International (HAI), and Peace Wind Japan (PWJ). As mentioned above, WHO, the chair organisation of the health cluster[37], focused on medical support such as controlling infectious diseases after a disaster, and facility renovation carried out by him is only a prefab-type laboratory in Buzi district where severe damage was reported[38].

(2) Recovery and rehabilitation needs

Regarding the city of Beira, there are 15 medical facilities shown in the table below, including Beira Central Hospital (CHB), the fourth-level medical facility of the top referral hospital. This assessment focused on restoring the facility's function, so the budget was calculated mainly for emergency roof measures. The total cost for it is up to 36,886 thousand MT[39]. This information plays an essential role in avoiding duplication

32 https://www.dw.com/pt-002/mais-de-oito-milh%C3%B5es-de-alunos-iniciam-aulas-em-mo%C3%A7ambique/a-56947015
33 In April 2019, a rapid assessment of the damaged health facilities was carried out mainly by the infrastructure directorate of MISAU, including DPSS. Since this is an emergency assessment, it has not been possible to grasp the status fully covering all facilities accurately due to floods. Source: 'Health PDNA_Mozambique IDAI_Damage Loss and Needs tables_Health & Nutrition Sector _12 May 2019' (DPSS provided)
34 Hearing survey to DPSS (February 2020)
35 ditto
36 In Beira, only Manga Mascarenha Health centre and psychiatric ward of Beira Central hospital were supported (as of Feb. 2020)
37 Regarding medical health, health sector clusters have been organized by the State Health Department and the lead agency, WHO, for the purpose of lifesaving, emergency response, and recovery after the disaster. The largest number of participating (and former) organizations was 13 in July 2019, with 75 activities. (Health Cluster 4W visualizer https://www.humanitarianresponse.info/en/operations/mozambique/pemba-health-cluster-4w)
38 Hearing survey to the director in WHO Beira Office, (February 2020)
39 ACTL_Sofala Levantamento de custos infraestruturas Ciclone IDAI. (Shared by SPSS)

and improving efficiency in planning projects and assistance among donors.

Table 5-12 Health facilities in Beira and required rehabilitation cost（Unit: MT）

	Facility and Category		Estimated cost for rehabilitation
1	Beira Central Hospital	4次	24,833,700
2	Ponta-Gea Health centre (Type A)	1次	2,895,000
3	Chingussura Health centre (Type A)	1次	562,500
4	Munhava Health centre (Type A)	1次	2,895,000
5	Nhaconjo Health centre (Type A)	1次	142,200
6	Manga Mascarenha Health centre (Type B)	1次	N/A
7	Nhangau Health centre (Type II)	1次	300,000
8	Ceramica Health centre (Type II)	1次	300,000
9	Chota Health centre (Type C)	1次	300,000
10	Macurungo Health centre (Type A)	1次	2,895,000
11	Marocanhe Health centre (Type II)	1次	300,000
12	Manga Loforte Health centre (Type C)	1次	300,000
13	Inhamizua Health centre (Type A)	1次	562,500
14	Chamba Health post	1次	300,000
15	Matadouro Health post	1次	300,000
	Note: Health centres are classified into urban and rural types according to the location, and types A to C represent the scale of the urban health centres. C is the minor facility, and the covered medical service is limited. Regarding the scale classification in rural areas, Type II is a smaller facility than I. The Health Post is the smallest one among all facilities. Renovation: The renovation of the psychiatric ward of Beira Central Hospital, and Manga Mascarenha HC were carried out by Peace wind of Japan (PWJ) and Health Alliance International (HAI) respectively.		

Source： JICA Project team created based on documents provided by DPSS

Regarding the priority for facility rehabilitation, it is not clearly defined based on assessment results since the on-site assessment could not cover all faculties, and donors have their preferences and tend to limit the area for assistance. However, rehabilitation has been promoted mainly for the facilities with many beneficiaries, higher-level facilities as bases for medical services, and facilities in remote areas where access to medical services without it is difficult.[40]

40 Hearing survey to the director of Planning and Cooperation directorate in DPSS (February 2020)

5.4 Review of laws, guidelines, and manuals related to the design and construction of public facilities

5.4.1 Related laws and regulations

(1) Overview

In 1995, the Ministry of Public Works and Housing (Ministério de Obras Púbicas e Habitação – MOPH), which is the predecessor of the Ministry of Public Works and Water Resources (MOPHRH), was established on December 26 by Presidential Decree 8/95. The ministry and its directorates have been facilitating the development of the construction sector, responsible for contracting and supervising public works, and providing technical advisory on large-scale projects undertaken within the administrative boundaries of local governments41.

Since the establishment of MOPHRH, various laws have been introduced to regulate the licenses of construction contractors and other engineers, construction inspection and quality, types of contracts, and so on. In addition, a law has been passed that allows direct control and licensing of the private sector.

MOPHRH has maintained the Colonial Law (May 10, 1960, 1976), which guides the construction of cities, and has updated the laws reflecting the reality of modern Mozambique. An example of such laws to be considered particularly in planning public facilities is the law on barrier-free42.

On the other hand, the old Portuguese standards mutatis mutandis are applied to the structural design, and so do ISO, EU standards and South African National Standards (SANS) for specifying material quality. Therefore, the norms and standards that apply to public facility plans will vary depending on the characteristics of financers (donors) and projects.

(2) Facility guidelines considered by the relevant ministries

1) Ministry of Education and Human Development（MINEDH）

MINEDH, which supervises educational facilities, has established laws and regulations[43] indicating various indicators (e.g., number of students/classes) for facility planning and operation but has not set standards against natural disasters.

Therefore, MINEDH has examined facility standards with UN-Habitat, INGC (the predecessor of INGD), UEM and others, with the support of WB[44]. Through this effort, the prepared risk map, the standard design for primary schools, and various standards such as the basic wind velocity and seismic force used in

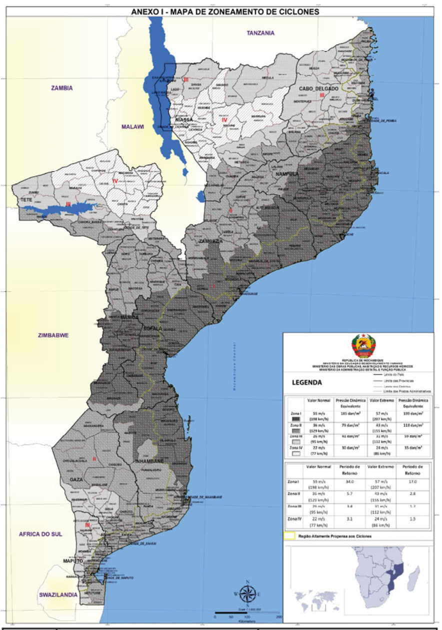
41 For building permission of public facilities, it is necessary to submit an application form with required drawings to obtain it from the construction-related competent authority. The municipal council is the authority if the planning area is in its jurisdiction. Then the provincial offices of public works, water resources and housing (DPOPHRH) are the competent authority for the other regions.

42 Decreto. No 53/2008: Aprova o regulamento de Construção e Manutenção dos Dispositivos Técnicos de Acessibilidade, Circulação e Utilização doe Sistemas dos Serviços Públicos à Pessoa Portadora de Deficiência ou de Mobilidade Condicionada, Especificações Técnicas e o uso do Símbolo Internacional de Acesso.

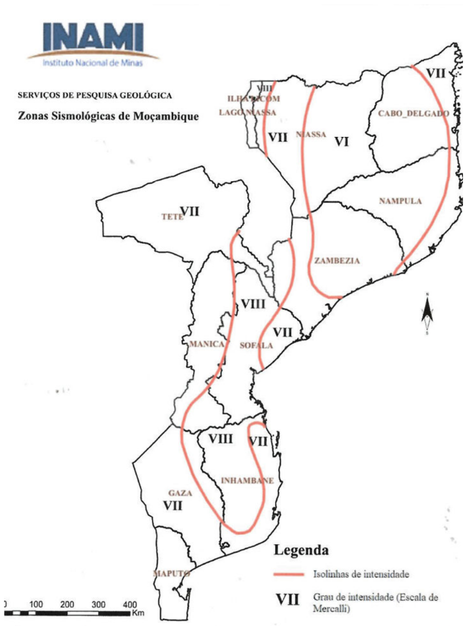
43 Diploma Ministerial n.º 61/2003, Diploma Ministerial n.º 46/2008, etc.

44 MINEDH et al (2015), SAFER SCHOOLS Developing Guidelines on School Safety and Resilient School Building Codes DIAGNOSIS & RECOMMENDATIONS Executive Summary

planning facilities resilient were enacted as a Ministerial decree 122/2021 (October 26, 2021).



Zona	Velocidade máxima dos ciclones	Pressão Dinâmica Equivalente:
I	43m/s - 57m/s (155km/h - 207km/h)	113dan/m^2 - 119dan/m²
II	31m/s - 43m/s (112km/h - 155km/h)	59dan/m² - 113dan/m^2
III	19m/s – 31m/s (69km/h - 112km/h)	22dan/m^2 - 59dan/m²



Zona	Grau de Intensidade (Escala Mercalli)	Valores médios da aceleração sísmica horizontal em g computados para 10% de probabilidade de excedência em 50 anos
I	VIII	0.163 -0.244g
II	VII	0.040 – 0.163g
III	VI	≤0.040g

Source: Ministerial decree 122/2021 （Oct. 26, 2021）

Figure 5-3 Basic wind velocity for structural design (Left)， Horizontal acceleration for structural design (Right)

2) Ministry of Health (MISAU）

Like MINEDH, MISAU, which supervises health and medical facilities, has established laws and regulations with various indicators required in operating and planning facilities. However, regarding the emergency response, MISAU had considered it mainly from curbing the spread of designated infectious diseases, not from facility resilience to the risks caused by large-scale natural disasters such as Cyclone Idai.
Currently, MISAU recognises that it is essential to consider a plan to respond to future disasters by lessons learnt from recent disasters. It also acknowledges that MISAU should regard it in collaboration with other sector authorities. Therefore, the person in charge of disaster response from MISAU is also participating in the conference held by INGD[45].

Furthermore, with the support of UN-Habitat, the Directorate of Health Infrastructure and Equipment of MISAU has examined health facilities' specifications since December 2020. The main objective is to apply the exact specifications to new construction and renovation of health facilities to improve their resilience[46]. The standard design will be unlike the ones examined by MINEDH for each disaster type; it will be considered for all kinds of disasters and mainly applied to primary-level health facilities mainly located in rural areas. Following that, MISAU plans to regulate various standards such as basic wind velocity and seismic force in planning facilities as MINEDH did[47].

5.4.2 Relevant guidelines

We assume that resilient educational facilities with a large capacity tend to be designated evacuation centres in preparation for natural disasters. However, there are no facility guidelines for using schools as evacuation centres. It is challenging to set uniform standards for facility renovation because the current condition of existing facilities varies widely. However, it could be desirable to meet the requirements for evacuation centres as long as it does not become excessive as an educational facility by precisely examining the current condition and referring to the published guidelines for planning new schools and evacuation centres.

45 Hearing survey to the director of Planning and Cooperation directorate in DPSS (February 2020)
46 Hearing survey to the director of Planning and Cooperation directorate in SPSS (May 2021)
47 Hearing survey to the director of Infrastructure directorate, MISAU (March 2022)

5.5 Assistance for planning public facility recovery/rehabilitation in BMRRP reflecting the hazard map.

5.5.1 The policy of assistance for public facility recovery/rehabilitation

(1) Issues to be considered for public facility recovery/rehabilitation

In Beira, 63 out of 190 facilities were rehabilitated entirely, and some were restored with a temporal measure, whereas many facilities have not yet been rehabilitated as of May 2021. CMB formulated BMRRP in 2019 and set the implementation policy shown in the table below for the recovery and rehabilitation of facilities, including houses, dividing the time frame into three steps - short-term, medium-term, and long-term.

Table 5-13 Term-wise implementation policy on recovery and rehabilitation in BMRRP

Physical intervention	
Short-term	· Vulnerability assessments: · Definition of Urban Recovery Plans at the city and neighbourhood scale for slums in central areas with a focus on social inclusion and increased resiliency. · Strategic action framework for the implementation of city and neighbourhood resilience plans · Strategic action framework for the implementation of city and neighbourhood resilience plans: urban regeneration for consolidated areas · Reconstruction and rehabilitation work with a focus on the most vulnerable · Support community-led infrastructure · Relocation of households in areas extremely vulnerable to disaster · Technical assistance for human-rights-based relocation
Middle-term	· Technical support on alternatives to relocation · Livelihood regeneration programme, Operationalise Livelihood regeneration programme
Long-term	· Retrofit and rehabilitate damaged structures following the BBB approach, use of created guidelines and via an owner-driven implementation. · Operationalise national-level social protection and housing strategies at the local level with a focus on the post-disaster housing recovery · Scaling up of incremental building housing developments: low-cost housing should be facilitated and promoted.

Source： BMRRP vol.2 Sector Reports, pp36-38

More than two years have passed since the above policy was announced, and then, the shift to medium-term and long-term measures is required based on the outcome of the short-term efforts.

Although each of the above measures mainly focuses on residences, we could grasp we can apply these measures to public facilities from the same context as the individual facilities scattered in the city. On the other hand, unlike residential facilities, public facilities have a variety of uses, so it is indispensable to rehabilitate facilities based on a well-planned schedule according to clear priorities, with a limited budget and human resources. When considering the priority, we think focusing on the "vulnerability" shown in the "recovery/reconstruction of highly vulnerable facilities" set in the short-term goals is crucial. This approach is indispensable for educational and health facilities to facilitate facility recovery/ rehabilitation, as with CMB facilities.

Regarding recovery/reconstruction of public facilities, some issues were recognised even before Cyclone Idai. One of them is that the facilities are poorly maintained and then deteriorate, even the facilities built before the independence which were durably structured compared with ones constructed recently. Moreover, the facilities built after the independence were planned with a lighter structure. Hence these facilities are generally vulnerable to a severe climate.

Then, the causes of this situation were indicated in BMRRP as follows:

(1) financial restraints; (2) lack of adequate climate-resistant building codes and regulations; (3) lack of technical knowledge of cyclone-resistant construction methods and lack of supervision and monitoring during construction; (4) the buildings in flood-prone areas with poor basic infrastructure leads to faster degradation[48]. Hence, we consider that the countermeasures to these causes shall be effectively woven into the recovery/reconstruction plan.

(2) The policy of assistance for public facility recovery and reconstruction

The authority of public facilities is required to formulate a recovery/reconstruction plan based on needs and issues as quantitative as possible. Still, at the same time, much rapid examination is necessary to meet the 5-year reconstruction period targeted by GREPOC. Reflecting on the context, the policy of this study is to ensure accountability throughout the rapid examination process as much as possible by making more effective use of PDNA, which is the preliminary assessment material, and other relevant documents.

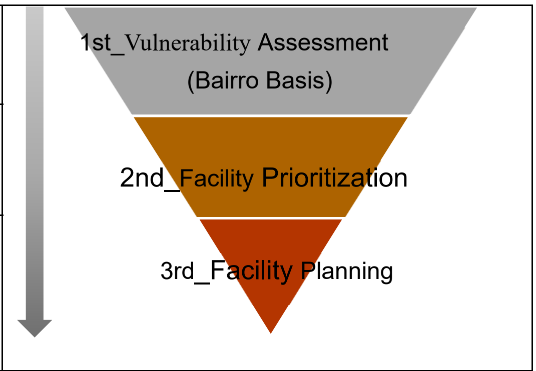
5.5.2 Assistance approach for public facility recovery/rehabilitation

The examination process for the recovery/rehabilitation of public facilities is divided into three steps to change the focal point from the urban level to the facility level. In addition, the examination method for each step was designed with already published materials to make it efficiently traced and reproduced even in a natural disaster in future. Furthermore, we hold discussions to build a consensus with CMB's engineers throughout the study to enable this study to contribute to solving the issues that appeared even before Cyclone Isai. Also, relevant documents published by other authorities and donors are referred to in examining the technical issues, especially for making facilities resilient.

48 BMRRP p.57

Table 5-14 Examination steps for assistance for planning public facility recovery and Rehabilitation

Step 1	Assessment of Bairro-wise vulnerability against natural disasters: based on Hazard map and indicators retrieved from relevant published study reports.
Step 2	Facility prioritisation reflecting the Bairro-wise vulnerability assessment: selection of facility can be used as an evacuation centre.
Step 3	Facility planning: Rehabilitation menus are examined to accumulate qualified resilient facilities as social assets efficiently.



Source: JICA Project team

(1) Step1：Bairro-wise vulnerability assessment to natural disasters

1) The focus of Bairro-wise vulnerability assessment

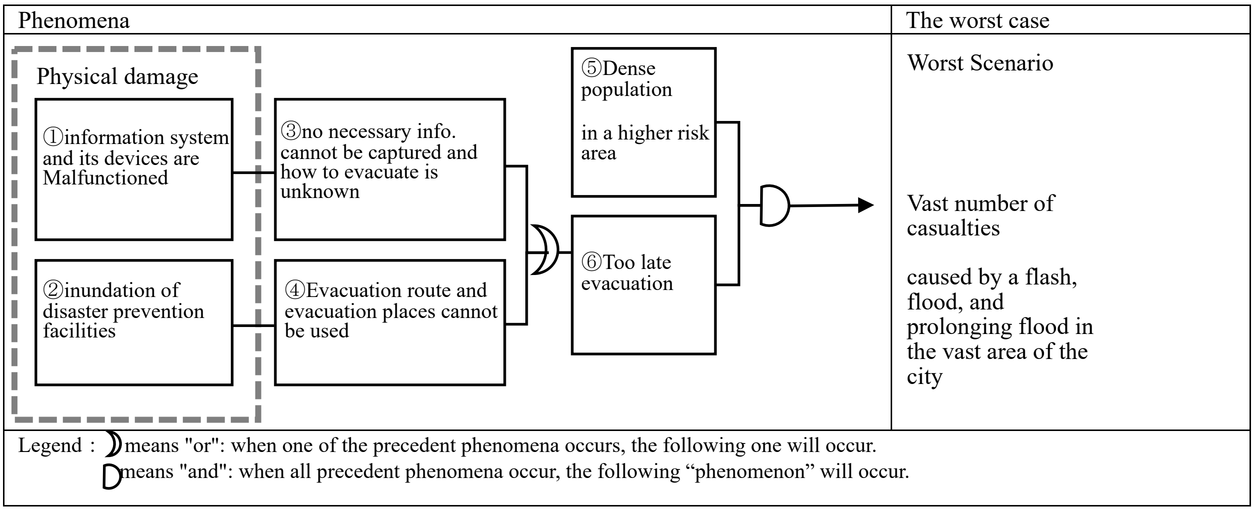
One of the characteristics of public facilities is that they set respective target areas for providing services and cover the whole area of the jurisdiction by complementing functions of each other.

In the case of administrative services, the principal office of CMB is placed at the centre, and branch offices in respective Post-Administrativos and Bairros are located to enable the public to access to receive public services efficiently. Through this formation, CMB provides administrative services over its jurisdiction.

In the case of education service, schools provide educational services while complementing the functions of each school within a zone (ZIP).

Similarly, regarding health care and medical services, a wider-area medical service coverage over Sofala province is forged, including Beira city, under the referral system consisting of primary to quaternary level facilities. Under this referral system, highly specialised medical services are provided at the central and provincial level hospitals, while district-wise health centres and health posts provide medical services related to common illnesses and public health services.

Like this, each public facility is not only a core for providing social services in the respective target area but also a node to construct a social service network over the whole jurisdiction. For this reason, recovery/reconstruction must be considered to ensure the functions of each public facility and not disrupt the social service network. Therefore, we think it practical to prioritise vulnerable areas with a high risk of damage caused by natural disasters and then carry out recovery/rehabilitation according to the priority.



Source: JICA Project team created it, referring Headquarters for Promoting the Establishment of the Disaster Resilient Japan (2018), 'the result of vulnerability evaluation'

Figure 5-4 Flowchart of occurrence of a vast number of casualties caused by flood

To assess the vulnerability of each area by an objective and easier-to-understand method, we examined it, referring to the method to evaluate the vulnerability to natural disasters in the "Fundamental Plan for National Resilience" promoted in Japan.

In the assessment method used in the reference, firstly, the "worst-case to be avoided" was set, and then "phenomena" which might lead to the worst possible case and their linkage were identified. Subsequently, the required measures for the "phenomena" were examined.

In this study, considering the damages caused by Cyclone Idai, we referred to the flowchart "the occurrence of a large number of casualties due to sudden or wide-area and long-term inundation of urban areas." (hereinafter "sudden flood") in the document. As is the case with the reference, we decided to assess Bairro-wise vulnerability focusing on "phenomena" which might lead to the "the worst case to be avoided".

2) Assessment indicators for Bairro-wise vulnerability

We decided to examine the assessment indicators focusing on the factors which cause the "phenomena" in the flowchart. However, some "phenomena" are not directly related to area-wise vulnerability. For example, "phenomena" (1), (2) and (4) are associated with the current condition of facilities. Furthermore, "relevant information cannot be obtained, and evacuation method is unclear" and "delayed evacuation" indicated as "phenomena" (3) and (6), respectively, are instead related to the weakness of preventive measures. We consider this situation will be improved by soft measures such as creating my timeline, hazard map and an evacuation facility list and executing disaster prevention drills.

Whereas, among "phenomena", (5) "population concentration in places with high disaster risk", it is suitable to assess the vulnerability of each Bairro because it largely depends on the characteristics of the facility location. Therefore, we decided to examine indicates for this assessment from this aspect.

a) Indicators for vulnerability assessment

In setting evaluation indicators, we focused on the “phenomenon” (5) "Population concentration in places with high disaster risk". However, we might determine that the probability of occurrence of this “phenomenon” could be mitigated in either of the following cases "the population is not concentrated even in places with high disaster risk" or "the population is concentrated in places with low disaster risk". On the contrary, if both "Population concentration" and "high disaster risk" show a high value, the risk of occurrence will be higher, leading to the worst scenario. Accordingly, we decided that both indicators - "population concentration" and "places with high disaster risk" - will be assessed separately.

Table 5-15 Assessment indicators for Bairro-wise vulnerability

	Assessment focus	Assessment indicator		Data source
1	Natural disaster risks	Topography, Topology	The ratio of expected flood area with over 50cm water depth, in case of the scenario of "Cyclone Desmond"	Hazard map (Scenario: Cyclone Desmond Equiv.). GIS data
2		Land use	The ratio of the unplanned development area	Land use GIS data, retrieved from MITADER, CMB et al (2019), ‘Relatório Preliminar de Diagnóstico da Cidade da Beira’
3	Population Condensation	Population Density		Population Census of INE (2017), GIS data

Source：JICA Project team

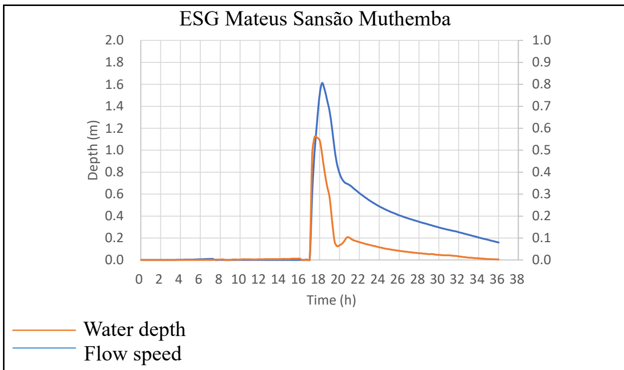
We assume that "natural disaster risks" will change depending on the inundation depth and dimensions associated with topology and how much the unplanned development area where vulnerable facilities are concentrated extends. Thus, we decided to evaluate from two indicators, "topography/Topology" and "land use". Regarding "population concentration", we decided to assess the population density of each Bairro based on the 2017 household Census. However, since the population density varies greatly depending on land use, we, therefore, calculated the population density after excluding the estuary area where almost no dwellings are available to enable the result to reflect the actual population density. Especially in the case of Inhamizua Bairro, nearly half of the area occupied by the estuary was excluded.

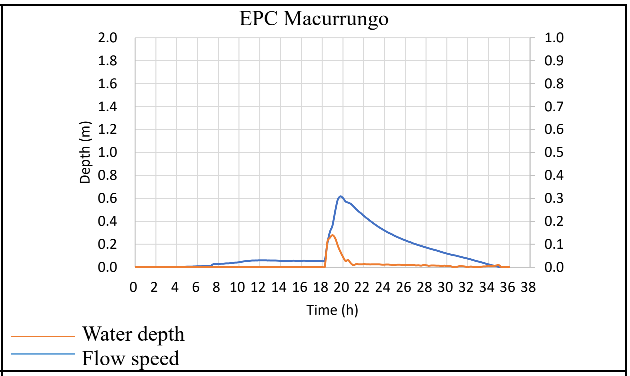
3) Bairro-wise vulnerability

a) Indicator 1 : the area with a higher risk of damages caused by natural disasters — Topography/Topology

When assessing the natural disaster risk, it is necessary to understand the impact on evacuation by the timing and duration of the maximum inundation depth by a cyclone and the expected flow velocity. Therefore, we applied the scenario when a cyclone equivalent to Cyclone Idai and the spring high tide overlap. Then, we examined the changes in inundation depth and water flow velocity along time at the three pilot project sites.

As a result, no inundation is expected at "the Inhamizua Post-Administrativo office and Chingussula Bairro office site" but is expected at the other two sites - "EPC Macurrungo" and "ESG Mateus Sansão Muthemba".



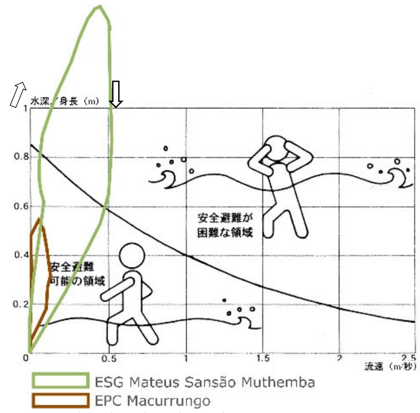


When a cyclone (Cyclone Idai equivalent) landfalls at the time of high tide, seawater is expected to come over the land, and its depth is expected to reach 1.6m with a flow speed of 1.0m/s.	When a cyclone (Cyclone Idai equivalent) landfalls at the time of high tide, seawater is expected to come over the land, and its depth is expected to reach 0.6m, but a flow speed stays around 0.3m/s.

Source：JICA Project team

Figure 5-5 Change of Inundation depth by time ESG Mateus Sansão Muthemba (left), EPC Macurrungo (right)

From the figure below, we can recognise that the more water becomes deep, the more difficult for people to evacuate on foot, and also, it isn't easy even in the low water depth when the water flow is fast.



At ESG Mateus Sansão Muthemba, when the inundation depth reaches the shoulder of a G1 student (6 years old) or more and the water flow velocity is expected to reach 0.5 m, it, therefore, interferes with walking within, as shown in the figure on the left. On the other hand, at EPC Macurrungo, although the inundation depth is assumed to be above the waist of a G1 student (6 years old), it is judged that walking is possible because of the slow water flow velocity. Accordingly, we can recognise that ESG Mateus Sansão Muthemba and EPC Macurrungo are required to have different evacuation methods and facilities set up for evacuees.

Source： JICA Project team created referring to the document issued by the Ministry of Land, Infrastructure, Transport and Tourism of Japan, https://www.mlit.go.jp/river/basic_info/jigyo_keikaku/saigai/tisiki/chika/pdf/g-11_g-14.pdf（accessed on August 7, 2020） and Simulation data JICA Project team created

Figure 5-6 Relationship between water depth and water flow velocity in underwater walking

This figure shows the relationship between water depth and flow speed expected at ESG Mateus Sansão Muthemba and EPC Macurrungo. From this figure, even though the water depth and flow are not homogeneous due to the characteristics of a liquid, we can expect difficulty during evacuation when water flows into the place at ESG Mateus Sansão Muthemba.

In the case of a cyclone or heavy storm, precautionary evacuation is a prerequisite. Hence, we can prevent life loss from the flood flow velocity should precautional evacuation is practical.

On the other hand, the flood depth largely depends on the height from sea level and the land profile where the evacuation centre locates. So, we cannot deny that it will be a constraint for evacuation, and the evacuation centres themselves will be sunk into it. Therefore, this study set indicator 1 as the inundation depth expected in a natural disaster.

b) Examination of the threshold of inundation depth which deters walking evacuation

Focusing on facility users, we can assume they are within a particular age cohort in the case of schools under regular operation. However, when using a school as an evacuation place or centre, it is necessary to assume evacuees of all ages, including children, the aged, and the physically challenging. When considering the threshold of the difficulty of evacuation from this context, we can assume that it is difficult where the flood depth exceeds the average height of around 50 cm, which is equivalent to the length of the waist of a 6-year-old child[49,50].

In addition, when evaluating the water depth of 50 cm from an aspect of the facility, we can assume it may

49 From Human Life Engineering Research Center (1997), 'Anthropometric data of Japanese people 1992-1994'.
Seat height (knee height) for 7-year-olds (both sexes), who are at school age for the second grade: 285 mm (both sexes), inseam height: 523 mm (female), 513 mm (male);
For 12-year-olds, who are in their 7th grade schooling years, the seat height (approximate knee height) is 360 mm (girls) and 368 mm (boys), and the inseam height is 690 mm (girls) and 677 mm (boys);
For adults aged 20-24, the seat height (approximate knee height) is 365 mm (female) and 404 mm (male), and the inseam height is 715 mm (female) and 760 mm (male).

50 In this study, definition on the MISAU(2018), 'Tabelas de crescimento para rapazes dos 0 ano 18 anos de idade' (male) and '… Para Raparigas…' (female) was used to estimate the average hight of a six year old child (Grade 1) and estimated as 115cm.

reach above the ground floor except for the facilities whose ground floor level is higher than 50cm. In such an area, it is necessary to consider mitigation measures for inundation and to facilitate precautionary evacuation.

Reflecting on this, we decided to set a water depth of 50 cm as a threshold to assess the vulnerability of each Bairro by comparing the proportions of areas that will be inundated over the threshold.

c) Hazard scenario allied to this study

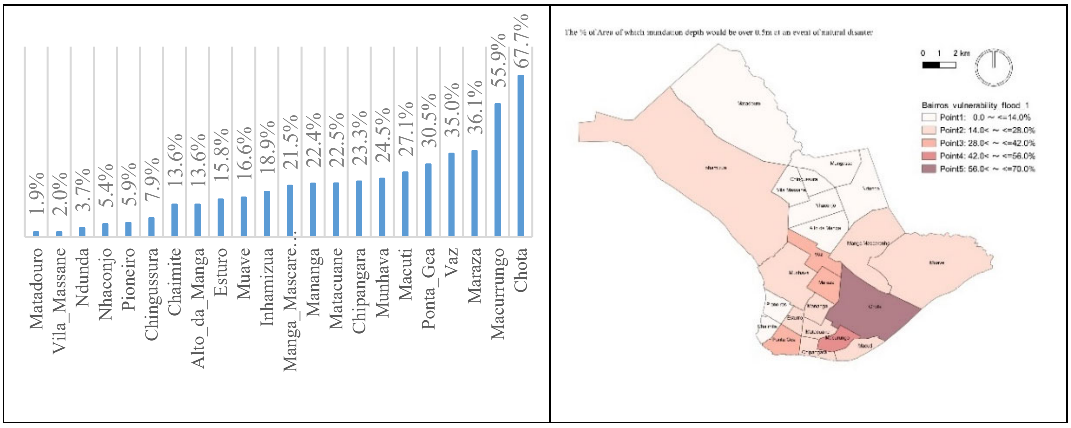
In this study, hazard maps have been created based on different scenarios. The worst scenario with significant damage expected is "when a cyclone equivalent to the Cyclone Idai with the spring high tide", and the water depth is likely to exceed 5 m in some areas.

However, this scenario is a 300-year return period which is a rare case. Also, the disaster prevention measures for such a large-scale disaster require a longer-term perspective, such as strengthening urban infrastructure and setting much wider-area evacuation solutions. Therefore, the expected flood caused by this scenario cannot be mitigated only by the recovery/reconstruction of the existing public facilities.

Then, in consultation with the CMB staff, we decided to prioritise maximising the utilisation of the existing public facilities for disaster prevention. Therefore, we applied the scenario of a heavy storm equivalent to Cyclone Desmond although it is smaller in size, but with a much higher possibility of landfall (return period of 30 years) and with more rainfall than Cyclone Idai.

d) The ratio of the area expected to be inundated with water depth over 50cm

The ratio of the area where water depth is 50 cm, or more is identified for each Bairro from the hazard map simulated based on the same rainfall as Cyclone Desmond. However, the areas of Tchondja, Nhangau and Nhangoma are excluded since their whole areas are not included in the simulation. In Inhamizua, the estuary occupying the majority is a non-resident area, so such an area is subtracted in this assessment.



Source：JICA Project team

Figure 5-7 The ratio of the area expected to be inundated with water depth over 50cm (Bairro-wise)

As a result, many Bairros in the southern parts of Beira will be inundated by 50cm or over. Especially in Chota and Macurrungo, the majority of the area is expected to be flooded. In contrast, in other Bairros, the inundation area is expected to stay less than one-third.

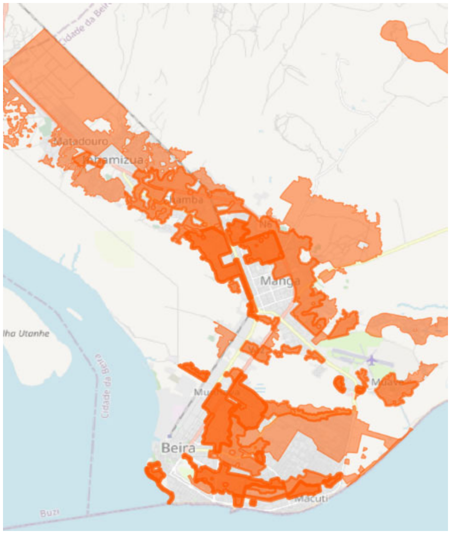
e) Indicator2：Higher risk of damages caused by natural disasters— Land use

Compared to planned development areas[51], unplanned development areas have relatively limited access to essential social services, and many houses are vulnerable to natural disasters. Since the number of evacuees is expected to increase than it of the planned development area, we focus on the ratio of the unplanned development area in the entire area.

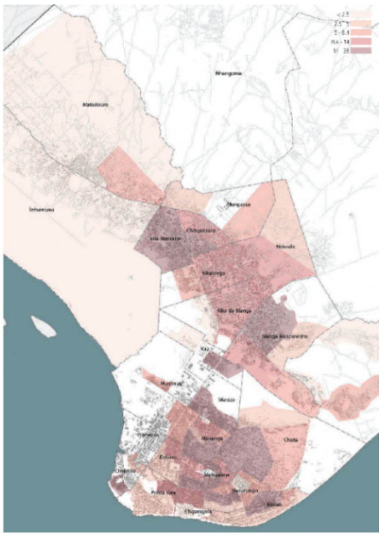
In BMRRP, "recovery/reconstruction for the vulnerable" of housing as one of the reconstruction support strategies exceeds 70% of the total estimated amount of physical support. Furthermore, we can recognise a relationship to a certain degree between the following two figures: the unplanned development area with many fragile premises (left) and the number of damaged houses per unit area when Cyclone Idai occurred (right). Accordingly, the unplanned development area can be assumed vulnerable.

In fact, from the rapid assessment result of Chipangara Bairro, for example, the trend is evident that the planned development area near the shoreline where facilities are rigidly constructed shows a lower proportion of damage. In contrast, many houses are damaged in the adjacent unplanned development area. Consequently, to compare the vulnerability of Bairros, we decided to identify the proportion of the unplanned development areas for each Bairro.

51 Compared to the other provinces, Sofala province is relatively highly urbanized (43%) in which Beira city contributes much. However, the ratio of unplanned development area is also high. In such an area, at least, one of the following characteristics can be confirmed: “1) Lack of access to improved water source, 2) Lack of access to improved sanitation facilities, 3) Lack of sufficient living area, 4) Lack of housing durability and, 5) Lack of security of tenure.” (UN-Habitat (2018). SDG Indicator 11.1.1 Training Module: Adequate Housing and Slum Upgrading. United Nations Human Settlement Programme (UN-Habitat), Nairobi.p8)



Source：MITADER et al (2019), 'Relatório Preliminar de Diagnostico da Cidade da Beira'



Source：BMRRP Vol.2 – Sector Reports, p19

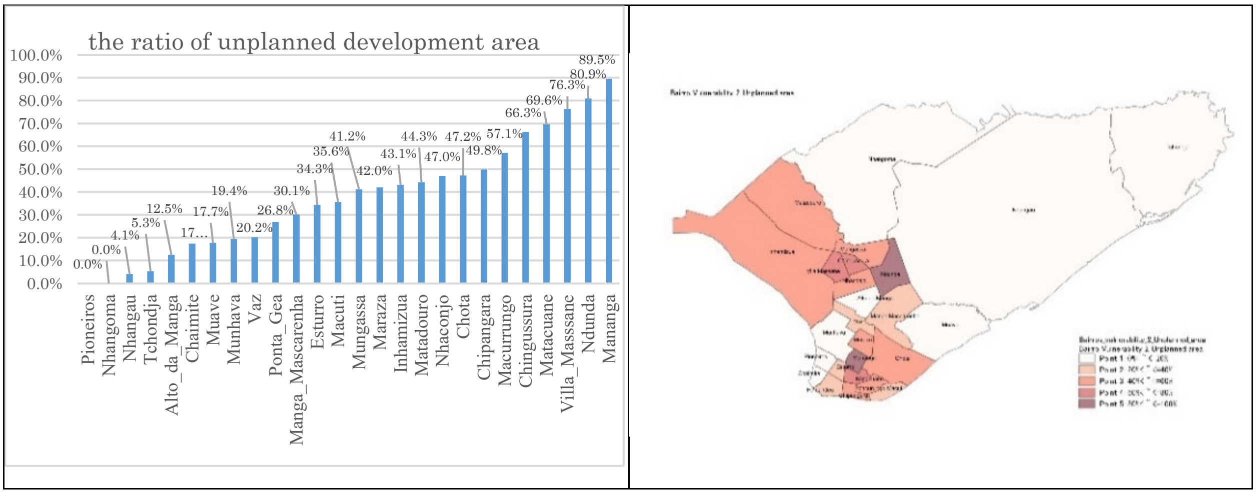
Figure 5-8 Dispersed unplanned development area (left), the number of damaged houses per unit area in the event of Cyclone Idai (right)

Source：UNITAR-UNOSAT (2019), Mozambique Chipangara Neighbourhood / Cidade da Beira Distrito / Sofala Province Imagery analysis: March 26 2019 | Published March 28 2019 | Version 1.0

Figure 5-9 Damaged facilities in the event of Cyclone Idai (Chipangara Bairro)

Regarding how to interpret the area where unplanned development spreads, it shall be considered in the middle or long-term development dynamism since the government will enforce development guidance and restrictions and change the land-use plan. Although it is necessary to grasp as such, we judged that assessing the current status of unplanned development areas is appropriate, taking account of the 5-year reconstruction target period GREPOC set. Reflecting on this, we decided to analyse the unplanned development areas shown in the relevant study report[52].

While the unplanned development areas are classified according to the development density in the report, this survey identifies the proportion of the unplanned development area for each Bairro, not considering such classifications. The result is shown in the following figure.



Source： JICA Project team

Figure 5-10 The ratio of unplanned development area (Bairro basis)

The proportion of unplanned development areas varies greatly depending on the Bairro. While the proportion is low in the Bairro in the peri-urban area, the proportion is high in urban areas, e.g., Mananga Bairro, where almost the entire area is classified as an unplanned development area. From the result, we can judge that vulnerability tends to be more prominent in urban areas.

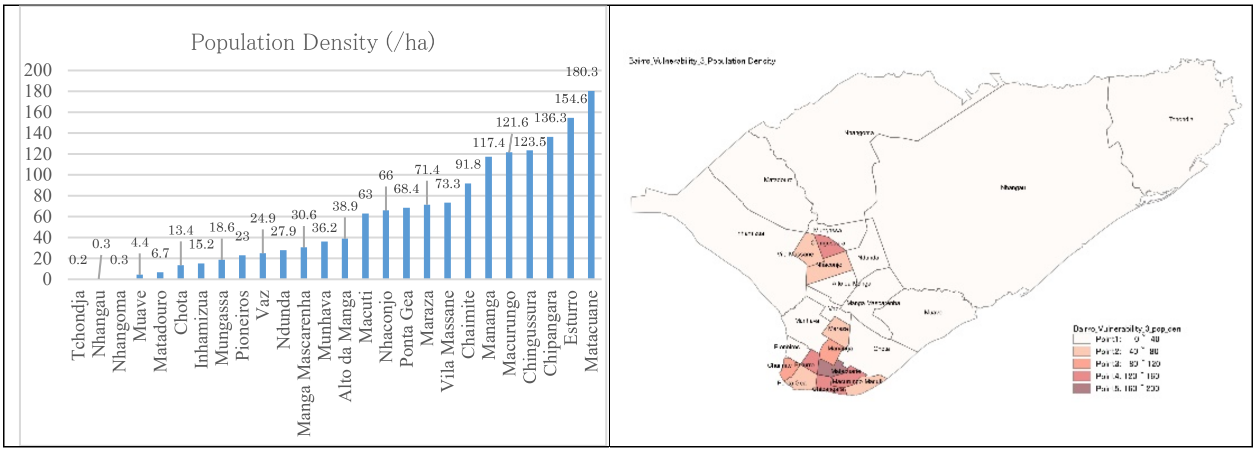
f) Indicator 3：Population condensation -Population density：

We cannot say that the expected number of evacuees changes depending solely on the population density alone. Still, even in areas where vulnerability is recognised as high in the above indicators (1) and (2), it can keep the occurrence of victims' low should the population density be below. On the other hand, if the population density is high, more evacuees will be expected.

As such, the estimated number of evacuees will change by the population density, even if it heavily depends on the situation. Accordingly, we analysed the population density as one indicator to identify each Bairro's vulnerability.

52 MITADER et al (2019), 'Relatório Preliminar de Diagnostico da Cidade da Beira'

In the analysis, we decided to calculate the population density of each Bairro based on the 2017 Census. Regarding Inhamizua, the estuary that is not suitable for human dwellings occupies the majority, and the most population is accumulated in the other area to avoid such an area. Hence the population density was calculated, being the estuary area excluded, to identify the most reliable figure showing the current state.



Source: JICA Project team

Figure 5-11 Population Density (Bairro basis)

The assessment result shows that the population density in Beira city varies in Bairros. As a whole, the population concentration in the southern part is relatively high. Among Bairros, Mananga to Matacuane in the city centre is remarkably high at 110-180 people/ ha[53]. 60-100 people/ha in the adjacent Bairros and the estuary lowlands and cultivated land widespread in the city's periphery show a low value of 40people/ha.

4) Evaluation of the result of the Bairro-wise vulnerability assessment

The assessment result with the above three indicators is summarised in the following table. Then we put points on each assessment result to enable us to evaluate the Bairros, based on the higher the total score obtained, the higher the vulnerability.

To eliminate bias among points gained from each indicator during the evaluation process, we set the highest score obtained in the evaluation of each index does not exceed 5 points, and also give points at equal intervals between the lowest and the highest values.

Regarding weightage, the vulnerability of Bairros will differ should it be applied. Hence, we examined it sensitively by comparing the results derived from different values, making the evaluation more realistic. After that, through discussions with the CMB staff, we gave a more significant weightage of 2 for indicator 1 than of 1 for other indicators since indicator 1 relies on the natural factor that is impossible to be controlled artificially.

53 Estimated population density of Tokyo Japan (as of 2020) is as follows: specified districts in Tokyo154.5/ha, peri-urban district 53.9/ha, rural district 1.5p/ha. Hence, we can assume the population density of Matacuane is quite high.

Table 5-16 Point allocation for evaluating the Bairro-wise vulnerability

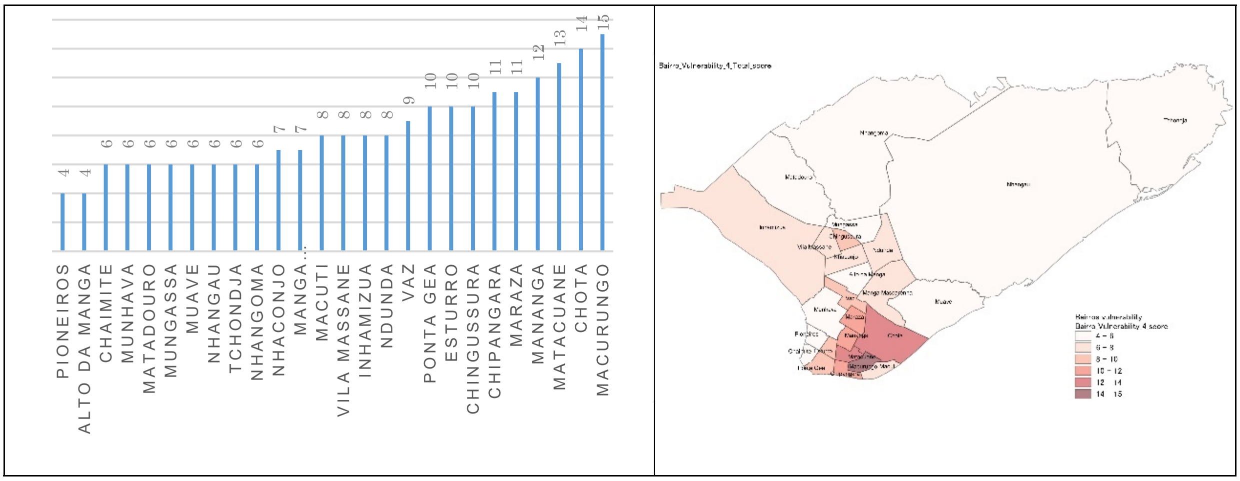
	Item	Assessment indicators		Point	Weightage
1	Natural disaster risk	Topography, Topology	The ratio of expected flood area with over 50cm water depth in the hazard map of the "Cyclone Desmond" scenario	5 points: from over 80% to 100% 4 points: from over 60% to 80% 3 points: from over 40% to 60% 2 points: from over 20% to 40% 1 point: 0 to 20% *The point given to the Bairro out of the area covered by the hazard map is 2 as the average point	2
2		Land use	The ratio of unplanned development area	5 points: from over 80% to 100% 4 points: from over 60% to 80% 3 points: from over 40% to 60% 2 points: from over 20% to 40% 1point: 0 to 20%	1
3	Population concentration	Population density		5 points: over 160 people/ha to 200 people/ha 4 points: over 120 people/ha to 160 people/ha 3 points: over 80 people/ha to 120 people/ha 2 points: over 40 people/ha to 80people/ha 1point: 0 to 40 people/ha	1

Source: JICA Project team

Table 5-17 Evaluation result of Bairro-wise vulnerability

Bairro No.	Bairro	Indicator 1 : The ratio of expected flood area over 50cm			Indicator 2 : The ratio of unplanned develop. Area			Indicator 3 : Population Density			Total pt.
		Area Ratio	Pt.	Weight-age	Area Ratio	Pt.	Weight-age	People/ha	Pt.	Weight-age	
1	Macuti	27.1%	2	2	35.6%	2	1	63	2	1	8
2	Chipangara	23.3%	2		49.8%	3		136.3	4		11
3	Ponta Gea	30.5%	3		26.8%	2		68.4	2		10
4	Chaimite	13.6%	1		17.4%	1		91.8	3		6
5	Pioneiros	5.9%	1		0.0%	1		23	1		4
6	Esturro	15.8%	2		34.3%	2		154.6	4		10
7	Matacuane	22.5%	2		69.6%	4		180.3	5		13
8	Macurungo	55.9%	4		57.1%	3		121.6	4		15
9	Munhava	24.5%	2		19.4%	1		36.2	1		6
10	Mananga	22.4%	2		89.5%	5		117.4	3		12
11	Vaz	35.0%	3		20.2%	2		24.9	1		9
12	Chota	67.7%	5		47.2%	3		13.4	1		14
13	Maraza	36.1%	3		42.0%	3		71.4	2		11
14	Alto da Manga	13.6%	1		12.5%	1		38.9	1		4
15	Nhaconjo	5.4%	1		47.0%	3		66	2		7
16	Chingussura	7.9%	1		66.3%	4		123.5	4		10
17	Vila Massane	2.0%	1		76.3%	4		73.3	2		8
18	Inhamizua	18.9%	2		43.1%	3		13.7	1		8
19	Matadouro	1.9%	1		44.3%	3		6.7	1		6
20	Mungassa	10.8%	1		41.2%	3		18.6	1		6
21	Ndunda	3.7%	1		80.9%	5		27.9	1		8
22	Manga Mascarenha	21.5%	2		30.1%	2		30.6	1		7
23	Muave	16.6%	2		17.7%	1		4.4	1		6
24	Nhangau	N/A	2		4.1%	1		0.3	1		6
25	Tchondja	N/A	2		5.3%	1		0.2	1		6
26	Nhangoma	N/A	2		0.0%	1		0.3	1		6

Source : JICA Project team



Source： JICA Project team

Figure 5-12 Evaluation of Bairro-wise vulnerability assessment

The Bairros judged to be highly vulnerable are concentrated in the southern part of Beira city. Hence, this area requires much preparation for disaster prevention since many evacuees might arise during natural disasters.

This evaluation is derived from the vulnerability assessment to natural disasters so that the vulnerability of the peripheral area stays relatively lower than the city centre so that the peripheral area looks like to be with fewer development needs. However, this area can be recognised as lagging in social development.

Therefore, it is essential to incorporate such an area (Bairros) in considering development plans, not only recovery/rehabilitation but also the perspective of social development being considered.

5) Consideration for the development indicators of each sector

One of the characteristics of public facilities in each sector is that each facility sets a target area and complements its functions with others to form a social service supply coverage. The priority of recovery/reconstruction for each Bairro is derived from an aspect of disaster prevention. However, when each sector's recovery/reconstruction plan is considered, it prioritises objectives set in each sector's strategic plan rather than disaster prevention. Hence, the most significant is how effectively incorporating disaster prevention perspective into it.

In future, it is expected to create a risk map identifying the more precise vulnerability through modification of land use plans based on hazard maps. However, such studies will require more data scrutinization and a certain period. Therefore, we hope that the Bairro-wise vulnerability identified in this study will contribute to the facility recovery/reconstruction until further precise materials are ready.

6) For rollout the area-wise vulnerability assessments to the other regions

In this study, we used three types of data: simulation data, land-use GIS data, and household survey data to identify the Bairro-wise vulnerability. Among data, land-use GIS data and household survey data can be possessed from the published information, whereas simulation data can be used in this study, but it can be expected that it or hazard maps might not be available in the other regions.

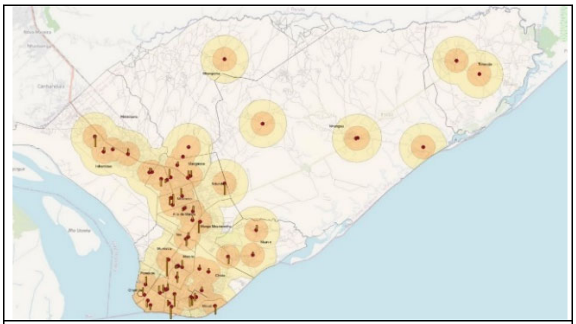
For this reason, from the perspective of disaster prevention, it is desirable to develop hazard maps, but when detailed hazard maps do not exist, we recommend that land-oriented risks be alternatively analysed using UN-HABITAT hazard maps and DEM data.

(2) Step 2：Facility prioritisation

The facilities damaged by Cyclone IDAI require immediate recovery/rehabilitation. However, considering the limited financial situation, it is necessary to take more systematic measures.
When considering the facility recovery/rehabilitation, it is necessary to ensure resilience to natural disasters that may occur after the facility is restored to enable it to be used continuously and desirable to be used as an evacuation centre during natural disasters. Therefore, it is necessary to clarify the role that CMB facilities can play when natural disasters occur so that we will understand the current status of evacuation centre selection and its these characteristics.

1) Facilities designated as evacuation centres

In the case of Cyclone IDAI, many schools were utilised as evacuation places or evacuation centres, along with community centres and churches. It is recorded that 29 of the 32 evacuation centres are schools (about two weeks after the landfall). Furthermore, 22 out of 29 schools had not been designated evacuation centres but coincidentally used for this purpose.[54]
Lessons learnt from Cyclone Idai, CMB, INGD and CLGRC have been designating public facilities as evacuation centres in light of the following selection criteria. Most of the facilities designated are larger size schools.



- Bar shows target population covered by an evacuation centre
- : 1km rad. form each evacuation center.
- : 2km rad. form each evacuation center;

Source： JICA Project team

Figure 5-13 Locations of designated evacuation centres in the event of Cyclone Idai

54 DTM_mozambique-site-assessment-round-1

Table 5-18 Selection criteria of designated evacuation centres

Safety to natural disasters			Facilities						Compound
Flood	Flush and storm	Land-slide	Resilient Roof material	Shape of Bldg.	Storeys of Bldg.	Cap. of Evacuees	Aval. of water supply, sanitation	No. of toilet booth	Aval. of fence or wall

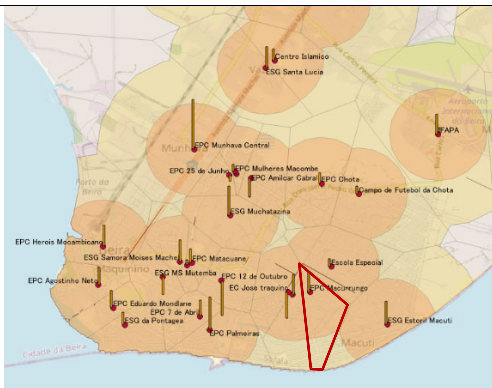
Source： JICA Project team

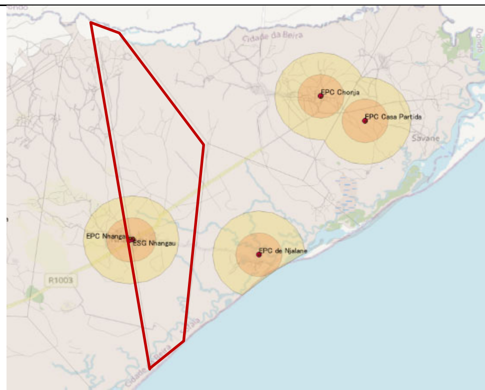
2) The capacity of designated evacuation centres and issues to be cleared

The accommodation capacity of evacuation centres is examined from the target population covered by the respective evacuation centres. However, it differs from urban to peripheral areas due to the difference in land use and population density, so we examined it in the urban and the peripheral area, respectively.

In urban areas, it is judged that it does not hinder accessing the evacuation centres in terms of planned evacuation since each facility is close to the others within walking distance. On the other hand, regarding the capacity of evacuation centres, the target population (calculated from the Voronoi diagram) to be covered by each evacuation centre much exceeds the accommodation capacity, although it depends on how many percentages of the target population expect to be evacuees. Therefore, it is required to set up more evacuation centres to lessen the number of evacuees or increase the capacity of each evacuation centre.

In the peri-urban areas, the issues related to the capacity of evacuation centres can be negligible, but the distance between evacuation centres is an issue from an aspect of accessibility. Evacuation centres are designated based on existing facilities. Therefore, it is difficult to solve this issue physically. Accordingly, in the future development plan, it becomes crucial to plan facilities in areas out of the service coverage of the currently designated evacuation centres.





Evacuation centres in the urban area: e.g., the target population covered by EPC Macurrungo is approx. 13,000 (the area in red lines is identified by Voronoi analysis)	Evacuation centres in the peri-urban area: e.g., ESG Nhangau covers a vast area, and the farthest point is beyond 5km.	
Issues to be considered	Capacity	Access (distance)
Urban area	×	○
Peri-urban area	○	×

Source： JICA Project team

Figure 5-14 The location of evacuation centres: in the urban area (left); in the peri-urban area (right)

The solution to alleviate these issues in urban and peri-urban areas seems to be the designation of more primary schools, which were constructed considering commuting on foot and with a certain large capacity, as evacuation centres. In fact, many schools were used as evacuation centres in the case of Cyclone IDAI.[55] Among these, the large-scale ones accommodated the evacuees shifted from adjacent districts such as BUZI for an extended period[56].

From this, facilities with a high capacity are suitable to be designated as evacuation centres, and it is surmised that this trend will become higher in securing a social distance to alleviate the potential of infestation of COVID-19.

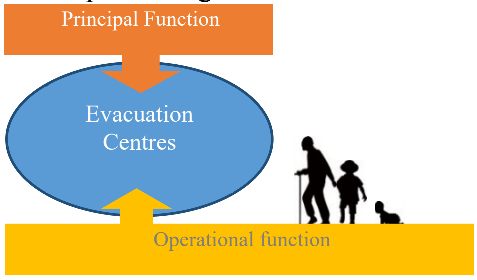
However, in peripheral areas where the population density is low, and there are blank areas where existing facilities are not available, soft components such as improvement of transportation means might be suitable to facilitate precautionary evacuation.

55 29 out of 67 elementary and junior high schools in Beira（source : DPEDHS material : Matriz para Monitoria dos danos. SOFALA revisto.xls, andIOM の dtm-mozambique-site-assessment-round-1.xls）

56 Hearing survey to ESG Mateus Sansão Muthemba and ESG Samora Machel (Feb 2020)

3) Required roles of CMB

In this context, it is necessary to clarify what the CMB facilities require in light of the roles that CMB should undertake. CMB is responsible for ensuring "a sound environment, basic sanitation, quality of life" and providing public administrative services related to education and health. From an aspect of disaster prevention, it shall be a principle that no one is left behind, including the socially vulnerable.



Source： JICA Project Team

Figure 5-15 Required roles of CMB

CMB's facilities are located throughout the city, and many are open to the public for public service. Therefore, it is assumed that they fulfil the minimum requirement as an evacuation centre or are likely to meet it with minor renovation or maintenance.

Based on this background, it can be practical to pre-set the functions required for the CMB facilities in natural disasters. One aspect is to secure the information transmission network (Principal Function) necessary to maintain the functions of each evacuation centre. Another is to ensure generous assistance, which is a challenging in large evacuation centres, However, evacuation centres located in an accessible range are suitable for the socially vulnerable such as the physically challenging people, the elderly, or pregnant women (operational function), as depicted in the figure above.

4) Identification of supporting facilities in operating evacuation centres

Table 5-19 Facility classification of CMB

1	Administrative services (CMB, Department)
2	Administrative services （post-administrativo office）
3	Administrative services （Bairro office）
4	Health post
5	Residence
6	Water supply facilities
7	Pool
8	Market
9	Community Centre
10	Parks, gardens, roundabouts
11	Football field
12	Cemeteries
13	Leased Properties
14	School

Source: document CMB provided

The CMB's facilities are a wide range of uses, unlike those of education or health sector. The administrative offices for the Bairro/Post-administrative are allocated under the city hall (main office) as the point for administrative services to the public. In addition, facilities not opening to the general public, such as funeral halls and vehicle (buses) workshops, whose functions cannot be replaced, are also included. Consequently, those have been classified into 14 according to facility use.

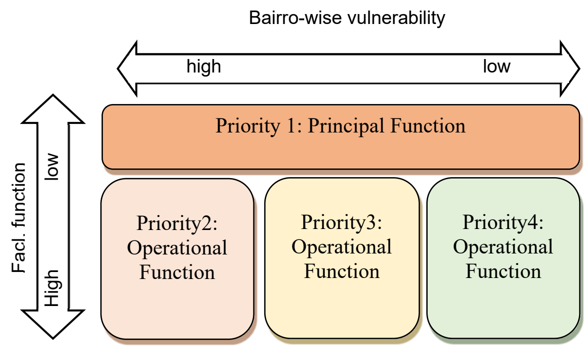
The appropriate category of facility use is examined from an aspect of the Principal or Operational function. In this facility classification, the facility adequate for Principal Function can be Group 1 in the above figure, including the city hall main government building.

Whereas facilities judged to be adequate for Operational function shall be located in respective administrative zones to secure the accessibility to the public, such as facilities of Group2, 3, 9, and 14.[57]

5) Facilities of CMB supporting evacuation centres and their priority

It can effectively strengthen or complement the functions of CMB facilities by taking the following steps:

1. facilities related to the "Principal Function" are extracted from the facility list and put "priority 1" since beneficiaries are all of the public in Beira
2. facilities related to the "Operational Function" are extracted from the facility list and put according to the priority derived from the Bairro-wise vulnerability assessment
3. then, selected facilities are bundled to make project packages.
4. finally, the implementation of each package will be considered.



Facil. Category		Macurrungo	Chota	Matacuane	Mananga	Chipangara	Maraza	Chingussura	Esturro	Ponta Gea	Vaz	Inhamizua	Macuti	Ndunda	Vila Massane	Manga Mascarenha	Nhaconjo	Chaimite	Matadouro	Muave	Mungassa	Munhava	Nhangau	Nhangoma	Tchondja	Alto da Manga	Pioneiros
	Priority(Bairro)	1	2	3	4	5	5	6	6	6	7	8	8	8	8	9	9	10	10	10	10	10	10	10	10	11	11
1	SERVICOS E DEPARTAMENTOS				1		1			2				3				4				2				1	
2	POSTOS ADMINISTRATIVOS				1							1		1									1				
3	SEDES DOS BAIRROS	1	1	1		1	1	1	1	1		1	1	1	1	1	1		1		1	1			1	1	1
9	DESENVOLVIMENTO				1	1	1					1								1		2					
14	ESCOLAS										1		1										2		1		

Regend : Priority1 Priority2 Priority3 Priority4
Selected facility Facility rehabilitated or under rehabilitation

Source : JICA Project team

Figure 5-16 Matrix to examine facility priority (Upper), Facilities extracted according to the priority (Lower)

57 As of June 2021, 4 Post-Administrativo offices and 20 Bairro offices were fully rehabilitated (from documents provided by CMB)

Table 5-20 Facilities to be renovated by priority (priority 1 to 4)

Priority 1

Code	Location (Bairro)	DESIGNATION	General indication of building damage	Score of bairro-wise vulnerability	Priority	Actual Situation (10/08/2020)	Actual Situation (20/09/2022)
01.08	Maraza	Oficinas Gerais	Grave	11	1	Sem Intervencao	Sem Intervencao
~~01.04~~	~~Ponta Gea~~	~~Serviços Autónomo de Saneamento~~	-	~~10~~	~~3~~	~~Sem Intervencao~~	~~Sem Intervencao~~
01.09	Ponta Gea	Edifício da AMB		10	1	Totalmente Reabilitado	Totalmente Reabilitado
01.11	Ndunda	Esquadra da PRM – Ndunda	Mediocre	8	1	Sem Intervencao	Sem Intervencao
01.12	Ndunda	Gabinete de Cadastro e Fiscalização – Ndunda	Grave	8	1	Sem Intervencao	Sem Intervencao
01.13	Ndunda	Sub –Unidade da Polícia Municipal	Grave	8	2	Sem Intervencao	Sem Intervencao
01.06	Manga	Direcções Municipais (BAU)		7	1	Reabilitacao em Curso	Totalmente Reabilitado
01.01	Chaimite	Edifício Principal do CMB	Mediocre	6	1	Reabilitado Provisoriamente	Parcialmente Reabilitado (Cobertura)
~~01.02~~	~~Chaimite~~	~~Direcções Municipais – (Direcção do Comércio)~~	~~Grave~~	~~6~~	~~1~~	~~Sem Intervencao~~	~~Sem Intervencao~~
01.03	Chaimite	Direcções Municipais – Edifício Serviços Urbanos e Plano e Finanças	Grave	6	1	Reabilitacao em Curso	Totalmente Reabilitado
~~01.05~~	~~Munhava~~	~~Direcções Municipais – Edifício Manutenção de Estradas~~	-	~~6~~	-	~~Sem Intervencao~~	~~Sem Intervencao~~
~~01.07~~	~~Munhava~~	~~Etar~~	-	~~6~~	~~0~~	~~Sem Intervencao~~	~~Sem Intervencao~~
01.10	Chaimite	Auditório Municipal		6	2	Parcialmente Reabilitado	Parcialmente Reabilitado
01.14	Munhava	Estádio Municipal		6	2	Reabilitado Provisoriamente	Reabilitado Provisoriamente

Note: ▬ ▬ ▬ identified prioritised facilities, --------------- facilities of autonomous bodies or facilities not prioritised by CMB

Priority 2

Code	Location (Bairro)	DESIGNATION	General indication of building damage	Score of bairro-wise vulnerability	Priority	Actual Situation (10/08/2020)	Actual Situation (20/09/2022)
3.05	Macurungo	Sede do Bairro de Macurungo		15		Totalmente Reabilitado	Totalmente Reabilitado
3.19	Chota	Sede do Bairro de Chota	Grave	14	1	Totalmente Reabilitado	Totalmente Reabilitado
3.17	Matacuane	Sede do Bairro de Matacuane		13		Totalmente Reabilitado	Totalmente Reabilitado
9.06	Mananga	Centro Desenvol. Comunitário de Mananga		12	1	Sem Intervencao	Sem Intervencao
3.07	Maraza	Sede do Bairro de Maraza	Mediocre	11	1	Totalmente Reabilitado	Totalmente Reabilitado
3.16	Chipangara	Sede do Bairro de Chipangara	Ligeiro	11	2	Totalmente Reabilitado	Totalmente Reabilitado
9.03	Chipangara	Centro Desenvol. Comunitário Chipangara	Ligeiro	11	1	Sem Intervencao	Sem Intervencao
9.04	Maraza	Centro Infatário de Maraza	Mediocre	11	1	Sem Intervencao	Parcialmente Reabilitado

Priority 3

Code	Location (Bairro)	DESIGNATION	General indication of building damage	Score of bairro-wise vulnerability	Priority	Actual Situation (10/08/2020)	Actual Situation (20/09/2022)
3.02	Ponta-Gêa	Sede do Bairro de Ponta-Gêa		10	1	Totalmente Reabilitado	Totalmente Reabilitado
3.04	Esturro	Sede Bairro do Esturro		10	2	Totalmente Reabilitado	Totalmente Reabilitado
3.09	Chingussura	Sede do Bairro de Chingussura	Mediocre	10	1	Totalmente Reabilitado	Totalmente Reabilitado
9.05	Ponta-Gêa	Centro Desenvol. Comunitário Goto		10	1	Sem Intervencao	Sem Intervencao
14.02	Vaz	Escola da Vaz	Grave	9	1	Reabilitacao em Curso	Sem Intervencao
2.02	Inhamizua	Posto Adm. Inhamízua	Mediocre	8	3	Totalmente Reabilitado	Totalmente Reabilitado
3.01	Macúti	Sede do Bairro de Macúti	Grave	8	1	Totalmente Reabilitado	Totalmente Reabilitado
3.10	Vila Massane	Sede do Bairro de Vila Massane	Grave	8	1	Totalmente Reabilitado	Totalmente Reabilitado
3.12	Ndunda	Sede do Bairro de Ndunda	Mediocre	8	1	Totalmente Reabilitado	Totalmente Reabilitado
3.14	Inhamizua	Sede do Bairro de Inhamizua e CDC	Mediocre	8	1	Totalmente Reabilitado	Totalmente Reabilitado
9.08	Inhamizua	Centro de Desenvol. Comunitário de Inhamízua	Mediocre	8	1	Sem Intervencao	Sem Intervencao
14.01	Macuti	Escola Primaria Macuti Miquijo	Mediocre	8	1	Totalmente Reabilitado	Totalmente Reabilitado

Priority 4

Code	Location (Bairro)	DESIGNATION	General indication of building damage	Score of bairro-wise vulnerability	Priority	Actual Situation (10/08/2020)	Actual Situation (20/09/2022)
2.03	Manga Loforte	Posto Adm. Manga Loforte	Grave	7	1	Totalmente Reabilitado	Totalmente Reabilitado
3.13	Manga Mascarenha	Sede do Bairro de Manga Mascarenha	Ligeiro	7	3	Totalmente Reabilitado	Totalmente Reabilitado
3.18	Nhaconjo	Sede do Bairro de Nhaconjo	Ligeiro	7	2	Totalmente Reabilitado	Totalmente Reabilitado
14.05	Manga	Casa da Associação	Grave	7	1	Sem Intervencao	Sem Intervencao
2.01	Munhava	Posto Adm. Munhava		6	3	Totalmente Reabilitado	Totalmente Reabilitado
2.04	Nhangau	Posto Adm. Nhangau	Grave	6	1	Totalmente Reabilitado	Totalmente Reabilitado
3.06	Munhava	Sede do Bairro de Munhava		6	2	Totalmente Reabilitado	Totalmente Reabilitado
3.11	Mungassa	Sede do Bairro de Mungassa	Mediocre	6	1	Totalmente Reabilitado	Totalmente Reabilitado
3.15	Tchonja	Sede do Bairro de Tchonja	Grave	6	1	Totalmente Reabilitado	Totalmente Reabilitado
3.20	Matadouro	Sede do Bairro de Matadouro	Grave	6	1	Totalmente Reabilitado	Totalmente Reabilitado
9.01	Muave	Centro Desenvol. Comunitário Muavi		6	1	Sem Intervencao	Sem Intervencao
9.02	Munhava Central	Centro Desenvol. Comunitário Munhava Central	Mediocre	6	1	Sem Intervencao	Sem Intervencao
9.07	Munhava Central	Centro de Desenvol. Comunitário Tchantchim	Ligeiro	6	1	Sem Intervencao	Sem Intervencao
14.03	Nhangau	Escola de Nhassassa	Grave	6	1	Sem Intervencao	Totalmente Reabilitado
14.04	Nhangau	Escola de Nhacamba	Mediocre	6	0	Sem Intervencao	Totalmente Reabilitado
14.06	Tchonja	Centro de Saude	Grave	6	1	Sem Intervencao	Sem Intervencao
14.07	Nhangau	Centro de Saude, Nhansassa	Grave	6	1	Sem Intervencao	Sem Intervencao
3.03	Pioneiros	Sede Bairro dos Pioneiros		4	1	Totalmente Reabilitado	Totalmente Reabilitado
3.08	Alto da Manga	Sede do Bairro de Alto da Manga	Mediocre	4	1	Totalmente Reabilitado	Totalmente Reabilitado

Source：JICA Project Team

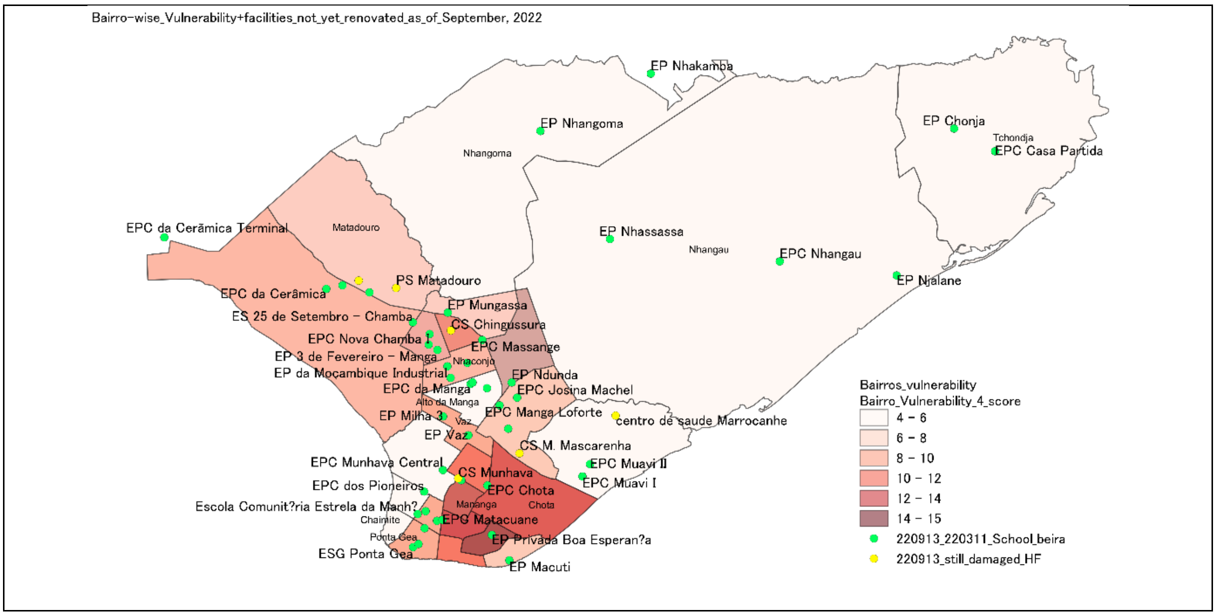
From the examination result, we can recognise that the facilities in groups (2) and (3) were renovated, and some facilities in groups (1), (9), and (14) have not been rehabilitated. However, regarding group (1) facilities, many facilities have already been transferred to service providers, such as water supply. Therefore, through discussions with the CMB, we confirmed that it is desirable to renovate groups' facilities in groups (9) and (14) according to their priorities.

After that, when checking the status as of September 2022, 4 facilities have been renovated in the two years from August 2020. In addition, in some facility classifications, facilities that were repaired once but deteriorated or were damaged by subsequent cyclones are also confirmed. For this reason, it is necessary to consider the maintenance plan systematically from a longer-term perspective based on budget allocation. Therefore, it is hoped that the Bairro-wise vulnerability in this project will be of help in the consideration of a plan.

Furthermore, since more than three years have passed since Cyclone Idai struck, it is believed that the area has already entered the phase of recovery and reconstruction and development, and the market has not yet reached a point where sufficient repairs have been made to support the daily lives of citizens. There is also a need for the restoration and reconstruction of things.

6) Application to other sectors

As shown in 5.3.2(1) Step 1: Evaluation of Vulnerability to Natural Disasters in Each City Block '5), the Consideration of Development Indicators in Each Sector' strategy is prioritised. However, it is essential to incorporate the perspective of disaster prevention into the perspective of development. As a specific example, we identified the priority of rehabilitation of educational and health facilities that have not been repaired as of 2022 as per the Bairro- wise vulnerabilities. In this way, it is desirable to incorporate the priority from the perspective of disaster prevention effectively when incorporating it from the planning stage. In particular, many educational facilities are considered to be designated as evacuation centres, so it is judged to be important from this aspect.



Source：JICA Project Team

Figure 5-17 The location of unrehabilitated educational and health facilities (as of September 2022)

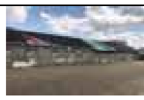
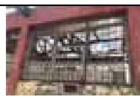
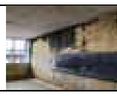
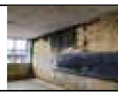
Table 5-21 The list of unrehabilitated facilities by priority (Health and Educational facilities)

Bairro	Facility	Priority of Bairro-wise vulnerability	Designated Accom. Centre
Health Facilities			
Mananga	CS Munhava	4	－
Chingussura	CS Chingussura	6	－
Matadouro	CS Inhamizua	8	－
Manga Mascarenha	CS Manga Mascarenha	9	－
Muave	CS Marrocanhe	10	－
Matadouro	PS Matadouro	10	－
Schools			
Chota	EPC Chota	2	☑
Matacuane	EPC Matacuane	3	☑
Chingussura	EPC Massange	6	
Esturro	EPC Esturro	6	
Esturro	ES Samora Moises Machel	6	☑
Esturro	Escola Comunit?ria Estrela da Manh?	6	
Ponta Gea	EPC Deficientes Visuais	6	
Ponta Gea	EPC Especial nº 3	6	☑
Ponta Gea	ESG Ponta Gea	6	☑
Vaz	EP Milha 3	7	
Vaz	EP Vaz	7	
Inhamizua	EPC da Cerâmica	8	☑
Inhamizua	EPC da Cerãmica Terminal	8	
Inhamizua	EPC Inhamízua	8	☑
Inhamizua	ES 25 de Setembro - Chamba	8	☑
Macuti	EP Macuti	8	
Ndunda	EP Ndunda	8	☑
Vila Massane	EPC Antiga Emissora	8	
Vila Massane	EP 3 de Fevereiro - Manga	8	
Vila Massane	EPC Nova Chamba I	8	☑
Manga Mascarenha	EPC da Manga Mascarenha	9	
Manga Mascarenha	EPC Josina Machel	9	
Manga Mascarenha	EPC Manga Loforte	9	☑

Bairro	Facility	Priority of Bairro-wise vulnerability	Designated Accom. Centre
Nhaconjo	EP da Moçambique Industrial	9	☑
Nhaconjo	EPC 11 de Novembro	9	☑
Nhaconjo	EPC Monomotapa	9	☑
Macurrungo	EP Privada Boa Esperan?a	10	
Matadouro	ES de Matadouro	10	☑
Muave	EPC Muavi I	10	
Muave	EPC Muavi II	10	
Mungassa	EP Mungassa	10	☑
Munhava	EP do 2? Grau EPC Mulheres Macombe	10	☑
Munhava	EPC Munhava Central	10	☑
Nhangau	EP Nhassassa	10	☑
Nhangau	EP Njalane	10	☑
Nhangau	EPC Nhangau	10	☑
Nhangoma	EP Nhakamba	10	
Nhangoma	EP Nhangoma	10	☑
Tchondja	EP Chonja	10	☑
Tchondja	EPC Casa Partida	10	☑
Alto da Manga	EPC 1º de Maio	11	☑
Alto da Manga	EPC da Manga	11	☑
Alto da Manga	ESG Manga	11	☑
Pioneiros	EPC dos Pioneiros	11	

Source : JICA Project Team created based on documents provided by GREPOC and SPSS

Table 5-22 Current status of unrehabilitated facilities (sample survey results)

EPC Antiga Emissora	
Degraded sheets and damaged roof structure; Poor painting; No fencing/safety for school users; Old room structures and totally degraded; Eroded school ground; Little free space; Access to school: poor.	   
EPC Esturro	
School totally destroyed; There is no roof in any of the classrooms; Roofing structure damaged almost non-existent; Too much free space; Toilets all damaged, 10 toilets in total; 21 rooms totally damaged; Access good, only lacking a fence.	   
Escola Especial N3	
Without Roof Sheet and Roof Structure; -Totaly damaged building; Poor Painting; NB: This building will have other function, will be office of Education Sector.	   
EPC Munhava Central	
School Partly damaged; Roof Sheet damaged; Concrete roof with fissure, Infiltration inside of classrooms; Windows Damaged; WC damaged, 18 classrooms damaged; without electricity, Hydraulic system damaged	   

Source: JICA Project Team

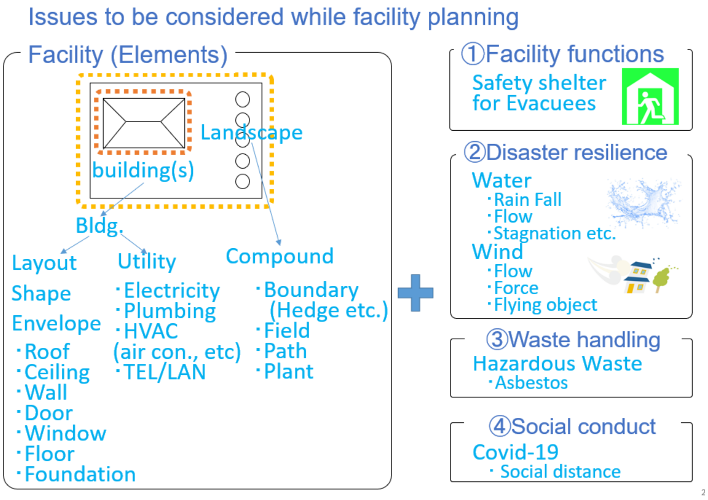
In addition, three years have already passed since the damage caused by Cyclone IDAI. CMB has expressed its intention to restore and reconstruct the markets supporting the facilities (e.g., Praia Nova fish market, Vila Massane market, Manga Loforte market, Chipangara market). It is also considered effective to indicate the priority of these facilities in light of the results of the Bairro-wise vulnerability assessment.

(3) Step 3：Facility planning

When planning facility renovation in line with the "Build Back Better" (BBB) concept, multifaceted consideration is required. In this study, we decided to examine it from four aspects.

- Aspect 1, we examine what facility functions are required when it is used for an evacuation centre in preparation for a disaster.

- Aspect 2, we examine the resilience of facilities in preparation for a disaster.
- Aspect 3, since the facility renovation generates a certain volume of waste by removing the damaged and fragile parts, we examine the appropriate handling of hazardous waste with asbestosis, which is prohibited from use.
- Aspect 4, social conduct changed significantly with the spread of COVID-19, and infection control measures have been required. Reflecting on this circumstance, we sort out the points and issues to be considered in evacuation centres and examine the effectiveness of using outdoor spaces for evacuation.



Source: JICA Project team

Figure 5-18 Facility elements and four aspects for facility recovery/rehabilitation

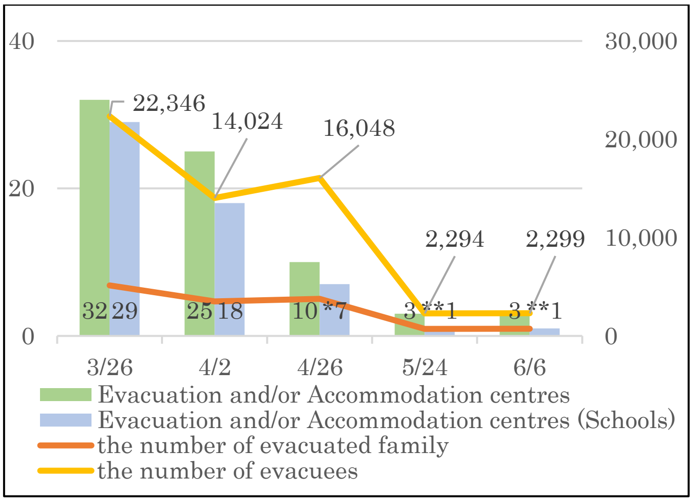
1) Aspect1 : facility functions required to use facilities as evacuation centres in natural disasters

a) Consideration of how long evacuation centres accommodate evacuees

Before examining the functions required of evacuation centres, we considered an appropriate period for evacuation shelters to accept evacuees based on the status of evacuation centre establishment and the changes in the number of evacuees in the event of Cyclone Idai.

In the case of Cyclone Idai, which came landfall on March 14, the number of evacuees accommodated in the evacuation centres established in schools gradually decreased, from 22,346 on March 26 (two weeks after the landfall) to 2,294 people on May 24 (eight weeks after it). From this, we can recognize that around 90% of the evacuees had returned to their homes or relocated to resettlement areas when two months passed after the cyclone.

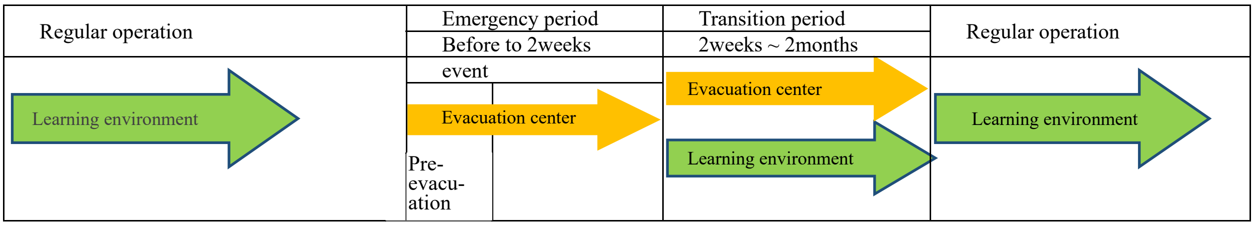
In some large schools, not to hinder the resumption of education, the facility had been operated as evacuation centres by continuously opening the auditorium and school playground to evacuees forced to stay longer. However, small schools have limited areas, so it is impossible to accommodate evacuees for a long time as in a big school. Hence, the period of accommodating evacuees for two months is expectedly adequate while designating schools as evacuation centres.



Source： JICA Project team created based on Displacement Tracking Matrix (DTM)

Figure 5-19 Changes in the number of emergency evacuation sites/centres, evacuees, and evacuation households in Beira, along a time frame

Reflecting on this, we can recognise that evacuation centres must have both functions as evacuation centres and the original in the transitional period shown in the figure below.

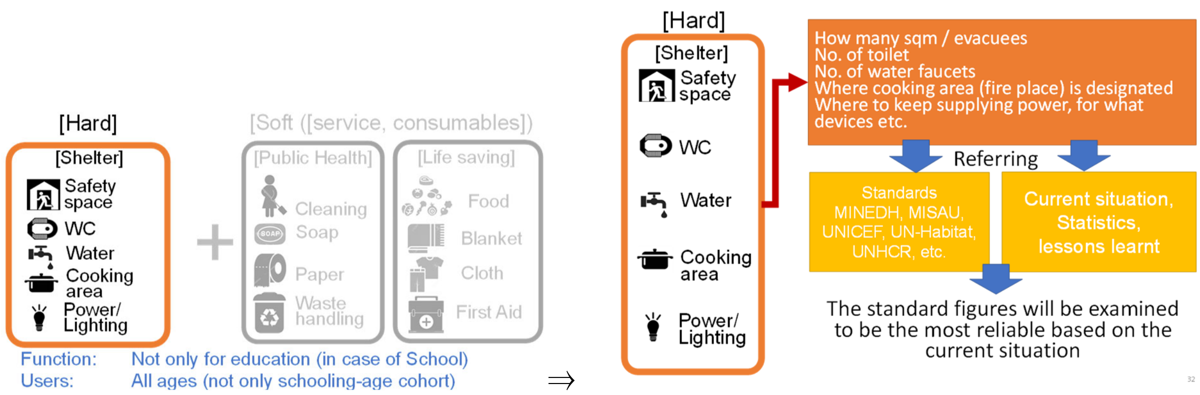


Source： JICA Project team

Figure 5-20 Required facility functions in the event of a disaster

b) Functions required for evacuation centres

For the facility to function as an evacuation centre, it is essential to have both hardware and software, as shown in the figure below. Regarding software, the main objective is to supply services and consumables to support evacuees. For this objective, we can expect assistance from various actors, including international organisations. However, hardware needs to be prepared and maintained even before the disaster. For this reason, we will examine facility functions from the hardware aspect, focusing on the evacuation function with the regular function such as securing a learning environment for schools and administrative and social service delivery for CMB facilities



Source：JICA Project team

Figure 5-21 The flow of studying functions required for evacuation centres

This chapter focuses on the specific requirement for normal and emergency operations in the case of schools designated as evacuation centres. To identify required specifications for respective operations, we must examine different guidelines or regulations.

For regular operation, we can refer to the standard specifications and guidelines for educational facilities such as the ones issued by MINEDH. As for the emergency operation, we can refer to the guidelines issued by of UN and other international institutes such as Sphere to give us specific indicators.

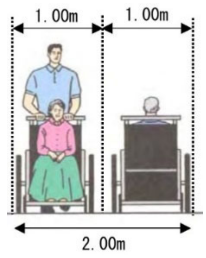
It is desirable to meet both standards in planning recovery/rehabilitation. Still, we must avoid the remarkably low cost-effectiveness in meeting both standards. Therefore, it is judged that it is realistic to apply appropriate specifications within a reasonable range based on the current state of facilities while referring to these guidelines.

The following table compares and examines the facility functions required for regular operation and emergency use as an evacuation centre. For example, values from both specifications applied to the facilities in the pilot project implemented in this study are shown (red frame part).

Table 5-23 Examination of facility standards for evacuation centres

		Normal school operation	Emergency Operation
Safety space	Corridor	1.8m(*1)	2.0m (2*)
	Slope	6degrees (approx. 1/10) (1*)	1/12～1/15 (recommended) (3*)
	Occupancy area/p	1.30sqm/p (4*)	Emergency period：2.0 sqm/p (5*) Transition period：2.3sqm/p~ 4.0sqm/p (6*),
Water	Water/p	Student, Teacher：25L/pp (8*)	Emergency period：15L/p, (9*) Transition period: 15L/p, Student 3L/p (9*)
WC	Persons /Toilet	20~50 students/booth (7*) 25 Female/booth, 50male/urinal basin (8*)	Emergency period：50/booth (9*) Transition period：20~50/booth (9*)
	Distance	30m: Seepage pit to borehole (7*)	
Power/ Lighting	Indoor, outdoor	Education equip., PCs, lights etc.	Power outlet shall be secured even at natural disasters: for PCs, communication, lights, etc. If possible, portable generators be equipped
Cooking area	outdoor	Canteen, kitchenette	Designated cooking spaces for evacuees

Reference:
(1*) Decree 2008/53
(2*) Ministry of Land, Infrastructure, and Transport of Japan (2022), Guidelines for facilitation of movement on road
(3*) UNICEF, Access to School and the Learning Environment I – Physical, Information and Communication Webinar Booklet
(4*) the specifications of the secondary schools planned using FASE by MINEDH
(5*) Examined based on physically required space for lying on the floor
(6*) Based on UNHCR Family tent (6~10pp) 23 sqm
(7*) MINEDH UNICEF Mozambique (2018), 'Evaluation of the Design & Use of School Wash Facilities in Primary Schools in Mozambique'
(8*) 25L is calculated by adding 5L for potable water to 20L for flushing toilets. WHO (2009). 'Water, sanitation and hygiene standards for schools in low-cost settings' Edited by John Adams, et al
(9*) Sphere (2018), 'The Sphere Handbook' 2018 ed.



Source： JICA Project team

2) Aspect 2：the resilience of facilities in preparation for a disaster

It is necessary to strengthen vulnerable parts to ensure facilities' resilience to natural disasters. However, before considering this, we decomposed a cyclone into elements - "water" and "wind" - as shown in the figure right, because natural disasters we need attention to in Beira are cyclones and floods.

From the satellite image of the roof damage, we can recognise that about 65% of the buildings were damaged[58], and we can assume that caused by wind.

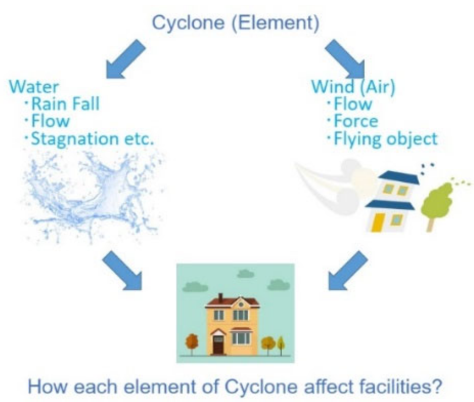
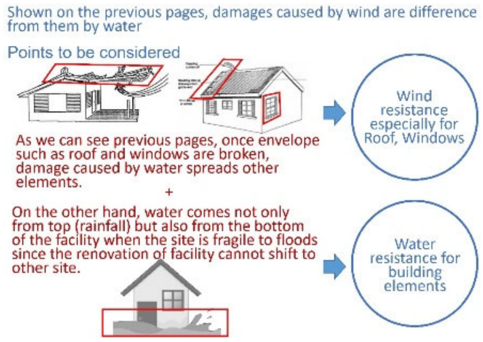


Figure 5-22 Elements of the cyclone that impact infrastructure

58 77099 premises about 65% of the premises 119,187 in Beira city were damaged, reported by UNITAR referring the satellite image (MOZAMBIQUE - Beira City Neighbourhood Damage Assessment - As of 26 March 2019)

a) Examination of facility parts resilience

In this study, we consider methods to strengthen the roof and openings damaged by the cyclone's wind pressure, as depicted in the figure right. Furthermore, inundation cannot be avoided even if we improve the roofs and openings. Hence, we will examine measures to improve the area around the bottom part of the building. As characteristics of buildings in Beira, we can confirm the followings:



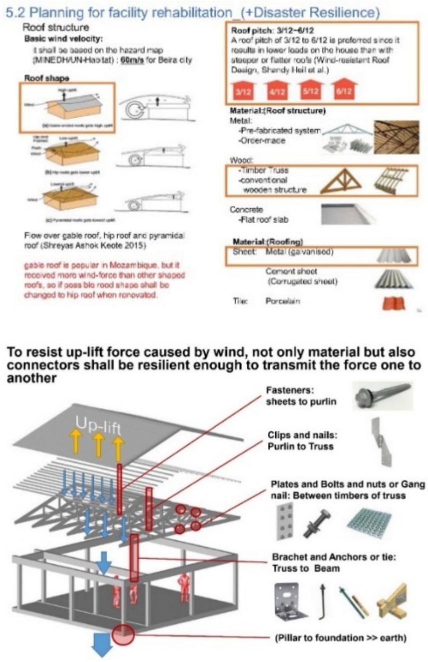
Source: JICA project team created based on UN-HABITAT document

Figure 5-23 Fragile parts of building

Most buildings in Beira are low-rise one- or two-storey facilities, although high-rise buildings exist in the city centre; As for the roof shape, it is generally gable or hipped; Regarding roofing materials, the thatched roof can be confirmed as a certain proportion in rural areas, but steel is commonly used in urban areas. From this context, we decided to focus on gables and hip roofs of low-rise buildings with steel roofing materials.

b) Roof improved resilient

Since the roof is required to be resilient against wind pressure, it is crucial to simultaneously avoid and alleviate the wind pressure. Hence, it is judged that it is necessary to study the roof form in addition to the roof material and structure. Therefore, in this study, the roof shape to alleviate the wind and the roof members and connection parts are examined. Then we created a check sheet.



Roof	Type	Applic-ability	Characteristics	Point to check	
Basic wind velocity		○	Basic wind velocity (Vo) is a provision for structural calculation	Vo shall be satisfied with hazardmap, relevant regulations	Vo is designated in the risk map published by MINEDH, UN-Habitat
Shape	Gable-roof	△	In Mozambique, Gable roof which received more strong wind force, is popular	If possible, roof shape changed to hip or pyramidal roof shape in renovating the roof.	Drawings, Structural calculation
	Hip-	○			
	Piramida-	○			
Pitch	3/12~6/12	○	This ratio is preferable for Wind resistant	If other pitch is applied, additional reinforcement shall be considered based on structural calculation	
Roof structure	Metal	○	More resilient but expensive	Species, Size of parts, pitch of placing, Maximum wind velocity acceptable	Drawings, Manufacturer's instruction
	Wood	○	Popular		
	Concrete	○	Resilient but for flat roof		
Roof cover	Metal Sheet	○	Popular	Thickness more than 0.5 mm (nominal thickness 0.6mm) is recommended, Material property, durability (life span over 10yrs) > zincalum alloy zinc coated is recommended	
	Cement Sheet	△	Popular, but it is easily cracked when bent	It shall be placed with fasteners at much narrower pitch.	
	Ceramic Tile	△	Popular, but expensive	Material Property, Fixing pitch	
	Thatched roof	X	Sustainable and popular for private, but not for public buildings	Regular maintenance is required at more frequent pace	Regular inspection on site

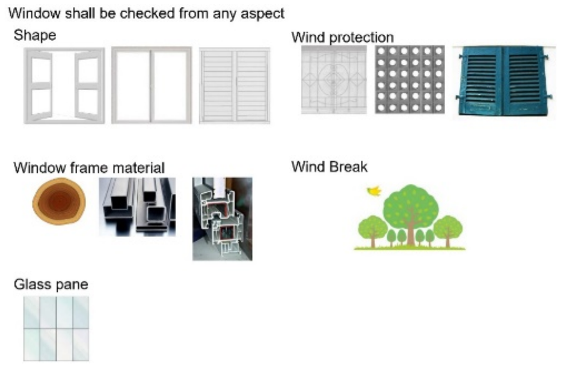
Source: JICA Project Team

Figure 5-24 Roof / connecting parts check sheet

c) Openings improved resilient

As with the Roof, the openings are fragile to wind pressure. In this disaster, we confirmed much damage to the windows where many glass panes were applied to ensure daylighting outside. For this reason, to strengthen the toughness of the window itself, the window elements were examined separately, and then the means to alleviate the wind pressure on the window was examined, as summarised in the check sheet.

Regarding the trees used as windbreaks, we confirmed through discussion with CMB that this measure effectively controls wind pressure. Still, it shall secure a certain distance from facilities since the fallen trees in this disaster damaged many buildings.



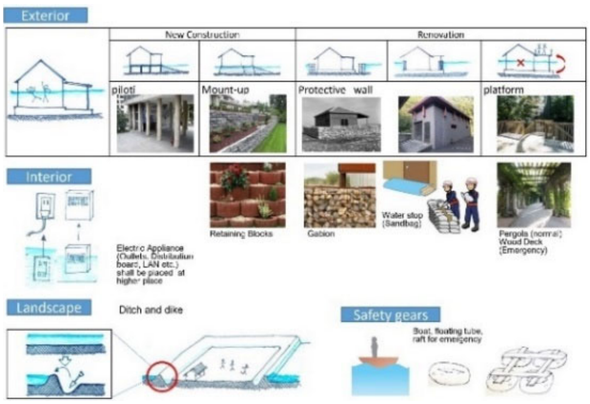
Window type		Applicability	Characteristics	Check point	What to Check
	-Awning	o	Fully opened but extrude much to receive wind	- Durable hinges and stoppers - Size to avoid injury when it opened - Water drip has not to damaged	Drawings, Manufacturer's instructions,
	-Sliding	o	Only 1/2 of whole can open, but not extruded	- Durable wheels, frames (thickness and chambers) and rails to drain water	
	-Jalousie	o	Popular Fully opened but not extruded much.	- Durable frame (thickness and materials such as aluminium or PVC), - the accuracy of setting not to distort glass panes.	
Window Frame					
	-Wood timber	o	Popular	- Durable Frame dimensions - Species: hard wood (Chanfuta or Umbila is recommended) to avoid termites - Weather tight over coat (where it rained)	Drawings, Specifications, Material specs (species), Manufacturer's instructions,
	-Metal	o	Popular, water tight	- Durable Frame dimensions - Connection parts durability	
	-PVC	o	Expensive, water tight, heat insulation		
Window Pane					
	- Float	o	Popular	Type of glass pane, dimensions and thickness, Type of gasket and seal to fix glass pane tightly	Drawings, Specifications, Manufacturer's instructions, standards such as SANS 10137
	- (Tempered)	o	Expensive, suitable for high-rise bldgs., High resistibility		
	-Embossed	o	Popular for interior, low resistibility		
Window Protection					
	-Steel grill	o	Common for burglar proof	Pitch of bars, durability of bars	Drawings, Specifications
	-Block screen -Blades	o	Expensive, but easy for weather proof	Maximum opening dimensions, Opening ratio for light and wind intake	
	-Shutter	o	Expensive, but easy for weather proof	Rigidity of hinges and shutter, opening dimensions (not only for visibility but also for ventilation)	
	-Windbreak	o	Common to alleviate wind force	Certain distance shall be kept from bldgs. to prevent bldgs. from damages caused by fallen trees and flown branches, species	Site map,

Source: JICA Project Team

Figure 5-25 Openings (window and doors) Check sheet

d) Flood measures

The Check sheet of flood measures is considered from the following aspects: (1) to keep internal functions of facilities; (2) exterior waterproof and exterior works to prevent water contact facilities; (3) safety gears for lifesaving when facilities are inundated.



	Solution	Applicability	Check point	What to Check
Exterior				
	Mount-up	New construction	Set DGL above HHWL, Durability: (water flow velocity, direction) Material, Method	Hazard map Drawings Structural calculation, specifications
	Piloti	New Construction	Ditto	
	Protective wall	New Construction, renovation	Ditto Durbility: resistance against horizontal force caused by water pressure Material: (Gabion, CB, Protective boards etc)	
	Platform, or rooftop garden	New Construction, renovation	Ditto Durability: (Limited capacity on platform, Strength of handrails)	
Interior				
	Electric Appliance (outlets, boards, LAN, etc)	New Construction, renovation	Ditto Material (water-tight is preferable) Cable routes, sealing material etc	Hazard map Drawings specifications
Landscape				
	Ditch and dike	Any if big enough compound is available	Setting hight (considering adequate hight) Depth of ditch Material (sandbag. etc) Method	Hazard map Drawings specifications
Safety gears				
	Boat, floating tube, Raft	Any	Capacity, space for storage, Durability (material etc), usability	Specifications

Source: JICA Project Team

Figure 5-26 Inundation measure check sheet

3) Aspect 3 : the appropriate handling of hazardous waste with asbestosis

When rehabilitating facilities damaged by natural disasters, a large amount of hazardous waste is generated. In particular, treating asbestos is a social issue since it has been prevalently used as a building material but is prohibited from being used due to health hazards. Asbestos has short and fine fibres; these are adsorbed on the respiratory tract and cause health problems. Therefore, appropriate handling of asbestos is necessary for restoring/rehabilitating facilities.

Source: UN-HABITAT, David Smith et al (2019), 'Sessão informativa sobre Asbestos'

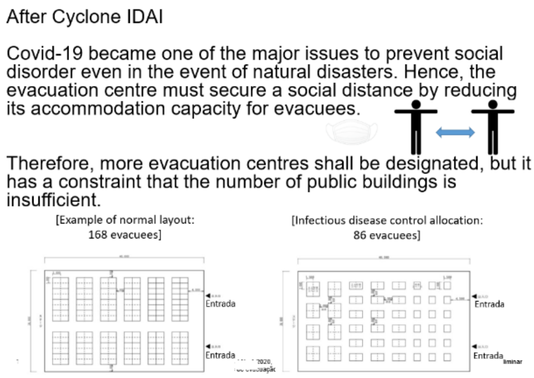
Figure 5-27 Overview of asbestos handling

UN-HABITAT has already compiled a guide on the handling procedures for the removal, renovation, and disposal of asbestos. Then through discussion with CMB, we concluded that it is practical to indicate the handling procedures in the specifications for restoring/rehabilitation works.

4) Aspect4 : measures for infectious diseases such as Covid-19 and for the Business Continuity Plan (BCP)

Covid-19 has also changed the social context; it needs more social distance and sanitary facilities for infectious diseases.

Similarly, in designated evacuation centres, the number of people accommodated will be limited, and also sufficient ventilation in each room will be required.



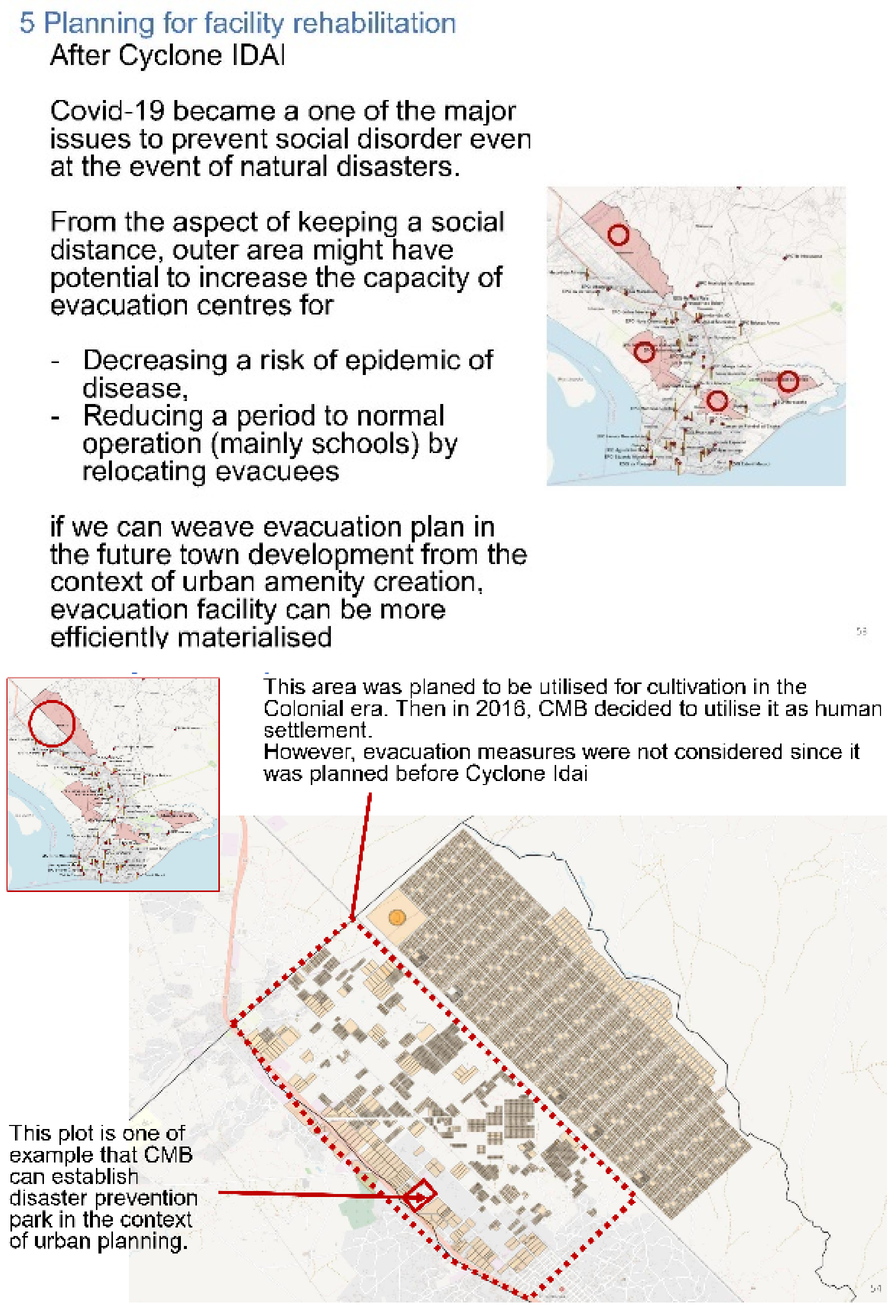
Source : JICA Project team based on TAKAOKA Seiko (2020), IRD - Edição Especial No.1 2020, Respondendo à propagação da infecção por COVID-19, Lista de verificação preliminar Versão 2 Para prevenir a infecção nos centros de evacuação de desastres, Versão simplificada- 30 de Abril de 2020

Figure 5-28 Social distance required under the Covid-19 pandemic

For this reason, it requires more effective use of existing facilities to boost evacuation capacity by designating them as evacuation centres. Furthermore, it is also considered effective to utilise outdoor spaces, not only indoor spaces, in an aspect of infectious disease control. On another side, in the case of Cyclone Idai, most evacuation centres were established in schools, and the period of use as evacuation centres was for two or more months. Therefore, there is an urgent need to restore schools as a good learning environment by promptly relocating evacuees to other places where they can safely stay until the next destination is defined.

Given this background, it is worth considering rolling out evacuation centres to the outdoor space. To make it materialised, it is essential to reserve areas for evacuation centres as preparedness for disasters would come, and it must be kept neatly maintained.

To overcome these issues, we found a way to consider a solution through discussions with CMB that evacuation centres can be established in disaster prevention parks should the park be installed in the context of the urban development plan. The park can provide amenities to the public during regular operations and extend evacuation functions during emergencies. We concluded that it would be the most suitable approach to consider disaster preparedness in the context of urban development, not merely tacking on disaster prevention, by CMB.



Source : JICA Project Team

Figure 5-29 Development area in Matadouro Bairro

To plan a park by incorporating the perspective of disaster prevention into urban development, we decided to execute a case study with CMB.

We firstly searched for a suitable area among the areas where detailed urban development plans have been prepared (left figure above). Then we selected the Matadouro area since it has a relatively high altitude and is unlikely to be inundated according to the hazard map.

As the historical background of the Matadouro, the area was divided into relatively larger plots to produce agricultural products before independence. However, those plots are under readjustment to be divided into much smaller plots through discussions with landowners to change the land use to the residential area.

From this context, we can expect population growth in this area. In addition, the area development plan examined before Cyclone Idai did not consider preparedness for disaster prevention, so we confirmed this area would be highly suitable for the case study.

After deciding the Matadouro as a target area, we conducted a field survey with CMB officers in charge of town planning and infrastructure. Then, we found a suitable site to plan a disaster prevention park where accessibility is high both by vehicles from distanced areas and by walking from the surrounding residential areas (the site is enclosed in the red line in the above figure (right)). Consequently, we decided this site is for the case study.


Case study site overview 1


Case study site overview 2


CMB officers (infrastructure, and urban planning departments)


Access road (N6) in front of the case study site

Source：JICA Project Team

Figure 5-30 Photos of site survey

【Required functions for the disaster prevention park】

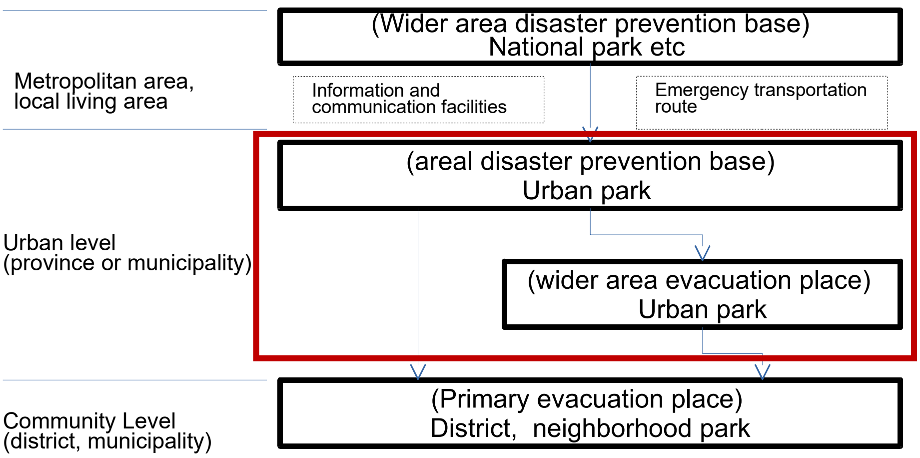
The following table is examined based on the case of an earthquake and fire, but it shows the role of the disaster prevention park from the viewpoint of planning purposes. Regarding the functions required for parks, since the disaster characteristics differ between earthquakes with fire and cyclones, a distinct difference can be seen that it is impossible to use the outer area as an evacuation place in case of a storm caused by a cyclone. However, fundamental functions for accommodating evacuees who need a temporary living area can be considered the same regardless of disaster type.

Hence, in this study, the study site can be suitable to be with the function of a regional disaster prevention centre or wide-area evacuation area, under an assumption that the site area of about 8ha and CMB undertakes maintenance of it. Therefore, referring to the table below, we examined the patterns of use in regular and emergency operations and practical means of maintenance based on the local circumstances.

Table 5-24 Role of disaster prevention park identified from the installation purpose (in case of earthquake and fire)

1	A wide-area disaster prevention base	Mainly a base for wide-area restoration/reconstruction activities (per Pop. 500~1500 thousand)	A wide-area park (over 50ha)
2	A regional disaster prevention base	Front-line bases for relief activities, restoration materials and equipment, or daily commodities	A wide-area park Urban Park (over 10ha)
3	a wide-area evacuation site	Wide-area evacuation sites for evacuees in the event of a natural disaster	A wide-area park Urban Park (over 10ha)
4	A primary evacuation site	Temporary evacuation sites for evacuees in the event of a natural disaster	Neighbouring parks, district parks etc. (over 2ha)
5	An evacuation route	Wide area evacuation area or similar safe place	Green road, etc (Width over 10m)
6	Disaster prevention buffer zone	The buffer zone of the petroleum complex area to prevent disaster in the adjacent urban area	Green belt, space, buffer
7	Transition base	a place to support returning home mainly from the city centre	District or small-scale park

		Fire prevention	Mitigation of damage caused by explosion	Support people returning home on foot	Temporary evacuation place			Final destination for evacuation	Evacuation route	The rescue activities	Temporary living space for evacuees	The base of recovery and restoration	A learning place of disaster prevention
					Emergent evacuation	Temporary evacuation place when fire	Designated evacuation place						
2	A regional disaster prevention base				○			○		◎	○	◎	○
3	a wide-area evacuation site	○			○			◎		◎	○	◎	○

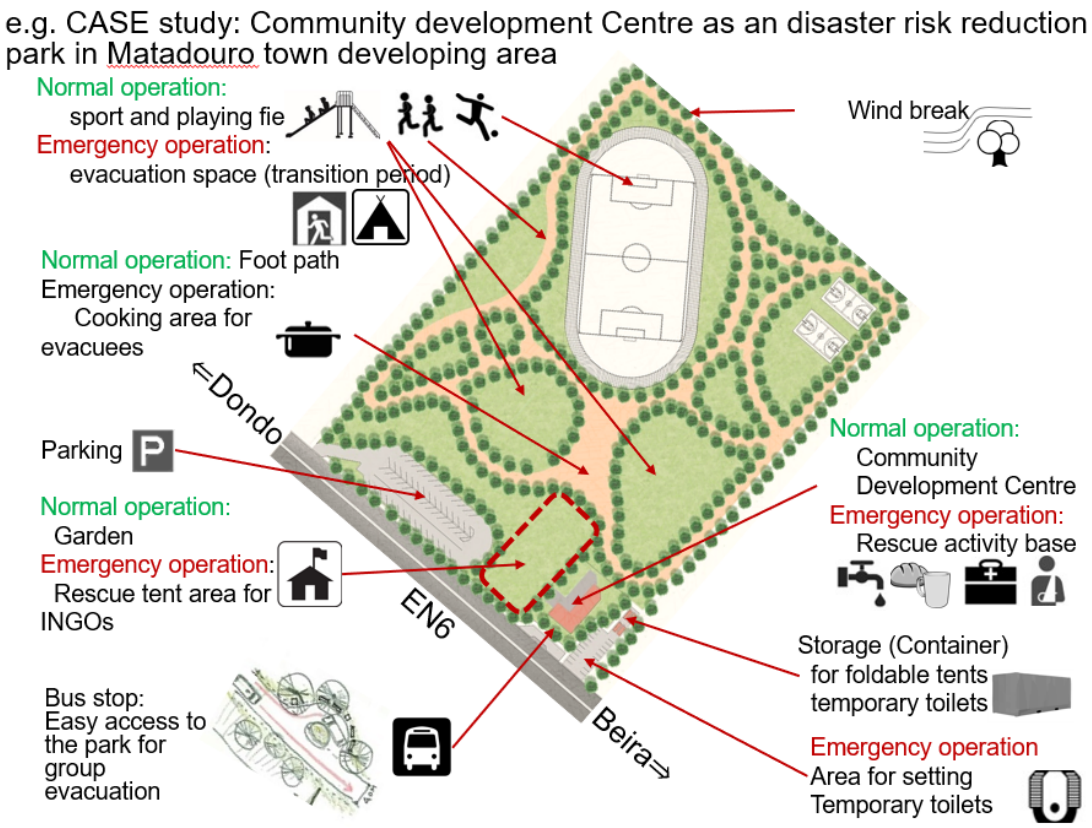


Source：National Institute for Land and Infrastructure Management Ministry of Land, Infrastructure, Transport and Tourism, Japan (2017), Guideline for planning, design and management of disaster prevention parks' (2nd revised ver.), p29, 30

Figure 5-31 The network of disaster prevention parks from the viewpoint of rescue activities

The following initial plan is a disaster prevention park through discussions with CMB. This park was planned as an evacuation place for evacuees waiting for resettlement, whereas as a park providing amenities to the public in a normal situation. Considering CMB's opinion that the involvement of the local community is indispensable in managing this facility, we planned that this park would belong to a community development centre.

In addition, after Cyclone Idai, the facilities in the yard of the city road department were used as an operating room for the CMB Mayor and staff to direct activities for rescue and recovery. It is considered adequate to allot sufficient space for establishing an operation room with a minimum function of communication tools.



Source: JICA Project Team

Figure 5-32 The Disaster Prevention Park diagram created in the case study

By developing such a park taking into account the occurrence of a natural disaster in future, it will be possible to establish a temporary living space, a kitchen for food preparation and temporary sanitation in the open area. Therefore, evacuees can start a transient living, keeping a social distance from each other. Furthermore, the evacuation period for the evacuees who lost their premises tends to prolong, so by quickly shifting such evacuees to a park of this kind, it can be expected to resume the proper function of schools which would be used as evacuation centres.

【Opinions and requests from the related authorities】

Collaborating with the related authorities is essential for CMB since CMB alone cannot execute the activities examined in the case study above. For this reason, we explained the contents of the case study and conducted a hearing survey to the related authorities. Then, we summarised their opinions and requests, as shown in the following table.

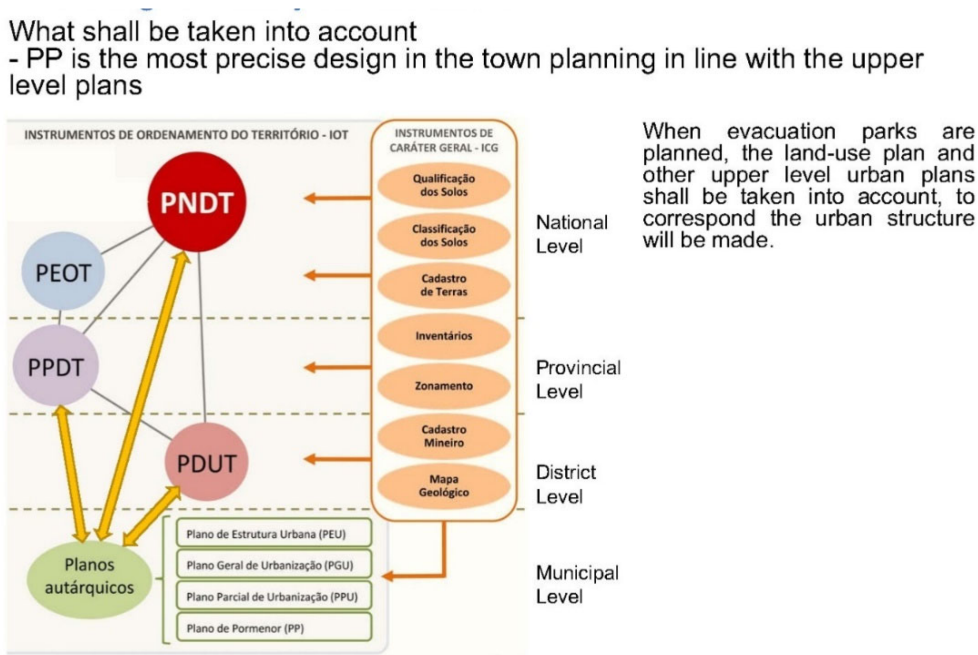
Table 5-25 Comments on the Case Study by the related authorities

Provincial directorate of Education, Sofala (DPES)	- Provisions of basic education services. - Installation of entertainment areas (television aids or giant screens) - Supplementary security service for evacuees (in cooperation with police)
State Provincial Secretary of Health (SPSS), Provincial Directorate of Health, Sofala (DPSS)	- It reflects what we must consider in preparing for natural disasters in this case study. SPSS or DPSS, if there is a place where a health centre can operate, health departments will deploy health experts to ensure health services, as did at the time of the Cyclone Idai. - The health staff will be selected and dispatched for health services in collaboration with the Health, Gender and Social Services (SDSMAS) of district offices. - As for the minimum necessary facilities, MISAU recommends building a health centre instead of a health post. The requirements will be the physical space and financial resources shown in the prototype design. We believe that a health centre of this kind can provide services to those who evacuate to the park and the surrounding residents.
National Institute for Disaster Risk Management and Reduction (INGD)	- The word “Evacuation” should be replaced by “accommodation”. Evacuation is the voluntary or involuntarily resident shifting from an area at risk. For this reason, we think it is appropriate to call them accommodation centres, transit centres, or resettlement areas. - Security services (community policing, police mobilization, public security lighting) - Hygienic environment: laundry facilities, clotheslines - Warehouse of food and other basic needs goods for provision - Information centre and meeting points - Incorporation of a place for mediation of internal disputes - Setting up a place for a health post
Ministry of Health (MISAU)	- Facilities providing health services, such as maternal and child examinations and outside care, should be placed on the premises. Here, we believe that evacuees will be able to receive complete care, from prevention to treatment, rehabilitation, and palliative care, even in an emergency environment.
Ministry of Education and Human Development (MINEDH)	- Same as DPES mentioned

Source: JICA Project Team

【Further issue to be considered】

In the context of urban planning, this study is a detailed plan of the green part in the following figure. Therefore, it is necessary to be consistent with the higher-level plans, such as the urban structure and land use plans, which are already planned or currently being examined.



Source：ENTRABALHO E METODOLOGIA DE ELABORAÇÃO DO PNDTCONTRO TÉCNICO do PNDT, Maputo March 15, 2018, 'PLANO DE TRABALHO E METODOLOGIA DE ELABORAÇÃO DO PNDT'

Figure 5-33 Structure of urban design

In addition, this case study put an emphasis on creating an area for activities in the event of a natural disaster by CMB. Therefore, when selecting sites and examining a more valuable plan, it is required to precisely contemplate not only regular maintenance but also the activities and management during natural disasters. Hence from the planning stage, it is essential to closely relate to INGD to collaborate with relevant authorities related to disaster prevention.

In addition, it is expected that duplication of the preparedness for disasters would be avoided by the involvement of related authorities in the planning process, enabling more efficient actions in responding to natural disasters

CHAPTER6 Formulation Support for Disaster Response Plan (Evacuation Plans)

6.1 Confirmation on Related Laws, Regulations, and Plans

Documents were collected on laws and regulations related to disaster response plan (evacuation plan) and its planning in Mozambique.

Table 6-1 Collected Documents and Outline with Abstracts

Classification		English Name	Contents	Relevance to Evacuation Plan
Disaster Management Law	Resolution	National Policy on Disaster Management Resolution No.18/1999 (June 10, 1999)	Definitions, principles, its objectives and strategies regarding Mozambique's disaster management along with national legal/systematical framework are indicated. Principles of National Institute of Disaster Management (INGC); to oversee national disaster management operations aim to address not only post-disaster responses but also to prevent or mitigate disasters and create a culture of prevention through a multi-sector approach against vulnerable communities.	It doesn't stipulate evacuation plans themselves, but describes taking multi-sectional/ multi-level measures in order to save human lives and properties from disasters, as its objectives.
	Decree	Statute of National Institute and Disaster Management Decree No. 38/1999 (June 10, 1999)	Regulations of the National Institute of Disaster Management (INGC) to implement the above policies. The purpose and scope of the organization are specified.	It does not specify evacuation plans but stipulates that the National Institute of Disaster Management (INGC) is responsible for disaster management activities.
	Decree	Organizational Statute of National Institute and Disaster Management Decree No. 52/2007 （November 27, 2007)	Regulations to approve the establishment of INGC following the above policies. It details the institute's scope of operations.	It does not specify evacuation plans but stipulates that Local Disaster Risk Management Committee (CLGRC) is responsible for implementing disaster management education with regard to prevention and mitigation of disasters.
	Decree	Amending the National Institute of Environmental Disasters Management Decree No. 29/2008 (July 3, 2008)	Regulation amendment to the above regulation: appends the capacity of the Reconstruction Coordination Office (Gabinete de Coordenação da Reconstrução(GACOR))	Not specifically mentioned. .
	Law	Disaster Management Law Law No. 15/2014 (June 20, 2014)	Mozambique's basic law on disaster management. States the development of prevention and mitigation of disasters, rescue and support activities and the establishment of a legal framework for the management of natural disaster risks.	The basis of disaster management plans. Specifies high risk areas to promote the residents' evacuation and/or relocation.
	Decree	Regulation of the Disaster Management Law Decree No. 7/2016 (March 21, 2016)	Regulation on the Disaster Management Law. It stipulates policies of each element regarding mitigation of disaster severity, such as introduction of a disaster management framework, disaster management education and an early warning system, establishment of an executive body, promotion of basic education, analysis of disaster risks, and improvement of support activity efficiency after a disaster.	It states that "Efforts must be made to protect citizens' lives," but does not detail evacuation plans. It recommends conducting disaster management education and sharing disaster-related information at the early stage of a disaster through an early warning system (emergency levels are classified into four; Emergency, Red, Orange, and Yellow).
	Decree	Regulation of Disaster Management Fund Decree No. 53/2017 (October 18, 2017)	Regulation on Disaster Management Fund: Established to function as support and subsidies for disaster management (meantime and post-disaster recovery). It is managed by the INGC and regulates its operational standards.	Not specifically mentioned.
Disaster Management Related	Master Plan	Mozambique Disaster Risk Master Plan (2006 - 2016)	It is released by the government in cooperation with INGC. Specifies policies on regularly facing issues such as water and food shortages and literacy. It mentions how to improve the supply of water and crops through independence of the population and their participation to communities, aiming to improve the search and rescue activities, and efficiency of the recovery as action plans in preparation for disasters.	It describes implementation of action plans against disasters through community participation, the security of irrigation area with at least 500m^2 for each household and recommendation for savings.
	Master Plan	Master Plan for Disaster Risk Reduction 2017 – 2030 (August, 2017)	It is formulated as a next step of the Disaster Prevention Plan (2006-2016) following the Disaster Management Law of 2014. Mozambique recognizes the importance of establishing principles and legal mechanisms to prevent and mitigate risks of disasters, and considers structures, contents and details of the plan, based on the evaluation of the previous plan.	The plan's five strategies include better understanding of disaster risks with all levels and increased public and private participation in DRR, especially by the units of states and districts. It also includes establishing international cooperation and partnerships. There is no mention about specific action plan for evacuation. ToT and textbook creation for schools and higher education, expected results and actions are listed at the beginning of the plan.

Disaster Management Related	Contingency Plan	Contingency Plan 2019-2020 (National Level)	Based on the 2019-2020 climate forecasts from the SARCOF (the Regional Climate Forecast Forum for Southern Africa), it describes the views on the anticipated disaster damage (food and water shortages, health effects, etc.).	Not specifically mentioned.
	Contingency Plan	Contingency Plan for Rainy Season and Cyclone 2018-2019 (State Level/Sofara)	It summarizes the views on Sofala's responsibilities and budgets for operations in response to the above Contingency Plan of National Level.	Each Bairro is classified into four levels of risk areas. There are 170 Local Disaster Risk Management Committees (CLGRC) in Sofala to manage disasters at the community level.
	Contingency Plan	Contingency Plan (Municipality Level)	A plan regarding views on disaster response at the city level and the budget for operation in response to the above Contingency Plan of National Level and State Level is planned to be established.	It was not established for Beira Municipality this year.
	Indicator	The Framework of Indicators of Disaster Risk Reduction (January, 2017)	It was designed to monitor the process of disaster risk reduction (DRR) in development plans and to assess the impact of governmental strategies. This is to be reflected in the goals of the Government's Five-Year Program (PQG 2015-2019) and the goals outlined in the Disaster Management Master Plan. The necessity of responding to international frameworks such as the Sendai Framework for Disaster Prevention is mentioned.	It refers the goal for reducing the number of evacuees regarding the Sendai Framework for Disaster Risk Reduction, but does not mention how to improve evacuation activities.
	Manual	INGC Manual of Global Facilitator (March 2009)	It shows necessity of forming volunteering groups and what and how to implement local GRC activities. It breaks the GRC down into elements and sets some examples of activities such as “preparatory” activities for "contingency" measures; to formulate communities' risk maps, to confirm evacuation routes and safe shelters, to raise awareness of early warning system … etc. which are all important in the evacuation plan. Moreover, necessity for preparing an emergency action plan, implementation of simulation training, and evaluation of organizations' or communities' capabilities are described.	The manual also clarify members' positions and their roles for CLGRC, District Technical Council for Disaster Management (Conselho Técnico Provincial de Gestão de Calamidades; CTDGC), and GRC School Committee (Comité Escolar de Gestão do Risco de Calamidades; CEGRC), in order to enhance efficiency of local GRC activities.
	Action Plan	Disaster Risk Management Action Plan	An Action Plan for disaster prevention to be formulated at city, Bairro and facility levels, based on the above INGC Manual of Local Facilitator.	Action Plans formulated at cities, Bairro and facilities levels, based on the above-mentioned INGC Manual of Local Facilitator.
	Manual	Guidelines for basic emergency plan for schools (PEBE)	Guidelines for emergency action plans for schools developed by MOE, INGC, UNICEF and UNHABITAT.	It describes basic items to be prepared and known for the disaster management. It requires the School Committee on Disaster Management (CEGRC) (confirming its position) to closely work with INGC and CLGRC. It attaches forms to be used to put information on school-surroundings situations and emergency contacts, as well as action plans for before, during, and after a disaster. This could be the basis for the CEGRC once it includes timelines.
	Manual	Students Manual for Basic Emergency Plan for Schools (PEBE)	An manual for school's emergency plans, which was established in cooperation with UNHABITAT, unisex, and INGC. It indicates who should do what and when, and sets examples of early warning systems and disaster prevention plans.	In the evacuation plan, the basis of a series of evacuation plans, such as who gives instructions to whom and how in the school community, and analysis of disaster risks of each area, are explained.
Climate Change Adaptation and Mitigation Measures	Long-term Vision	National Climate Change Adaptation and Mitigation Strategy 2013-2025 (13 November 2012)	It was formulated with an increase in frequency and intensity of natural disasters, due to the recent climate change. It identifies areas that have a high risk of natural disasters and summarizes policies to reduce the impact of weather disasters as well as carbon emissions. It is a long-term vision of measures, including mitigation ones, to be taken against climate change.	It describes the INGC's improvement of its capabilities as the coordinating body for evacuation, provision of relief supplies, reconstruction, and support for victims during disasters.
	Mid-term Vision	National Adaptation Programme of Action (NAPA) （4th, Dec. 2007）	In order to achieve the priority goals in the Five-Year Plan (2005-2009), NAPA (a multi-sector group including INGC) was organized by the Ministry for Environmental Coordination (MICOA). With the support of the United Nations Framework Convention on Climate Change (UNFCCC), 48 least developed countries (LDCs) are preparing a National Adaptation Action Plan (NAPA).	One of the most relevant activities to evacuation plans is "enhancement of early warning systems", which is listed on both long-term and short-term goals. It is going to be developed in order for all targeted communities to become able to access warnings at the right time. Risk areas need to be identified at every Post Administrative (PA) level, and evacuation sites and routes for PAs with high risk of hydro-disasters should be specified, as well. As the visions are set for nation wise, there seem to be gaps between PA and communities, in terms of their scales/contents.
	Indicator	Monitoring and Evaluation System of the National Strategy for Adaptation and Mitigation to Climate	NA	NA
	Master Plan	Master Plan of Adaptation to Climate Change	Master Plan on Beira City's Climate Change Adaptation Measures formulated in the Project in response to Climate Change Adaptation Measures (Projecto Adaptaç ão as Mudanças Climáticas). implemented by GIZ, INGC and Beira City. This master plan is made to official through the approval of the city council.	Items related to disaster prevention are included in climate change adaptation measures, but specific descriptions regarding evacuation plans are not included.

Development Plan	Long-term Vision	Agenda 2025 (strategic vision for 2025)	Long-term vision for Mozambique's development plan. The following master plan states strategic vision for 2025. It indicates necessary innovations and changes to accomplish the goal of 2025 brought up from past tendencies and world trends of moral development.	There are references to the development of early warning system and monitoring (observation) systems for natural disasters, but no mention of evacuation.
	Mid-term Vision	Mozambique's five-year plan for 2015–2019 （February 17th, 2015）	Five-year Polivies (2015-2019) Presents policies on sustainable and transparent management of natural resources and the environment, promotion and monitoring of land use plans, clarification of responsible parties and effective planning, promotion of analysis and research on disaster risk and climate change responses, and improvement of communities and economies' vulnerability.	The policies are to disseminate disaster risks and provide early information, take planned actions against disasters, and improve cooperation between communities by strengthening mobility of communities.
	Action Plan	Poverty Reduction Action Plan 2011-2014 (3 May 2011)	It has been developed as a preparatory step to implement the five-year policies. It mentions promotion of infrastructure in potentially productive areas, ensuring sustainable natural resources, supporting self-reliance to increase employment and its periods (especially for women), ensuring safety of human lives (by understanding risks of natural disasters), etc. are mentioned. *Plans after 2015 have yet to be confirmed.	It mentions the creation of maps showing disaster risk areas and measures against climate change, but it doesn't refer to evacuation.
Others	Explanatory Material	Early Warning System	Early warning system: A disaster information sharing system developed by the government in cooperation with INGC. Considering floods, droughts, cyclones, burns, and tsunamis as phenomena, receivers (members) receive disaster information (visible on a map, etc.) and guidance on dissemination.	It stipulates warnings when a disaster is about to hit the area, so that this notification to people and communities enable people to evacuate more quickly. *Specific measures are specified by the evacuation plan (to be referred later).
	Explanatory Material	School Fire Brochure	Brochure created after a fire broke out at a school. It shows brief introduction of what to do in case of fires at school.	Since fire is used to cook foods in secondary evacuation sites, it is better to tell children how to take actions in case of fire there.

Source: JICA Project Team

6.1.1 Relevant Laws and Regulations

(1) National Policy on Disaster Management (Resolution No. 19/99, issued on June 10, 1999)

This describes the definitions and principles of Mozambique's disaster management, sets out its objectives and strategies, and prescribes the national legal and institutional framework. It states that Mozambique's disaster preparedness will address not only a post-disaster response but also prevention and mitigation and policy to form a preventive culture through a multi-sectoral approach for vulnerable communities.

It also describes an organization that supervises Mozambique's disaster management operations, which is the basic concept of the INGC[1]. The INGC has been established according to the government ordinance on the establishment of the INGC, approved on June 10, 1999 (Statute of the National Institute for Disaster Management; Decree 38/99, issued on June 10, 1999).

(2) Statute of the National Institute for Disaster Management (INGC) （Decree No. 52/2007, November 27, 2007）

This is a regulation to approve the National Institute for Disaster Management (INGC), which supervises national disaster management operations to implement the above national policy. It stipulates the organization's purpose, the scope of work, and others.

1 INGC changed its name to INGD according to the revision of the Disaster Management Act Decree 41/2020 issued on 28th December 2020.

(3) Disaster Management Law (Law No.15/2014, issued on June 20, 2014)

Disaster Management Law (Law No.15/2014) is a basic law on the disaster in Mozambique.

The law states the establishment of a legal framework to prevent and mitigate disaster damage, to develop rescue and support activities, and to manage natural disaster risks.

It states its purpose in Section 1 as "…disaster response shall be prepared with efficiency through multisectoral activities with participation from the entire society and individual citizens. Not only the current natural disaster shall be responded but also possible disasters or future impacts shall be prevented through prior action." It stipulates a policy to take prior measures.

As for specific plans, Contingency Plan and Disaster Management Plan are listed. The Contingency Plan is to be annually produced based on weather prediction. Disaster Management Plan is to cover nationwide plans, including disaster risk prediction.

The law does not stipulate the term "evacuation plans." Although it does not describe the term "prior evacuation," Article 39 stipulates an authority for governor, council head in disaster-affected cities and district administrator to force residents to evacuate at disasters, and Article 33 describes that the government shall develop land less vulnerable to disasters to relocate residents' step by step. Descriptions regarding the evacuation plan are extracted as below.

Table 6-2 Extracts regarding Evacuation Plan from Law No.15/2014

Article	Extracted Passage	Remarks
ARTICLE 7 (Preventive measures)	1. The coordinating committee for disaster management promotes training courses in disaster management for public and private entities and others, especially at the local level.	Local Disaster Management Committee (CLGRC) related
ARTICLE 18 (Exceptional measures)	1. In the case of imminence or occurrence of disasters, the Council of Ministers may establish the following exceptional measures: c) Occupy facilities and any other premises of any nature or destination, except for those used as housing.	Exceptional measures for occupancy of facilities at disasters
ARTICLE 31 (Risk areas)	1. Spatial planning shall define the areas with risk of disasters. 2. Disaster risk areas shall be classified in zones with high risk, medium risk, and low risk. 3. The construction of housing in high-risk areas is prohibited. 4. Placement of construction and housing banning signs in zone areas.	Areas with risk of disaster and construction regulation
ARTICLE 32 (Rights of citizens in risk areas)	a) Special attention of the State or of the local autarchy, which consists in the implementation of measures to reduce risk of disaster and the existence of systems of early warning, simulation, and priority in the creation of risk management committees;	Early warning system, CLGRC related
	b) To be evacuated by safe means, to know, to visit and to make a timely assessment of the evacuation sites;	Evacuation related

Article	Extracted Passage	Remarks
ARTICLE 33 (Obligations of citizens in risk areas)	1. Citizens in risk areas shall have the duty to observe the construction regime defined specifically for its area and to promptly obey evacuation orders, under penalty of criminal liability for disobedience. 2. The refusal of timely compliance with the conditions of evacuation obliges the State to resort to compulsory measures in defense of life and other rights of citizens. 3. The government should, progressively, provide infrastructure in low-risk areas to encourage the settlement of the populations in those areas.	Evacuation and relocation related
ARTICLE 34 (Emergency assistance)	2. Assistance programs shall comprise, in particular, food, medical and drug assistance, education, evacuation of high-risk zones, resettlement, and promotion of activities of food production and socio-economic and cultural development.	Evacuation and Relocation related
ARTICLE 37 (Special Protection Regime)	3. Especially vulnerable people, such as the elderly, women, children, and impaired, have the right to special protection, such as: a) Right to property at the moment of evacuation and resettlement the right to special protection against abuse during the period of emergency;	Evacuation and Relocation related (vulnerable people)
ARTICLE 39 (Compulsory evacuation of the high-risk zone)	1. In situations of imminent risk, compulsory evacuation of people and goods can be determined by the Governor of the Province, district administrator, or president of the affected municipal council.	Compulsory evacuation

Source: JICA Project Team

(4) Regulation of the Disaster Management Law (Decree No. 7/2016, issued on March 21, 2016)

This regulation sets out regulations and procedures for the implementation of the Disaster Management Law regarding disaster prevention, mitigation, response, recovery, and reconstruction.

It is noted that Local Disaster Management Committee (Commités Locais de Gestão do Risco de Calamidades “CLGRC”) undertakes simulation training in line with the Disaster Management Law with the involvement of administrative organizations for disaster coordination, provincial or local governments, CLGRC and local communities.

In addition, alert warnings are expressed in colors. The yellow color alert means that a phenomenon with human and physical damage is predicted, and the GLGRC starts its operation. The orange color alert indicates that the probability of a phenomenon with human and physical damages is high, and administrative organizations have a duty on disaster coordination to urge residents in the risk area to evacuate to a safe place. The red color alert means that human and physical damages are highly likely to result in disasters so that the search and rescue system shall be set up.

Moreover, the regulation describes that risk area maps shall be produced in coordination with administrative organizations responsible for disaster coordination, focusing on inundation, flood and other risks, under the jurisdiction of local government and regional autonomies.

6.1.2 Relevant Plans, Manual and Guideline

(1) Mozambique Disaster Risk Master Plan (2006 - 2016)

Mozambique Disaster Risk Master Plan (2006-2016) is based on the National Policy on Disaster Management (1999) and aims to reduce the human and economic loss caused by disasters. It plans to protect agriculture and water resources as well as use rainwater and water resource infrastructure (dam and levee). It mentions action plans to reduce and prevent vulnerabilities and strengthen disaster response as well.

(2) Master Plan for Disaster Risk Reduction 2017 – 2030 (August 2017)

In response to the Disaster Management Law (Law No.15/2014), Master Plan for Disaster Risk Reduction was formulated in 2017 as the next plan for Mozambique Disaster Risk Master Plan (2006 - 2016).

In Mozambique, the importance of establishing principles and legal systems to prevent and mitigate disaster risks has been recognized, and based on the evaluation of the previous plan, the planning structure, contents, and details are examined. The purpose of this plan is to reduce disaster risks, human death, and damaged critical social infrastructure, and prevent any future disaster risks by strengthening the resilience of people and social infrastructure. The plan's five strategies include efforts to deepen understanding of disaster risks at all levels, promote public and private participation for disaster management, and enhance disaster prevention, response, and recovery, especially in the province and district levels. The plan’s five strategies also include the establishment of international cooperation and partnership.

Relevant action plans include the development of human resources who are responsible for disaster management, the preparation of disaster management education programs, the implementation of CLGRC training and drills, and the establishment of early warning systems.

(3) Disaster Management Plan in Provincial and District Level

The Disaster Management Law (Law No.15/2014) mentions only the Disaster Management Plan at the national level and does not stipulate duties to formulate the plan at the provincial or district level.

According to the INGC, Disaster Prevention Plan is prepared at the district level to be submitted to the provincial office. The provincial office consolidates all district plans and submits them to the central government.

Although the Beira Municipality has not prepared a master plan particularly for disaster management, it has the Master Plan of Adaptation to Climate Change, which was formulated and approved by the municipal council in 2015. As this master plan includes the disaster management plan, the Beira Municipality has taken disaster prevention actions in line with this master plan.

A confirmation has not made yet on whether the disaster management plan at the provincial level has been established. This is a subject for further research.

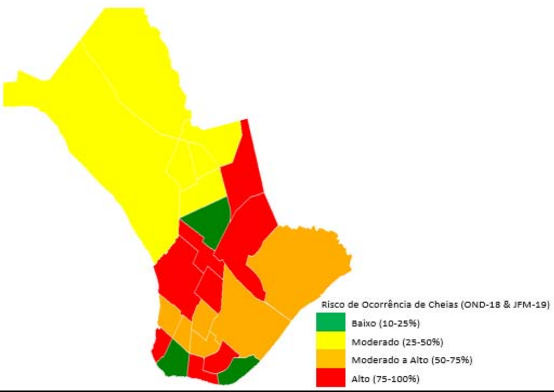
(4) Contingency Plan

Contingency Plan is to be annually formulated at the district, provincial and national levels, according to the Regulation of the Disaster Management Law (Decree No. 7/2016).

It is formulated based on the weather forecast related to the rainy season announced by INAM every September. Respective city and district offices submit their plans to the provincial office, which compiles them to submit to the national government. After the provincial plans are compiled, they are integrated into the Contingency Plan at the national level.

Contingency Plan for the rainy season and cyclones from 2018 to 2019 in Sofala Province classifies urban flood risk areas in Beira City into four flood risk groups at four Bairro levels. As shown in the national-level contingency plan, the map indicates Maputo, Matola, and Qualimane as a map for urban flood risks.

Table 6-3 Flood Risk in Beira City (Oct. 2017 Oct. – Mar. 2018 Mar.)

<table>
<tr><th>Map</th><th>Classification of risks</th><th>Bairros</th></tr>
<tr><td rowspan="4">
</td><td>1. Low</td><td>Alto da Manga, Ponta-Gêa e, Macúti</td></tr>
<tr><td>2. Mid</td><td>Matadouro, Vila Massane, Mungassa, Inhamízua, Chingussura e Nhaconjo</td></tr>
<tr><td>3. Mid-high</td><td>Pioneiros, Matacuane, Mananga, Chota, Muhave e Esturro</td></tr>
<tr><td>4. High</td><td>Ndunda, Manga Mascarenhas, Vaz, Munhava, Macurungo, Chipangara, Chaimite e Maraza</td></tr>
</table>

Source: Plano de Contingência para Época Chuvosa e Ciclones 2018/2019

(5) INGC Manual of Local Facilitator (March 2009)

This manual was produced by the Mozambican government through technical support from GTZ and published by the INGC in 2009. It aims to function as a guide for facilitators involved in Disaster Risk Management (Gestão do Risco de Calamidades; GRC) at the regional level.

The manual mentions the formation of volunteer groups, activity details, and execution procedures for local GRC activities. It describes activity examples for "preparation" in the item of "emergency response" listed as a GRC element. Examples include community risk map production, confirmation on an evacuation route, and venue for disaster shelter and recognition on early warning systems as necessary elements for an evacuation plan. They also cover essential preparation items such as contingency plan, simulation drill, and response capability assessment for organization and community.

The manual also clarifies the member structure and their roles for CLGRC, District Technical Council for Disaster Management (Conselho Técnico Provincial de Gestão de Calamidades; CTDGC), and GRC

School Committee (Comité Escolar de Gestão do Risco de Calamidades; CEGRC) to enhance regional GRC capabilities (member structure is described in 5.2.2).

(6) Guidelines for Basic Emergency Plan for Schools (PEBE, 2018)

These guidelines were developed by the Ministry of Education and Human Development (MINEDTH), UN-HABITAT, and UNICEF. The guidelines set out the basic assumptions, concepts, factors, practical considerations, and procedures to be considered.

The Emergency Plan for Schools, as an important element, aims to secure the safety of students, teachers, staff, school infrastructure, and equipment as well as to implement practical exercises for planning and disaster response. The Emergency Plan also mentions the establishment of CEGRC and its planning execution in close collaboration with CLGRC. The activity plan for guidelines is based on the regional facilitator manual.

The MINEDH will select 25 schools in the areas affected by Cyclone Idai (including Beira City) and examine the pilot project to be conducted in line with these guidelines. However, mainly due to the limitation of budget, the activity is not conducted year. Based on the interview to the DPE officer the activity is planned to be conducted with priority for the activity to be done in EPC Macurungo and ESG Mateus Sansão Mutemba where DRR education was conducted in the project.

6.1.3 Disaster Response Plan (Evacuation Plan) in Mozambique

The National Policy on Disaster Management released in 1999 indicated that Mozambique would deal not only with post-disaster damages but also with disaster prevention and mitigation as well as the formation of disaster preventive cultures in vulnerable communities. With this background, the INGC was established in 2007 as an organization responsible for overall disaster management.

In the INGC Manual of Local Facilitator released in 2009, the CLGRC, the CEGRC, and the CTDGC are supposed to formulate their action plans. The plan should include basic information on school and local area, regional disaster history record, risk analysis based on disaster risk and resource maps, an action plan with them in mind for prevention, mitigation and preparation, and emergency contact list.

Based on the example of “preparation” mentioned in 5.1.2 (5), it is expectable that some elements of the evacuation plan may be well planned, but it does not indicate the idea of combining them into a flow of evacuation action plan and the list of activities/actions that should be included in the plan.

The Disaster Management Law (Law No.15/2014) stipulates a policy to evacuate residents in vulnerable areas and to develop relatively low-risk areas to relocate them. However, it does not cover the formulation of the evaluation plan regarding the way to evacuate the residents at the community level.

The Regulation of the Disaster Management Law (Decree No. 7/2016) stipulates that local governments/local autonomies shall coordinate with INGC to develop risk area maps. In the regulation, as the information delivering tools for the community, the CLGRC starts the action when the yellow color alert is issued. In the case of the orange color alert, the INGC acts to search safe community places in the risk areas. However, it does not mention the prior planning of evacuation methods. In the red color alert, though search and rescue operation are set up, it does not include a concept to urge residents to evacuate to safer places beforehand.

Also, one of the five strategies of the Master Plan for Disaster Risk Reduction 2017 – 2030 states to "enhance preparation, response, and timely recovery, especially at the province and district levels." Moreover, as related action plans, it includes the development of human resources responsible for disaster management, the formulation of disaster management education programs, implementation of drills including CLGRC training, and the establishment of the early warning system. If these capabilities are enhanced with the mechanism, people in the community can take proper action and mitigate disaster risks, even though these individual action plans are not collaborated to structure a series of disaster response plans. In the event of the Cyclone Idai disaster (as presented in 5.3.1), although the INGC, the Beira Municipality, and the CLGRC urged people living in the risk areas to evacuate, the residents did not know where to evacuate and struggled to seek safe places under the storm. This indicates that the need for the formulation of the evacuation plan is not adequately shown in the above legal framework. Therefore, the evacuation plan has neither legal support nor planning concept for prior evacuation.

Table 6-4 Positioning in Evacuation Availability of Plans

		Classification	Names of documents	Main bodies	Contents	Related to the plan of ...					Key Points
						Nation	State	District	Bairro	Facility	
Nationwide Efforts	Plans based on Disaster Management Law	Plan	Disaster Management Plan	INGC	Directive Plan for Disaster Risk Reduction 2017 – 2030 was formulated based on the Disaster Management Law.	○	×	×	×	×	The Disaster Management Law requires only contingency plans to be formulated for units smaller than province. **There is no obligation to prepare an evacuation plan.**
		Plan	Contingency Plan	Nation, State, District Levels	Nation, states and districts are mandated to make annual budget plan.	○	○	○	×	×	
	Efforts not mentioned in the Disaster Management Law	Manual	Disaster Management Plan based on Manual of Local Facilitator (March 2009)	District, Bairro, Facility Level	A disaster management action plan, which districts, Bairro and schools are recommended to formulate based on the Facilitator Manual. **It sets examples of** disaster management systems, **risk maps and evacuation routes.**			○	○	○	INGC's manual sets some **examples of items including evacuation planning** which are not provided in the Disaster Management Law. Evacuation plans are formulated according to these manuals.
		Manual	PEBE Guidelines for Basic Emergency Plan for Schools (Orientation, manual for students)	INGC, UNICEF, UNHABITAT, etc.	A manual to supplement the above manual, specializing in school (facility level)'s emergency action plans.					○ school	
Efforts to be made by Beira City		Master Plan	National Climate Change Adaptation and Mitigation Strategies	GIZ, INGC, Beira City	Beira City's Master Plan which includes disaster management policies, however does not mention evacuation plan. **It is approved by the municipality council.**			○	×	×	**Positioning of evacuation plans need to be clarified and well adjusted, considering inconsistency with** the approved master plans.
		Master Plan	Disaster Management Plans based on the Manual for Local Facilitator (March 2009)	Six Bairros/ Units in the Beira City	Six Bairros/units have formulated emergency action plans based on the Manual of Local Facilitator.			×	○	×	

Source: JICA Project Team

6.2 Emergency System

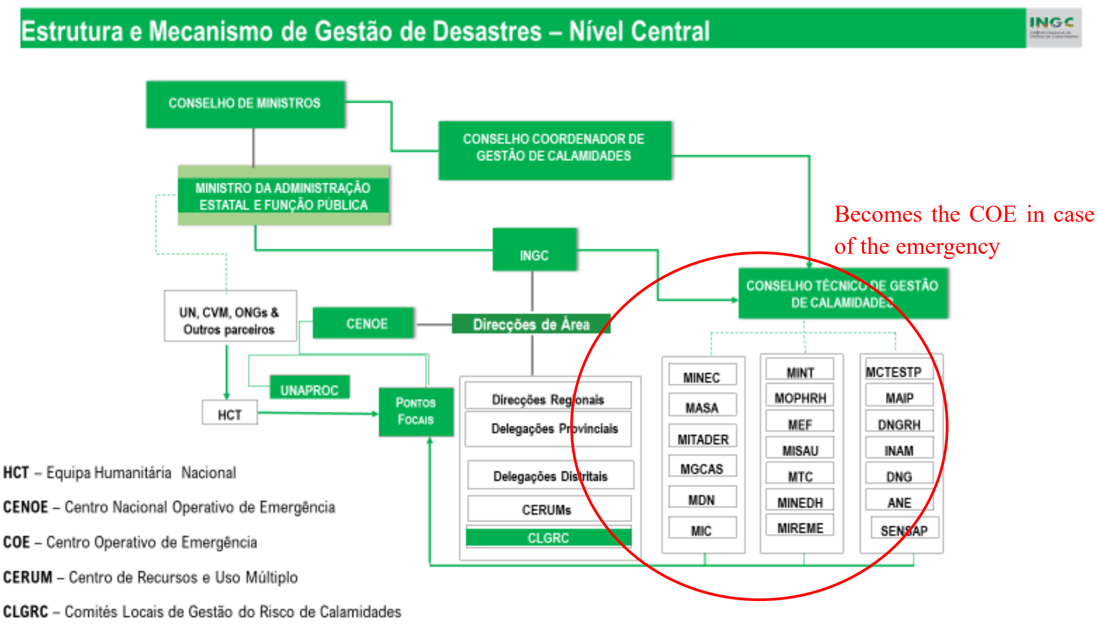
6.2.1 System of Province Level (Case of Sofala Province)

The INGC takes responsibility for disaster management operation in Sofala Province. There are 170 CLGRCs in Sofala province, and the INGC oversees each CLGRC to manage disasters in the communities.

Each province has Provincial Technical Council for Disaster Management (Conselho Técnico Provincial de Gestão de Calamidades; CTPGC), and the CTDGC has been set up in the city of Beira, Caia, Dondo, Nyamatanda, Chemba, Malomeu, Bhuj and Machanga. The CTPGC becomes Emergency Operation Center (Centro Operativo de Emergência; COE) to instruct the disaster management in case of emergency.

The INGC calls on the COE members to hold a meeting and discuss disaster response at the time of disasters.

The following figure shows the disaster management system in Mozambique for reference. The provincial management structure is similar to the national one. The red-colored frame indicates CTDGC, which becomes the COE in the emergency situation.



Source: JICA Project team based on Panorama de Gestão do Risco de Desastres em Moçambique, INGC

Figure 6-1 Structure of Disaster Management Structure Mechanism

6.2.2 System of District Level (Case of Sofala Province)

The CTDGC is responsible for district disaster management. The facilitator manual describes the CTDGC structure, consisting of the INGC executives, local government officials, citizens, community leaders, partners, and administrative committee representatives, and the following subcommittees are organized.

a. Coordinator
b. Sub-coordinator

c. Education/Information subcommittee
d. Damage and needs evaluation subcommittee
e. Preparation and response subcommittee
f. Social welfare subcommittee
g. Transportation and Infrastructure subcommittee

In Sofala province, the delegate of INGD Sofala in in charge of the coordinator and subcommittee are the Social Service subcommittee, Communication subcommittee, Planning subcommittee, Infrastructure subcommittee which consists of the institutions bellow.

- Social Service subcommittee: Provincial Services for Social Issues and Provincial Services of Health.
- Communication subcommittee: Institute for Social Communication
- Planning subcommittee: Provincial Services of Economy and Finances and Provincial Directorate of Finances
- Infrastructure subcommittee: Provincial Directorate of Infrastructure and Provincial Directorate of Public Works Housing and Water Resources

The CLGRC is a volunteer organization at Bairro levels. At the time of disasters, they are supposed to provide community people with INGC's information, and grasp disaster damage status to report them to the INGC. Out of 26 Bairros in Beira Municipality, 21 Bairros have already established the CLGRC.

According to the INGC Manual of Local Facilitator (2009), each CLGRC is composed of 15 to 18 volunteers, who are assigned to respective roles. As the CLGRC functions under the direction of the INGC, all their members need to receive the training supplied by the INGC. Once a member finishes the training, the member is registered to the INGC as the CLGRC and provided equipment such as bicycle, megaphone, raincoat, and rain boots, and others. The member must store them in a locked space and be inspected by the INGC staff once a month.

Table 6-5 Members of the CLGRC

	Role	No. of Persons
1	Coordinator	1
2	Sub-coordinator	1
3	Rep. responsible for equipment inventory	1
4	Rep. responsible for radio information	2
5	Rep. responsible for communication	2 - 3
6	Rep. responsible for evacuation	2 - 3
7	Rep. responsible for search and rescue	2 - 3
8	Rep. responsible for shelter	2 - 3
9	Rep. responsible for information management and post-disaster needs assessment	2

Source: JICA Project Team

The following table shows a list of the CLGRC establishment status in Beira Municipality, which consists of 20 persons as a basic structure.

Table 6-6 Launched CLGR Structure Status in Beira Municipality

Base de dados dos Comites Locais de Gestao de Risco de Calamidade de Sofala

DISTRITO	POSTO ADMINISTRATIVO	LOCALIDADE	COMUNIDADE (Nome do Comitê)	Criacao: Criados	Criacao: Nº de Membros	Capacitacao: Capacitados	Capacitacao: Nao capacitados	Capacitacao: Data da ultima capaciotacao	Raio de cobertura do comite (numero de membros da comunidade coberta pelo comite)	Equipamento: Com Kites / Kit prontidao: Equipados	Equipamento: Com Kites / Kit prontidao: Por Equipar	Equipamento: ano de alocacao do kit	Localizado no Bairros de Reassentamento	DATA DE CRIACAO: Dia	DATA DE CRIACAO: Mes	DATA DE CRIACAO: Ano	Observacoes: Outras informacoes relevantes	Coordenador	Contacto	Coord. Adjunto	Contacto
Beira	Munhava		Maraza	1	20	1	0			0	1	2012	0	15	5	2011		João Augusto	84 64 999 51	Catarina Francisco	
			Chota	1	20	1	0			0	1	2012	0	2	7	2010		Flora Verónica Sampaio	82 52 09 508	Ibraimo Saide Mufaumue	84 78 22 3
			Munhava Central	1	20	1	0			0	1	2013	0	4	4	2013					
			Munhava Matope	1	20	1	0			0	1	2017	0		12	2014					
			Mananga	1	20	1	0			0	1		0	28	3	2015					
			Vaz	1	20	1	0			0	1	2013	0	10	4	2013					
	Baixa		Praia Nova	1	20	1	0			0	1	2012	0	7	7	2010		João Augusto	84 64 999 51	Catarina Francisco	
			Macurongo	1	20	1	0			0	1	2012	0	5	5	2011		Emilio Amizade	82 26 08 635	Arminda M. Matira	82 61 78 0
			Matacuane	1	20	1	0			0	1	2012	0	18	4	2011		Meque Gomundanhe		Maria Chombe Jacopo	
			Goto	1	20	1	0			0	1	2013	0	2	7	2013					
			Chipangara	1	18	1	0			0	1	2012	0	20	5	2010				Rosa dos Santos Muchanga	82 6239 06
	Manga		Chingussura	1	20	1	0			0	1	2013	0	2	4	2013					
			Vila Massane	1	20	1	0			0	1	2013	0	8	4	2013					
			Mungasa	1	20	1	0			0	1	2013	0	2	10	2013					
			Inhamizua	1	20	1	0			0	1	2013	0	17	5	2013					
			Ngonpa	1	20	1	0			0	1	2013	0	0	10	2013					
			TChundja	1	20	1	0			0	1	2015	0		12	2014					
			Njalane	1	20	1	0			0	1	2015	0		12	2014					
			EPC Massange	1	20	1	0			0	1		0	28	3	2015					
			Ndunda	1	20	1	0			0	1	2017	0	26	2	2015					
			Nhangau	1	30	1	0			0	1	2013	0	6	5	2013					
				21	428	21	0	0	0	0	21		0	200	130						

Source: INGD Sofala

6.3 Disaster Management (Evacuation) Situation in the Event of Cyclone Idai

6.3.1 Evacuation Situation at Cyclone Idai

The following table shows the actual evacuation status in the community, including preliminary interview survey results. It is organized to understand the pre- and post-disaster status in the survey.

As it is crucial for evacuation planners to confirm the actual disaster status in supporting the formulation of evacuation plans in this project, this process to grasp the status is introduced for panning formulation.

Table 6-7 Interviewed Targets

	Interview	Date
1	Beira Municipality	6/12,9/19
2	INGC Sofala Office	6/13
3	Community: Bairro Mungassa Unit A Block 4	6/13
4	Community: Bairro Vaz	6/13
5	Community: Secondary Evacuation Site (Accommodation Center) *Evacuees from Praia Nova of Bairro Chaimitte and from Goto of Bairro Ponta Gea	6/13
6	Bairro: Esturro	1/17
7	Bairro: Macurungo	1/21
8	Bairro: Chingussura	1/22

Source: JICA Project Team

(1) Pre-Disaster Status

Cyclone Idai-related information was disseminated via TV or radio about four days before the cyclone attack. During the interview survey with the INGC Sofala office, it was found that the information about the cyclone's landfall on Beira City was available three days in advance. This information was disseminated to the community through the CLGRC. In interviews with community leaders, it was revealed that while there were some areas where the information was not effectively delivered, the majority of people in most areas had prior knowledge of the cyclone's landfall. This highlights the importance of effective communication and dissemination of information to ensure that communities are well-informed and prepared for impending natural disasters.

However, most people, including Beira Municipality and ministry agency officials, continued ordinary life as they did not expect to suffer from severe damage. Even though the CTPGC and the CTDGC confirmed general information on the cyclone, and the CLGRC or the municipality notified the community about the cyclone landfall, these organizations continued ordinary day-to-day operations without initiating a pre-cyclone response. The Beira Municipality staff operated day-to-day duties until 14:00, March 14, 2019 and most companies also worked on regular duties.

(2) Status at Time of Cyclone Landfall

At 14:00 on March 14, 2019, Beira Municipality officers returned the home with the instruction given by the Mayor. Subsequently, the Mayor started an announcement on radio and urged citizens to stay home, if their houses are safe.

Most citizens moved to safer places in the storm, once their houses began to be flooded after the storm started. As there was no information on the evacuation center beforehand, most of them moved to schools in the neighborhood. However, as some small schools and public facilities had already been damaged by the disaster, evacuees struggled to seek evacuation centers in some communities in the storm.

At the time of Cyclone Idai, people did not consider prior evacuation, and evacuation centers or venues were not decided beforehand in the case that citizens’ houses were at risk.

(3) Post-Disaster Status

After Cyclone Idai passed the city, the rain continued to fall intermittently for ten consecutive days, and most evacuees had to stay at shelters for two or more weeks. As noted in Chapter 6, though most evacuees stayed at schools, specific figures or research data were not confirmed to clarify the two weeks after the cyclone.

The INGC distributed food or relief goods at evacuation venues after the disaster. Some rural areas only received two to three days amount of food and suffered from food shortage for evacuees staying for more than two weeks. In most cases, because evacuation venues were managed by regional leaders under the direction of the INGC, significant confusion was not seen for evacuees. However, restrooms caused hygienic problems as they were used by a greater-than-expected number of people. There was an unmatching toilet size issue as well, as adults used the toilets for children in schools.

Although most schools were used as evacuation centers, some evacuees sheltered in the gym or under the expressway, and not all evacuees sheltered in the indoor facility. If facilities in the neighborhood are not safe, residents hesitate to evacuate from their houses. Therefore, some residents spent days on the table in their flooded houses without searching for safe remote facilities.

Table 6-8 Action of People in Before and After the Disaster

	Overall	Beira City	CLGRC	Community
A week before				Landing of the cyclone was notified.
4 days before (Mar. 10)	Landing of the cyclone was broadcasted through media	Landing of the cyclone was notified.		Landing of the cyclone was notified, however did not take it seriously.
3 days before (Mar. 11)	Landing of the cyclone on Beira City became sure.		Informed responsible communities about the landing of the cyclone.	
5 days before (Mar. 12)		No Action		Local staff received information on cyclone from government and local institutions, and notified community residents of it.
1 day before (Mar. 13)				Most of the residents did not take any action.
Landed day 1 (Mar. 14)		Operated as usual.		Did not care about the cyclone.
About 14:00	Wind and rain began to strengthen.	Cityhall staffs went back home.		
		Mayor announced to stay at safe houses through radio. Water gate was closed.		Wind and rain got severe. The residents moved furniture. Some began to evacuate to nearby schools and gyms. They evacuated with nothing in their hands as they did not prepare for evacuation.
After 18:00	Severe damages begins.			
Landed day 2 (Mar.15) About 14:00	Storm reaches a peak.	Communication tools interrupted.		Flood water reached to the height of thigh. Residents from flooded houses evacuated to school or others.
				Evacuees moved to another sites, once their evacuated school suffered from damage.
1 day after (Mar. 16)	Communication tools were damaged in the whole city.	Emergency headquarters launched.		
2 days after (Mar. 17)	People had no transportation method to leave the city.	Removal of road obstacle began.	Checked the damage situation of responsible Bairros and reported to INGC.	
3 days after (Mar. 18)		Staffs were sent to communites which did not have any contact method.		2-3 days amount of foods were distributed through INGC. Community leader managed evacuation site (in case of Bairro Mungassa communities). Evacuation sites were operated by INGC and community leaders and secretaries were in support. As toilets were available only for children's size, they were very inconvenient for adults (in Bairro Vaz community).
A week after	Water-related problems were caused at evacuation centers.			
	Cholera and malaria began to spread.			
2 wees after	The spread of cholera came to an end, but malaria was still ongoing at evacuation sites. Most evacees reurn home, though their houses were severly damaged.			The rain continued for 2 weeks and many evacuated under viaduct. They went back home after the water was removed (in case of Bairro Mungassa community).
A month after				Stayed at the school for a month and went back to their houses (in case of Bairro Vaz community) Some residents stayed at the school for a month, however their residential areas were yet unable to return and therefore moved to evacuation sites for longterm stay (in case of Bairro Praia Nova and Goto).

Source: JICA Project Team

6.3.2 Current State and Challenges on Disaster Response Plan (Evacuation Plan)

(1) Formulation of Response Plan (Evacuation Plan) in Beira Municipality

As mentioned earlier, there is no obligation to formulate evacuation plans under the legal framework in Mozambique. Beira Municipality has not prepared an evacuation plan at the municipality level, as there is no concept for prior evacuation.

After the INGC Manual of Local Facilitator was published in 2009, the GIZ, the INGC and the Beira Municipality had implemented the capability enhancement training for CLGRC as a pilot project, to boost its operational capability in five Bairros (Chipangara, Chota, Macurungo, Maraza and Matacuane) and one unit (Praia Nova)[2]. Under these conditions, CLGRC's disaster management action plan was formulated in training, based on the manual. The action plan included prevention, mitigation, and preparation activities. Some areas even included calling out for residents to evacuate.

The manual describes action planning examples, including confirmation on evacuation route or the safer place for shelter as evacuation planning elements, reflecting the policy of the Disaster Management Law, which stipulates the need for residents to evacuate in risk areas. However, sufficient guidance is not given on how to compile a series of evacuation plan with the elements in mind and how to implement prior evacuation for residents.

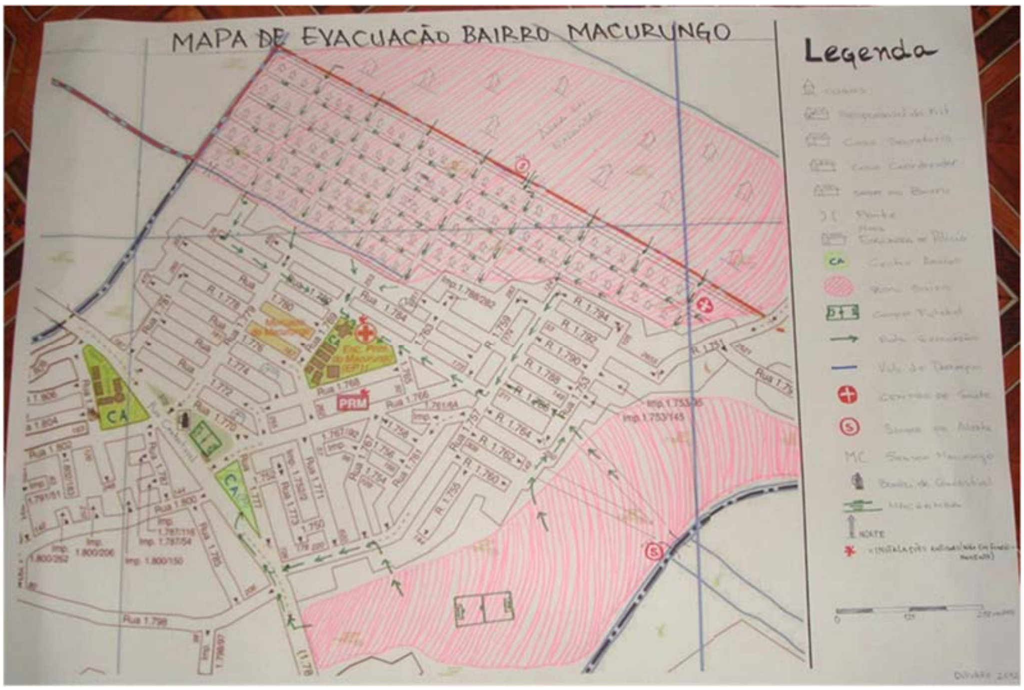
As an example of the CLGRC Disaster Prevention Action Plan for Bairro Macurungo, where Macurungo Elementary School is located, under one of the pilot projects in the JICA project, an evacuation map, as shown below, is created. The preparation plan covers action plans 24 to 48 hours, 24 hours, and 6 hours before the cyclone landfall.

The areas highlighted in pink color are lowland with green arrows indicating evacuation direction. In addition to Macurungo Primary School, a plaza, where Bairro Office is located, serves as an evacuation site.

In the plan, specific actions are described in the respective timeframes. In 24 to 48 hours before the cyclone landfall, confirmation is necessary on evacuation center safety and its route. In 24 hours before, evacuation centers are set up, and voluntary evacuation is encouraged. In six hours before, residents in risk areas are forced to evacuate.

However, Beira Municipality officials or Bairro Macurungo leaders said that the CLGRC activities were not vitalized after the pilot project and did not recognize that the CLGRC had not acted in accordance with the plan at the time of Cyclone Idai.

2 The intervention was implemented through the Adaptation to Climate Change with Disaster Prevention in Beira as a GIZ funded program conducted from 2010 to 2012



Source: Plano de Acção de Gestão do Risco de Macurungo

Figure 6-2 Evacuation Map of Bairro Macurungo

(2) Challenges of Response Plan (Evacuation Plan) in Beira Municipality

As a challenge of evacuation in the Beira Municipality, though information on Cyclone Idai landfall was gained, the prior systematic evacuation did not proceed. The reason behind this was neither the "evacuation plan" nor the way to consider prior evacuation. Under these conditions, the INGC, the Beira Municipality, the CLGRC, and community executives could not direct "who, where, when, and how to evacuate," and residents could not receive the information.

Therefore, the evacuation plan for the expected hazard should be worked out. Based on the plan, timeline action plans should be produced at Bairro, community, and individual levels.

Moreover, as the CLGRC's plan produced in the above pilot project describes when, who and what to do in respective items, it is considered as a complete plan. However, for example, in the "who to do" section, though the specific CLGRC official has been assigned, detailed operations have not been decided, such as the official does what or when to do in the 24-hour timeframe, and also which officials or each action properly collaborates. However, as basic actions are listed, and the specific officials are assigned to respective duties, disaster management plans, produced in Bairros, are to be updated as a viable evacuation plan, ensuring consistency with the city level plan.

The following table shows the challenges of the disaster management plan (evacuation plan) in the Beira Municipality and supporting policies in this project.

Table 6-9 Issues in the Response Plan (Evacuation Plan) of Beira Municipality and Supporting Policy of This Project

Categories	Issues	Supporting Policy
System	The policy and plan regarding disaster management in Mozambique stipulate the disaster prevention and mitigation, the establishment of disaster management culture, and efforts to urge residents in risk areas to evacuate. However, as there is no concept of prior evacuation, specific planning methods or systematic guidelines are not prepared	In this project, the formulation of an evacuation plan in the Beira Municipality will be supported. The formulation of the evacuation plan and evacuation site management plan for Bairro will be supported as pilot support activities.
Organization	Planning formulation needs to be carried out in corporation with the INGC, local autonomies, the CLGRC, and communities. The CLGRC plays a vital role in evacuation planning and implementation for residents; however, its organizational capacity has to be enhanced at the same time.	In the process of supporting evacuation plan formulation, the participation of CLGRC members will be discussed and advised with the INGC and the Beira Municipality under part of C/P's capacity building through the project.
Plan	Municipal-level plan needs to be formulated to grasp who and where to evacuate.	The formulation of municipality-level evacuation plans is supported by the hazard map produced in the project.
	Hazard map is needed on the basis of evacuation plan.	
	Community plan is needed to direct who and where to evacuate.	The formulation of collaborated plans is supported in evacuation centers with Bairro involved in the pilot project site.
	System structures are needed for evacuees' community and facilities or communities accepting evacuees.	

Source: JICA Project Team

6.4 Progress in Supporting for Response and Evacuation Plans

6.4.1 Progress in Supporting Formulation of the Plans

In response to the evacuation status on Cyclone Idai, as mentioned earlier, in order for C/Ps to recognize the need in formulating evacuation plans, project details and the flow of evacuation planning formulation were explained for the Beira Municipality, the INGC Sofala, Bairro leaders in pilot project sites and site-related persons.

Especially to Beira Municipality, the explanations and consultations are carefully repeated until the Beira Municipality representatives, Advisor for Construction and Infrastructure Sector/Director of Risk Management and Coastal Protection Department understand enough to be able to explain them to other organizations, and they made presentations on this at the JCC.

The stakeholders at the pilot project sites received the explanation that this project supports the formulation of the plan in community level and operational plans for evacuation sites, following the evacuation plan of the municipality. There were no concrete discussions as the hazard map was not completed. The plan was confirmed to be the base of the activity schedule for such as evacuation drills, disaster prevention education, and disaster prevention workshops before the commencement of the pilot project's facilities construction (assuming July).

Table 6-10 Meeting Arrangements Made Regarding on Evacuation Plan

Dates	Institution	Details
2019/09/12	INGC: Chief of the technical department	Brief explanation of the project
2019/09/19	Beira Municipality: Director of Risk Management and Coastal Protection Department	Briefing about disaster response plan
2019/09/23	Beira Municipality: Director of Risk Management and Coastal Protection Department Officers	Confirmation of the disaster management system in Beira Municipality
2019/09/24	Beira Municipality: Director of Risk Management and Coastal Protection Department, CLGRC Macurungo leader	Confirmation of CLGRC activities and annual plan regarding disaster activity
2019/12/03	Macurungo Primary School: Principal, Vice-principal, etc.	Introduction of school-related activities to be considered in the project and information collection
2019/12/03	Beira Municipality: Main members	Confirmation of implementation policy on hazard map and community activities
2019/12/04	Mateus Sansao Mutemba Secondary School: Principal	Introduction of school-related activities to be considered in the project and information collection
2019/12/06	Beira Municipality: Director of Risk Management and Coastal Protection Department, Officers	Briefing about evacuation plan production step
2020/01/17	ANAMM: Secretary General, Project Manager	Introduction of project details, municipality-level evacuation plans or community activities
2020/01/17	Beira Municipality: Director of Risk Management and Coastal Protection Department, Officers	Preparation for evacuation planning details for working meeting, seminar and JCC
2020/01/20	Macurungo Primary School, Mateus Sansao Mutemba Secondary School	Interview surveys on status during rainfall
2020/01/21	Bairro Esturro: Head of Bairro	Brief explanation of project outline, evacuation plan, pilot area candidates and related activities
2020/01/21	Beira Municipality: Main members	Pilot site confirmation, hazard map introduction, confirmation on inundation area status, and tent setup location in Macurungo Primary School
2020/01/21	Bairro Macurungo: Head of Bairro	Brief explanation about project overview, evacuation plan, pilot project area candidates and related activities
2020/01/22	Beira Municipality: Deputy director	Confirmation on installed drainage pipes and piping status in Beira City
2020/01/22	Bairro Chingussura: Head of Bairro	Brief explanation about project overview, evacuation plan, pilot project area candidates and related activities
2020/01/23	DPEDHS Chief of Construction Department	Confirmation of on-site information on Mateus Sansao Mutemba Secondary School
2020/01/23	Mateus Sansao Mutemba Secondary School: Principal	Confirmation on inundation area in school site and evacuation life status at Cyclone Idai
2020/01/28	Beira Municipality: Director of Risk Management and Coastal Protection Department, Officers	CLGCR vitalization and community activities proposed by Beira Municipality
2020/01/31	INGC: Chief of Technical Department	Briefing about project overview, disaster response plan details and model deployment with requests for CLGRC engagement
2020/01/31	Beira Municipality: Main members	Preparation for evacuation planning details for working meeting, seminar and JCC
2020/02/04	Beira Municipality: Main members	Confirmation on facilities layout in the pilot projects sites
2020/02/07	DPEDHS	Confirmation on school disaster response and UNICEF's guideline
2020/02/08	Beira Municipality: Director of Risk Management and Coastal Protection Department	Preparation for JCC presentation
2020/02/12	MINEDH: Director in charge of tackling issues in a cross-sectional manner	Confirmation on PEBE guidance

*Above arrangements do not include architecture-related meetings. Source: JICA Project Team

6.4.2 Flow of Formulating the Evacuation Plans

The following figure shows a flow of evacuation planning formulation to be proceeded by C/Ps and evacuation planners.

Briefings were given to the Beira Municipality on the two-step planning in the municipality evacuation plan. The first step is a basic plan to draw up who and where to evacuate in which route selection on the map, and the second one is a timeline action plan to direct who, where, and when to do in the timeframe. As a result, the Beira Municipality has understood its future project details.

6.5 Methodology of Disaster Response Planning Activities

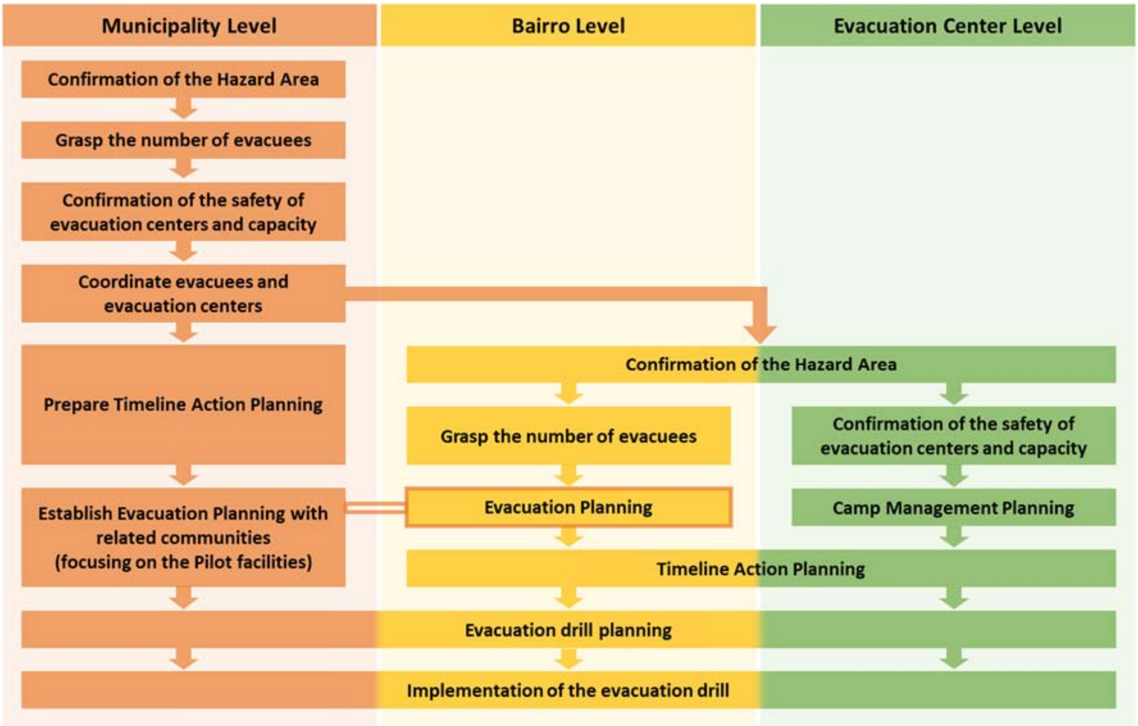
The following is an overview of the basic procedures and contents of the evacuation planning activities conducted in Beira.

6.5.1 Flow of Content Planning and Implementation

(1) Overall Flow

Evacuation plans will be developed at three levels: city, district (Bairro), and evacuation center.

The municipal plan will be created first and, after confirming the overall plan, the plan for the target Bairros will be developed. At the same time, the operational plan for evacuation centers is developed after confirming the operational structure of the centers Since each of the plans needs to be aligned, adjustments will be made as each plan is laid out.



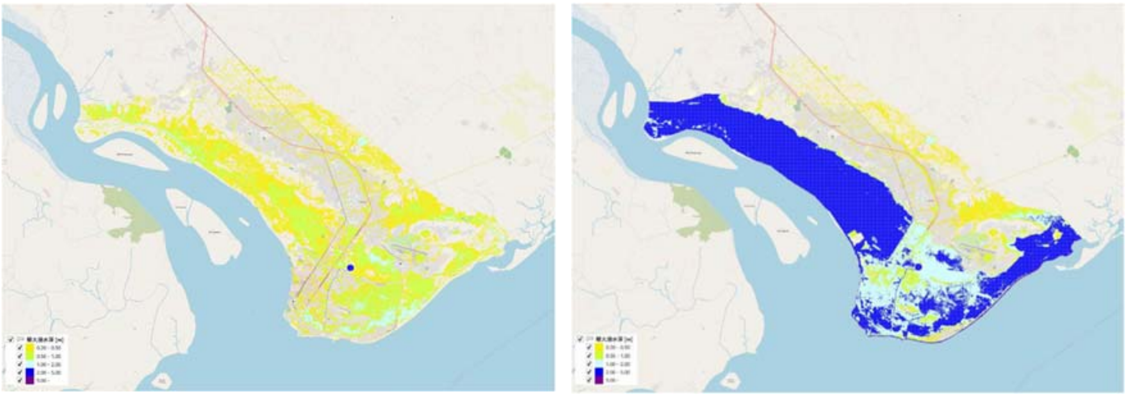
Source: JICA Project Team

Figure 6-3 Survey results for evacuation routes

(2) Scope of activities

1) Target hazards

As a result of discussions with the Evacuation Plan Working Group (Evacuation Plan WG) as described below, it was decided that the city evacuation plan would cover three types of hazards: cyclones with a storm surge, cyclones without a storm surge, and heavy rains, while the evacuation drill and the evacuation plan in the Bairro and evacuation center level to be based on a cyclone with no storm surge.

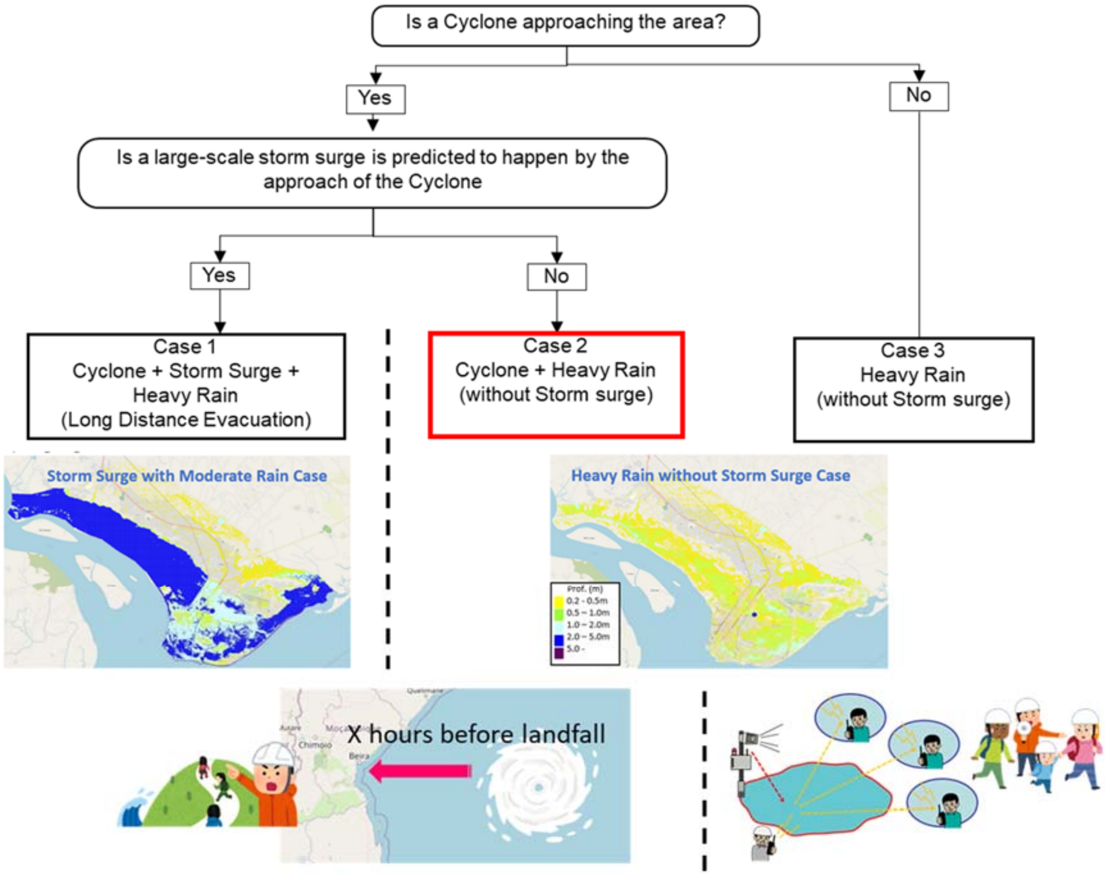


Cyclone with no storm surge and with heavy rains | Cyclone with storm surge

Source: JICA Project Team

Figure 6-4 Hazard map for each case

The evacuation drill is based on a situation in which a cyclone is expected to make landfall, but for case which a large storm surge is not expected (Case 2 below). Namely, the evacuation plan assumes that the landfall time of the cyclone can be predicted and that no large-scale flooding will occur, which will allow evacuation to nearby evacuation centers.



*The red box indicates a situation for which evacuation drills are held.

Source: JICA Project Team

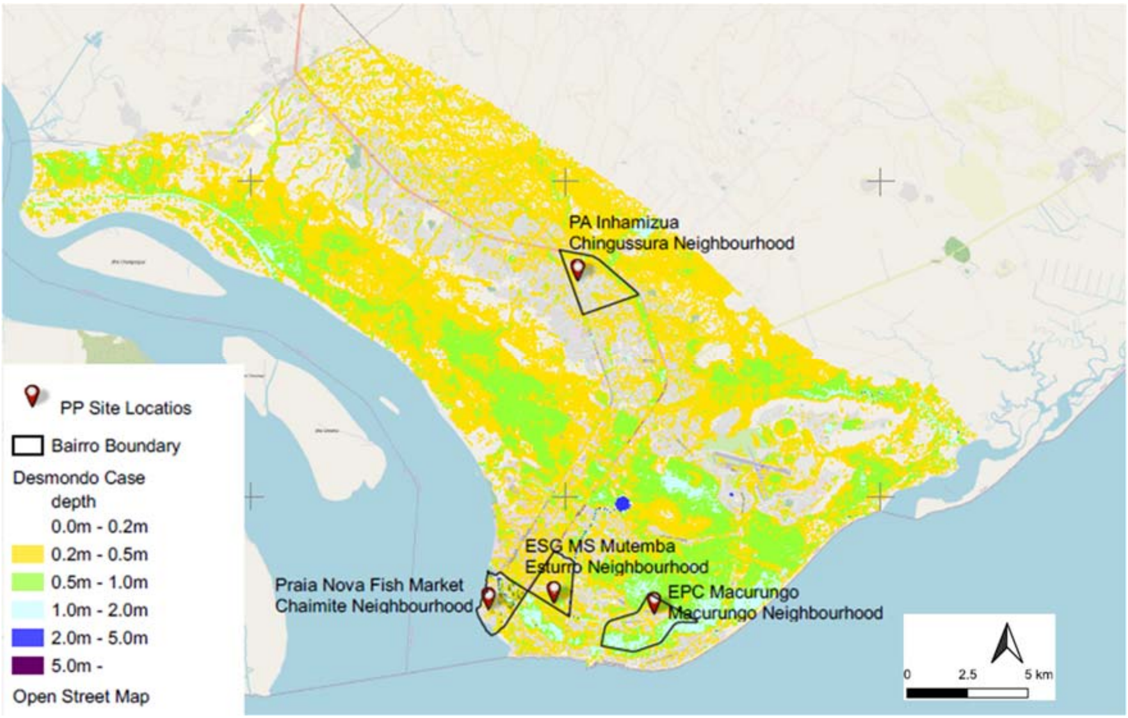
Figure 6-5 Organization according to evacuation plan type

2) Target Bairros

The target areas will be the three Bairros of Macurungo, Esturro, and Chingusura, where a pilot project for resilient building is being implemented under this project. A disaster response plan for the fish market in Praia Nova will also be developed and training will be carried out, including the assembly and disassembly of *kigumi* wooden stalls, which is described in Chapter 7.

3) Target Evacuation Centers

The target evacuation centers will be the three target facilities of the pilot project: Macurungo Primary School, Mateus Sansáõ Mutemba Secondary School, and Inhamizua Administrative Office / Chingusura Bairro Office. Note that the fish market is not targeted for resident evacuation activities and it is a drill for disaster response of the market.



Source: JICA Project Team

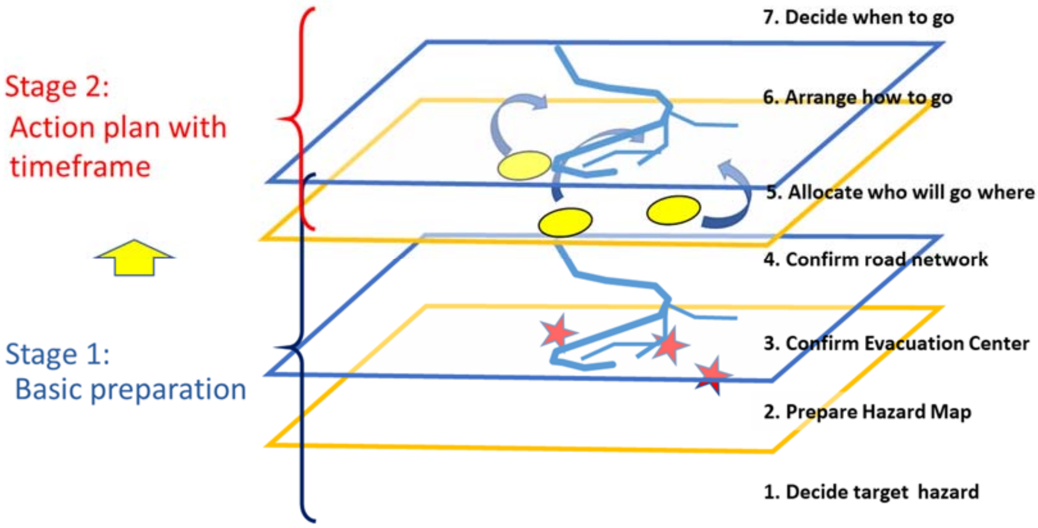
Figure 6-6 Location of Target Bairros and Evacuation Centers

(3) Details of Plan

Evacuation planning is a two-step process.

Step 1: Basic preparation: "Where to evacuate?

Step 2: Action plan with timeframe "How to evacuate."



Source: JICA Project Team

Figure 6-7 Structure of evacuation plan

1) Step 1: Who and Where (Basic Preparation)

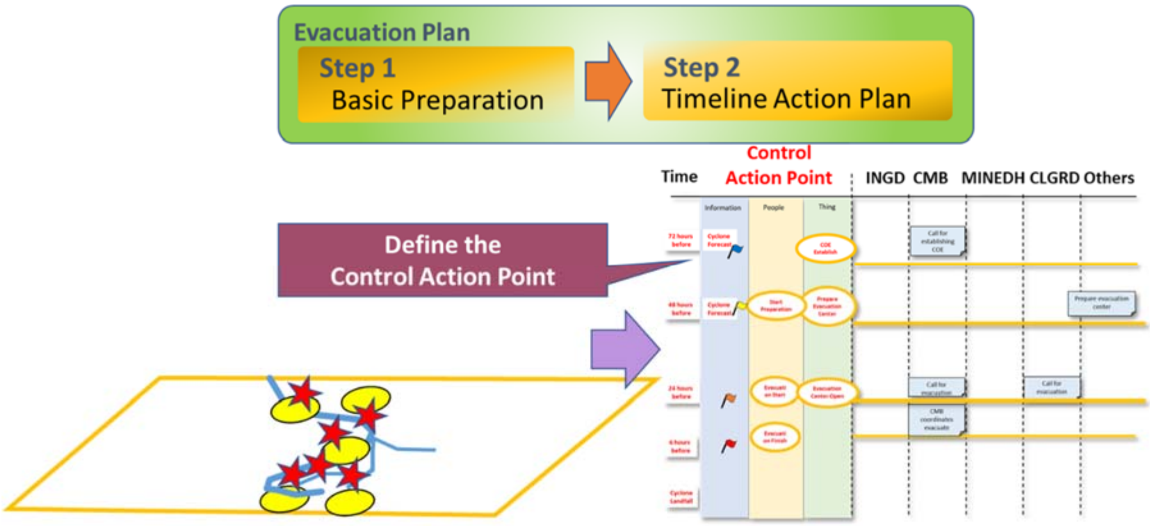
- Determine the target hazards.
- Prepare hazard maps.
- Confirm the safety of the evacuation centers.
- Check the road network.
- Consider the distribution of evacuees and evacuation centers.

2) Step 2: When, Who, What and How (Timeline Action Plan)

- Coordinate evacuation methods. (Determine who will do what and assign roles.)
- Determine a timeline for evacuation. (Decide what to do when, and how to coordinate.)

3) Three Levels of Planning

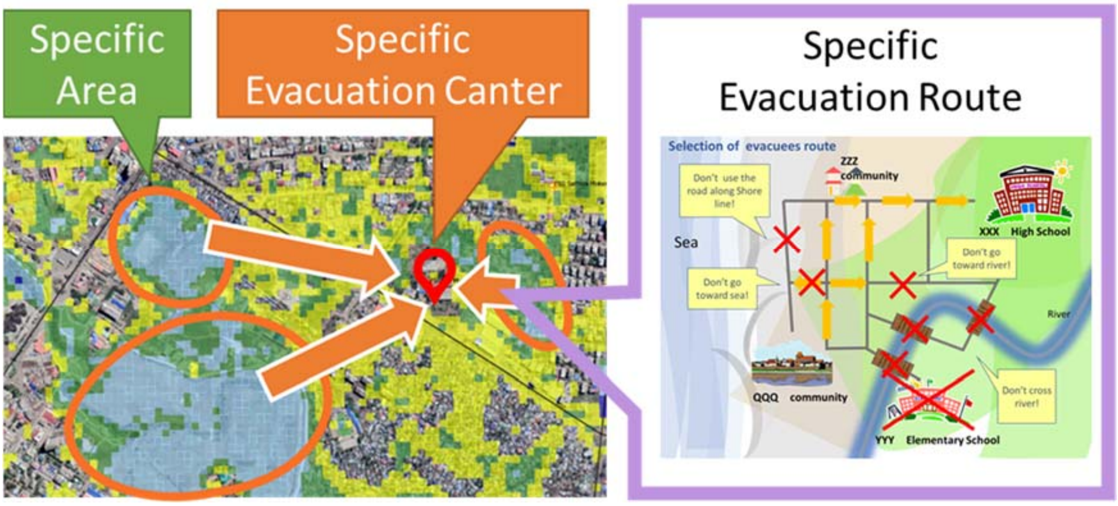
The plans for Step 1 and Step 2 will be developed at the city level. For Step 1, after looking at the overall flooding situation, the city determines an overall general picture of which residents in what areas should evacuate to which evacuation center. Step 2 is to develop a timeline action plan. The timing for determining overall movement is set by control action points—for example, the timing for "start evacuation preparations," "start evacuation," and "end evacuation."



Source: JICA Project Team

Figure 6-8 Image for city-level plans

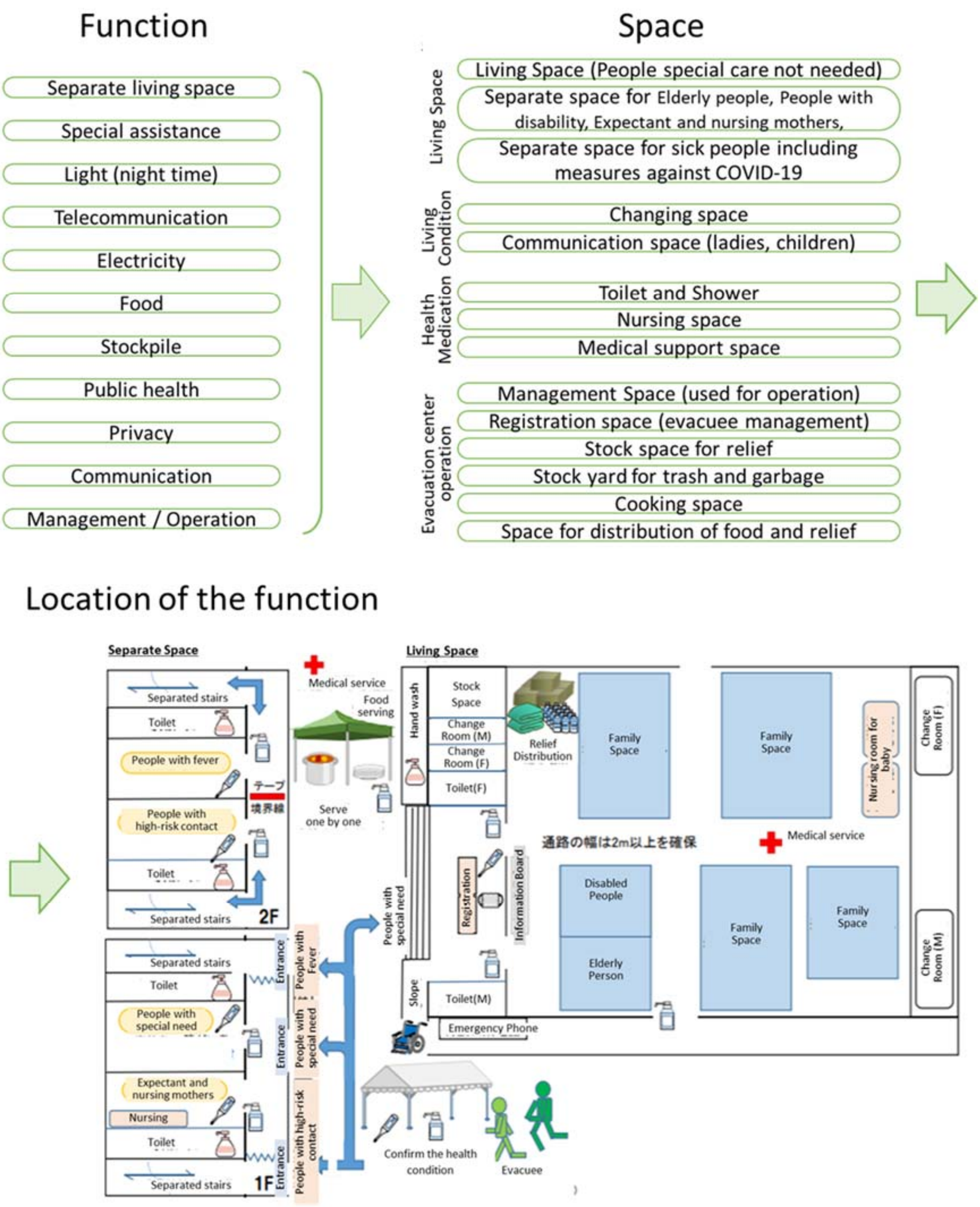
Using the city plan as the base, Steps 1 and 2 will again be implemented at the Bairro level but with more specifics, such as which families go to which evacuation center, and what routes they are to take.



Source: JICA Project Team

Figure 6-9 Image of the Bairro-level planning for Step 1.

For evacuation centers, the necessary functions of the evacuation center need to be identified and the placement of those functions considered. Particular consideration should be given to the countermeasures in the evacuation center to avoid COVID-19 infection. The timeline action plan for the evacuation center should be coordinated with the Bairro plan, and the evacuation center should be ready to open by the time the evacuees begin arriving.



Source: Created by the JICA Project Team

Figure 6-10 Concept for Step 1 at the evacuation center level

A timeline action plan will be made for each of the three planning levels. The planning at each level needs to be coordinated to ensure consistency.

Source: JICA Project Team

Figure 6-11 Concept for coordinating plans at each level

6.5.2 Evacuation Drills and Disaster Education in Pilot Areas

(1) Evacuation Drills

Since the target evacuation centers are also the previously decided pilot project sites, evacuation drills will be conducted for residents who evacuate to those facilities.

Based on the evacuation plan above, an evacuation drill plan will be developed. Planning procedure are as follows.

Beira Municipality, the target Bairro, and the target evacuation center will each develop an evacuation plan for Step 1 and Step 2.

Based on the evacuation drill plan, a Disaster Imagination Game (DIG) will be conducted, and each person in charge will check movements on their map.

The evacuation drill plan is revised based on DIG results.

The revised evacuation drill plan is used to organize the plans at each level into blocks of time each day following a timeline from about 72 hours before the forecast landfall until evacuation is complete.

The contents of each of the three training plans is confirmed and the necessary adjustments made.

For the fish market, disaster response training will be done in coordination with the activities of the Fish Market Working Group (Fish Market WG).

(2) Disaster Risk Reduction Education and Public Health Education

Prior to the evacuation drills, disaster risk reduction education and public health education will be conducted for drill participants and for the students of the two schools that will serve as evacuation centers. By conducting disaster risk reduction education in advance, participants will be able to understand the importance of evacuation and the evacuation plan for their own Bairro, while public health education will help them understand the behaviors to be aware of in the evacuation center. In addition, students will learn how to create their own timeline (individual timeline action plan) and will create their own timeline as homework before the evacuation drill.

Table 6-11 Disaster Risk Reduction Education Content

Item	Content
Part 1	Learn what to expect when a cyclone makes landfall in Beira
Part 2	Review hazard maps and check what the expected flooding depth will be for your home
Part 3	An explanation from each WG member for understanding the timeline action plan for both the Bairro level and evacuation center level
Part 4	Participants present what individual actions they will take based on the content of the timeline action plan content.
Part 5	Participants create their own timeline action plan.

Source: JICA Project Team

6.6 Status of Disaster Response Planning Activities

In March 2020, travel from Japan to Mozambique was suspended due to COVID-19. As such, activities were carried out remotely until October 2021, when travel to Beira became possible.

6.6.1 Local Studies Carried Out in Beira

(1) Field Surveys in Beira

The following field surveys were conducted with officials from the Beira Municipality Council (CMB).

1) Survey on Inundation situation during Cyclone Ida

A field survey was conducted with the cooperation of Bairro leaders and the Local Disaster Management Committee (used to be named CLGRC, and now CLGRD) to determine the depth of inundation and inundated areas immediately after Cyclone Idai, and then after one and two weeks had passed. All 26 Bairros were visited, the sites confirmed in person, then the inundation situation was mapped.

Table 6-12 Survey on Inundation Situation after Cyclone Idai

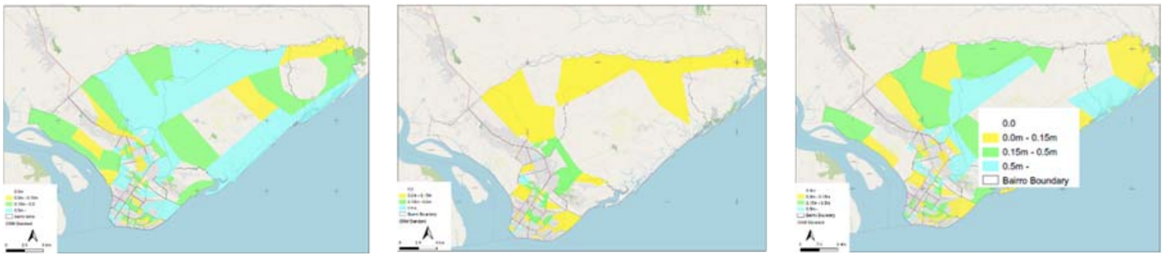
Survey Date 2020	Visited Bairros
2/11	Inhamizua, Nhangau, Nhangoma, Chonta
2/12	Munhava Central, Matadouro
2/13	Nhaconjo, Mungassa, Ndunda
2/14	Vaz, Maraza, Alto da Manga, Manga Mascarenhas, Muave
2/17	Chota, Mananga, Chingusura, Vila Massane
2/18	Macuti, Chipangara, Macurungo, Pioneiros
2/19	Ponta-Gêa, Chaimite, Esturro, Matacuane

Source: JICA Project Team

Source: JICA Project Team

Figure 6-12 Photos during the inundation status field survey

The following maps shows the survey results, which were based on interviews about the flooding situation. Rain continued to fall once the cyclone had passed, and the survey was able to identify areas that were still inundated two weeks later.



Immediately after Idai | One week after Idai | Two weeks after Idai

Source: JICA Project Team

Figure 6-13 Survey result of the inundation situation after Idai

(2) Cyclone Response Status Survey

A survey was conducted through interviews on the response status for the institutions that were responsible for the disaster response and evacuation of residents during Cyclone Chalane (landed on December 30, 2020) and heavy rains (February–March 2022) that caused flooding damage. Both events affected Beira after Cyclone Idai. The results of the interviews were organized in chronological order to understand the actual disaster response at the time.

1) Target Disasters for the Survey

The survey covered Cyclone Chalane (December 30, 2020) and heavy rains that affected Beira in March 2022. A summary of each disaster and a comparison of the damage are shown in the table below. A summary of Cyclone Idai is also included for reference.

Table 6-13 Overview of Outline of the Disasters and Damages Caused

	March 2022 Heavy rains	Cyclone Chalane	(Ref) Cyclone Idai
Date of closest approach to Beira/Impact period	March 17–22, 2022 *Duration of inundation in two districts with significant inundation damage	2020/12/30 (early morning)	2019/3/14 (late at night)
Lowest center pressure	—	983hPa When nearest Beira: 992hPa[1]	944hPa (second lowest in history) When nearest Beira: 967hPa[1]
Deaths (nationally)	0	1[2]	More than 600[3]
Persons affected (nationally)	736,015 (estimated)[4]	46,376[2]	More than 1.5 million[3]
Damage to houses (destroyed and partial damaged)	N/A	14,425 houses[2]	240,000 houses[3]

[1] Meteo France La Réunion RSMC 2 ING data (as of 01/04/2021) 3 PDNA [4] UNHCR Cyclone Gombe Report #2

Source: Compiled by JICA project team from the above.

2) Chronological Summary of the Response Situation

In the time of Cyclone Chalane, before the landfall of Cyclone Chalane the alert was announced to the residents by the CMB, the National Institute for Disaster Management (INGD) and CLGRD to take precaution action and evacuate, as shown in the table below. A total of 2,570 people were evacuated from Bairro Chaimite which is located in the coastal area, including the Praia Nova area, to designated evacuation centers before the cyclone made landfall. Two evacuation centers were established.

Table 6-14 Disaster Response Situation in Beira at the Time of Chalane

Time	Overall	INGD	CMB	CLGRD	Residents
12/26 (14:00)	INAM forecast and announced on SNS that the cyclone would make landfall on 12/30.				
12/27 (9:00–15:00)		INGD and CMB staff visit Bairro Chiveve to check and inform CLGRD about advance preparations and advance evacuation.			
(19:00)	Via SNS, President Nyusi urges coastal residents to stay safe				
12/28 (9:00–15:00)		INGD and CMB staff visit Bairro Manga-Loforte to check and inform CLGRD about advance preparations and advance evacuation.			
12/29 (9:00)		COE* launched and necessary actions confirmed by INGD, CMB, Red Cross, etc. INGD shares list of designated evacuation centers		CLGRD instructs residents to implement advance measures	
(11:00)		CMB announces 5 districts to be evacuated and distributes megaphones to those districts			
(14:00)		CMB mayor calls for residents in coastal areas to evacuate in advance			
(17:00)		INGD, CMB staff and CLGRD urge residents to evacuate			Evacuation begins
(19:00)					Evacuation completed
12/30 (4:00)	Landfall				

＊COE：Emergency response center

Source: JICA Project Team

In the time of heavy rain on March 2022, as shown in the table below, heavy rain was forecast by INAM a few days before the rainfall began in March 2022. However, no evacuation order was issued by the government beforehand, and the Emergency Operations Centers (COE) was set up after residents voluntarily began evacuating to evacuation centers once flooding had started.

Table 6-15 Disaster Response Situation in Beira at the Time of March 2022 Heavy Rains

Date/Time	Weather Info/Inundation Status: Ndunda	Weather Info/Inundation Status: Mungassa	INGD	CMB	CLGRD	Residents
3/12	Notification to pay attention to weather announcements due to heavy rain forecast from INAM					
3/17 (7:00)	1.2m	0.0m			Ndunda: Emergency meeting held as flooding began.	
(19:00)					Mungassa: Emergency meeting held as flooding began.	Voluntary evacuation in Ndunda begins
3/18 (7:00)						
(8:00)	1.4m	1.5m	CMB and INGD held internal meeting to discuss district evacuation situation			Evacuations in Mungassa begin
(10:00)			COE is set up and INGD, CMB, etc. confirm necessary response.			
(17:00)			INGD, CMB, etc. arrange emergency supplies for evacuation centers			
(18:00)						Mandatory evacuation in Ndunda begins
3/19	1.4m	2.0m	INGD, CMB, CLGRD and related agencies continue to operate evacuation centers			
3/20	1.2m	1.0m				
3/21	0.7m	0.8m				
3/22	0.5m	0.5m				
3/23 (16:00)	0.0m	0.3m	Ndunda evacuation centers closed			
3/24 (12:00)	0.0m	0.0m	Mungassa evacuation centers closed			

Source: JICA Project Team

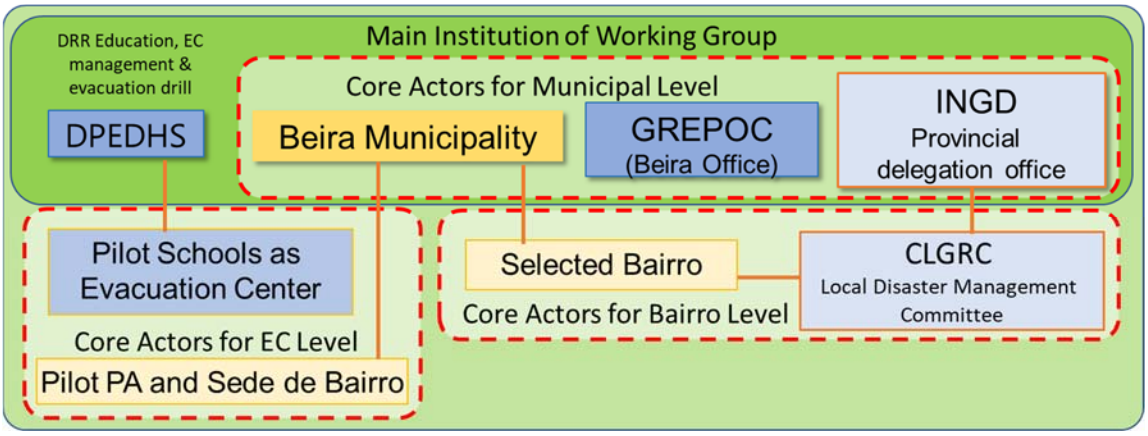
6.6.2 Evacuation Plan Working Group Activities and Local Surveys

During the first “training in Japan” in the latter half of February 2020, evacuation plan working group (Evacuation Plan WG) was established after returning to Mozambique. However, due to subsequent difficulties getting the JICA Project Team onsite in Mozambique due to COVID-19, it was decided to proceed with the plan remotely.

(1) Working Group and Regular Meetings

The Evacuation Plan WG was launched on May 8, 2020 with INGD Sofala Office, CMB and GREPOC as members. Regular meetings were held about once every two weeks.

From June 2021, a member from the Sofala State Department of Education and Human Development (DPE) was also assigned, and in October 2021 Bairro leaders and CLGRD members started a pilot Bairro level working group, as well as an evacuation center working group that included school officials.



Source: JICA Project Team

Figure 6-14 Implementation system for disaster response plan formulation activities

The results of the Evacuation Plan WG activities are shown below.

Table 6-16 Evacuation Plan WG Implementation Result

No.	Date	Main Topics of Discussion
1	2020/ 05/08	Working group kickoff meeting
2	7/23	Confirm evacuation center selection status for the city-level evacuation plan
3	9/18	Confirm evacuation center selection status for the city-level evacuation plan, and confirmation of how to proceed with the study of evacuation routes.
4	10/08	Confirm the scenarios (target disaster) for the city-level evacuation plan.
5	11/19	Confirm evacuation center selection standards for the city-level evacuation plan and confirm points to keep in mind when considering evacuation routes.
6	12/09	Confirm the approach for assigned evacuees to each evacuation center for the city-level evacuation plan.
7	2021/ 02/18	Confirm the method of calculating the number of evacuees for each Bairro under the city-level evacuation plan and confirm the disaster response shown for Cyclone Chalane and Cyclone Eloise.
8	03/10	Confirm evacuation center selection status for the city-level evacuation plan.
9	03/23	Confirm the number of evacuees for each Bairro under the city-level evacuation plan and confirm the disaster response shown for Cyclone Chalane and Cyclone Eloise.
10	04/06	Confirm the method of calculating the evacuation center capacity under the city-level evacuation plan and share the items to be considered in the city-level timeline action plan.
11	04/13	Discuss the possibility of introducing flooding sensors for evacuation during heavy rains
12	04/20	Discuss the possibility of introducing flooding sensors for evacuation during heavy rains and consider action items to be included in the city-level action plan.
13	04/27	Confirm cyclone trigger information for the city-level timeline action plan.
14	04/30	Carefully examine evacuation center capacity in city-level evacuation plan and confirmation trigger information for heavy rains.
15	05/04	
16	05/06	Discuss review methods for Bairro-level evacuation plans and timeline action plans
17	06/03	Confirm Bairro WG briefing materials and control action points in the timeline action plan
18	06/08	Confirm how to proceed with the Bairro WG briefing meeting and confirm the status for using flooding sensors in heavy rains.
19	06/29	Confirm evacuation center–level plans, content and procedures and confirm the content of evacuation drills.
20	07/01	
21	07/06	Confirm the study schedule for the evacuation drills (3 Bairros, fish market).
22	07/22	
23	07/27	Confirm the status for using flooding sensors in heavy rains.
24	07/29	Exercise for filling out a timeline action plan in preparation for the Bairro WG briefing
25	08/17	Confirm implementation status of Bairro-level evacuation plans and confirm procedures for future activities.
26	08/18	Confirm content of evacuation center–level plans and procedures
27	08/30	
28	09/15	Confirm content and procedures for evacuation drills and disaster risk reduction education, public health education.

No.	Date	Main Topics of Discussion
29	10/10	Confirm procedures for reviewing timeline action plans at the Bairro level
30	11/24	Confirm results and items to be improved following the disaster risk reduction education public health education program and confirm relevant organizations for collaboration.
31	12/02	Confirm relevant organizations for collaboration and items to be considered for wide-area evacuations
32	12/15	Confirm the overview materials for explaining the evacuation plan to related organizations
33	12/23	Confirm items to be considered for wide-area evacuation and discuss how to proceed with the involvement of related organizations
34	2022/ 03/15	Confirm results of CLGRD revitalization activities, discuss how to proceed with involvement of related organizations, and confirm the arrangement of reference material chapters.
35	04/20	Discuss how to proceed with the involvement of related organizations.
36	04/25	Confirmation the agenda for the meeting with the administrative heads at related organizations and the provincial governor.

Source: JICA Project Team


Source: JICA Project Team

Figure 6-15 Photo of the Evacuation Center WG meetings

(2) Survey on Evacuation Centers and Routes

In the early stages of the Evacuation Plan WG, the CMB in particular played a central role in carrying out field surveys related to the selection of evacuation center candidates and evacuation routes.

1) Status Survey of Candidate Evacuation Centers

For determining evacuation center candidates, safety was confirmed, and a survey of the facility size and functions was carried out. CMB officials, Bairro leaders, and CLGRD leaders visited 55 candidate facilities, confirming location safety, building structure, living space, the number and condition of toilets, etc. at each facility


Source: JICA Project Team

Figure 6-16 Photo from the evacuation center survey

The following items was confirmed: facility name, name of Bairro where facility is located, safety (against heavy rains, storm surges, landslides), roof structure, building type, number of floors, number and size of rooms, capacity, other free spaces, plumbing hygiene, number of toilets, presence/absence of perimeter fencing, etc. The results have been organized in the following table.

Table 6-17 Table to Summarize the Situation of Candidate Evacuation Centers (partial)

Evacuation. center name, Bairro name

Safe or not against specific disaster types (flooding, storm surge, landslides)

Type of roofing material, number of floors

Classroom size, capacity

Free space, hygiene conditions, number of toilets, presence/absence of perimeter fence

Assessment Result

	School names	Neighbourhoods	Safety against			Roof Structure of the Building				Type of Building	No. of Floors	Dimensions	Capacity during Pandemic (4m2/person)	Capacity (2m2/person)	Free space	Water and Sanitation	No. de WCs	Fence	Assesment
			Inundation	Tides and storms	Landslides	Fiberocement	Zinc	Concrete	Wood	Straight									
1	12 De Outubro Primary School	Matacuane	x	✓	✓		✓		✓	✓	1	16 classrooms, 8,6x6,79m2, multipurpose field of 512,89m2	15 people/ classroom, , 240 people/ 16 classrooms, 128 people around the multipurpose field	29people/ classroom, 432 people/ 16 classrooms, 256 people around the multipurpose field	No free space, multipurpose field	Good	20 latrines and 2 urinals	Good	**APPROVED**
2	Agostinho Neto Primary School	Chaimite	✓	✓	✓	✓		✓		✓	3	9 classrooms of 5x8,6m2, multipurpose fied of 454,20m2	11 people/ classroom, 97 people/ 9 classrooms, 114 people around the multipurpose field	22 people/ classroom, 194 people/ 9 classrooms, 227 people around the multpurpose field	No free space, multipurpose field	Normal	14 latrines	Normal	**APPROVED**
3	Eduardo Mondlane Primary School	Ponta-gêa	✓	✓	✓		✓	✓		✓	1	9 classrooms, 6x8m2	12 people/ classroom, 108 people/ 9 classrooms	24people/ classroom, 216 people/ 9 classrooms	There's not much free space	Normal	10 latrines and 1 urinal	Good	**APPROVED**
4	Sofala Educational Center	Muabvi	✓	x	✓	✓	✓		✓	✓	1	8 classrooms, 7,0x7,53m2	13 people/classroom, 104 people/ 8 classrooms	26 people/classroom, 208 people/ 8 classrooms	A lot of free space	Good	10 latrines	Good	**APPROVED**
5	Jorge José Tranquino Communitary School (AZEMU)	Macurungo	x	✓	✓		✓		✓	✓	1	5 classrooms of 8,74x6,24m2 3 classrooms of 4,80x8,16m2	14 people/ classroom of 8,74x6,24m2, 10 people/ classroom of 4,80x8,16m2. 100 people/ 8 classrooms	28 people/ classroom of 8,74x6,24m2, 20 people/ classroom of 4,80x8,16m2. 200 people/ 8 classrooms	There's free space, prompt to inundation	Good	12 latrines, 2 urinals and 1 bathroom	Good	**APPROVED**

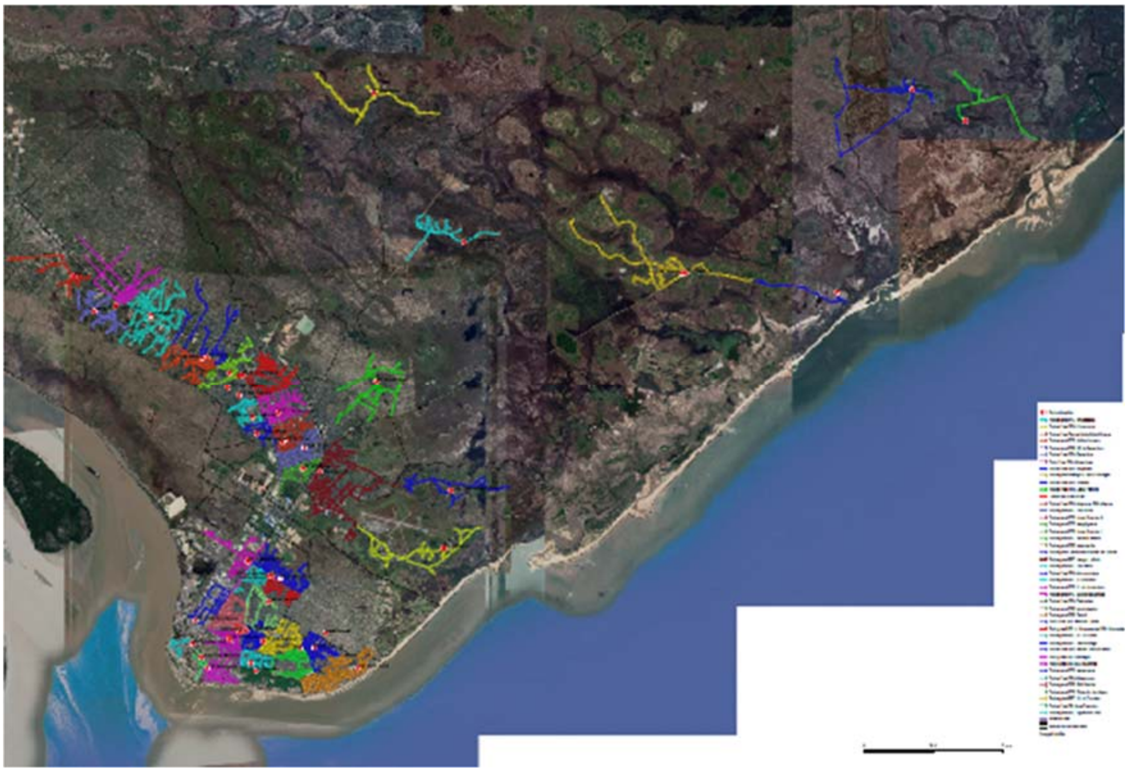
Source: Evacuation Plan WG

2) Evacuation Route Survey

Based on the hazard map without storm surge, evacuation routes from high-risk areas to evacuation centers were confirmed for 26 Bairros. The assumption is that evacuations will be carried out before wind and rain intensify and before flooding begins. However, considering a case in which timely evacuation could not be done, routes were selected that will be relatively safe to walk even during flooding.

Source: JICA Project Team

Figure 6-17 Photo from the Investigation of Appropriate Evacuation Routes



Source: Evacuation Plan WG

Figure 6-18 Result of the Evacuation Route Survey

The results of the evacuation center candidate facilities survey and the evacuation route survey are shown below.

Table 6-18 List of Evacuation Center Candidate Facilities and Evacuation Route Surveys

Date 2020	Bairro	Facility Name	No. of Surveyors
8/3	Vila Massane	EPC Chamba I, EPC Chamba II	2
8/4	Nhaconjo	EPC Monomutapa, EPC 11 de Novembro, EPC Mozambique Industrial	3
8/5	Alto da Manga	ESG Manga, EPC Manga, EPC 1 de Maio, EPC Maguiguane	4
8/6	Inhamizua	EPC Ceramica, EPC Metodista Africana, ESG 25 de Setembro	3
8/7	Matadouro	ESG Matadouro	1
8/10	Muave	Sofala Educational Center, ESG Marrocanhe	2
8/11	Manga Mascarenhas	EPC of Manga-Loforte	1
8/12	Munhava Central	EPC Munhava Central	1
8/13	Mananga	EPC Macombe, ESG Muchatazina and EPC 25 de Junho	3
8/14	Maraza	EPC Amilcar Cabral	1
8/18	Matacuane	EPC 12 de Outubro, EPC Matacuane	2
8/19	Esturro	ESG Samora Machel, ESG Mateus Sansáõ Mutemba	2
8/21	Chipangara	EPC 7 de Abril, EPC Palmeiras	2
8/24	Macurungo	EPC Macurungo, EC Jose Traquino	2
8/25	Macuti	ESG Estoril	1

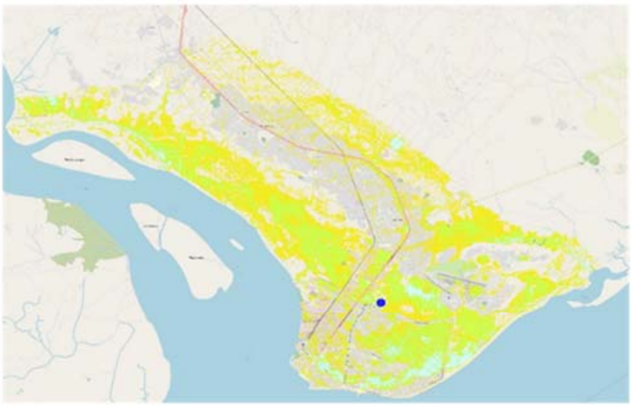
Date 2020	Bairro	Facility Name	No. of Surveyors
8/26	Ponta-Gêa	ESG Ponta-Gêa and EPC Eduardo Mondlane	2
8/27	Chaimite	EPC Agostinho Neto	1
8/28	Chingusura	PA Inhamizua	1
	Tchonja	EPC Tchonja, EPC Casa Partida	2
	Pioneiros	EPC Herois Mocambicanos. EPC Pioneiros	2
8/29	Nhangoma	EPC Nhangoma	1
8/30	Ndunda	EPC Ndunda Anexa	1
	Nhangau	EPC Nhassassa, EPC Nhancamba, EPC Nhangau, ESG Nhangau and EPC Njalane	5
8/31	Chota	EPC Chota, Chota football field	2
	Mungassa	HD Company, EPC Mungassa's annex school, Bobby Camioes, EPC Nharrime - municipal school, Reis dos Reis Private School	5
	Vaz	Santa Lucia Secondary School, EPC Vaz, Islamic Center	3
Total	26 Bairros	Total	55 facilities

Source: JICA Project Team

6.6.3 Evacuation Plan Formulation for a Cyclone (No Storm Surge): Neighborhood Evacuations

(1) Step 1: Who and Where (Basic Preparation)

An evacuation plan will be created for the case of a cyclone with no storm surge. The hazard map assumes the maximum inundation used for this project, calculated for this project using the daily rainfall at the time of Cyclone Desmond's approach (as recorded on January 22, 2019, when the annual maximum daily rainfall in the last 20 years was recorded).



Cyclone Level	Not Considered to effect of Cyclone
Tide	Not Consider the changed of tide
Storm Surge	Not Considered storm surge caused by Cyclone
Rainfall	279.6mm/day *Case of Cyclone Desmond Jan 22nd 2019

Source: JICA Project Team

Figure 6-19 Hazard map used for the evacuation plan

Based on the above hazard map, the number of evacuees was calculated under the assumption that all residents living in areas with inundation depths of 0.5 m or more would evacuate. The estimated number of evacuees was calculated for each Bairro based on the inundated area on the hazard map and the population. This calculation provides only a rough estimate of the number of people and was calculated simply by multiplying the percentage of the flooded against the Bairro's land area by the Bairro's population.

Table 6-19 Calculated Results for the Number of Expected Evacuees per Bairro (without Storm Surge Case)

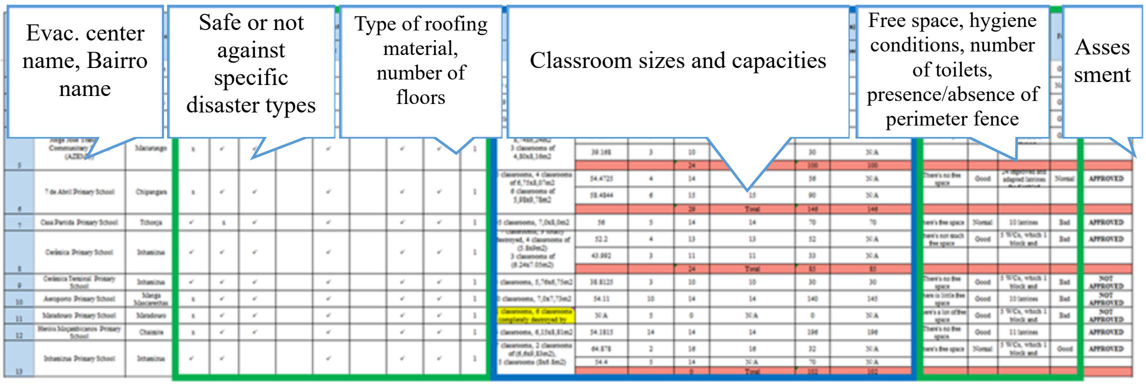
No.	Bairro	(A) População Total	(B) Persentage of Area with more than 0.5m inundation depth (%)	Estimativas do Nº de Evacuados (A) × (B)
1	Alto da Manga	20,441	10.85%	2,218
2	Chaimite	14,479	12.27%	1,777
3	Chingunssura	28,099	8.27%	2,323
4	Chipangara	25,757	23.80%	6,130
5	Chota	19,284	65.55%	12,641
6	Esturro	24,210	17.07%	4,132
7	Inhamizua	14,872	1.46%	218
8	Macurrungo	29,324	59.22%	17,366
9	Macuti	16,180	30.85%	4,991
10	Manga	26,685	23.06%	6,154
11	Manga Mascarenha	37,548	12.13%	4,555
12	Maraza	21,491	30.91%	6,643
13	Matacuane	38,098	25.18%	9,594
14	Matadouro	21,625	1.33%	287
15	Muave	6,588	4.50%	296
16	Mungassa	3,901	5.81%	227
17	Munhava	33,850	7.04%	2,381
18	Ndunda	21,772	3.60%	784
19	Nhanconjo	31,712	6.14%	1,947
20	Nhangau	7,119	0.01%	1
21	Nhangoma	3,138	0.18%	5
22	Pioneiros	5,433	5.95%	323
23	Ponta Gea	20,762	27.82%	5,776
24	Vaz	9,135	17.39%	1,588
25	Vila Massane	26,270	2.30%	605
	Total	507,773		92,962

* One Bairro (Tchonja) is outside the scope of the hazard map, so no calculated results are available.

Source: Evacuation Plan WG

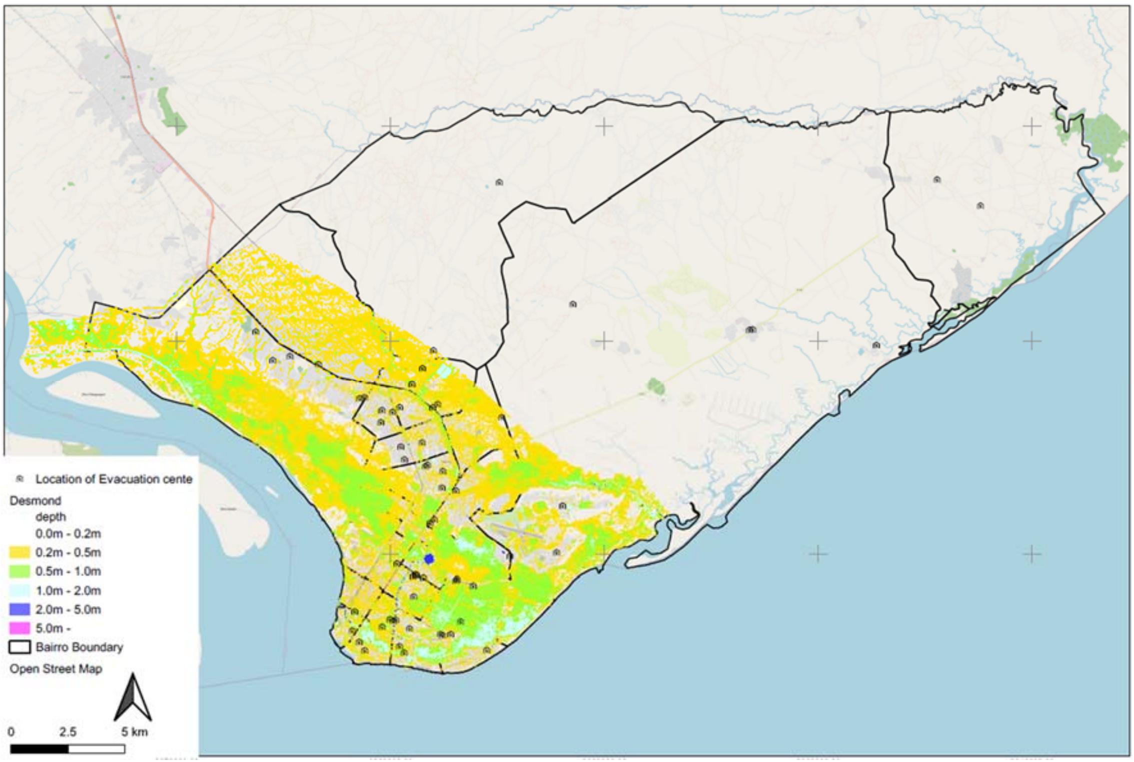
In the next step, the facilities that can be used as evacuation centers were confirmed for capacity and safety. Including additional facility surveys that were done after the after mentioned original survey, the status of 68 facilities was confirmed, with the Evacuation Plan WG approving 52 facilities as evacuation centers.

Table 6-20 List of Selected Candidate Evacuation Center Facilities (partial)



*Green box: Facility safety and presence/absence of disaster risk, Blue box: Confirmed items regarding capacity

Source: Evacuation Plan WG



Source: Evacuation Plan WG

Figure 6-20 Location of candidate evacuation centers

Allocations were made by checking the number of evacuees mentioned above and the capacity of the facilities. Also taken into consideration was the location of evacuation centers and flooding conditions, the evacuation routes identified in the site survey, and which residents would evacuate to which evacuation centers.

Table 6-21 Considerations when Allocating Evacuees and Evacuation Centers

Bairro name, estimated no. of evacuees

Capacity for all evacuation centers in the Bairro

Evacuation center name and Bairro

Available floor space for use at each Bairro

Capacity at each evacuation center

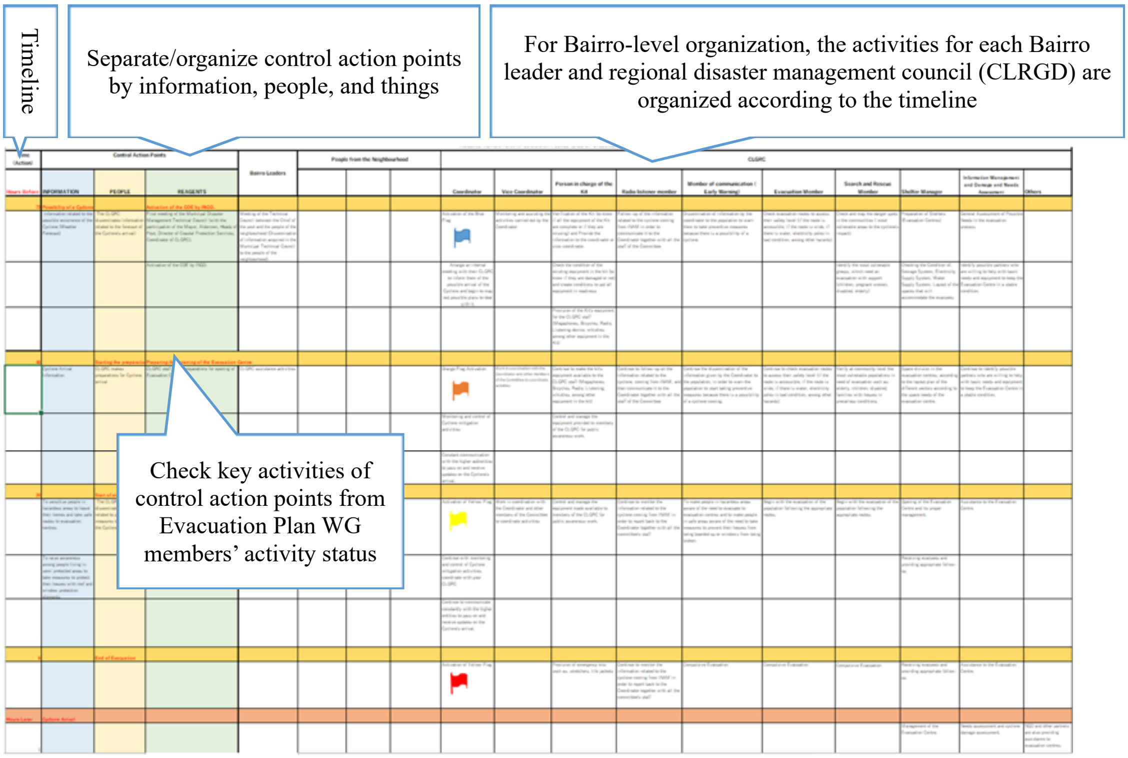
Bairo Name	Estimated Evacuee	Evacuation Center							
			No.	Name	Location of the Ecvacuation Center		Capacity during Pandemic (3 m2/person)	Note	Capacity during Pandemic (4m2/person)
					Bairro	Capacity to accommodate people from each Barirro			
Alto da Manga	2,218	1,764	35	1 de Maio Primary School	Alto da Manga	439	352, 244 around the free space		439
			36	Manga Primary School	Alto da Manga	143	198		143
			37	Maguiguane Primary School	Alto da Manga	65	90		65
			41	Manga Secondary School	Alto da Manga	1117	796, 722 around the free space		1,117
Chaimite	1,777	211	2	Agostinho Neto Primary School	Chaimite	211	135, 152 around the multipurpose field		211
Chingussura	2,323	0	-	PA Inhamizua	Chingussura	-	Recalculate		
Chipangara	6,130	386	6	EPC 7 de Abril	Chipangara	146	196		146
			30	EPC Palmeiras	Chipangara	240	332		240
Chota	12,641	815	34	Escola Especial	Chota	315	100, 320 around the free space		315
			56	EPC Chota	Chota	90	120		90
			64	Campo de Futebol da Chota	Chota	410	546		410
			66	Sede de Bairo da Chota			Input rough etimation	The WG did not approve	no data
Esturro	4,132	2,164	48	ESG Samora Moises Machel	Esturro	405	567, 2345 around the free space		405
				Campo de Futebol da ESG SM Machel	Esturro	1759	2345		1,759
			-	ESG Mateus Sansao Mutemba	Esturro	-	Input rough etimation		no data
			33	EPC Esturro			Input rough etimation	Still have to go, when we went there the school director was not present we were not aloowed to work	no data
Inhamizua	218	1,187	8	EPC da Ceramica	Inhamizua	85	117		85
			15	EPC Julius Nyerere	Inhamizua	413	380, 178 around the free space		413
			13	EPC Inhamizua	Inhamizua	391	139, 386 around the free space		391
			42	ESG 25 de Setembro	Inhamizua	210	294		210
			67	EPC Metodista Aficana	Inhamizua	58	80		58
			9	EPC Ceramica Terminal	Inhamizua	30	39	No free space no fence security	30
Macurrungo	17,366	1,233		EPC Macurrungo	Macurrungo	-	Input rough etimation		no data
			69	Campo de Futebol de Macurrungo	Macurrungo	1,133	1,512		1,133
			5	EC Jose traquino	Macurrungo	100	137		100
Macuti	4,991	1,430	43	ESG Estoril Macuti	Macuti	1,351	372, 1434 around the free space		1,351
			16	EPC Macuti	Macuti	79	128	no free space, the school infrastructure is mostly adapted, old and weak.	79
Mananga	6,796	421	52	EPC 25 de Junho	Mananga	112	152, 308 around the free space		112
			51	EPC Macombe	Mananga	91	126		91
			54	EPC Mulheres Macombe	Mananga	78	110		78
			53	ESG Muchatazina	Mananga	140	196, 264 around the free space		140
Manga Mascarenha	4,555	368	14	EPC Josina Machel	Mnaga Mascare	120	160		120
			17	EPC Manga Loforte	Manga Mascare	368	308		368
				IFAPA	Manga Mascare	-	351 around the free space		no data
			10	EPC Aeroporto	Manga Mascarenha		190	very prone to inundaton	145
Maraza	6,643	253	55	EPC Amilcar Cabral	Maraza	253	345		253
Matacuane	9,594	548	18	EPC Matacuane	Matacuane	308	190, 224 around the free space		308
			1	EPC 12 de Outubro	Matacuane	240	320, 171 around the free space		240
Matadouro	287	392	45	ESG Matadouro	Matadouro	270	368		270
			11	EPC Mataduoro	Matadouro	66	94, 75 around the free space	No fence	122
Muave	296	482	44	ESG Marocanhe	Muave	156	216		156
			4	Sofala Educational Center	Muave	104	144		104
			19	EPC Muabvi I	Muave	126	171	bad condition of WCs, no fence security	126
			20	EPC Muabvi II	Muave	96	129	no free space, no fence security	96
Mungassa	227	8,449	68	ESG Rei dos Reis	Mungassa	-	Input rough etimation		no data
			59	Transportes Bobby	Mungassa	8,414	11219		8,414
			61	Escritorios HD	Mungassa	-	Input rough etimation		no data
			21	EPC Mungassa	Mungtassa			Still hav no data because the street was damaged by cyclone	
			-	EPC Mungassa Anexa	Mungassa	35	49		35
Munhava	2,381	270	50	EPC Munhava Central	Munhava	270	360		270
			49	EPC Munhava Cmatope	Munhava	90	120	very prone to inundaton	90
Ndunda	784	161	23	EPC Ndunda I	Ndunda	150	207	The access road is very damaged	150
			58	EPC Ndunda II - Anexa	Ndunda	-	38		11
Nhanconjo	1,947	520	39	EPC Mocambique Industrial	Nhanconjo	84	114		84
			38	EPC 11 de Novembroa	Nhanconjo	256	352		256
			40	EPC Monomotapa	Nhanconjo	180	240		180
Nhangau	1	332	27	EPC de Nhassassa	Nhangau	66	Recalculate		66
			46	ESG Nhangau	Nhangau	112	152		112
			25	EPC Nhangau	Nhangau	108	143		108
			22	EPC Njalanhe	Nhangau	46	73		46
Nhangoma	5	94	26	EPC Nhangoma	Nhangoma	28	38		28
			60	Escola Municipal de Mungassa	Nhangoma	-	Input rough etimation		no data
			27	EPC Nhanssassa	Nhangoma	66	96		66
Pioneiros	323	391	30	EPC Pioneiros	Pioneiros	195	270		195
			12	EPC Herois Mocambicano	Pioneiros	196	266		196
Ponta Gea	5,776	388	47	ESG da Pontagea	Ponta Gea	280	294, 81 around the free space		280
			3	EPC Eduardo Mondlane	Ponta Gea	108	144		108
Tchondja	0	144		EPC Chonja	Tchondja	74	98		74
			7	EPC Casa Partida	Tchondja	70	95		70
Vaz	1,588	187	57	EPC Vaz	Vaz	112	152		112
			62	Centro Islamico	Vaz	-	Input rough etimation		no data
			63	ESG Santa Lucia	Vaz	75	104, 2865 around the free space	The free space is prone to	75
Vila Massane	605	1,063	29	EPC Nova Chamba I	Vila Massane	362	240, 244 around the free space		362
			28	EPC Nova Chamba II	Vila Massane	701	99, 833 around the free space		701
			-	EPC 3 de Fevereiro			Input rough etimation	The WG did not approve	no data
			-	EPC Antiga Emissora			Input rough etimation	The WG did not approve	no data
Total	93,604	23,653							

Source: Evacuation Plan WG

(2) Step 2: When, Who, What and How (Timeline Action Plan)

As step 2, the timeline action plan was created, which sets out a timeline for who does what and when.

In the case of cyclone, the timing of landfall, the scale of the cyclone, and the strength of the winds and rain can be predicted in advance, so the plan starts from 72 hours before landfall.



Source: Evacuation Plan WG

Figure 6-21 Image of Timeline action plan at the City and Bairro levels

6.6.4 Planning at the Bairro and Evacuation Center Levels

After an approximate allocation of evacuees and evacuation centers was discussed at the city level, planning began at the Bairro level from June 2021 and at the evacuation center level from September 2021. Evacuation Plan WG members explained the concept and methodology to Bairro and evacuation center management members and obtained their understanding of the planning process content and their cooperation in conducting evacuation drills.

Bairro leaders, CLGRD members, others involved in Bairro-level planning, and school officials (school teachers, school councils, etc.) also established working groups (WGs) in October 2021 to conduct their own respective activities.

The WGs are made up of three Bairros targeted for pilot activities (Macurungo, Esturro, and Chingusura) and three facilities that will serve as evacuation centers in the pilot evacuation exercise (Macurungo Primary School, Mateus Sansáõ Mutemba Secondary School, Inhamizua Administrative Office / Chingusura Bairro Office).

Table 6-22 List of Bairro and Evacuation Center WG Activities

Date	Participants	Main Activities
5/12	Bairro leaders of the chosen Bairros, Evacuation Plan WG	Explain the concept behind the city evacuation plan and timeline action plan
6/18	Bairro leaders of the chosen Bairros, CLGRD coordinators, Evacuation Plan WG	Study evacuation routes and city evacuation plan, and explain the timeline action plan content
8/19	Bairro leaders of the chosen Bairros, CLGRD coordinators, Evacuation Plan WG	Create a timeline action plan for each Bairro
8/24	Evacuation Plan WG	Confirm review procedures at the evacuation center level
8/26	Bairro leaders of the chosen Bairros, CLGRD coordinators, Evacuation Plan WG	Identify matters in the timeline action plan for improvement
8/30	Evacuation Plan WG	Confirm materials that explain review procedures at the evacuation center level
9/3	Inhamizua Administrative Office/Chingusura Neighborhood Office Evacuation Center WG	Explain the concept of evacuation planning at the evacuation center level and how to proceed with considerations
9/23	Mateus Sansáõ Mutemba Secondary School Evacuation Center WG	
9/24	Macurungo Primary School Evacuation Center WG	

Source: JICA Project Team

Source: JICA Project Team

Figure 6-22 Photo from the Evacuation planning activity under the guidance of the Evacuation Plan WG

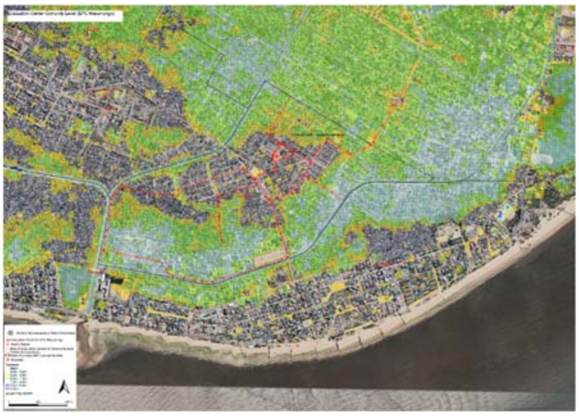
(1) Bairro-level Evacuation Plan: Timeline Action Plan

1) Step 1: Who and Where

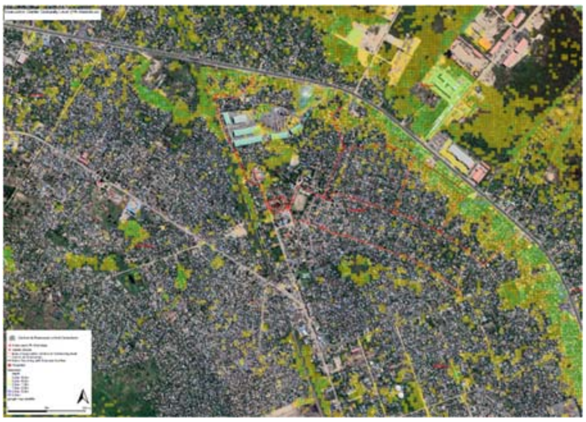
On June 18, 2021, Evacuation Plan WG members explained the concept behind the city's evacuation plan and timeline action plan to Bairro leaders and CLGRD coordinators in the three target Bairros to begin Bairro-level activities.

Based on the city's plan, the evacuation route from the inundated area to the evacuation center was confirmed using a map, with local conditions and other factors taken into consideration.

Evacuation routes in Bairro Esturro



Evacuation routes in Bairro Macurungo



Evacuation routes in Bairro Chingusura

Considering evacuation routes on the map

Source: Evacuation Plan WG

Figure 6-23 Photo from the Evacuation planning activity at the Bairro level

2) Step 2: When, Who, What and How (Timeline Action Plan)

In the next step, Bairro-level timeline action plans were created.

In August 2021, members of the Evacuation Plan WG visited the three target Bairros and developed a timeline for each Bairro in consultation with the Bairro leaders and the CLGRD. The timeline action plans for the Bairros were developed based on the control action points, which were set by the city. The Evacuation Plan WG reviewed the content and provided feedback on revisions.

The JICA project team decided that it would be difficult to further develop the Bairro-level timeline action plan under remote implementation conditions. The project team decided to put the work with CLGRD on hold until September 2021, and to proceed with the establishment of the WG on evacuation center management first.

(2) Creating a Timeline Action Plan at the Evacuation Center Level (School Council and Other School Officials)

At the Evacuation Plan WG on August 30, 2021, matters such as how to set up working groups at the evacuation center level, how to explain the evacuation plan, and how to explain the concept of timeline action plans were discussed, and the schedule on how to proceed was confirmed. Subsequently, briefings on the formulation of a timeline action plan at the evacuation center level were held at the Inhamizua Administrative Office /Chingusura Bairro Office on September 3, Mateus Sansáõ Mutemba Secondary School on September 23, and Macurungo Primary School on September 24, in order to explain the plan to the relevant parties. The briefings were attended by the principals and teachers at the target schools, as well as the leaders of each Bairro and the CLGRD coordinators, and each Evacuation Center WG was set up.

6.6.5 Evacuation Drill Plan for Pilot Areas

(1) Finalizing the Timeline Action Plan

Since there was a prospect of the JICA Project Team being able to visit Beira in October 2021, the timeline action plan was finalized 2021 and an evacuation drill implementation plan was developed with the goal of holding an evacuation drill during the team's visit.

Table 6-23 Preparation activities for evacuation drills

	Activity	Overview
1)	Finalize the timeline action plans	Create timeline action plans (including adjustments) at the city level, Bairro level, and evacuation center levels.
2)	DIG (Disaster Imagination Game)	Using DIG, confirm whether the timeline action plan is realistic.
3)	Disaster prevention and public health education	An education program in which Bairro and evacuation center WG members, residents (those participating in evacuation drills), students, etc. understand the concept of hazard maps and timeline action plans and consider their own evacuation behaviors (including at evacuation centers).
4)	Evacuation drill	Create a training program that compresses actions from the three days before cyclone landfall into a single day and simulate evacuation-related activities in accordance with the timeline and actions timeline action plan.

Source: JICA Project Team

The table below summarizes the main activities in the field from October to December 2021.

Since it was difficult to conduct all the evacuation drills during the two weeks in October when the JICA Project Team was in Mozambique, drills were limited to the evacuation drills at Macurungo Primary School and the fish market. For the remaining two sites (Inhamizua Administrative Office / Chingusura Bairro Office and Mateus Sansáõ Mutemba Secondary School), the Evacuation Plan WG took the lead in conducting the drills.

Table 6-24 List of Activities Related to Evacuation Drills for the Bairro and Evacuation Center WGs

Date	Members Other Than Evacuation Plan WG	Main Activities
10/13	-	Explain DIG and prepare for the simulation
10/13	Macurungo Primary School Evacuation Center WG, Macurungo District CLGRD	Confirmation of necessary responses to disasters by bairros and evacuation centers using DIG
10/15	Macurungo Primary School Evacuation Center WG, Macurungo District CLGRD	Confirmation and scrutiny of timeline action plans
10/18	-	Coordination of timeline action plans at each level
10/18	(New) Director of the INGD Sofala Office, technology officers from the Sofala provincial government	Explanation of evacuation plans, timeline action plans, and evacuation planning drills
10/19	-	Timeline action plan format changes
10/20	Macurungo CLGRD members and school-related persons	Modifications to timeline action plan at each level
10/22	Macurungo CLGRD members and school-related persons	Coordination between Bairro and evacuation center plans, creation of programs for evacuation drills
10/22	Macurungo Primary School Evacuation Center WG, Macurungo District CLGRD, Macurungo children (Grades 7–8)	Disaster prevention education and public health education
10/25	-	Preparation work to support readjustment of timeline action plan
10/26	Macurungo CLGRD members and school-related persons	Readjust timeline action plan and evacuation drill program
10/28	Macurungo Primary School Evacuation Center WG, Macurungo District CLGRD, city-level WG	Preparatory exercise for evacuation drill
10/29	Macurungo Primary School Evacuation Center WG, Macurungo District CLGRD	Evacuation drills carried out
11/1	Mateus Sansáõ Mutemba Secondary School, Esturro CLGRD, Bairro leaders	Explain activities, confirm schedule
11/3	Mateus Sansáõ Mutemba Secondary School council (including students)	Explain activities, confirm schedule
11/5	Persons involved in the Mateus Sansáõ Mutemba Secondary School evacuation plan	Create a timeline action plan
11/5	Chingusura CLGRD, Bairro leaders	Explanation of activities, confirmation of schedule, creation of timeline action plan
11/8	Persons related to the Mateus Sansáõ Mutemba Secondary School Evacuation Plan, drill participants	Disaster prevention and public health education
11/9	Chingusura CLGRD, Bairro leaders, drill participants	Disaster prevention and public health education
11/13	Persons involved in the Mateus Sansáõ Mutemba Secondary School evacuation plan, drill participants	Evacuation drill
11/15	Chingusura CLGRD, Bairro leaders, drill participants	Practice for evacuation drill
11/16	Chingusura CLGRD, Bairro leaders, drill participants	Evacuation drill carried out

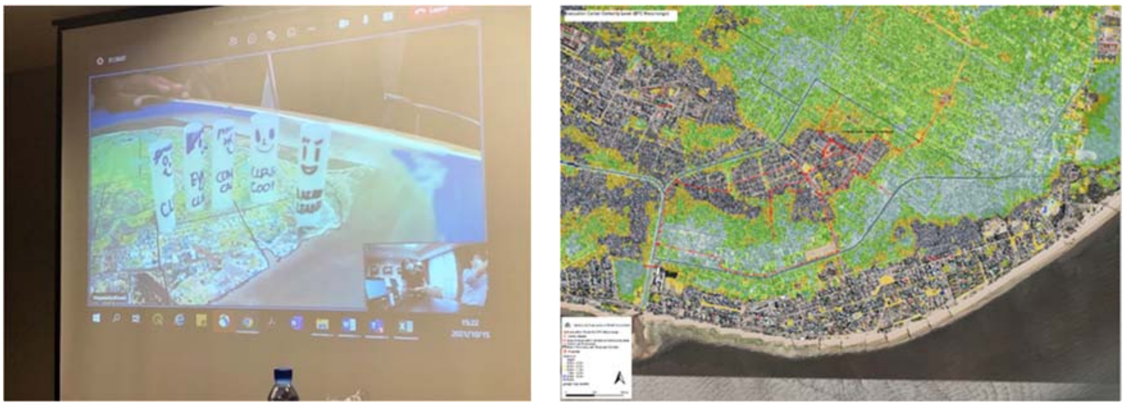
＊Orange cells: Evacuation Plan WG independent activity, Yellow cells: Activity related to Macurungo Evacuation Plan, Blue cells: Activity related to Mateus Sansáõ Mutemba Evacuation Plan, Light purple cells: Activity related to Inhamizua Administrative Branch Office/Chingusura Neighborhood Office Evacuation Plan

Source: JICA Project Team

1) DIG (Disaster Imagination Game)

A DIG was conducted in October 2021, but this was done remotely from Maputo as the JICA Project Team was conducting remote Japanese training there.

While checking the map, the DIG exercise was held to observe how each person in charge would move according to the timeline action plan. DIG was initially meant to be a preliminary exercise to identify areas for adjustment as part of the process of finalizing the timeline action plan. However, it was difficult to move the frames on the map while checking the timeline action plan and confirming on-screen, so it was decided that finalization would be done after confirming some issues and after the team arrived in Beira.



Source: JICA Project Team

Figure 6-24 Photo from the Activity to Identification of issues through a remote

2) Review of Timeline Action Plans and Confirming the Consistency

The timeline action plan was reviewed again based on the issues identified in the DIG session.

Participants felt that “X hours before landfall” made it difficult to understand “at what time,” so it was decided to revise the format to “3 days before,” “2 days before” and “1 day before,” and the plan was readjusted within the Evacuation Plan WG.

The Evacuation Plan WG gathered the Macurungo CLGRD, Bairro officials, and school officials to explain the organizing points again and to write down specific actions such as "3 days before at what time.”

As a result of this coordination, it was decided that the Bairro-level activities themselves would be conducted during daytime hours, from around 7:00 a.m. to 6:00 p.m. (set by the Bairro), since Bairro-level activities include patrols of the district, communication activities, cleaning of waterways and other duties, and because nighttime evacuation would be dangerous even if it was before the wind and rain became severe. Therefore, it was assumed that evacuation would be completed by the evening of the day before a cyclone makes landfall.

Timeline action plans at the evacuation center level were similarly adjusted so that preparations could be made for activities during daylight hours from the morning to the early evening three days prior to the day of landfall.

The Evacuation Plan WG brought back two plans prepared by the above Macurungo WG, and further checked their consistency and identified points for adjustment.

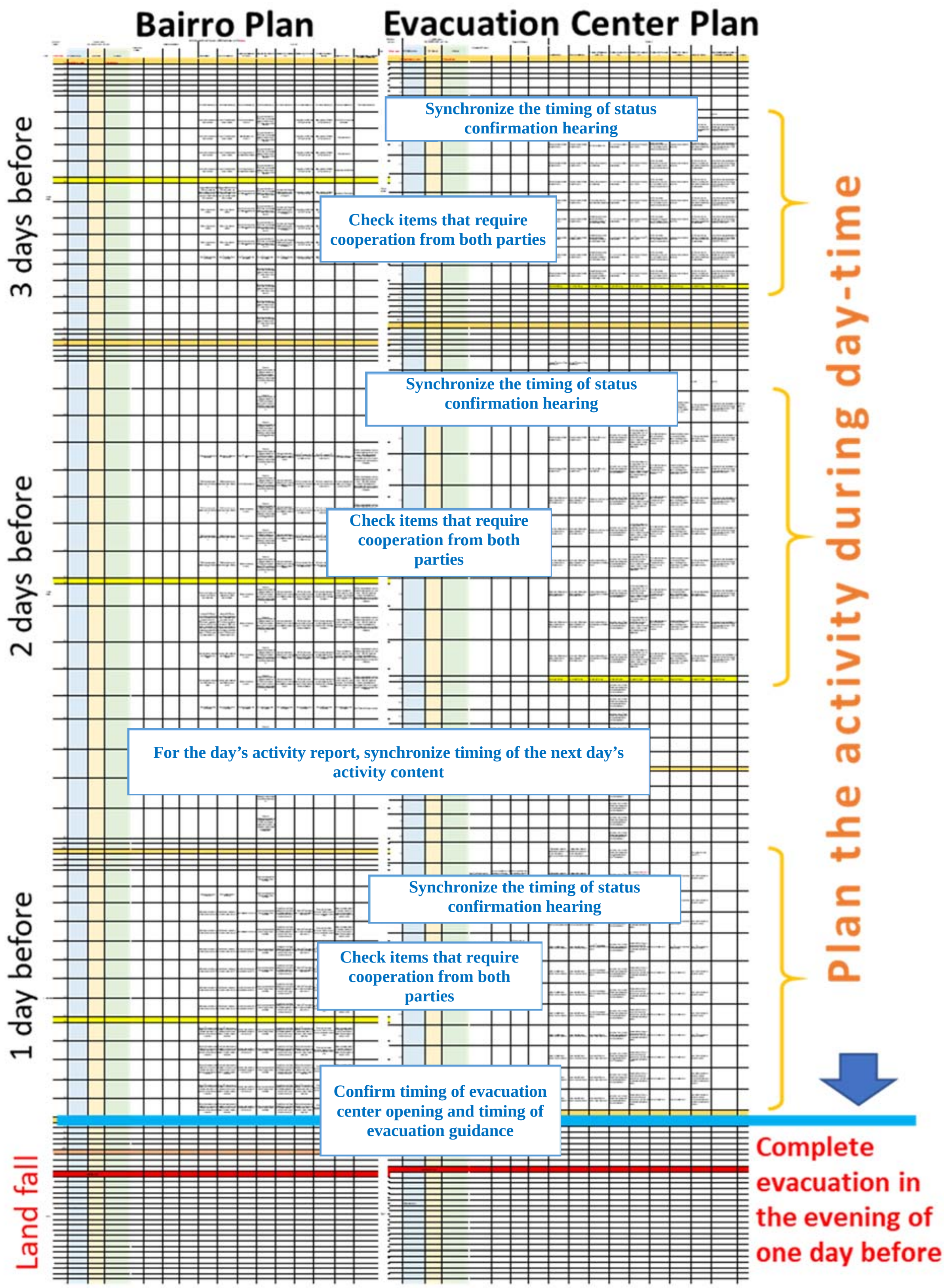

Source: JICA Project Team

Figure 6-25 Photo from the Activity Revising the timeline action plan

On the following day, while the Evacuation Plan WG members explained the points confirmed above, the Bairro-level and evacuation center-level plans were reviewed side by side, and adjustments made by hand for the timing of each activity and the division of responsibilities for checking the evacuation route. Members also confirmed and mapped the residences of those in need of assistance and finalized the timeline action plans.


Source: JICA Project Team

Figure 6-26 Photo from the Activity to Finalize timeline action plan and confirmation of housing for those in need of assistance



Source: Evacuation Plan WG

Figure 6-27 Consistency check for the timeline action plan for the Bairros (left) and evacuation centers (right)

(2) Disaster Risk Reduction Education and Public Health Education

Disaster risk reduction education and public health education was conducted according to the program shown in the table below after discussing the contents with the Evacuation Plan WG members. Disaster risk reduction education was conducted prior to the evacuation drills and focusing on what participants needed to understand to participate in the drills.

Table 6-25 Disaster Risk Reduction Education and Public Health Education Programs

Subject	Content
Disaster Risk Reduction Education	
Understanding disaster risk	- Confirm the situation when Cyclone Idai made landfall using pictures, etc. - The role of CLGRD and the information to be announced by INGD - Understand the size of an incoming cyclone and the situations it brings
Understanding hazard maps	- Understand how to read hazard maps - Confirm the expected inundation around one's home using the Bairro hazard map
Confirming evacuation routes	- Confirm the city's evacuation plan, the location of evacuation centers, and evacuation routes from home using the hazard map for one's Bairro
Understanding the content of the timeline action plan	- Understand the timeline action plan used by CLGRD and the Evacuation Center WG for the evacuation drill
Creating My timeline action plan	- Present one's own activities in a disaster, using the CLGRD and Evacuation Center WG's timeline action plan - Exercise to create your own timeline using the worksheet
Public Health Education	
Basics of infectious disease	- Understand transmission routes and basic infection control measures for COVID-19, cholera, and other infectious diseases
Explanation of measures against infection at evacuation centers	- Understand the importance of infection control measures in evacuation center - Hand-washing demonstration and practice session

Source: JICA Project Team

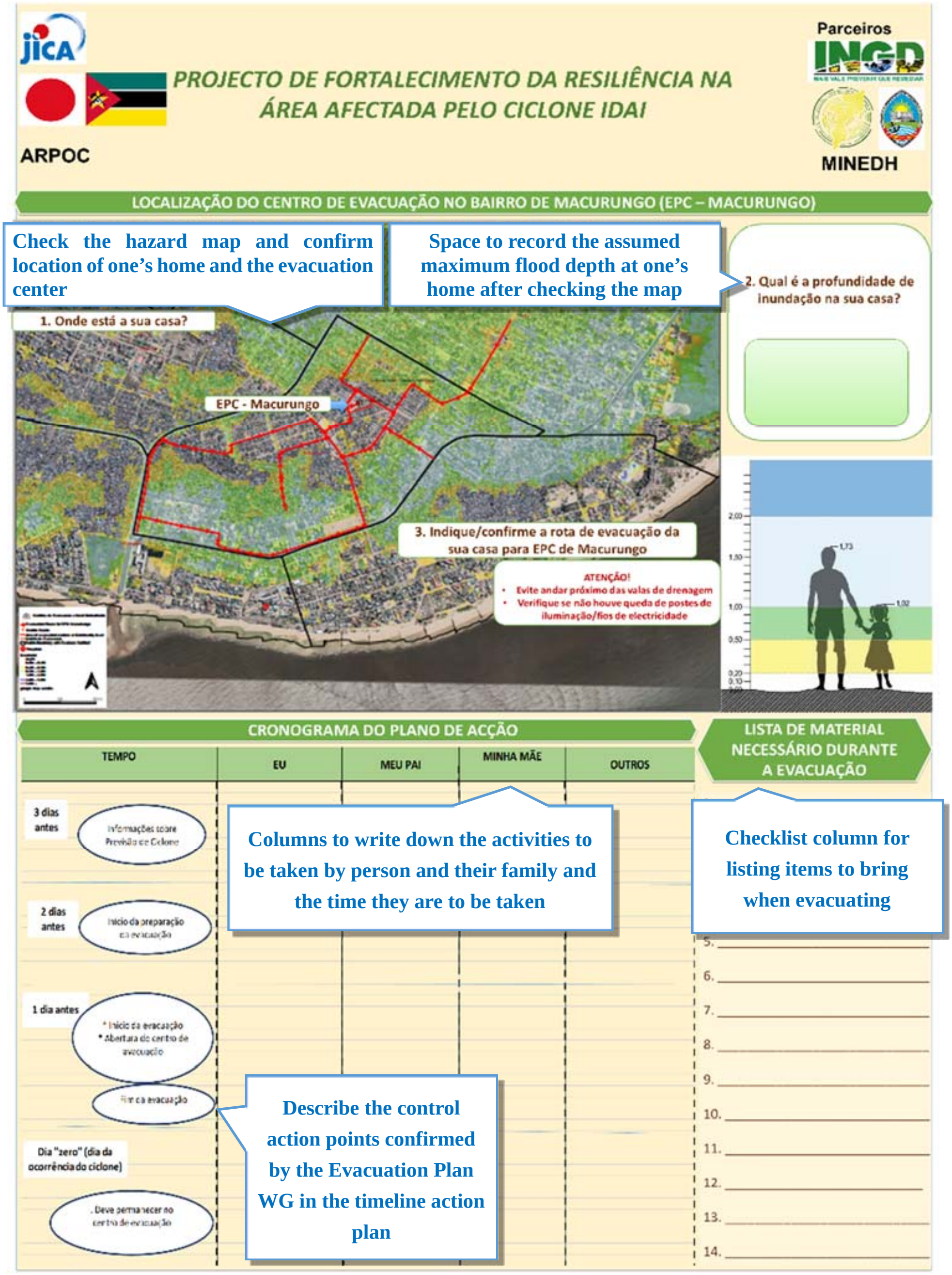
Disaster preparedness and public health education was conducted at Macurungo Primary School, Mateus Sansáõ Mutemba Secondary School, and the Inhamizua Administrative Branch/Chingusura Neighborhood Office premises. The result of activities in each district is shown in the table below. In addition to CLGRD members and Evacuation Center WG members in each district, students from primary and secondary and local residents participated, with INGD staff serving as instructors for disaster education and instructors from the Ministry of Health serving as instructors for public health education. The number of participants was limited to 50 on account of the COVID-19 situation.

Table 6-26 Status of Disaster Prevention and Public Health Education

Date	Location	Participating Organization	Participants
2021 10/22	Macurungo Primary School, tent classroom	Macurungo CLGRD Evacuation Center WG Primary school students	16 6 9
11/08	Mateus Sansáõ Mutemba Secondary School classroom	Esturro CLGRD Evacuation Center WG (including secondary school students)	14 19
11/09	Inhamizua Administrative Branch, adjoining square	Chingusura CLGRD, Evacuation Center WG and residents	20 24

Source: JICA Project Team

For the disaster risk reduction education, an exercise was conducted using a worksheet (see below) to describe timeline action plans so participants could plan their own actions ("My Timeline"), thinking for themselves and raising their awareness regarding evacuation.

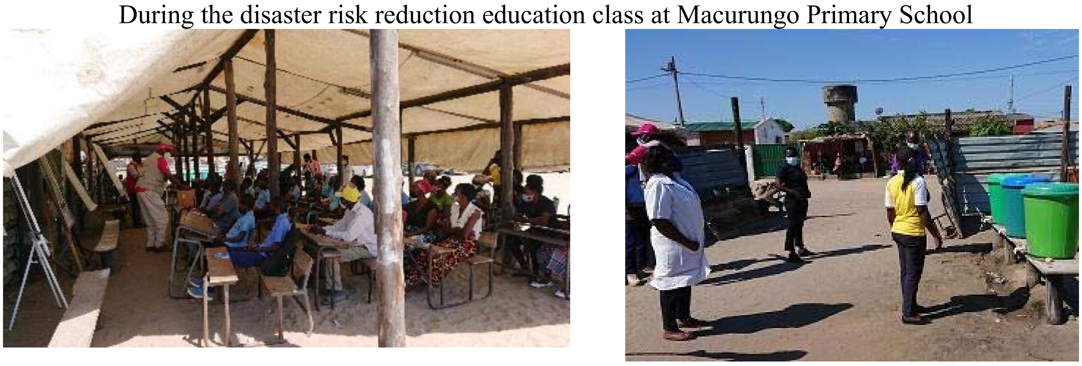


Source: JICA Project Team

Figure 6-28 Worksheet used to create My Timeline Action Plan

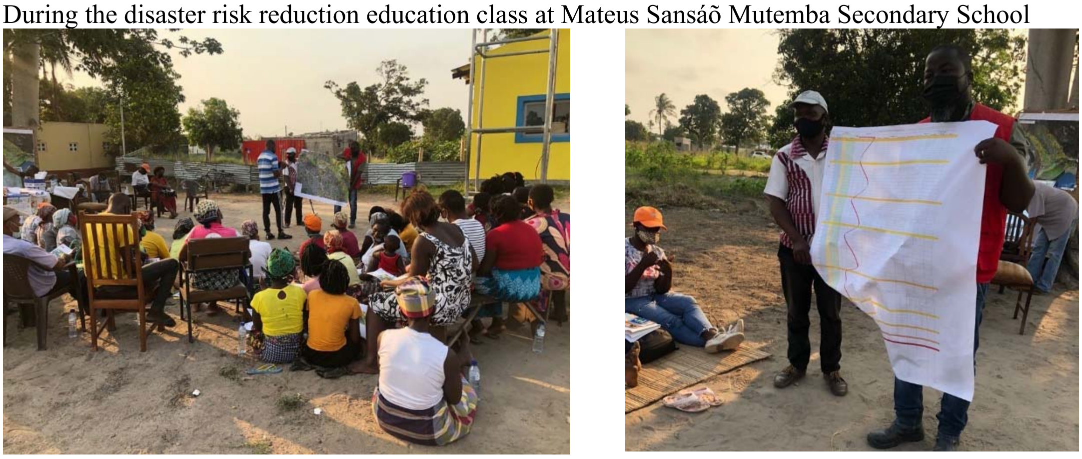
Based on the activities, it was decided to also prepare a disaster risk reduction education booklet that organizes content regarding disaster risk reduction education and public health education. The details of the booklet are described below in 6.7.2 Disaster Risk Reduction Education Booklet.

During the disaster risk reduction education class at Macurungo Primary School



During the public health education class at Macurungo Primary School

During the disaster risk reduction education class at Mateus Sansáõ Mutemba Secondary School



During the disaster risk reduction education class at Inhamizua Administrative Office

Source: JICA Project Team

Figure 6-29 Status of disaster risk reduction education and public health education

6.6.6 Preparation for Carrying Out Evacuation Drills in Pilot Project Areas

An evacuation drill program was developed that compresses the aforementioned three-day evacuation plan into one day. This program was distributed to all the participants, and each person followed the program while checking it over time. On October 28, the day before the drill, participants practiced carrying injured and sick people using stretchers and bicycles as a rehearsal for the drill.

The drill participants received disaster risk reduction education and public health education in advance, and brought their own personal timelines, which they created as a homework exercise.

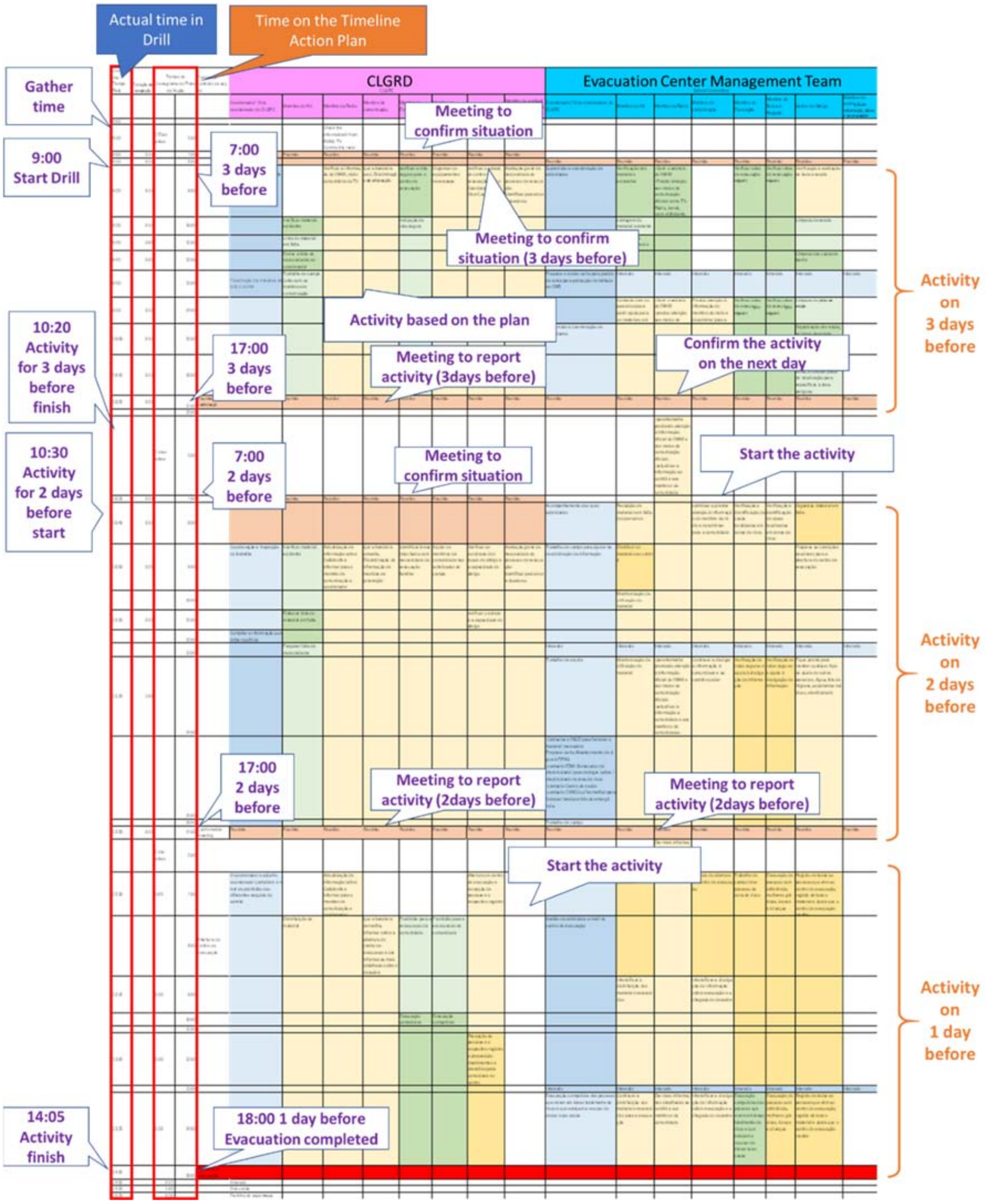
(1) Macurungo Primary School

The evacuation drill at Macurungo Primary School began when everyone gathered at 8:30 a.m. on October 29, with the drill starting at 9:00 a.m. following a review of the program.

At the start of the drill, greetings were made by a provincial government official (the Administrative Deputy Secretary) and the evacuation plan and status of the created timeline were explained by the Evacuation Plan WG, Macurungo District WG, and the Evacuation Center WG, along with the evacuation drill program. At the request of the Director of the Sofala Regional Office INGD, the police and emergency services were invited to participate in the drills as observers from October 18.

In accordance with the program, the drill began with a meeting in which each group identified activities to be carried out up to three days before the cyclone would make landfall. Calls for evacuation were made in certain areas in the vicinity of evacuation center, and the extent of the drill and the time required were recorded so that the necessary time could be estimated if the drill was extended to the entire area.

The time for completing the evacuation one day before the cyclone made landfall (6:00 p.m.), was set at 2:05 p.m. on the day of the drill. The drill ended when CLGRD and the evacuation center management team confirmed that the evacuation was complete. A review meeting was then held by the participants and it was confirmed that there were no major problems, and the exercise went as planned. Evacuation drill activities ended at 3:20 p.m.



Source: JICA Project Team

Figure 6-30 Evacuation drill program at Macurungo Primary School

The plan was explained to the Administrative Deputy Secretary from Sofala Province.

Meetings among the WGs

Calling upon residents to evacuate

Source: JICA Project Team

Figure 6-31 Photos from the Macurungo Primary School evacuation drill

(2) Mateus Sansáõ Mutemba Secondary School

After the evacuation drill in Macurungo Primary School was completed and the JICA project team left Beira, the Evacuation Plan WG took the lead in developing an evacuation plan and timeline action plan for Mateus Sansáõ Mutemba Secondary School, prepared for the evacuation drill, and conducted disaster prevention and public health education and the drill.

On November 1, members of the Evacuation Plan WG explained the activities of the WG to the officials of Mateus Sansáõ Mutemba Secondary School, the CLGRD coordinator, and the Bairro leader. On November 3 and 5, the timeline action plan was formulated, the evacuation drill program was prepared, and the drill preparations were made. The school's students also participated in the planning activities as members of the school council and developed a timeline action plan.

Source: JICA Project Team

Figure 6-32 Photos from Mateus Sansáõ Mutemba Secondary School activities to create an evacuation plan

Disaster risk reduction and public health education was conducted on November 8 (as was also done at Macurungo Primary School), and the evacuation drill was conducted on November 13 with the timeline actions plans the participants had created.

Source: JICA Project Team

Figure 6-33 Photos during the evacuation drill at Mateus Sansáõ Mutemba Secondary School

(3) Inhamizua Administrative Office / Chingusura Bairro Office

As with Mateus Sansáõ Mutemba Secondary School, the Evacuation Plan WG took lead to prepare an evacuation plan, timeline action plan and conduct an evacuation drill program, as well as carry out disaster risk reduction education and public health education.

On November 5, the Evacuation Plan WG briefed the CLGRD and the Chingusura Bairro leader on the activities and plans and prepared a timeline action plan.

On November 9, disaster risk reduction education and public health education was conducted for the local participants of the evacuation drill. On November 15, the evacuation drill program was created, and preliminary run-through and preparations were conducted. On November 16, the evacuation drill took place.

Explaining how to create a plan

The created plan and drill program

The drill in progress

Source: JICA Project Team

Figure 6-34 Photos from the process of creating a plan and during the drill at Inhamizua Administrative Office / Chingusura Bairro Office

6.6.7 Disaster Response Training for the Pilot Project for Fish Market Resiliency

(1) Formulation of a Disaster Response Plan by the Fish Market Working Group

As one of the activities of the Pilot Project for Building Resilience of the Fish Market, disaster response plan was also considered in Praia Nova Fish Market, so the same activities were conducted in cooperation with the working group of partners in the fish market (the market management association and the fishermen's association), referred to as Fish Market WG below.

Table 6-27 List Activity of Fish Market WG Evacuation Drill Activities

Date	Participants Other Than Evacuation Plan WG	Main Activities
2021 10/8	Fish Market WG	Explanation of timeline action plan, formulation of a disaster response plan by the Fish Market WG, drill preparation, confirmation of drill schedule
10/18	Fish Market WG	Discussion on how to proceed with disaster response plan and the content of the explanation
10/20	Fish Market WG	Explanation of evacuation drill, creation of timeline action plan
10/21	Fish Market WG, drill participants	Practice assembling kigumi stalls in the public fish market parking lot
10/25	Fish Market WG, drill participants	Adjustment of the fish market disaster response plan, confirmation, and adjustment of drill preparations
10/27	Fish Market WG, drill participants	Fish market disaster response drill

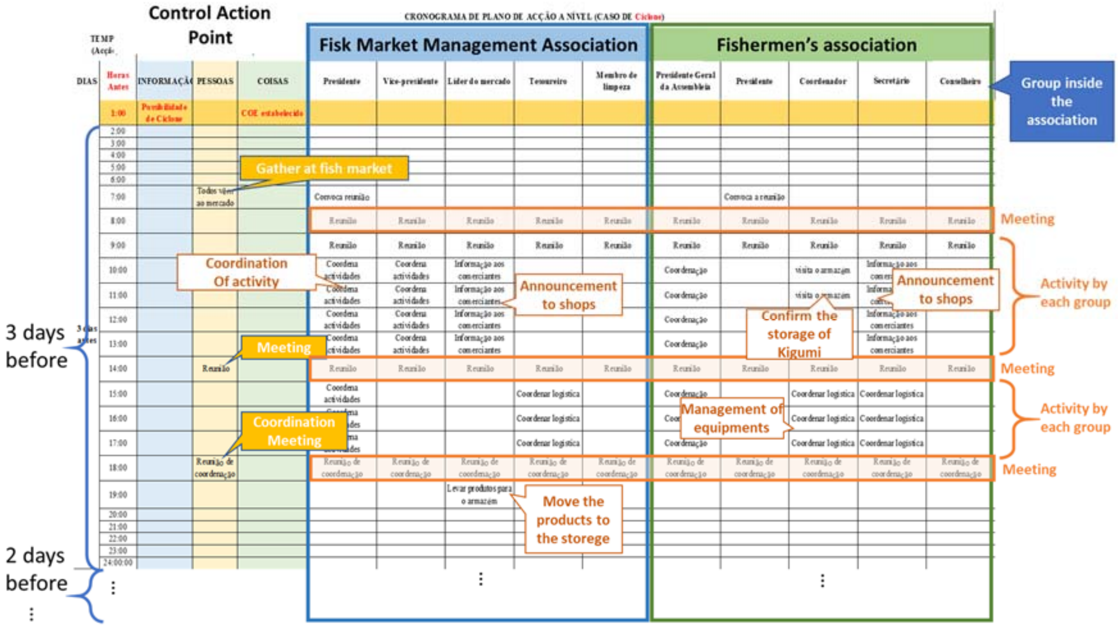
Source: JICA Project Team

(2) Disaster Response Plan Formulation

For the disaster response plan of Pilot Project for Fish Market Resiliency a timeline action plan was developed and a disaster response drill was conducted as follows: (1) three days before the cyclone’s forecasted landfall, inform fish market workers and fishermen about the possibility of the cyclone making landfall, and (2) two days before landfall, disassemble and remove the kigumi wooden stalls created in the activities described in Chapter 7 and transport the stalls to a warehouse by vehicle. The timeline action plan was developed with the participation of the Fish Market Management Association, the Fishery Management Association, the CLGRD coordinator of the Bairro, and the Evacuation Plan WG.

A kickoff joint meeting of the Evacuation Plan WG and the Fish Market WG was held on October 8. The Evacuation Plan WG explained the concept of the timeline action plan and confirmed the schedule to prepare for disaster response training. After the arrival of the JICA Project Team arrived discussions were held on how to the Fish Market WG should proceed with the disaster response plan and content explanations. Evacuation Plan WG members explained the evacuation drill to the fish market and prepared a timeline action plan.

Because the fish market would be closed the day before cyclone arrives, the plan calls for clearing out stalls, etc. at least two days beforehand.



Source: JICA Project Team

Figure 6-35 Timeline action plan for the fish market disaster response (partial)

(3) Disaster Response Drill

On October 21, participants practiced assembling a kigumi wooden stall in the parking lot of the public fish market in Praia Nova, and it was confirmed that assembly and disassembly of one unit can each be performed in about 30 minutes. On October 25, the study team confirmed and adjusted preparation conditions for the fish market's disaster response plan. The location of the stalls was changed a few days before the planned drill, and CMB stated they could not definitively decide on a location by the date of the drill, so it was decided to omit the transport aspect of training, but to still include training for loading and unloading trucks.

Based on the above plan, a disaster response drill was conducted on October 27 at the Praia Nova Fish Market.

The plan calls for confirming that the market has been cleared by the evening of the day before the cyclone's predicted landfall.

For the disaster response training, a compressed one-day program was created that simulated the three days (three days, two days and one day) before the cyclone's arrival. At the post-drill review meeting, the response was that the actual program could be carried out without any problems. The JICA Survey Team pointed out that although no actual cleanup other than dismantling the stalls was conducted this time, everyone should assume that it would take somewhat longer in the case of an actual cyclone.

Source: JICA Project Team

Figure 6-36 Photos from the fish market disaster response drill

6.6.8 Dissemination of Activities to Other Regions

After completing a series of evacuation plan formulation activities and evacuation drill implementation activities in the pilot areas, the evacuation plan (especially the timeline action plan) was explained to relevant organizations at the provincial level. The Evacuation Plan WG approached each organization to create a timeline action plan. In order to expand the timeline action plan to other parts of Beira, 16 Bairros that are highly vulnerable to flooding were selected and the timeline action plan was explained as part of CLGRD revitalization activities, as shown in the table below.

Table 6-28 CLGRD Revitalization Program

Required Time	Content	Presenters
(1) The meaning of CLGRD activities		
15 minutes	Explain the significance of CLGRD revitalization	INGD/CMB/GD (Beira District Government)
20 minutes	Describe the organization, function, and mission of CLGRD	
30 minutes	The importance of community (Bairro resident) participation	
(1) Understanding CLGRD basic activities and discussion of disaster risks, etc. (group work)		
30 minutes	Explanation of basic concepts related to disaster risk management	INGD/CMB/GD
90 minutes	Examination and discussion of necessary responses and measures in the event of a disaster	Group work
30 minutes	Confirmation and discussion of disaster history	
30 minutes	Creation of a community resource map	
(2) Understanding the timeline action plan		
15 minutes	Explanation of the timeline action plan content	INGD/CMB/GD
30 minutes	Explanation of hazard maps and careful examination of threat maps	
30 minutes	Examples of timeline action plan	
30 minutes	Review	-

Source: JICA Project Team based on information provided by INGD

Table 6-29 Activities for Expansion to Other Areas

Date 2021	Target Organization	Summary of Activities	No. of Participants
12/15	Bureau of Meteorology (INAM), Department of Education (DPE), Mozambique Police (PRM), National Public Rescue Service (SENSAP)	History of consideration of evacuation plans, concept/case studies of timeline action plan	9
12/21～12/29	CLGRDs in 16 targeted Bairros (Mananga, Maraza, Chota, Munhava-Central, Vaz, Chaimite, Macurungo, Chipangara, Mungassa, Ndunda, Inhamizua, Chingusura, Tchonja, Nhangau, Nhangau Sede, Ponta-Gêa)	As part of the CLGRD revitalization workshops, the concept of the timeline action plan and case studies were introduced according to the program in the table above.	266

Source: JICA Project Team

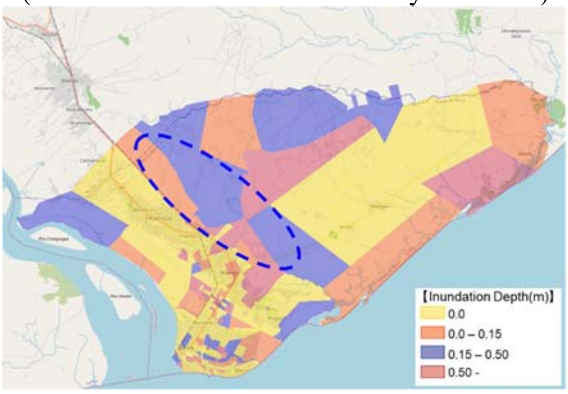
INGD is proactive and preparing with regard to activities to expand the evacuation plan (especially the timeline action plan) to other regions, such as explaining the evacuation plan to the Sofala Provincial Administrator. For activities after April, the plan will be reflected in the DFR after confirmation during the field activities in June.

6.6.9 Evacuation plan formulation for long-distance evacuation

Long-distance evacuation can be defined as a situation in which evacuation to neighboring Bairro is necessary and coordination among Bairros is required. After discussions with the Evacuation Planning WG, it was found that in addition to the situation that cyclone of the intensity of Cyclone Idai to make landfall at spring high tide, flooding from the Mungassa River (which is normally dry) flowing northeast of the Beira city center could cause situation in need of long-distance evacuation.

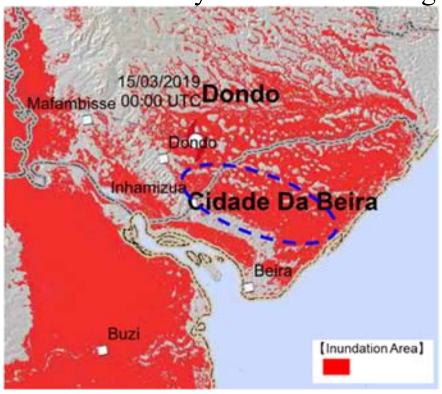
Specifically, based on past disaster experience, it was found that the Bairros located within the blue dotted line in the figure below (Mungasa, Ndunda, etc.) are subject to widespread flooding during heavy rains, and need to evacuate to neighboring Bairros.

Inundation depth based on interviews in Bairros (One week after the landfall of Cyclone Idai)



Source: Prepared by JICA project team

Flooded area after the landfall of Cyclone Idai based on analysis of satellite image



Source: UNITAR

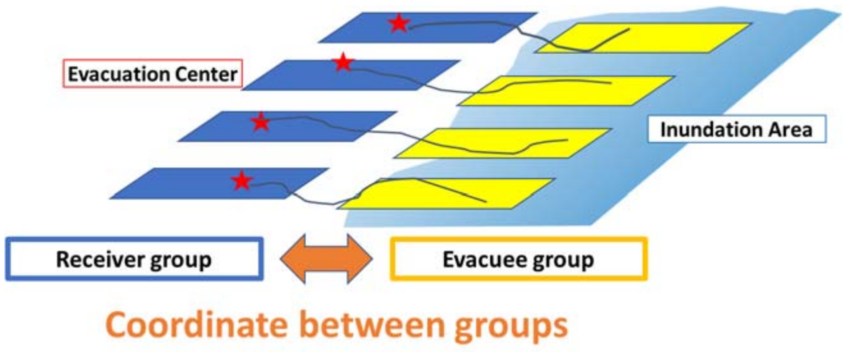
Figure 6-37 Flooding Situation in the Area East to the Beira city central area1

As a result of discussions with the Evacuation Planning WG, it was decided to consider the long distance evacuation targeting the situation of inundation from the Mungassa River, which flows northeast of the Beira urban area. This is because it easier to imagine the inundation situation and actual damage caused by the inundation based on past experience and thus easier to foster a sense of cooperation among residents.

(1) Step 1: Who and Where (Basic Preparation)

When evacuating to nearby Bairros, it is first necessary to identify areas that are flooded and need to be evacuated (evacuee groups) and areas that are not flooded and can accept evacuees from the neighborhood (receiver groups). After clarifying the evacuee and receiver groups, the following coordination should be implemented as Step 1 (see next page for an image of the consideration).

- Evacuee groups to confirm the number of evacuees in the event of long-distance evacuation.
- Receiver group to secure capacity of evacuation center that can accommodate evacuees in the event a long-distance evacuation.

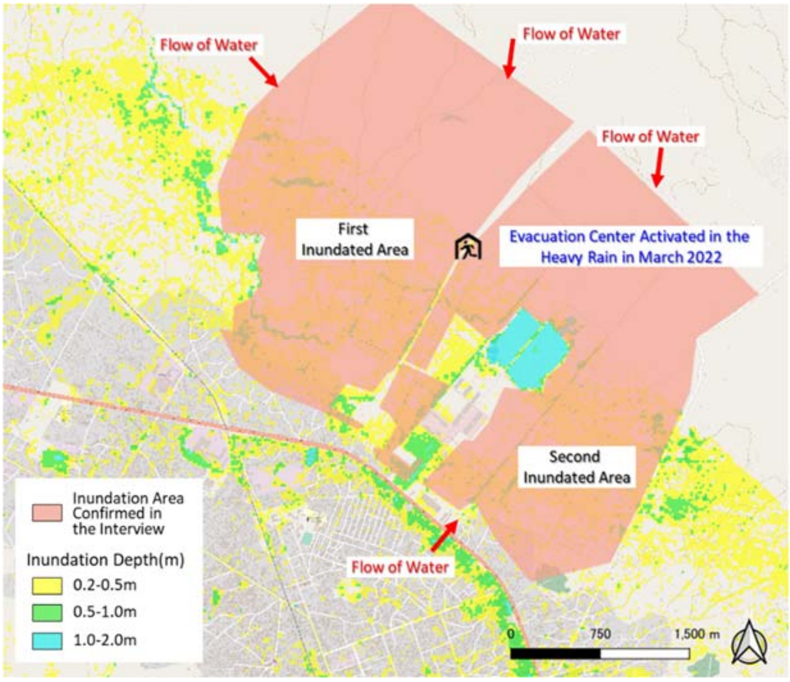


Source: Prepared by JICA project team

Figure 6-38 Image of Identifying Evacuee Groups and Receiver Groups

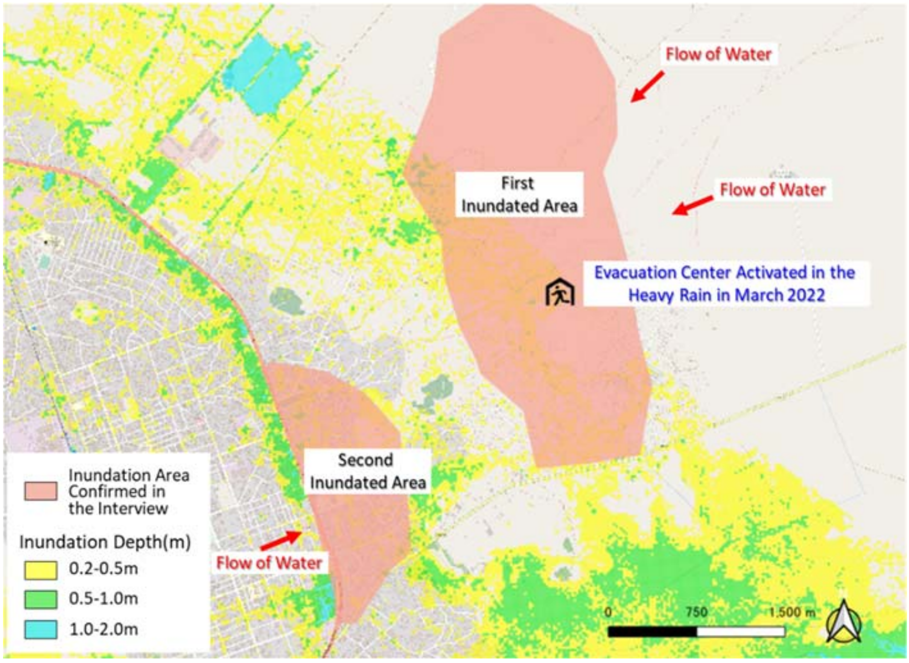
As evacuee groups, the project targeted Mungasa and Ndunda, which are inundated by flooding from the Mungassa River. At first, interviews were conducted to residents and CLGRD members regarding the inundation situation occurred in March 2022 in order to understand the inundation situation in both areas. The interviews were conducted to determine the extent of inundation area, the areas where the inundation happened first, and the flow of water in the time of inundation. The figure below shows an overlay of the estimated maximum inundation depth based on the simulations conducted in this project and the inundation situation recognized based on the interviews.

During the heavy rain on March 2022, residents evacuated to shelters established inside each Bairro. Although the evacuation centers were located in the area with inundation, the ground level of the school identified as the evacuation center was higher than the surrounding area and it was not inundated. On the other hand, if the rainfall were more prolonged or if it is more intense, the evacuation center is likely to be inundated. Thus, it was found that evacuation to neighboring Bairros is necessary before the surrounding area are inundated.



Source: Prepared by JICA project team

Figure 6-39 Inundation situation in Mungasa due to heavy rains in March 2022



Source: Prepared by JICA project team

Figure 6-40 Inundation Situation in Ndunda due to heavy rain in March 2022

CLGRD members, Bairro leader, and others participated in a workshop and confirmed the inundation situation caused by heavy rain on March 2022. In addition, after confirming the inundated area and water flow on a map, the activities taken, and the inundation depths was confirmed by each time and was summarized in a chronological order (results of the workshop shown in

Table 6-15).


Talking about the situation in the time of heavy rain


Confirmation of inundation situation and flow of water on the map


Confirmation of inundation depths and activities in a clonogical order

Source: JICA project team

Figure 6-41 Workshop to confirm inundation situation due to heavy rain in March 2022662

Next, we selected Bairros from the neighboring Bairros of Mungasa and Ndunda to serve as the receiver group. As the receiver group, the Bairros were selected on the basis that the area of the Bairro would not be inundated broadly due to heavy rains and it is possible to secure capacity of evacuation center in the event of long-distance evacuation. As a result of the selection, Chingsura and Nyakonjo were selected as the receiver groups for Mungasa and Ndunda respectively. Inundation situation in Chingesura and Nyakonjo during heavy rains was confirmed by the results of inundation simulations conducted in this project and it was understood that the two Bairro will not be inundated broadly. In Chingesura and Nyakonjo, although current the capacity of evacuation center cannot secure enough capacity to accommodate the evacuee, many schools and facilities that could be considered to be used as evacuation centers are located and thus considered possible to act as receiver group.

For the consideration of the timeline action plan for Step 2 one evacuee group and one receiver group was selected as a pilot consideration. Since evacuation planning against cyclones have been conducted in Chingesura, and CLGRD and residents already have a better understanding of the importance of evacuation. Therefore, the consideration of the timeline action plan was conducted in Mungasa and Chinggsura, based on the idea that experience in the consideration of evacuation inside the Bairro conducted in Chinggsura could be utilized.

(2) Step 2: When, Who, What, and How (Timeline Action Plan)

In order to secure smooth implementation of long-distance evacuation, the following items must be coordinated in advance between the receiver group and the evacuee group. It is important to establish a coordination system between the receiver group and the evacuee group by holding enough discussions in advance, and administrative institutions such as the CMB and INGD should lead the coordination to strengthen cooperation between the two groups.

- Trigger information and timing for evacuation
- Necessary preparation and role sharing to be considered to receive evacuees
- Identification and coordination points between receiver group and the evacuee group as well as among related organizations

As a result of verifying the information available as advance information to make evacuation decisions during heavy rain, it was decided to use information of rainfall forecasts as a trigger information for evacuation during heavy rains. The process to decide to use rainfall forecasts is described in "6.6.11 Evacuation plan formulation for Heavy Rain". This section describes the criteria for determining whether long-distance evacuation is necessary.

It is necessary to refer to the trigger information and make a decision is long-distance evacuation is needed based on the assumed scale of inundation that could happen. In the case of heavy rains, the direct relationship between the amount of rainfall and inundation situation is difficult to analyze, so it is necessary to consider the extent of inundation according to the amount of rainfall based on past experience of each district. On the other hand, although it is out of the scope of consideration in this consideration, for long-distance evacuation against a large-scale storm surge caused by a cyclone, it is assumed that the relationship between the estimated minimum central pressure and astronomical tide level can determine whether long-distance evacuation is needed according to the estimated tide level.

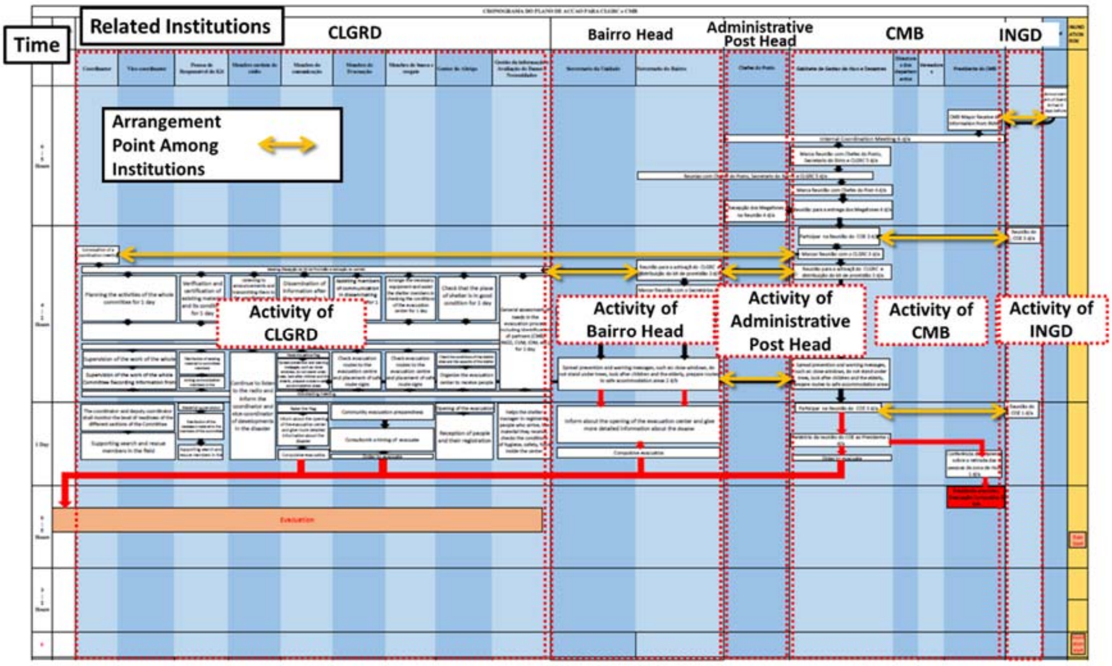
Table 6-30 Criteria for determining if long-distance evacuation is needed61

Hazard	Information	Evaluation criteria	Announced by
Heavy rain	Rainfall Forecast (3 days before)	Long-distance evacuation will be carried out if necessary, based on the rainfall forecast three days in advance, and based on the past experience on the extent of flooding that is expected to occur based on rainfall amount.	INAM
Storm surge	Estimated minimum central pressure at the time of cyclone landfall (3 days before)	Long-distance evacuation will be conducted when the tide level exceeds the level to cause inundation in urban areas according to the estimated minimum central pressure and the astronomical tide level at the time landfall is predicted in the cyclone forecast three days in advance.	INAM
	Astronomical tide table		INAHINA

Source: Prepared by JICA project team

In the case of evacuation from Mungasa to Chingesura, 3-day rainfall forecast from INAM for the heavy rain on March 2022 was about 220 mm/day. In the case of 220 mm/day Mungasa area was inundated up to 1.5m, but the evacuation center functioned without flooding. Therefore, if the daily rainfall is higher situation in the heavy rain on March 2022, evacuation centers could be assumed to be flooded and evacuation will be difficult. Therefore, through discussions with the CLGRD it was decided to conduct long-distance evacuation when the rainfall forecast from INAM is higher than 250 mm/day.

Next, a timeline action plan was formulated. To ensure effective functioning of coordination and collaboration between the two Bairros, in the formulation of the Timeline Action Plan, CLGRDs of both Bairros as well as the Bairro leader, the district (Administrative Post) leader, CMB and INGD Sofala Provincial Office to promote coordination between the Bairros participated in the process. The Administrative Post is an administrative division located between the city level and the Bairro level. After creating a timeline action plan for each institution, we identified the activity items that needed to be coordinated among related institutions, and points to be coordinated was clearly mentioned in the timeline action plan form.



Source: JICA project team

Figure 6-42 Table to Summarize the Activities and the Points to be arranged among institutions

For the aforementioned consideration of long-distance evacuation, workshops were held with the CLGRD and related institutions to discuss a timeline action plan. In addition, simulation of evacuation on foot from Mungasa to the evacuation center in Chingesura was conducted. In the simulation of evacuation, the group gathered at EPC Nharrino, an evacuation center in Mungasa, and moved on foot to the Chingsula Administrative office in Chingsura as a long-distance evacuation site. The distance between the starting point and the finishing point was 4 km and took 1 hour and 10 minutes to actually walk, and during the walk safe evacuation routes were also confirmed by the participants.

Evacuee group at Mungasa.
Activities with CLGRD members and others

Receiver group in Chingsura.
Activities with CLGRD members and others

Examining evacuation routes, based on map (right) and timeline action plan (left) for long-distance evacuation

Coordinating with INGD Sofala Provincial Office staff on the details of the long-distance evacuation

Source: JICA project team

Figure 6-43 Situation of the workshop to discuss long-distance evacuation63

6.6.10 Evacuation plan formulation for long-distance evacuation

(1) Step 1: Who and Where (Basic Preparation)

As shown in Figure 6-3, the evacuation plan for heavy rains uses the same estimated maximum inundation depth map as for neighborhood evacuation for a cyclone (without storm surge), therefore, for Step 1, the considerations are the same with those explained in "6.6.3 Evacuation Plan Formulation for a Cyclone (No Storm Surge): Neighborhood Evacuations".

(2) Step 2: When, Who, What, and How (Timeline Action Plan)

Evacuation in the event of cyclone landfall can be planned from weather forecasts based on the time of landfall and the hours prior to the landfall. On the other hand, in the case of heavy rain, it is not possible to make a prediction such as "after how many hours rain will intensify," so it is necessary to consider the timing of evacuation based on metrological or hydrological information.

In Beira City, damage caused by inland flooding is evident during heavy rain events in low-lying areas due to poor drainage, overflows from drainage channels, and inflows from the Mungassa River east of the Beira city central area. The Mungassa River is actually a flow of water which the rainwater in low-lying areas is gathered in time of heavy rain, and the situation of flooding is different from that of flood caused by overtopping of levees or levee failures from river.

In Japan, evacuation orders and evacuation advisories are issued based on rainfall forecasts, water level in the pumping station or the sluice gate, and in each facility, it has a standard for conducting operation to avoid flooding which can be used as one criterion for the coming risk. But this kind of system is not established in Beira city.

Therefore, it is necessary to make decisions of evacuation based on information available and considerable in Beira city. The table below shows the information that is expected to be utilized for evacuation during heavy rain, and the advantages and disadvantages of each type of information.

Table 6-31 Information expected to be used for decision in evacuation during heavy rain62

Information	Measures required for implementation	Advantage	Disadvantage
Information of water levels in drainage channels and low-lying areas (visual check with Water level markers)	Water level markers	Since only watermark are needed there is no need to worry about theft or damage.	Very dangerous because it is necessary to approach drainage channels during flood situation
Information of water levels in drainage channels and low-lying area (Water level sensors)	Water level sensors	Alerts (sirens) based on actual water levels can be issued Water level status can be monitored without directly approaching the drainage channel, etc.	Water level sensor needs to be installed. Relatively expensive to maintain. Risk of theft.
Actual accumulated rainfall (rain gauge)	Rain gauges capable of measuring hourly rainfall and analysis of the relationship between flood depth and rainfall (if scientifically based)	Since the water level is not checked, it can be determined without directly approaching the drainage channel, etc.	A rain gauge capable of measuring hourly rainfall should be installed. Need to accumulate information on how much rainfall will cause how much inundation
Predicted rainfall	Rain gauge and forecast model system (to improve forecast accuracy)	Information issued by INAM 3 days in advance when major rainfall is predicted. Improved forecasting accuracy allows for evacuation and advance preparation with sufficient lead time	Need to accumulate information on how much rainfall will cause how much inundation Need to improve INAM's weather forecasting related capacity to increase accuracy

Source: Prepared by JICA project team

Information which can be used in times of evacuation during heavy rains can be divided into two categories: water level information and rainfall information, and the following describes the process of the consideration of information to be utilized.

By utilizing water level information, it is possible to detect actual flooding conditions and situation of water level raising in drainage channels and is available to issue an alert or signal for evacuation before the inundation begins. Water level markers and water level sensors could be considered as a method to understand the situation of water level. However, water level markers are not recommended for information during evacuation because of the danger of having to approach drainage channels in time the water level is raising.

Regarding water level sensors, location of their installation and the means of communicating alerts issued by flooding sensors was discussed with the evacuation planning WG. As a result, in addition to installing water level sensors in the areas where flooding begins the earliest in Beira to detect the situation of flooding as soon as possible, idea to installing multiple low-cost sensors that would detect flooding conditions and issue alerts at the community level in low-lying areas where inundation frequently occurs has been considered. On the other hand, it was determined that it would be difficult to utilize water level information as information to make evacuation decisions under the current circumstances due to the cost of installing flooding sensors as well as the challenges of securing maintenance and management capabilities and information communication systems to inform the situation to the community.

By utilizing weather information, by correlating relationship of the amount of rainfall with the inundation situation in each area it is possible to prepare for evacuation in advance by checking the cumulative rainfall or the rainfall prediction is exceeding the specific amount.

As mentioned in Table 6-31, in order to analyze how much rainfall will cause how much amount of flooding scientifically based on actual accumulative rainfall of and estimated rainfall, it is necessary to accumulate data of hourly rainfall and the inundation situation caused by that specific rainfall. However, based on the interview with INAM, the accuracy of the rainfall prediction is somehow secured, but the information is limited in times when major rainfall is predicted, and capacity enhancement is necessary to improve the accuracy of prediction.

INAM announces a rainfall forecasts three days in advance when major rainfall is predicted. For example, in March 2022 when 220mm/day rainfall was predicted the forecast was announced. Although there are challenges in improving the accuracy of the forecasts, it was decided to use INAM as a source of information to be used for evacuation considering the current available information in Beira.

Instituto Nacional de Meteorologia
Direcção de Análise e Previsão de Tempo
Departamento de Análise e Previsão de Tempo

Maputo, 21 de Janeiro de 2021

Boletim Nº	002/INAM-DAPT/**250.2-CT**/2021
Emitido:	11:00 Horas (Tempo Local)
Valido até:	24:00 Horas do dia 23 de Janeiro de 2021
Tipo de Comunicado:	**Aviso**
Fenómeno Meteorológico:	Tempestade Tropical ELOISE
Áreas de risco	**Chuvas acima de 200 mm/24h com trovoadas, ventos fortes de 150 Km/h e rajadas de 170 Km/h** **Provincia de Sofala** (Todos Distritos); **Provincia de Manica** (Machaze, Macate, Sussundenga e Mussorize); **Provincia de Inhambane** (Govuro, Inhassoro, Vilankulo, Mabote e arquipelago de Bazaruto). **Chuvas acima de 100 mm/24h, acompanhadas de trovoadas** **Provincia de Manica** (Gondola, Vanduzi, Manica, Barue, Macossa, Guro ,Tambara e Cidade de Chimoio); **Provincia da Zambézia** (Chinde, Luabo, Mapeia, Inhassunge , Morrumbala, Nicoadala e Cidade de Quelimane); **Provincia de Inhambane** (Massinga, Mabote e Funhalouro). **Provincia de Gaza** (Massangena, Mapai, Chicualacuala e Chigubo).
Descrição	A tempestade tropical moderada Eloise, já entrou no canal de Moçambique e desloca-se em direcção a provincia de Sofala, podendo se intensificar e atingir o estagio de Ciclone Tropical de categoria 3. Prevê- se que o seu epicentro com ventos de 150 Km/h e rajadas até 170 Km/h atinja a costa na região entre os distritos de Muanza e Machanga, nas primeiras horas do dia 23 de Janeiro de 2021.
Recomendações	Face a ocorrência de trovoadas, chuvas intensas e ventos muito fortes, recomenda-se a tomada de medidas de precaução e segurança.
Actualização	Hoje, dia 21 de Janeiro as 16:00 horas.

O Chefe do Departamento

Acácio M. Tembe

Rua de Mukumbura nº 164, Caixa postal 256, Maputo - Moçambique
Previsão do Tempo: Telefaxes (258) 21 49 01 48 e 21 46 51 38
http://www.inam.gov.mz, Email: mozmet@inam.gov.mz

Maputo, 23 de Janeiro de 2022

Boletim Nº	002/INAM-DAPT/**250.2-CT**/2022
Emitido:	09:00 Horas (Tempo Local)
Valido até:	24:00 Horas do dia 24 de Janeiro de 2022
Tipo de Comunicado:	**Aviso**
Fenómeno Meteorológico:	DEPRESSÃO TROPICAL
Áreas de risco	**Chuvas acima de 200 mm/24h com trovoadas, ventos fortes de 90 Km/h e rajadas de 120 Km/h** **Provincia de Nampula** (todos distritos); **Provincia da Zambézia** (todos distritos); **Provincia de Sofala** (principalmente nos distritos de Marromeu, Cheringoma, Caia, Chemba, Maringuè, Gorongosa, Muanza, Nhamatanda e cidades de Beira e Dondo); **Provincia de Manica** (Machaze, Macate, Sussundenga e Mussorize). **Chuvas acima de 100 mm/24h, acompanhadas de trovoadas** **Provincia de Niassa** (Mecanhelas, Cuamba, Mandimba, Metarica, Maúa, Ngauma, Nipepe, Chimbonila e cidade de Lichinga); **Provincia da Cabo Delgado** (Mecufi, Chiure, Ancuabe, Metuge, Quissanga, Meluco e cidade de Pemba).
Descrição	O sistema de baixas pressões atmosféricas formado no dia 16 de Janeiro de 2022 já atingiu o estágio de uma Depressão Tropical, o seu epicentro já se encontra no Canal de Moçambique, e continua a intensificar-se e podendo evoluir a Tempestade Tropical severa, com ventos de 90 a 120 Km/h e rajadas até 140 Km/h nas primeiras horas de amanhã dia 24 de Janeiro. O seu epicentro atingirá a provincia de Nampula, entrando entre os distritos de Mogincual e Larde, no período de tarde do dia 24 de Janeiro de 2022. Nos dias 23 a 27 de Janeiro, prevê-se chuvas fortes a muito fortes acompanhadas de trovoadas nas provincias de Nampula, Zambezia, Sofala, Tete, Niassa, Cabo delgado e Manica.
Recomendações	Face a ocorrência de trovoadas e chuvas fortes e fenómenos associados, recomenda-se a tomada de medidas de precaução e segurança.
Actualização	Amanhã, dia 24 de Janeiro as 09:00 horas.

Source: INAM

Figure 6-44 Rainfall Forecast Information Published by INAM

6.6.11 Challenges in Developing a Cyclone Evacuation Plan (No Storm Surge)

For the central urban area of Beira, when a cyclone with no storm surge (inland flooding only) effects the area, the Evacuation Plan WG should be able to take the lead in developing future based on the hazard map created during this JICA project. However, since the northeastern area of Beira has a river (Mungasa river) and there are also areas near waterways that experience backflows from tidal flows, it will be necessary to take these effects into consideration. In the future, it will be necessary to accumulate data when such flood damage occurs by recording when and how the waters rose.

Just as in Japan, when a cyclone passes at a certain speed, the timeline action plan can be applied. However, due the characteristics of cyclone trajectories in this region, when a cyclone stalls or changes its course and returns, it can cause heavy rains that lead to complex disasters. So, although there may be a fixed amount of rainfall before the cyclone arrives, peak rainfall does not necessarily occur just before or after arrival. Therefore, a response to such “non-standard” cases needs to be considered in the future.

Even when a cyclone is not accompanied by a storm surge, the capacity of evacuation centers (23,000) is far less than the number of evacuees (about 93,000). CMB intends to continue its steady efforts to seek cooperation from owners of non-public large facilities to have those locations open up as evacuation centers in the event of an emergency. There is also recognition of the necessity to secure locations now so that facilities that can serve as an evacuation center can be constructed in the future. However, if we keep in mind the case of wide-area evacuation, it is also essential to construct gymnasiums, stadiums, and other facilities with some capacity to serve as disaster prevention centers.

6.7 Reference Materials for the Disaster Response Plan

6.7.1 Reference Materials for Evacuation Planning

(1) Content

Project outputs were organized, and a reference document was prepared as a possible reference for implementing similar activities in other areas. The document organizes evacuation planning methods at the municipal, Bairro, and evacuation center levels, and summarizes the findings and lessons learned through the development of evacuation plans and carrying out evacuation drills in Beira. The purpose of the reference materials and the targeted users and chapter breakdowns are listed in the table below.

Table 6-32 Reference Materials for Evacuation Planning

Item	Content
Purpose	A resource that can help city officials in other areas to develop evacuation plans for cyclones by learning about the experience of developing evacuation plans in Beira.
Audience	City officials trying to develop an evacuation plan
Structure	01. Evacuation Planning Steps
	1. Background
	2. The importance of evacuation plans
	3. The structure of evacuation plans
	4. Evacuation planning for local governments
	5. Step 1 Basic preparation
	6. Step 2 Timeline action plan
	02. The Case of Beira
	03. Related Information

Source: JICA Project Team

(2) Expected use of the Material

How to utilize the reference materials for evacuation planning was discussed with evacuation plan WG members. First, it is expected to be used in the formulation of evacuation plan within the city of Beira in the Bairro or at the planning activity by relevant institutions for disaster response in the province of Sofala. In addition, this reference material is expected to be used throughout the country after the confirmation by the INGD head quarter.

Continuous activities such as securing budget for evacuation planning activities and promotion of the use of reference materials to be used throughout the country are expected to be carried out for the dissemination of the outcomes. The table below provides details on how the reference material for evacuation planning could be used and the challenges to be widely used in the country.

Table 6-33 Expected Utilization of the Reference Material for Evacuation Planning63

Points	Details of utilization method and challenges for dissemination
Utilization in Bairro-level evacuation planning activities in Beira city	CMB in collaboration with INGD Sofala Provincial Office, has agreed on the commitment for this project activity to develop evacuation plans in all CLGRD in Beira city by December 2023. In addition, the concept and case studies of the Timeline Action Plan have already been presented to the CLGRDs of 16 biros during the project. It is expected that timeline action plans will be developed in all districts using the referenced documents. On the other hand, there is no budget prospect for ongoing activities, and it is necessary to secure a budget for activities through requests for support from international donors.
Utilization by institutions involved in disaster response within the Sofala province	The INGD Sofala Provincial Office has agreed in the commitment for this project activity to develop an evacuation plan, including a timeline action plan, by December 2023 by the relevant agencies (Provincial Department of Education and Human Development, Provincial Department of Health, Police, Fire Department, etc.) on disaster response in Sofala Province. In order to promote activities in relevant agencies in the state, the concept of the Timeline Action Plan was explained during the project. On the other hand, it is necessary to go through the process of approval of the activities to formulate Timeline Action Plan by the Mayor of Beira city, State Secretary and the Governor of the State for the related institutions to start consideration.
Promote nationwide use of reference materials for evacuation planning	INGD has prepared a regional facilitator manual that summarize the disaster response action items, including the establishment of a CLGRD (at that time called CLGRC) in 2009. The manual is still being used during INGD and CLGRD activities at this time. The Timeline Action Plan implemented through this project supplements the manual with the importance of pre-evacuation and actions with a timeline. It is expected that this reference document will also be used in conjunction with the Regional Facilitator Manual as a reference document through internal INGD discussions.

Source: JICA Project Team

6.7.2 Disaster Risk Reduction Education Booklet

(1) Content of the Booklet

Using knowledge obtained from disaster risk reduction education and public health education during the project, a booklet was prepared that can be used for ongoing disaster risk reduction education in Beira. The booklet was also prepared with information based on Japan's "My Timeline" efforts (Shimodate River Office, Edogawa Ward, Tokyo). For details, please refer to the additional work report (submitted July 2020).

Table 6-34 Overview of Disaster Risk Reduction Education Booklet

<table>
<tr><th colspan="2">Subject</th><th colspan="2">Content</th></tr>
<tr><td colspan="2">Purpose</td><td colspan="2">A disaster prevention education reference for Beira residents and Primary/middle school students, and to promote advance evacuation when a cyclone lands or approaches.</td></tr>
<tr><td colspan="2">Audience</td><td colspan="2">INGD staff and school teachers who carry out disaster education activities</td></tr>
<tr><td colspan="4">Configuration plan:</td></tr>
<tr><td colspan="3">Item</td><td>Content</td></tr>
<tr><td>1</td><td colspan="2"><u>Learn</u>
Gain basic knowledge about natural disasters</td><td>Deepen one's understanding of the natural phenomena that cause disasters, especially focusing on cyclones and storm surges caused by cyclones.</td></tr>
<tr><td>2</td><td colspan="2"><u>Understand</u>
Understand what kind of situations arise in a natural disaster</td><td>In addition to understanding the natural conditions of Beira, deepen one's understanding of hazard maps and understand the characteristics of the disaster risks that Beira faces.
Learn and understand the lessons from Cyclone Idai.</td></tr>
<tr><td>3</td><td colspan="2"><u>Think</u>
Consider the needed measures in the event of a disaster</td><td>Understand the importance of taking precautions and evacuating to an evacuation center in advance.
Examples of necessary measures before, during, and after disasters, and consider necessary measures.</td></tr>
<tr><td>4</td><td colspan="2"><u>Plan</u>
Create one's own timeline</td><td>Worksheet and entry examples for creating one's own timeline.</td></tr>
<tr><td>5</td><td colspan="2"><u>Share</u>
Share the acquired knowledge with one's community and family</td><td>Under the premise of disseminating the contents of disaster prevention education, students and residents receiving the disaster prevention education will understand the importance of sharing the content of this education with other residents, their families, and surrounding communities
Understand the point to be aware when in evacuation centers the importance to contributing to the management of the evacuation center when using the evacuation center.
Understand the importance to understand and observe the manners and to take care of public health in order to maintain a safe and comfortable evacuation center living condition.</td></tr>
</table>

Source: JICA Project Team

(2) Expected use of the DRR Education Booklet

How to utilize the DRR education booklet was discussed with evacuation plan WG members and the Ministry of Education and Human Development (MINEDH) and the National Civil Defense Unit (UNAPROC) of the INGD Headquarters. In addition to its utilization in the formulation of evacuation plans in the city of Beira, and utilization in school classes in Beira and surrounding districts, the DRR education booklet is expected to be officially approved by MINEDH to promote its use throughout the country. Continuous activities such as securing a budget for activities and promoting official approval of the DRR education booklet are expected to promote the dissemination. The table below provides details on how the DRR education booklet could be used and the challenges to be widely used in the country.

Table 6-35 Expected Utilization of the DRR Education Booklet

Points	Details of utilization method and challenges for dissemination
Utilization in Bairro-level evacuation planning activities in Beira city	CMB in collaboration with INGD Sofala Provincial Office, has agreed on the commitment for this project activity to develop evacuation plans in all CLGRD in Beira city by December 2023. In the project evacuation planning was conducted by combining consideration of timeline action plan, DRR education, and evacuation drills to strengthen disaster response capabilities. Similarly, it is expected that the booklet to be used in the evacuation planning activities in the CLGRD. Especially when the evacuation planning is conducted by targeting education facility as evacuation center, DRR education activities in cooperation with school disaster prevention councils (CEGRC) is also expected.
Points	Details of utilization method and challenges for dissemination
Utilization in school classes in the district surrounding the city of Beira in Sofala province	The Sofala State Department of Education and Human Development (DPEDHS) have prepared a draft action plan for DRR activities, including the promotion of lessons on natural disasters and disaster management in school education in collaboration with the County Education, Youth, Science and Technology Office (SDEJT), the School Disaster Management Council (CEGRC) and other relevant agencies. On the other hand, there is no budget in sight for activities, and it is necessary to secure a budget for activities through requests for support from international donors.
Official approval of the DRR Education Booklet to promote its use throughout the country	MINEDH has developed a guidebook called PEBE (School Emergency Response Planning Orientation Guide) and using it as a teaching tool for DRR education in educational settings. The DRR education booklet developed in this project can complement the contents of PEBE by the contents on understanding cyclones, understanding hazard maps, and content related to the implementation of pre-evacuation. For this reason, it is expected to be used as part of the educational material together with PEBE. For dissemination, approval within MINEDH must be obtained to be used as an official teaching material.

Source: JICA Project Team

6.8 Achievement of the activities and expected future activities and recommendations

6.8.1 Expected future activities and challenged for implementation

Based the inputs from the project, the dissemination of evacuation planning in Sofala province, continuous improvement of the evacuation plan in Beira city, development of evacuation plans at the Bairro and evacuation center level in Beira city, development of a timeline action plan by relevant agencies in Sofala Province, and implementation of DRR education activities in elementary and secondary schools in Sofala Province is expected. In addition, for the national level activity, it is expected that the reference materials for evacuation planning to be used by the INGD and other local governments, and the DRR education booklet to be used by the Ministry of Education and Human Development (MINEDH).

In particular, it is important that the Evacuation Planning WG take the lead in promoting activities in Sofala province and show the effectiveness of the inputs of the project.

There are two perspectives on the challenges of implementing the dissemination activities. First is the issue of securing a budget for activities. Due to the limited financial resources in Mozambique, usually the country's own budget is used for urgent issues, including disaster response, and it is difficult to secure a budget for disaster management activities before a disaster happens. As a result, pre-disaster disaster management activities are currently dependent on international organizations and donor assistance. Therefore, it is necessary to continue to request for assistance from Germany, the Netherlands, and the World Bank, which provide related assistance in Beira. The second is to strengthen the coordination among the relevant institution to continuously implement activities, and to clarify the institutional role of the relative institution. For example, activities related to evacuation planning, including timeline action plans, could be positioned as part of the activities of the State Technical Council for Disaster Prevention (CTPGC), as stipulated in the Disaster Prevention Law.

CHAPTER7 Pilot Project for Disaster-Resilient Fish Market

7.1 Current Situation at Praia Nova Fish Market

7.1.1 Selection of Target Site

It was decided to target the Praia Nova fish market for this project in consideration of livelihood recovery. The reasons for the selection have been outlined below.

- The target site is a major domestic fish market with many visitors come from other cities and has potential as a tourist destination.
- The target site is located in the area which is vulnerable to annual storm surges (during the Cyclone Idai, shop stalls and houses were damaged/destroyed by following long-term flooding and more than 2,500 people, including the traders of the market, had no choice but to evacuate, bringing economic activity to a halt).
- Assuming to move the structures in times of floods, the structures are built with simple and fragile shacks rather than a resilient building. (details on the structure is provided in later sections).

7.1.2 Management System of the Market

The Praia Nova Fish Market is located on the west coast of Beira, at the mouth of the Pungwe River. Beira Municipality overlooks the site, where about 1,400 merchants (wholesalers) and fishermen gather.

Each market has its own Market Management Committee (CGM; Comite de Gestao do Mercado) established. The CGM is required to report monthly on its activities to the CMB in accordance with the guidelines distributed by the CMB. These activities include administrative contact with market parties concerned, troubleshooting, cleaning, security, and coordination of internal events. For managing and coordinating these activities on behalf of the CMB, the CGM will receive 5,000Mt (including electricity subsidy) from the CMB. The representative members of the CGM are elected from among the market's merchants, and they carry out their management duties while balancing their own business activities.

The Praia Nova Fish CGM was established in 2012, and as of 2022, it has approximately 30 members. The work is divided between cleaning the public toilets (4 people), security and refrigeration equipment management (3 people), and overall market cleaning and mediation of commercial disputes (23 people). In addition to the CMB, the CGM works with the CLGRD for local disaster management, the Fisheries Community Committee (CCP, Comité Comunitário das Pescas) for market management, and CGMs of other markets in case of events, etc.

CGM's office was in the nearby public fish market, but the office facilities are no longer usable due to roof damage from Cyclone Idai. Although the roof remains unrepaired, CGM staff utilize the limited area where remaining roof covers, but often works outdoors due to lack of adequate space and facilities. CCP’s beachside office was damaged and washed away in the storm surge, and they now work without a base.

CLGRD does not have an office near the Praia Nova fish market but makes frequent-visits as part of managing the annually-flooding area, and conducts educational activities on disaster preparedness with CMB.

7.1.3 Users

Many of the shops lined up in the market are very simple structures, with posts mainly made of tree branches, and materials such as iron sheets, blocks and stones used for walls and roofs. There are also shops with no stall that simply lays out products the plastic sheets laid on the ground.
A wide variety of items are sold in the market in addition to fish, such as drinks, sweets, clothes, toys, and medicines. The fish being sold are caught by fishermen on the coast every morning and sold by wholesalers. There is a significant sanitation problem; fresh products are left in the open for hours with nothing cover/preserve them and flies gather around attracted by the rotting food and the scattering garbage. Sand and dust flutter in the wind and fall onto the products. It appears that not many other kinds of fresh foods are sold here other than fish.

Raw fish for sale at stalls are placed on a plastic sheet or a board.

The road is barely wide enough for cars to pass each other. Water gathers in depressions and remains for several days, even after light rainfall.

Source: JICA Project Team

Figure 7-1 Praia Nova Fish Market

Most of the merchants live in the area surrounding the fish market. The area protrudes from the seawall, and hence is not allowed to be inhabited according to the Municipal land-use plan. However, as the merchants have their business at the market, it is difficult for them to leave the area and have to suffering themselves for being affected by annually occurring cyclones and floods.

Source: JICA Project Team

Figure 7-2 Area around Praia Nova Fish Market

7.1.4 Proposal for *Kigumi* Wood Construction Techniques

In light of the above situation, it was considered that a means of breaking the negative loop would be to remove the structures to a safe location before a cyclone or storm surge occurs, and then rebuild it after the cyclone has passed, a measure that has been the goal of merchants. In order to achieve this, it was essential to introduce a construction method that would allow for easy assembly and disassembly. In considering this technology, emphasis was placed on the following points: the availability of locally trained personnel, the ability to use locally available tools, and the applicability of locally available materials.

During the site survey made in November 2019 at Beira, the project team observed numerous woodworkers processing wood to make furniture and trusses. Most of them belonged in workshops of a few people, and their business seemed to be strongly related with the local community, making it a suitable industry to strengthen the local community as a whole. The furniture and trusses made by the local carpenters proved that the carpenters had sufficient basic woodworking skills, the necessary tools for wood processing, and enough distribution of easy-processing timbers. If these local craftsmen could learn and hone their skills in new technique that allows assembling and disassembling, they would be able to create a much wider variety of products and contribute to the strengthening the resiliency of the local community.

Considering the above situation of human resources, materials, and tools is sufficient, the project team came to a conclusion of introducing “Kigumi”, a traditional Japanese construction method which allows repeated assembling and disassembling.

7.2 Introduction of Kigumi Wood Framing Techniques

7.2.1 Kigumi Training (September 2021)

(1) Preparation of the Training

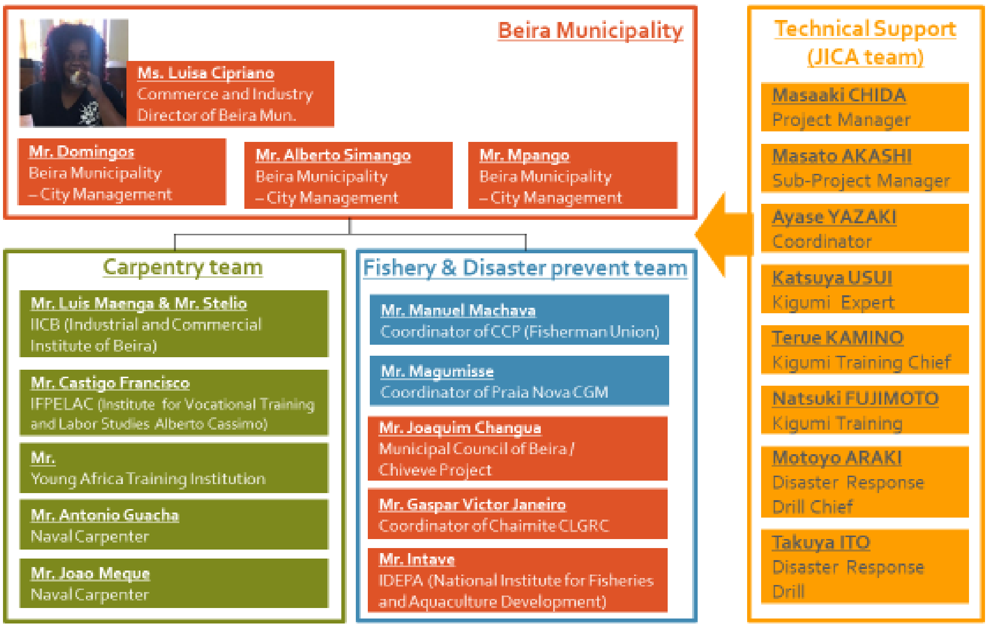
1) Kigumi Working Group

In the process of introducing woodworking technology to the local community, a working group (hereafter referred to as "WG") was established to study activities related to Kigumi. The WG, which had originally been examining activities to restore livelihoods, was taken over with new members who were expected to be involved in woodworking. The list of members of the Kigumi WG is provided below, and the agenda items are mentioned in the following sections.

Table 7-1 Kigumi WG Members

<table>
<tr><th>Organization</th><th>Position</th><th>Name</th></tr>
<tr><td>GREPOC</td><td>Engineer</td><td>Mr. Carlito Dino Nhama</td></tr>
<tr><td>CMB Department of Industry and Commerce</td><td>Director</td><td>Ms. Luisa Mateus Cipriano</td></tr>
<tr><td>CMB Department of Construction</td><td>Director</td><td>Mr. Alberto Simango</td></tr>
<tr><td>CMB Department of Livestock, Fisheries & Environment</td><td>Technician</td><td>Ms. Pamela Isabel Jorge Sacur</td></tr>
<tr><td>Praia Nova CGM</td><td>President</td><td>Mr. José Magumisse</td></tr>
<tr><td>Maquinino CGM</td><td>Coordinator</td><td>Mr. Albano Armando Choande</td></tr>
<tr><td>Praia Nova CCP</td><td>President</td><td>Mr. Manuel António Machava</td></tr>
<tr><td>Vocational School IICB (Industrial and Commercial Institute of Beira)</td><td>Director for Production</td><td>Mr. Luis Maenga</td></tr>
<tr><td rowspan="2">Vocational School IFPELAC (Alberto Cassimo Institute for Vocational Training and Labor Studies)</td><td>Deputy Director</td><td>Mr. Castigo Francisco</td></tr>
<tr><td>Lecturor</td><td>Mr. José Manico</td></tr>
<tr><td>Carpenters (from nearby Praia Nova Fish Market)</td><td>—</td><td>Mr. Antonio Guacha
Mr. Joao Meque</td></tr>
</table>

Source: JICA Project Team



Source: JICA Project Team

Figure 7-3 Structure of the Kigumi Working Group

WG members include people working in
the fisheries or at vocational training schools.

There were about 10 participants,
and participation remained stable.

Source: JICA Project Team

Figure 7-4 Kigumi Working Group discussions

2) Training Venue

The training site had to be large enough to accommodate a large group of people, to allow for the assembly and disassembly of wooden stalls, to allow for the use of electronic equipment such as power drills, to be unencumbered by rain, and to allow for the storage of timber during the training period. There were four candidate sites for the training venue based on proposals from the vocational training schools and CMB officials who were part of the Kigumi WG. The IICB venue was the most suitable in terms of the overall evaluation, but IICB had to close for the COVID-19 measure, so the second candidate venue, IFPELAC, was selected.

Table 7-2 Training Facility Candidates

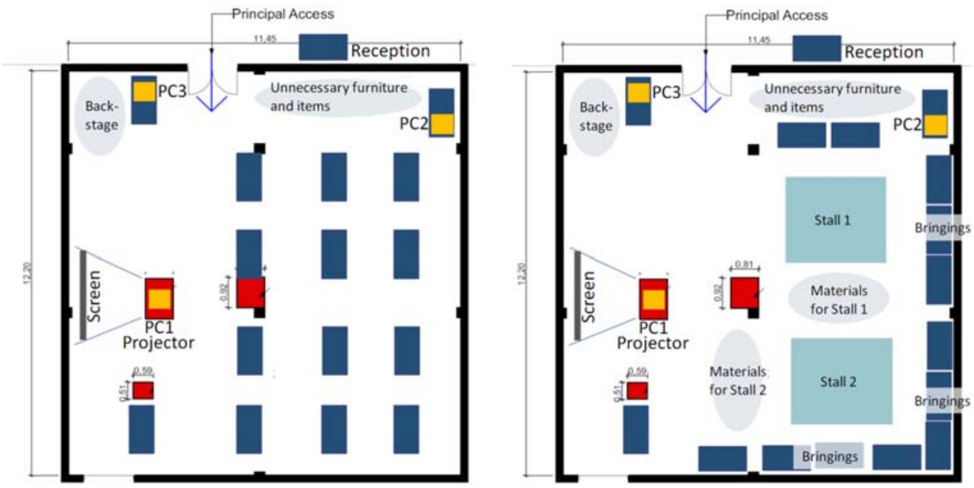
Facility Name/Characteristics	Training Rooms	
IICB (Vocational training school) - Size: Good - Ventilation: Acceptable (Sufficient openings) - Equipment: Good (Various new equipment available) - Movable equipment: Good (Mostly movable) - Access: Good (Central Beira)		
IFPELAC (Vocational training school) - Size: Good - Ventilation: Good (Large openings) - Equipment: Acceptable (Old, but sufficient for training) - Movable equipment: Acceptable (Some not movable) - Access: Good (Central Beira)		
Young Africa (Vocational training school) - Size: Good - Ventilation: Good (Large openings) - Equipment: Acceptable (Old, but sufficient for training) - Movable equipment: Some Issues (Basically not movable) - Access: Some Issues (Northwest Beira, far)		
CMB Novo Cine (Beira City) - Size: Good - Ventilation: Some Issues (Openings in training space are small) - Equipment: None - Movable equipment: Some Issues (Basically not movable) - Access: Some Issues (Northwest Beira, far)		

Source: JICA Project Team

3) Training Method

In considering the training method, the COVID-19 pandemic and official measures taken in Mozambique made difficult for the project team to travel to Beira, therefore it was decided that the training would be conducted remotely in July 2021 via online video calls. However, after remote training started, COVID-19 cases in Mozambique dropped and the infection measures were eased, and travel to Beira became possible. The JICA Project Team decided to visit the site after the training to confirm the effectiveness of the remote training and to conduct the necessary follow-up.

For conducting live-remote training, online conference applications were used to connect Japan and Beira. Cameras were set up both sides to enable communication between the two sides. A complete set of Kigumi stall was also prepared in Japan to show the processing and assembling in real-time. For Beira side, cameras were installed at three locations (front center, front side, rear) to get a more detailed view. On the Japan side, a wide-angled fixed camera was used to capture a full view of Kigumi stall, and a handheld camera (smart phone) was used for better visibility of the wood processing. The training venue in Beira was arranged as follows; one for classroom lectures and the other for practical training and assembling the stalls.



Source: JICA Project Team

Figure 7-5 Layout of the training room

In the online-meeting style training, time lags caused by local internet connection stability and interpretation (translation), measures were taken to minimize such time lags. Scripts to be read by local staffs were prepared in advance for preliminary explanations and precautions that did not need to be presented by instructors from Japan side. Also, local staffs and Project Team in Japan were secured with multiple communication methods (SNS and email applications) to avoid not-communicable situation.

Since remote training is subject to the effects of Wi-Fi signals and time lags caused by interpreters, and significantly impact the outcome of the training, measures were required to minimize these effects. The following measures were implemented.

(1) Text and video materials were prepared and played on-site so that even limited speech could be conveyed accurately.
(2) In order to allow local staffs to proceed with the training even in the unlikely event that the internet connection was interrupted, a manuscript was prepared for all the training contents. (The parts that did not require interpretation, such as preliminary explanations were handled by the local staff using the manuscripts.)
(3) To ensure that the training would proceed smoothly even in the event of a problem, in-depth meetings and rehearsed with the local staffs were held in advance.
(4) In order to ensure constant contact with local staffs, multiple internet providers were secured on the Beira side, and a variety of devices and SNS services were made available.

4) Training Contents

The training contents were decided within the discussion made in the Kigumi WG. The training materials include the followings.

- The history of Kigumi techniques
- Characteristics of locally available timber
- Types of wood joinery and finishes
- Use of various tools
- How to process each part
- Measurements of parts (development diagram)

Videos were created for items that required detailed motion showing how to use each tool, how to process components, and how to assemble them.
In addition, the number of Kigumi stalls to be created during the training period was set at 10 as the request of Beira City.


3-2 Chisel

I. Major Function

Chisels are often used to dig a groove into the wood. It is designed to be hit on the end of handle with a hammer and this allows precise control in angle and depth of the groove. The hammer must hit the end of the chisel with accuracy and control to give a uniform impact on the cutting edge.

II. How to Use

When holding the chisel, place it at the base of your fingers and round the fingers on to the handle. When hitting the chisel hard to deeply carve into the wood, it is safer to hold the upper end part of the handle. For precisely working, place the hand a little lower and place the thumb upward to give extra support and control. Bend the wrist inward to protect the grabbing arm from the hammer mistakenly hitting.

Have your grooving target on your left and sit on the wood post as shown in the below pictures. Do not bestride or straddle the wood as this way you are more likely to mistakenly hit yourself. This will keep your artery safe from being mistakenly hit by one of your tools. Grab the chisel tightly and keep your arm relaxed. The furthest and the left edges are where to carve. To carve the other sides, sit on the other side of wood for safer working.

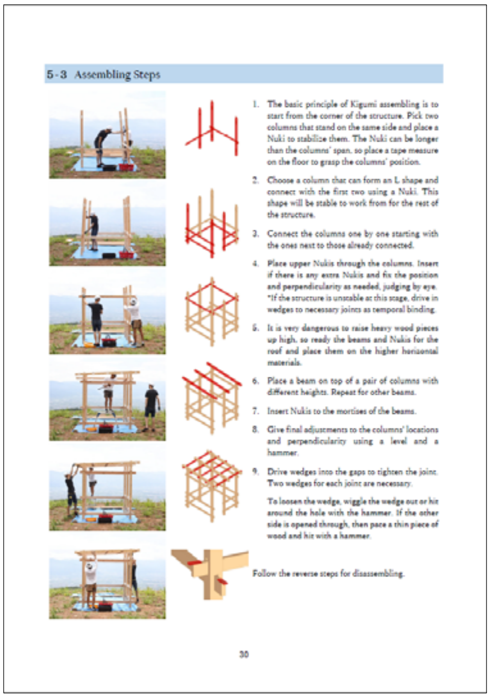
Chiselling stood

Chiselling sat down

Chiselling the narrow edge

The left and the furthest carving edges

13


5-3 Assembling Steps

1. The basic principle of Kigumi assembling is to start from the corner of the structure. Pick two columns that stand on the same side and place a Nuki to stabilize them. The Nuki can be longer than the columns' span, so place a tape measure on the floor to grasp the columns' position.
2. Choose a column that can form an L shape and connect with the first two using a Nuki. This shape will be stable to work from for the rest of the structure.
3. Connect the columns one by one starting with the ones next to those already connected.
4. Place upper Nukis through the columns. Insert if there is any extra Nukis and fix the position and perpendicularity as needed, judging by eye. *If the structure is unstable at this stage, drive in wedges to necessary joints as temporal binding.
5. It is very dangerous to raise heavy wood pieces up high, so ready the beams and Nukis for the roof and place them on the higher horizontal materials.
6. Place a beam on top of a pair of columns with different heights. Repeat for other beams.
7. Insert Nukis to the mortises of the beams.
8. Give final adjustments to the columns' locations and perpendicularity using a level and a hammer.
9. Drive wedges into the gaps to tighten the joint. Two wedges for each joint are necessary.

   To loosen the wedge, wiggle the wedge out or hit around the hole with the hammer. If the other side is opened through, then pace a thin piece of wood and hit with a hammer.

Follow the reverse steps for disassembling.

30

Source: JICA Project Team

Figure 7-6 Excerpt from the training text (English version)

5) Trainees

In order to build the 10 Kigumi stalls, the project team assumed that each stall would be finished by two people, for a total of 20 participants, taking into account the duration and the amount of work required. (The number of participants was determined to be sufficient to allow for remote supervision.)

Originally, the training was targeting carpenters around the Praia Nova fish market, but following discussions made in the Kigumi WG concluded that to include instructors from carpentry courses at vocational schools who are essential for disseminating Kigumi techniques, carpenters from CMB to monitor the levels of techniques, and carpenters from other administrative districts within Beira to efficiently disseminate the techniques. The selection of carpenters from other administrative districts was implemented by the CMB. The list of final participants are as follows.

Table 7-3 List of Trainees

Affiliation	Number of Attendees
CMB	2
Praia Nova Fish Market area	4
Praia Nova CLGRD	2
Chiveve Bairro	2
Munhava Bairro	2
Inhamizua Bairro	2
Manga-Loforte Bairro	2
Nhangau Bairro	2
IFPELAC (vocational training school)	1
IICB (vocational training school)	1
TOTAL	20

Source: JICA Project Team

6) Training Program

In consideration of the local carpenters' own work schedules, training was held once per week for three weeks (a total of three days). The 3 days program of the remote training is shown in the table below. Make-up classes were held as needed for those who could not attend or complete their work.
The follow-up training held face-to-face was conducted tailored to the level of the individual trainees.

Table 7-4 Program for Remote Kigumi Training

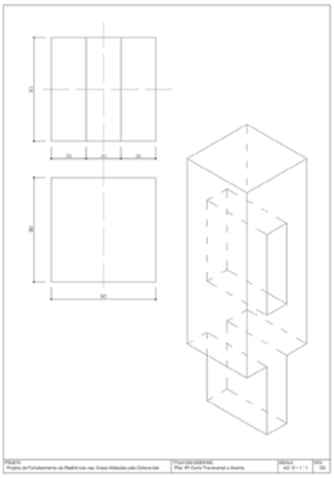
Time	Day 1	Day 2	Day 3
Homework	Read through Textbook	Finish up Hozo (tenon) and Kusabi	Finish up Hozo whole (Mortise)
8:00～	Preparation		
8:30～	Participants gather		
9:00～ Opening	**Opening** Attendance check, Confirmation of the goal of the day, Check the schedule of the day, Explanation of Precautions (Filming Permits, Distributed Materials, Handling of Hazardous Materials, etc)		
9:30～ Session 1	**Explanation on processing** • Hozo (Tenon) • Kusabi (Wedge)	**Explanation on processing** • Hozo whole (Mortise)	**Explanation on processing** • Hozo whole (Mortise)
10:30～	Break (10min)		
10:40～ Session 2	**Self-practice** (1to1 Q&A Available)		
12:00～	Lunch (60min)		
13:00～ Session 3	**Self-practice** (1to1 Q&A Available)		**Discussion** • Did you feel the need for Kigumi techniques? • What can Kigumi be utilized for? • How can we spread and develop this skill?
15:10～ Closing	**Closing** Confirmation of the goal of the day, Photo shooting, Explanation of later schedules, Homework by next training, Questionnaire		
15:30～	Finish		

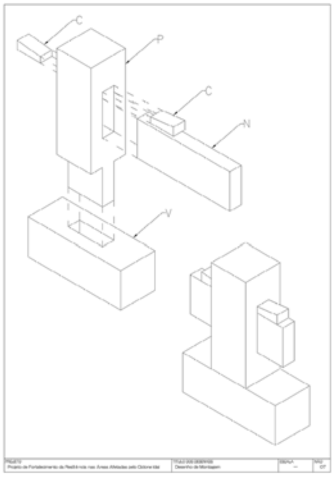
Source: JICA Project Team

7) Postponement of Training and Addition of Pre-Training Assignments

The training was initially scheduled for July, but as the number of COVID cases rose, the Presidential order was activated including restriction for the number of people who could gather indoor (50% of capacity or a maximum of 15 people) and limiting hours for public services from 8:00 a.m. to 2:00 p.m. Conduction of the training in fewer participants was discussed but considering the effect of the training and anxiety the participants may feel, postponement of the training was decided.

Since the participants had to spend more time at home due to the order, additional pre-training preparatory task was assigned until the training could be held. (It was also difficult to hold Kigumi WG meetings, so WG members were contacted individually to confirm matters.)
The preparatory assignment was to process a whole set of Kigumi joints which are used in the Kigumi stall, in order to practice for the actual up-coming training. The participants were given about 1.5 months to practice and asked to submit their work on the very first day of the training.





(a) Detailed Diagrams (b) Instruction of How to Assemble (c) Submittion of the Assignment

Source: JICA Project Team

Figure 7-7 Pre-training Assignment

(2) Implementation of Kigumi Training

1) Remote Training (September 2021)

The first day of the remote training was very high-profile, with greetings from the mayor of Beira and from Director of CMB Department of Industry and Commerce, who also served as the Kigumi WG representative. The opening was highly profiled with local media covering the event.

Since neither the participants nor the study team had any experience with remote training, prepared texts and videos were used to explain each step. From the second day forward, more two-way communication was attempted (including live streaming) so that instructor from the project team at Japan could demonstrate detailed techniques not conveyable in text or video. Despite being unfamiliar with the tasks, the willingness and concentration of the participants were so high that they postponed their break, and the study team was overwhelmed by their motivation.

Also, on the final day of the training, rather than just practicing processing and learning techniques, a discussion was held on how participants could make use of and disseminate the Kigumi techniques they had acquired. Participant opinions included making furniture and temporary scaffolding at construction sites. In response to the opinions, the project team also asked questions and gave their own opinions. The project team kept the interactive nature of the exchange in mind and took care to motivate participants and make them aware of future technique development.

During the remote training in the first processing step of center-lining the timber, it was found that the general wood in Mozambique is unevenly cut, and some of the wood was moldy due to careless management. The quality of the wood differed greatly from what is available in Japan. The training materials were designed to have participants take measurements based on the surface, but the uneven surface made this very challenging, so the method was hastily changed to measuring from the core. Japanese

Kigumi carpenter (project team member) made a live demonstration, and the carpenters on Beira side followed along frantically to try to replicate what they were being shown.

Although some sudden adjustments to the actual training were required, in three days of remote training (plus two extra preparatory days), two out of the originally envisioned 10 stalls were fully completed, and eight were partially completed. At the end of the final day, Director of the Social and Productive Area of GREPOC presented certificates of completion to the carpenters that completed stalls.

Source: JICA Project Team

Figure 7-8 Remote Training Sessions

2) Follow up Face-to-Face Training

Face-to-face training involved three days of intensive session, and training participants were encouraged to actively participate. It was found that the importance of the suddenly added content and the points to be noted had not been conveyed well, so the project team did an intensive follow-up on those contents. As a result, all 10 stalls were successfully completed.

Source: JICA Project Team

Figure 7-9 During in-person training

3) Use after the Handover Ceremony

The 10 stalls processed by the participating carpenters were handed over to the CMB at the Praia Nova Fish Market on 8th December. The handover ceremony was attended by the Director of CMB Department of Industry and Commerce head of the Kigumi WG, Architectural Engineer from GREPOC, staff from the local JICA local office, and others. The carpenters who attended the Kigumi training demonstrated assembling and disassembling of the Kigumi stalls.

Source: JICA Project Team

Figure 7-10 Handover ceremony

After discussions between the CMB and the market management committees (CGMs) in Beira, it was agreed that one or two kigumi stalls would be placed in different popular markets to increase their recognition. By mid-December, most of the stalls were distributed through the CGMs to those who wished to use them, with the users prepared additional materials such as roofs, counter table-panels, etc to start operating. As of October 2022, all stalls were handed over to the users and nine of them have been confirmed to be operational.

Table 7-5 Example of How the Kigumi Stalls Are Being Used

No.	Market	Photo	Status of Use
1	Praia Nova Fish Market		Status: Operating Uses: Fish Seller Devises: Corrugated plates are attached to the roof.
2	Praia Nova Fish Market		Status: Operating Uses: Breakfast Restaurant Devises: Corrugated plates are attached to the roof, and clothes are attached on the sides to prevent the sand and bugs coming into the cooking area.
3	Mobeira Market		Status: Operating Uses: Fish Seller Devises: It is painted blue to be very conspicuous and corrugated plates are installed on the roof. Because of the high concentration of stalls and protruding roofs, front of the stalls are relatively dark therefore light bulbs are also installed.
4	Ceramica Market		Status: Operating Uses: Greengrocer Devises: Located at the southernmost point (entrance) of the market, the roof is covered with corrugated sheets as well as plastic sheets for shade.
5	Ceramica Market		Status: Under Preparation Uses: Unknown Devises: Corrugated plates are attached to the roof.

No.	Market	Photo	Status of Use
5	Boa Vontade Market		Status: Operating Uses: Greengrocer Devises: The roof is fitted with corrugated plates, which are also installed on the side surfaces. The rainwater is oriented to fall behind the stall.
6	Chingussura Market		Status: Operating Uses: Shoes Store Devises: Because of the large number of products, it is used as an integral part of the original stall.
6	Vila Massani Market		Status: Operating Uses: Fish Seller Devises: The roof is covered with plastic sheets, and the tables are attached to expand the sales space.
7	Vila Massani Market		Status: Operating Uses: Fish Seller Devises: Plastic sheets are attached to the roof which extends to the front of the stall.

Source: JICA Project Team

Based on this training and subsequent use of stalls, the following comments were received from a survey of participants and organizations.

Table 7-6 Response from Officials, Organizations and Carpenters

Organization/Person	Response
CENOE Mr. Pedro Nhampule (construction technologist) October 2021	• Wooden houses also used to be the norm in Mozambique. • This initiative to revive facilities using wood is very interesting.
GREPOC Mr. Nhama January 202	• This technology will greatly contribute to low-income communities. • Various uses can be expected: If kigumi is used for the structural part and tent fabric is used for walls, etc., it is possible to construct temporary housing, small offices, and multi-purpose offices at disaster victim relocation sites, etc. • The techniques obtained through the use of kigumi stalls are sufficiently effective and can be used for housing and other structures as well. • I am in favor of becoming a core person for ongoing activities related to kigumi construction in the future. • Vocational training schools such as IFPELAC and IICB are suitable organizations to carry on the dissemination of these techniques. • The involvement of the Ministry of Land and Environment would greatly support the use of wood. • As for promotion, the IOM (International Organization for Migration) could be expected to require these woodworking skills.
CMB Councilor (Assistant to the Mayor) April 2022	• I have the sense the Beira carpenters were able to master kigumi techniques. • Beira City would like to consider the possibility of creating a way for kigumi techniques to play an active role in the community.
Organization/Person	• Response
Beira CMB Ms. Luisa (manager at Beira City Department of Industry and Commerce) December 2022	• Expectations for use in a variety of ways in Beira (offices, residences, kiosks, etc.). • Positive consideration is being given to increasing the number of facilities that utilize kigumi techniques.
IFPELAC (vocational training school) Mr. Castigo, Mr. Manico (woodworking course instructors, participants in kigumi training) January 2022	• We feel that this is a very new technology that can be used as an alternative to conventional housing (block construction). • It is effective for small-scale facilities, as there are markets without offices or restrooms, and as sheds for police, security guards, etc. that are needed but not available. • We have seen the kigumi technique and would very much like to include it in the school curriculum. In order to do that, we need to consult with SEJE (Secretary of State for Youth and Employment) and ANEP (National Authority for Vocational Education) and get their approval, so they should be included in the discussions. • Since the price of wood is considered to be an obstacle to the dissemination of wood assembly technology, organizations involved in the wood industry should be included in the process.

Organization/Person	Response
IICB (vocational training school) Mr. Maenga (Fish Market Kigumi WG) January 2022	• I find kigumi techniques to be a very interesting technology. However, the price of wood is still a concern. • We believe that kigumi techniques could contribute to structures such as temporary classrooms and temporary offices. • We welcome its introduction into the curriculum; we should include SEJE in our discussions in the future, as a curriculum change needs to be approved by them. • Due to the high price point of wood, many people prefer inexpensive block construction or twig/earthen walls.
IFLOMA (forestry company) Mr. Owana (sales) October 2021	• At the time Mozambique became an independent country, easily processable timber was bought up by the wealthy and became a resource that the poor could not afford to purchase. In light of this situation, the government established IFLOMA, a state-owned company that operates the entire timber production process from afforestation to sawmilling and marketing. • Timber is mainly grown and milled in Manica and sold in Maputo, Beira, and Nampula. The main timbers are African pine and eucalyptus, which can be purchased at a lower price than what is generally available in the market. • Since the quality and standard of wood is not controlled in Mozambique, wood sizes are basically made to order. • The main buyers are resellers or construction companies, and the wood seems to be used for trusses, rafters, ceiling materials, etc. • We are very interested in activities using lumber. We would like to know more about the progress on kigumi from time to time.
UNDP May 2020	• Tents are disposed of after use, but in the case of a facility that utilizes kigumi, there is no waste, which is very good because it is environmentally friendly.
Training program participants (carpenters) October 2021	• I understand that kigumi techniques are not limited to stalls and are highly versatile, but I feel that further improvement is necessary to construct houses and other structures. • I'd like to know more about how to utilize kigumi techniques to realize my own ideas.

Source: JICA Project Team

Based on the above responses, additional kigumi activities will be conducted with the aim of following up and further improving the level of kigumi training participants to ensure that kigumi is established in the field.

7.2.2 Additional Activities (June–September 2022)

(1) Consideration of Additional Activities

Additional activities were discussed and examined in consultation with JICA and local parties from two perspectives: 1) to effectively embed the content of the Kigumi training conducted in 2021 in the local communities, and 2) to conduct promotional activities to disseminate the Kigumi techniques. The following sections describe the background and details of each of these activities.

1) Promote the establishment of Kigumi techniques

In order to establish the Kigumi technique, Kigumi WG concluded through discussions that it is necessary to first improve the technique to meet local needs, and then to train people who will continue to play a role in teaching and disseminating the Kigumi technique.

Acquiring techniques that meets local needs

The content of the Kigumi training in 2021 was limited to the scale of easily constructed building the general framework of a small-scale structure with posts and beams. The structure was limited to the size of a food stall and was not intended to be "spent" inside the structure, as it did not include boards for the roof, floor, walls, etc. The wooden frame stalls were well received by GREPOC, the CMB, and the general public, but many of the questions rose from them were focused on the use of the stalls as houses, and the CMB and the carpenters who participated in the training (including instructors from vocational training schools) expressed a desire to develop the technology to build a practical building that would be used to “stay” a longer time.

In light of this, the project team has planned a training program to teach Kigumi techniques at a level that will enable the construction of relatively large-scale buildings with roofs, walls, and floors.

Table 7-7 New Elements for Additional Kigumi Training

Element	Description
Extension Joints	The timber available in Mozambique is generally about 4 meters in length. When constructing larger structures, the timber must be extended with joints. An extension joint is a method of fabricating and assembling a joint, calculated to ensure that the Timber pieces are securely joined.
Designing	The basic knowledge required to design a building. The designer needs to know how the structural parts work, the Mozambican regulations, the expected size of the various rooms, and any future/equipment that may be installed.
Roofs, Walls, floors	Methods of attaching boards.

Source: JICA Project Team

Key personnel in the dissemination of Kigumi technique

Participants in the 2021 Kigumi training included some who teach carpentry courses at vocational training schools. Among other things, IFPELAC is a public vocational training school, which is inferior to private vocational training schools in terms of the quality and age of its facilities, course variation and content, etc., and with the background that the number of applicants for enrollment is decreasing every year, the director of IFPELAC Beira showed strong will to introduce the Kigumi technique into the carpentry course.

Therefore, IFPELAC was transferred some of the tools and the teaching materials used in the Kigumi training and assisted in the development of a curriculum plan to incorporate Kigumi techniques into the carpentry course.

2) Promotion of Kigumi Techniques

At the suggestion of local carpenters, it was decided to consider establishing a Kigumi Technical Carpenters' Association of Sofala in the discussion of how to promote Kigumi techniques after the training in 2021. The reasons behind the establishment are that the establishment of an organizational structure will allow the carpenters for the sharing of opportunities to improve skills as well as placement of orders, and for stable continuity of activities. Then, additional activities are decided as supporting the establishment of this association, organizing an exhibition of Kigumi techniques, and providing support for the preparation of necessary publicity materials.

In June, additional Kigumi training will be conducted mainly for members who wish to join the association, and they will be asked to build a shed using Kigumi techniques; in July, the shed, teaching materials, and tools used in the training will be transferred as common property to the association and the IFPELAC, while advancing the establishment of the association. While proceeding with the procedures, the association will use the shed to hold Kigumi exhibitions starting in August in areas where it is considered effective. In addition, IFPELAC will be assisted in developing a curriculum for introducing Kigumi techniques into woodworking courses and in conducting trials of Kigumi sessions by instructors of carpentry course.

(2) Preparation of the Additional Training

The venue for the additional training was decided to be at IFPELAC, a vocational training school, as in the previous training. Fortunately, the increase in the number of Covid cases had calmed down and the participants were able to travel, so the training was to be conducted in person at the site.

Of the participants from the previous training, 16 wished to continue to participate, while others declined to participate due to conflicts of convenience. The available slots were filled by acquaintances of the participants who wished to participate, and by participants from the Dondo area (about 20 km northwest of Beira), where another school of IFPELAC is located, for a total of 20 participants.

Table 7-8 List of Trainees

Affiliation	Number of Attendees (New commers)
CMB	2
Praia Nova Fish Market area	4
Praia Nova CLGRD	2
Chiveve Bairro	3 (1)
Munhava Bairro	2
Inhamizua Bairro	1
Manga-Loforte Bairro	1
Nhangau Bairro	1
IFPELAC (Beira)	1
IFPELAC (Dondo)	3 (3)
IICB (vocational training school)	1
TOTAL	20

Source: JICA Project Team

Regarding the content of the training, while confirming the opinions of the parties involved in the ongoing Kigumi WG and the project team it was agreed that the shed would be created using Kigumi techniques. Incorporating the aforementioned new elements, and based on that Kigumi shed, the project team will teach a system that can respond to expansion in scale and changes in layout. This meant an increase in content and difficulty level, which necessitated a significant increase in training time. The final training program was as follows, based on the convenience to those who wished to participate. In addition, at the request of the carpenters, the start time was moved up to 7:30 a.m. to allow time for the carpenters to discuss about the establishment of the association after the training, and the training itself was to be closed at 3:00 p.m., followed by a 30-minute discussion slot.

Table 7-9 Program for Additional Kigumi Training

Time	Day 1	Day 2	Day 3
Session 1 8:00～9:45	• Flow from planning to management • Explanation of Design Method - Concept of lines and points	• Design • Building specifications • Positioning of columns and beams (street center) • How to pick up the number of parts	• How to draw developed plans • How to determine the length of a column (how to make a slope) • How to draw mortise holes, joints and fittings
Session 2 10:00～11:15	• Timber Sorting • Sharpening the chisel • Aligning the ends of the wood	Processing Hozo joints	Inking of the Extension joints • Adjustment of joint position
Session 3 11:30～12:45	• Force flow of the structure • Center marking • Characterizing and allocation of timber		Processing of the Extension Joints
Session 4 13:15～14:30	Inking of the Hozo joints • Marking the clearance • Adjustment of mortise and tenon position		

Time	Day 4	Day 5	Day 6
Session 1 8:00～9:45	Mozambique Construction and Building Codes	Case study of a triangular shaped shed	Demonstration of Assembling and Disassembling
Session 2 10:00～11:15	Processing of the Extension Joints (cont.)	Fixation of wall sheets	Practice of Assembling and Disassembling
Session 3 11:30～12:45		Fixation of roof sheets	
Session 4 13:15～14:30		Fixation of floor sheets	

Items in gray were originally planned but were not implemented in the actual additional training due to schedule changes.

Source: JICA Project Team

(3) Implementation of the Additional Kigumi Training

The first day of the additional training was hastily changed to a classroom lecture because the planned timber did not arrive in time, and participants introduced themselves, reviewed the 2021 Kigumi Training (the content was explained to new members from the 2021 training participants), and conducted the planned classroom lecture and chisel sharpening.

On the second day of the training, as the timber arrived, the participants began with the center lining and other activities originally planned for the first day. In sorting the timber, the timber was arranged according to the degree of warping and bending, with the straightest lumber being placed on the corner posts (columns) of the structure, other lumber with similar warping to be used on the same side of the structure, the most warped lumber meant to be used for the short beams, and the rest on the longer beams. Since it took more time than expected to draw the center-lines, the training was to last seven days, one day longer than the originally planned six days.

The lecture on Mozambican laws and regulations on the fifth day, given by Mr. Simango of the CMB's Construction Division, was very refreshing for the participants, who usually only work with furniture and fittings and have never thought about laws and regulations. The lecture was also very meaningful in terms of connecting the carpenters with the CMB's Construction Division.

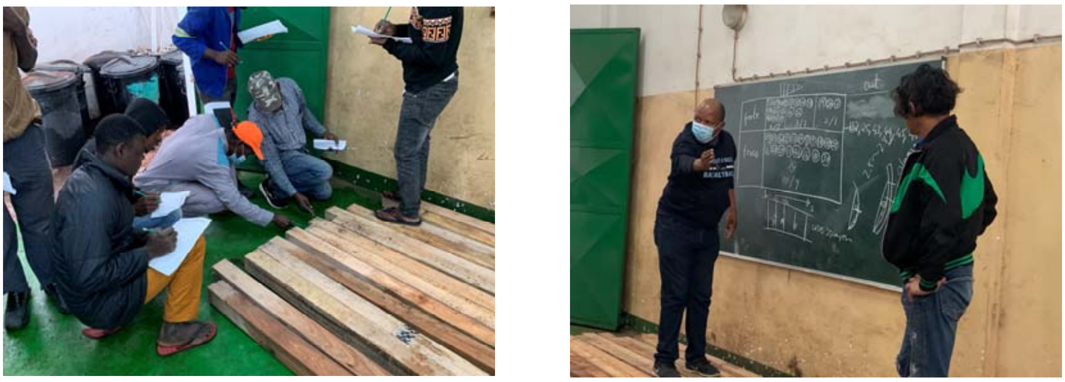
On the sixth and seventh days, the students actually learned how to assemble and install the finishing boards (roof, walls, and floor) on a real scale. In the assembly and disassembly exercises, the event was held in the square in front of the CMB as a publicity campaign. Passersby stopped to watch the shed being assembled and disassembled in a matter of seconds and asked a number of questions. The participants were convinced that it is very effective to show the public outdoors, and the wood frame carpenters' association decided to actively hold the exhibition later as well.

(a) Revision of 2021Kigumi Training (Day 1)

(b) Designing Lecture (Day 1-4)

(c) Mozambique Regulations (Day 4)

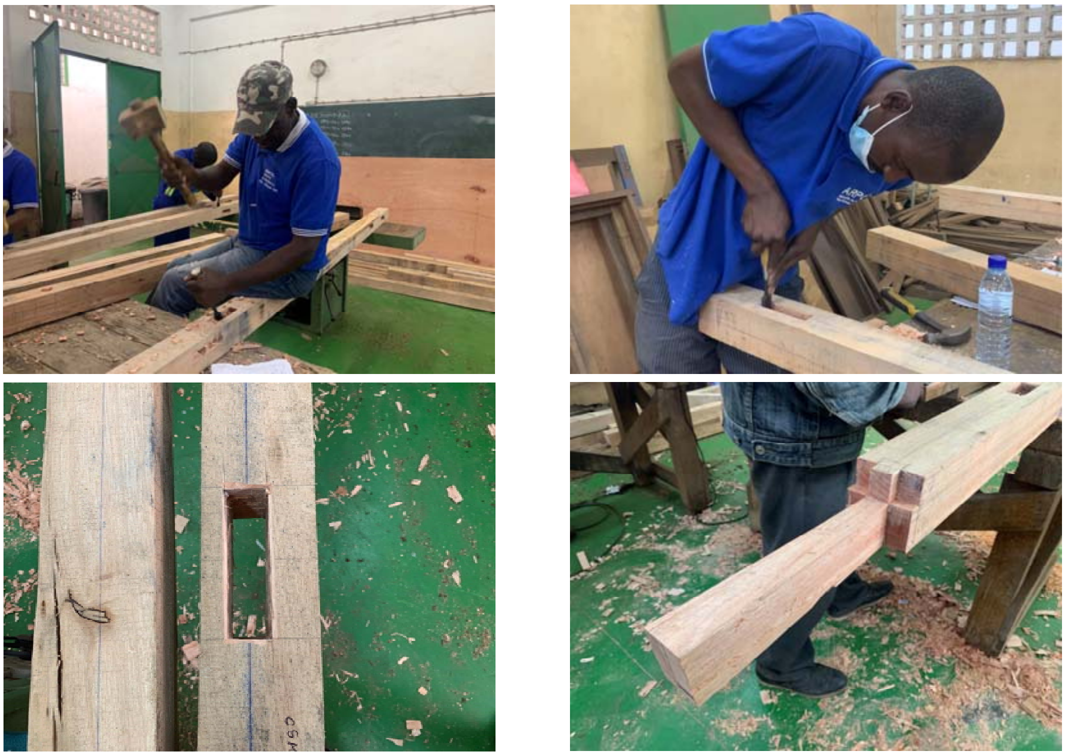
(d) Sharpening Chisels (Day 1)



(e) Timber Sorting, Characterizing and Allocation of Timber (Day 2)

(f) Centerlining (Day 2)

(g) Marking Joints (Day 3)




(h) Processing the Joints (Day 3-4)



(i) Fixation of Sheets (Day 5-6)


(j) Assembling and Disassembling Practice (Day 6-7)

Source: JICA Project Team

Figure 7-11 Additional Training

After the training, it was decided that the Kigumi shed made during the training, tools and teaching materials used in the training would be handed over as common property of the association and IFPELAC. This was the result of discussions held by the WG on woodworking, and the decision was beneficial to both, as IFPELAC will serve as a base for carpenter’s association until a storage space is secured, and IFPELAC can use the tools and the Kigumi shed in the newly introducing Kigumi curriculum as an actual product.

The handover ceremony was attended by many government officials, including the mayor of Beira, Director of Department of Industry and Commerce, Director of Department of Construction and Infrastructure, and Director of the Social and Productive Area of GREPOC, to reacquaint the participants with Kigumi techniques. The additional Kigumi training was very motivating for the carpenters, as they received certificates of completion from the mayor of Beira and the Director of the Social and Productive Area of GREPOC.

(a) Explanation of Kigumi Shed

(b) Explanation of Kigumi Joints

(c) Certification

(d) Group Photo

Source: JICA Project Team

Figure 7-12 Handover ceremony

(4) Establishment of the Association and Conduction of Kigumi Exhibitions

After the training, the members, mainly carpenters who participated in the 2021 Kigumi training and the additional training in 2022, voluntarily began working to formally establish the association. Regular meetings are held every Saturday morning, and meetings have been held with experts on the establishment of the organization from the Praia Nova fish market, CMB officials, lawyers, etc. Since August, they have been visiting the legal affairs bureau to begin the written procedures (currently in progress as of October). In addition, the association actively participated in meetings with government organizations such as GREPOC and INGD, and received advice on future activity policies, showing a strong desire to promote the association's activities.

Table 7-10 Overview of the Kigumi Carpenters' Association of Beira

Purpose	Develop and disseminate kigumi techniques in Beira City and throughout Mozambique
Goals	• Promotion of Kigumi techniques • Development and consideration of products using kigumi • Sharing and cooperating for orders related to kigumi techniques
Composition	Chairman (1), Deputy Chairman (1), Secretary (1), Accounting (1), Advisors (4), General Members

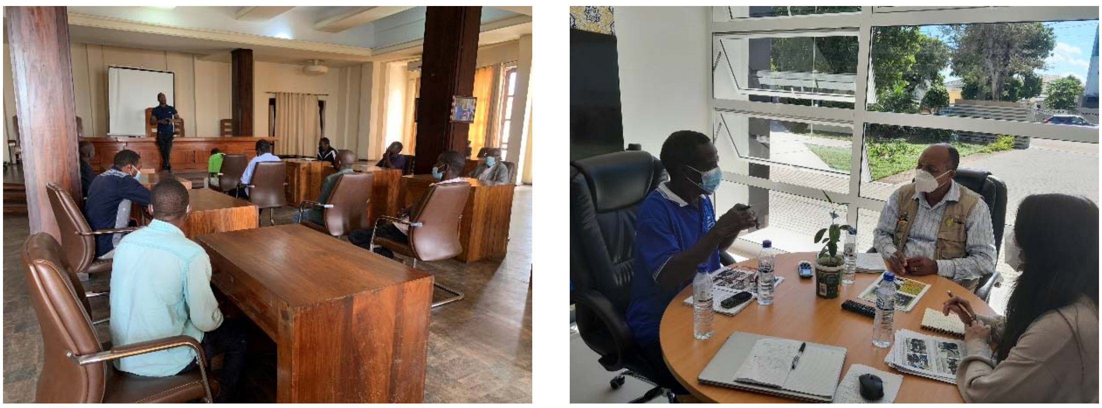
Source: JICA Project Team

In light of the upcoming completion of its formal registration as an association, the association has already begun discussions and activities on the following points as of October 2022. Once officially registered, the association will be able to borrow CMB facilities, equipment, vehicles, etc., and will be allowed to conduct business activities publicly.

Table 7-11 Activities already began

Activity	Details
Provide support for utilization/operational startups of kigumi stalls	Carpenters will periodically check on the kigumi stalls to confirm whether the stalls are being used safely and correctly, assembled correctly, need any repairs or replacement, etc., as well as to collect opinions from the users and surrounding people.
Promote kigumi techniques	In addition to promoting kigumi techniques to government agencies such as GREPOC and INGD, publicize the technology to the general public by participating in or organizing exhibitions.
Study kigumi products	Utilize the kigumi techniques already learned to develop prototypes, such as improved versions of furniture and food stalls, beginning from the easiest to handle.
Secure timber procurement routes	Establish connections with government agencies related to forestry and agriculture, timber sales companies, etc., as this resource is traded at a relatively high price in Mozambique.

Source: JICA Project Team



(a) Regular Meeting with Experts (b) Meeting with GREPOC

Source: JICA Project Team

Figure 7-13 Activities of the association

(5) Support for Vocational Training Schools in Formulating Kigumi Curriculum

After the additional training, in July 2022, the instructor of the carpentry course, the director, the deputy director of the IFPELAC Beira, and the Provincial Director of IFPELAC central began a full-scale study on introducing Kigumi techniques into the school course.

IFPELAC is a public vocational training school, and its courses are established by the National Authority for Professional Education (ANEP), which includes only the bare minimum contents, and according to the carpentry instructor, the carpentry course has time to spare for other contents.

In contrast, private schools, while more expensive, offer an original curriculum (ANEP-approved) with additional time and contents, as well as links to employers, which has led to a significant difference in popularity compared to the public schools. IFPELAC is looking for ways to turn this situation around, and now that they have been able to work with Kigumi technology, which is unique, the school is looking to turn this into a great opportunity. (The Director of IFPELAC Beira has kindly suggested of involving IFPELAC Dondo, which is located in the more prosperous area of the forestry industry to the Kigumi training.)

The current carpentry course is offered in three semesters a year, with each semester lasting approximately three months. Classes are held every weekday, and in response to the needs of students who commute to school while working, there is a switch between morning classes (Morning Class) and day classes (Day Class). The first two weeks of classes are general education classes, followed by specialized classes for each course.

According to the carpentry instructor, the students have half a day (the course only takes place either in the morning or afternoon) a week to spare and he thinks to devote the half-day every week for 3 months (12 weeks) which results to 6 full days to Kigumi curriculum. The content of the 2021 Kigumi training and the additional Kigumi training conducted in 2022 and the actual time allotted for the training were shared to IFPELAC as reference, and the level of the instructor's confidence in teaching the Kigumi contents was discussed.

In order to avoid duplication with what is covered in the carpentry course itself, the instructor has selected and added general-purpose joints from the Kigumi textbook that were not covered in the trainings, so that Kigumi techniques can be used for general furniture and fixtures as well. The proposed curriculum as of September 2022 is outlined below.

Table 7-12 Overview of the Kigumi Curriculum

Contents	Details	Time Allocation
Lecture	Introduction to Kigumi, Units and Scaling, Calculation, Design Method	4.5h
Preparation of Timber and Tools	Timber sorting, characterizing and allocation of timber, usage of tools, center-lining, assembling and disassembling in small scale models,	4.5h
Processing Practice	Hozo, Hozo holes, dovetail joint, miter joint, scarf joint, etc (14 types)	56.0h (4h × 14 types)
Finishing, Assembling	Assembling and disassembling of the whole structure, additional adjustments, fixation of boards	2.5h

Source: JICA Project Team

Table 7-13 Kigumi Curriculum Excerpted

KIGUMI CARPENTRY TRAINNING COURSE IFPELAC 2022

UNIT	CONTENTS	PROGRAM OBJECTIVES	TRAINNIG METHODOLOGY	TIME
1 1.1 1.2	CARPENTRY INTRODUCTION CHARACTERISTICS	At the end of period, the trainee is able to define the kigumi carpentry techniques, understand the characteristics and the differences between carpentry and the cabinet making.	In the instructions, the instructor should explain the different occupations and characterstics of carpentry and cabinet making.	1 hr
2 2.1 2.2 2.3	MEASUREMENTS Numerical & Decimals Operarations of metric system in measuring Fractions and Divisions	At the end of the period, the traimee should be able to: - Define and classify different measures, - Differencite and know the equivalence between the metric system measurements for volume and relationships, -Able to calculate, subtract, multiply, divide etc as presented in English and metric system.	- With the help of a rectangular timber plank the instructor demonstrate how to measure, calculate with the use of metric divisions. - Distribute timber planks to trainees and explain how to measure and calculate. - Does fractions in the relation of centimetres	1 hr
3 3.1 3.2	TECHNICAL DESIGNS Types of Kigumi Designs Analysis of Designs	In the finality, the trainee is able to define a technical design, classify types, projections, practical demostrations as being applied in Kigumi. At the end of the period, the trainee should be able to read, anaylsis and understand the particular design to be applied as of natural scale, amplified or reduced perspectives.	The instructor explains various and different designs, projections and measurements, the design importance and application. The instructor explains various & different types of designs scales, projections pespectives and the design nature, amplified scale and reduced scale application.	1,5 hr
4 4.1 4.2 4.3	PROJECTS Analysis Distribution timber Kigumi Tools	Distribution of Timber Beams and planks. At the end of the lesson the trainee should be able to analise and interpret the kigumi project. Trainee should be able to know how to use the distributed timber from kigumi design point of view. Trainee should be able to know how to use the different types of kigumi japanese tools.	The instructor demostrate how to interpret the difference on the distributed timber beams and planks in kigumi projections. Explains and demonstrates how to analise the timber as of from the kigumi design point of view. The instructor explains and demonstrates how to use different types of kigumi japanese tools.	1,5 hr

Source: JICA Project Team

The above proposed curriculum was submitted to IFPELAC Central Headquarters in August 2022, and approval for implementation was received from Headquarters in September. IFPELAC Beira aims to start the Kigumi curriculum from next semester, which will begin in January 2023.

In addition, a one-day trial was conducted in October with the Kigumi content. The purpose of this trial is not only to confirm that the above curriculum has been developed in an appropriate time allocation, but also to gather information for a short course that IFPELAC is considering establishing to encourage participation by those who already make their living as carpenters. The consideration of the short course will include the number of days, what will be created, and the content will be a general-purpose and popular technique.

The future schedule is as follows.

- January 2023: Kigumi Carpentry Calicular First Batch Start
- End of March 2023: Kigumi Carpentry Calicular First Batch End
- April 2023: Revision and Update of the Kigumi curriculum
- After May 2023: Kigumi Carpentry Calicular will be implemented, and it would be revised and updated regularly

7.3 Future Prospects for Kigumi Techniques

The Kigumi stalls and shed introduced in the trainings received very high praise from the people and institutions involved. If the carpenters can create demand for additional classes with content that meets local demand, and if IFPELAC can respond to this demand with design and construction techniques, the market of Kigumi will expand, and when high expectations are placed on them, it would be ideal for the carpenters who learned the Kigumi at the IFPELAC to support the experienced carpenters.

In addition, the policy of banning timber exports to prevent smuggling has cast a shadow over Mozambique's forestry market, but from a long-term perspective, the increased demand for timber in the country as a result of Kigumi is expected to have the effect of promoting employment not only in the forestry industry but also in the fields of sawmilling, transportation, and processing. If the dissemination of Kigumi techniques leads to the development of houses that can be assembled and disassembled, and if they can be successfully coordinated with GREPOC/INGD, it will be possible to minimize damage from natural disasters, which will be of great benefit. The carpenters who participated in this project have established a carpenters' association to improve and disseminate their skills, and the IFPELAC, a vocational training school, has introduced Kigumi techniques into its curriculum and will begin implementing them next year. The organizations involved in this project are moving toward the establishment and dissemination of the Kigumi techniques.

7.4 Disaster Mitigation Workshops

7.4.1 Background and Purpose

Cyclone Idai made landfall in Mozambique in March 2019, causing significant damage largely in the Beira area. Damages mainly focused on roofs and windows as a result of strong winds. As for the damages on roofs, they make the whole building unusable hence need to be fixed as soon as possible, but even two-and-a-half years has passed since the Cyclone Idai, and yet many of them remain unrepaired. This is considered due to the lack of financial resources for repairing roof damage in general housing and public facilities, and a lack of carpenters in the surrounding areas who can do such repair work.
Considering the situation, a workshop was held to teach low-cost and effective roof repair and reinforcement techniques to local carpenters with sufficient tools and skills and who also have strong roots in the community.

7.4.2 Selection of a target facility

To conduct this workshop, the project team obtained a list of facilities owned by CMB which damages caused by Cyclone Idai remain unrepaired.

Table 7-14 List of Unrepaired Facilities Owned by Beira City

Bairro	Name	Location	Size (㎡)	Constructed	Intervention?
Vila Massane	Mercado Vila Massane	Estrada Nacional n°6	678	—	Needed
Praia Nova	Mercado Praia Nova (as of August 20)	Praia Nova	—	—	Needed
Ponta-Gêa	Mercado Municipal da Pont-Gea	Rua Filipe Samuel Magala Ponta-Gêa	—	—	Needed
Muave	Centro Dessenvol. Communitario Muave	20° Bairro Muavi	—	—	Needed
Munhava Central	Centro Dessenvol. Communtario Munhava Central	Estrada Nacional n°6 Munhava Central	130	—	Needed
Chipangara	Centro Desenvol. Comunitario Chipangara	Chipangara	128	—	Needed
Maraza	Centro Infatario de Maraza	Rua Kruss Gomes Maraza	230	2005	Needed
Maquinino	Centro Desenvol. Communitario Goto	Av. Armando Tivane	—	—	Needed
Mananga	Centro Dessenvol. Comunitario de Mananga	Rua Kruss Gomes Mananga	—	—	Needed
Munhava Central	Centro de Desenvol. Comunitario Tchantchim	Av. Samora Machel Thantchim	259	1990	Needed
Inhamizua	Centro de Desenvol. Comunitario de Inhamizua	Estrada Nacional n°6 Chamba	45	2011	Needed
Pioneiros	Santa Isabel	Av. Samora Moises Machel	—	—	Needed

Source: Information provided by CMB Construction Division

From the above list, the Maraza Infantry Center was selected with two main reasons; the level of damage was able to be reinforced within a few workshop days, and it is an important facility in the community that takes care of small children and many families live the surrounding areas suffer for having nowhere to leave their children when the parents are off to work.

7.4.3 Overview of the facility

The Maraza district is one of the most poverty-stricken areas of the city, and this facility was established in 2007 in an existing building (believed to be built between 1980 and 1990) with the cooperation of the CMB as a care center to support street children and single parents. All other daycare centers in the surrounding area are private and expensive, costing more than 3,500Mt per month. The demand for the Maraza infantry center is very high, as the admission fee is 750Mt and the monthly fee is 500Mt. The entire facility is approximately 220 m^2 and accommodates 125 children, but CMB is considering expanding the facility later, as it is still not meeting the local demand. It accepts children from 2 to 5 years old and operates from 6:30 AM to 4:00 PM. During that time, two meals (breakfast and lunch) are provided, and the children are taught how to make toys out of paper and recycled items, sing and dance, and learn letters and numbers.

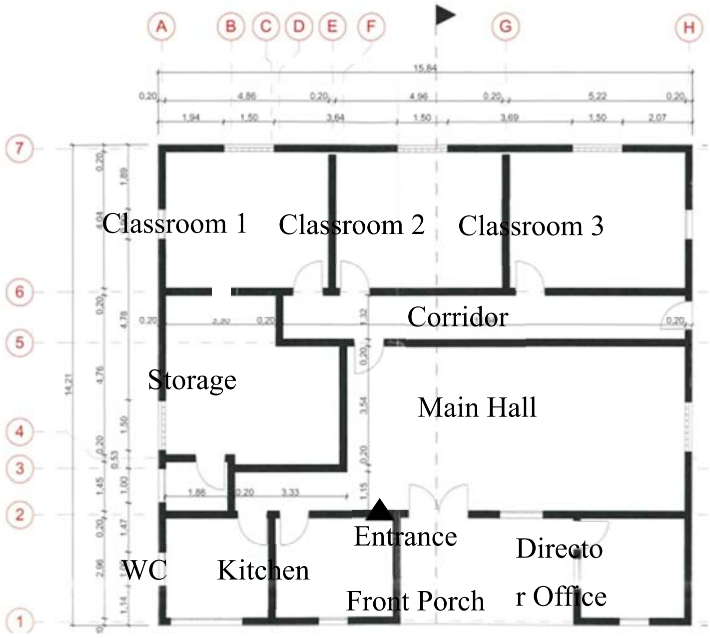
However, the roof as a whole was damaged by Cyclone Idai and the rain continued for about a month afterward, causing intermittent rain leaks and forcing the care facility to close. The center was reopened for a while with the support of intervention by a Muslim organization donating roofing materials and repairs by the CMB, but it was forced to close several times due to further damage to unrepaired areas caused by Cyclone Chalane and Eloise that occurred later, as well as a presidential order on the measurement against COVID-19. The detailed history of the facility and photographs showing the damage are not available due to the breakdown of CMB's equipment, and the table below is a summary of interviews with the CMB Education Department.

Table 7-15 List of Unrepaired Facilities Owned by Beira City

Time	Event	Influence to Maraza Infantry Center
2007	Maraza Opened	—
2019 March	Cyclone Idai	Roof was damaged
unknown	Long Rain	Ceiling was damaged by draining water Maraza Closed (closed more than 6 months)
About 2019 October	Intervention by CMB	Some of the roof sheets on the front side where most damaged got replaced with the new ones which were donated from Muslim organization. **Maraza reopened.**
2020 December	Cyclone Chalane	More damages on the roof sheets. **Maraza closed** due to draining water.
2021 January	Cyclone Eloise	Damages got aggravated.
2021 March	Intervention by CMB	Replaced some roof sheets in the back side. **Maraza reopened.**
2021 July	Presidential Order (COVID-19)	**Maraza had to close** like all other schools.
2021 September	—	Some schools and kindergarten reopened but many were still closed due to lack of adaptation to Covid measures.

Source: JICA Project Team

The facility is approximately 220 m^2 in total, with an entrance porch in the front that leads into the hall, and three classrooms at the end of the hallway in the back. The children spend most of their time in these three classrooms and the hall. The roof is gabled, and in the plan below, the roof is folded in half separating the top and bottom.



Source: JICA Project Team

Figure 7-14 Floor Plan of the Facility

7.4.4 Damages of the Facility

A field survey was conducted on October 18, 2021 to ascertain the details of damages.

(1) Roof Damage

Donated roofing materials were installed on the southwestern half of the roof, which considerably reduced rain leakage. (Images will be added to the final version.)

On the other hand, nothing was done on the other half; the cyclone's strong winds and long rains caused roof peeling or corrosion, creating gaps in various places that would leak during rainy weather.

(a) Deformation/damage of existing roofing

When the washer comes off the nail due to strong wind (see d below), the roofing material can be loosened by the wind, causing deformation and damage, which impedes rainwater flow and causes accelerated corrosion.

(b) Damage and gaps in existing roofing

When roofing is agitated by strong winds and nails are dislodged or gaps are created due to deformation or damage, rainwater will enter the interior. This rainwater travels inside the roofing, causing corrosion of the embedded nails and reducing its anchorage strength.

(c)Gable Concrete

The gable end has a concrete wall rising up and sandwiching the roofing material, but due to roof deformation, wind pressure, and age, the paint is peeling, and water is infiltrating. Because the roofing material is wedged into the concrete, it is difficult to replace the roofing material.

(d) Corrosion of existing nails

The washer (hoop) is not corroded, but the nail head is brittle due to corrosion. When a strong load is applied to the roofing material, the head of the nail is chipped, the washer is easily pulled out, and the fixing strength of the roofing material is reduced.

(e) Corrosion of existing nails

Since the upper part of the nail (the part embedded in the roofing material) has corroded, it can be seen that the water had penetrated to the inside through this hole. The part where corrosion did not occur is the part buried in the purlin (wood).

(f) Corrosion of existing roofing

Deformed parts of the roof and obstacles such as leaves prevent rainwater from flowing down, with corrosion progressing in areas where water remains.

Source: JICA Project Team

Figure 7-15 Roof Damage

(2) Ceiling Damage

Secondary damage from the roof damage included leaks, and the brittle ceiling material had corroded due to water that had traveled through the material. With the exception of some classroom ceilings, the ceilings of the entire facility had fallen due to the corrosion, and the CMB Education Department had judged that the living spaces were not safe for children because the warmed-up air beneath the steel roof sheets which was supposed to be isolated by the ceiling sheets, flows down into the living spaces where children spend. Another concern is that the nearly corroded ceiling materials spread dust into the air and health of the children may be affected.

(a) Corroding Ceiling Sheets
Each ceiling panel is sandwiched between the framework and edging material on the ends and secured with nails.

(b) Main Hall
The ceilings in the great hall where the children eat and play have all fallen in decay.

Source: JICA Project Team

Figure 7-16 Ceiling Damage

(3) Current Condition of Windows

The facility's windows are consisting of decorative bricks and cannot be opened or closed. In the winter, sunlight is blocked by the bricks and no sunlight reach the interior, and cold air can easily enter the building cooling down the whole facility. In contrast, during the summer, ventilation is inadequate, and heat tends to accumulate, and considering the importance of ventilation to mitigate the spread of COVID-19 in recent years, the CMB concluded that the facility did not meet the requirements for a day-care center environment. Therefore, in light of the lack of a safe and secure environment for the children and the strong requests from the infantry staffs at this facility, it was decided that the window renovation would also be the subject of this WS.

(a) Interior during Daytime

Sunlight does not penetrate deep into the room, and the room is dimly lit even during the day. Ventilation is inadequate, and there are concerns about the hygiene of the mattresses used for napping.

(b) Decorative Bricks

Classrooms used for classes and recreation are dark and difficult to see, and the safety of the children is at stake.

Source: JICA Project Team

Figure 7-17 Current Windows

7.4.5 Contents of WS

Roofs damaged by Cyclone Idai and windows which do not meet the CMB requirement for infantry center were rehabilitated in the WS in 2021.

After the repairs in 2021, the CMB Education Department requested additional repairs to the ceiling that had corroded and fallen due to leaks in preparation for the full reopening of the Maraza infantry center, so in June 2022, such rehabilitation was implemented. The participants and dates of the WS are as follows.

Table 7-16 Overview of the WS

	2021 WS	2022 WS
Target Facility	Maraza Infantry Center	
Objective	Repair damaged roofs and teach repair methods to local carpenters	Final adjustments to reopen the facility (Confirmation of repair areas and additional repairs)
Participants	20 Carpenters from the Kigumi Training	20 Carpenters from the Additional Kigumi Training
Program	Oct. 18 Site survey and decision of rehabilitation method Oct. 29 (Day 1) Roof Rehabilitation Nov. 1 (Day 2) Roof Rehabilitation Nov. 11 (Day 3) Window Refurbishment Nov. 12 (Day 4) Window Refurbishment Nov. 15 (Day 5) Window Refurbishment	Jun. 13 - Site Survey Jun. 17 (Day 6) Ceiling Rehabilitation Jun. 20 (Day 7) Ceiling Rehabilitation & follow-up session of 2021 Jun. 27 – Opening Ceremony
Notes	Its survey and roof rehabilitation were conducted while the project team was at the site, and for window refurbishment was conducted remotely after the team returned to Japan, as window frames are a part of the carpenters' specialty field.	All of the above dates are to be conducted while the project team was at the site.

Source: JICA Project Team

(1) Roof Rehabilitation

Based on the damages explained, it was decided to use the following repair/reinforcement methods in the workshop.

Table 7-17 Roof Repair Policy

Damage	Repair Policy
Deformed/damaged roof	For areas that severely damaged, twisted, corroded, and cannot be expected to maintain their functions over the long term, replace with new roofing.
Deterioration where nails have been driven	Remove existing nails and replace with new nails. By driving the nails through an iron strip, the roofing can be fixed in with a strip line instead of at points, which helps guard against peeling.
Openings	Fill holes with caulking to prevent rainwater from entering.

Source: JICA Project Team

The carpenters who participated in the workshop were unfamiliar with working with anything other than wood, as they usually make furniture and windows. Roof repairs require work both inside and outside (on the roof), and the project team arranged to work efficiently and safely. When climbing up on the roof sheets, carpenters were explained that if weight is placed on any part of the roof other than the structural parts that support the roofing materials, such as the purlin and rafters (trusses), it will give extra load on the originally weakened roofing materials, which will aggravate the damage, and confirmed the spots where weight should be placed.

Since this reinforcement was only an emergency response measure, it was not an attempt to apply the highest level of repair, but rather to maximize the effectiveness of the minimum rehabilitation.

(a) Rehabilitation on the Roof

The interval of holes which the nails be hit was determined and marked on the metal band based on the actual corrugation of the roof sheets on the roof. The metal band then brought down to the ground for the holes to be drilled and pulled up to the roof once again to hammer the nails.

(b) Rehabilitation on the Roof

Corroded areas, old holes, and gaps visible from the roof top are filled with caulking glues to increase the degree of sealing together with the indoor side.

(c) Rehabilitation from inside

Gaps and holes seen from indoors are clearly visible due to light leakage, so the holes are filled with the same caulking glues from inside.

(d) Discussion

Carpenters themselves, who are familiar with the situation in Mozambique, exchanged their opinions on the new repair style and how it could be utilized in the future.

Source: JICA Project Team

Figure 7-18 Rehabilitation of Roof

The post-repair is shown below. The main repairs were made in October 2021, and by the time of travel in June 2022, small leaks were identified, so additional repairs were made to reinforce the gable ends and to reinforce the sealant. It is highly likely that incorrect loads were applied to the roof sheets by carpenters unfamiliar with roof repair.

(a) Reinforcement by Metal Band

By interlocking the metal bands with each roofing nail, the entire nails are responsible for holding the roof in place, increasing strength and preventing damage such as roof tear even if nails are partially missing.

(b) Rehabilitated Roof

By straddling the metal bands at the overlap of each corrugated sheet, the connection between each piece of roofing is strengthened, preventing the roofing material from being blown off by strong winds.

(c) Reinforced Gable

For the edge where the concrete was sandwiching the roof sheets, as the sheets are not replaceable, it was reinforced and covered with cement cloths.

(d) Filled-gaps

The gaps are no longer visible from inside the room, and the area where rainwater is transmitted is securely blocked.

Source: JICA Project Team

Figure 7-19 Post-Rehabilitation of Roof

(2) Window Refurbishment

For repairing the windows, the following four points were taken into consideration and repair policies were decided upon.

Table 7-18 Window Repair Policy

Topic	Repair Policy
Ventilation	Install windows that can be opened and closed. Use sliding windows that do not require space to open and close.
Light	Use glass windows.
Pests	Install screens to keep out insects.
Security	Install iron bars for crime prevention, as the Maraza area is a crime-ridden neighborhood. In addition, the glass windows will be lockable.

Source: JICA Project Team

(a) Removal of Bricks

The removal of the block was broken toward the interior, as people may pass outdoors.

(b) Installation of Window Frames

Measure the effective width and install a window frame slightly smaller than the effective width.

(c) Iron Grating and Gap Filling

The bars are inserted between the window frame and the concrete wall, and the mortar is used to fill in the gaps. When the mortar hardens, the bars and window frame are firmly fixed to the concrete wall.

(d) Installation of glass and screen doors

Adjust and install glass and screen doors to match the installed window frames.

Source: JICA Project Team

Figure 7-20 Refurbishment of Windows

Source: JICA Project Team

Figure 7-21 Post-Refurbishment of Windows

(3) Ceiling Rehabilitation

The following three points were taken into consideration when deciding on the rehabilitation of the ceiling sheets. It was agreed with the CMB Education Department to limit the scope of the rehabilitation to the rooms that the children usually use due to the number of working days available.

Table 7-19 Ceiling Rehabilitation Policies

Topic	Repair Policy
Missing ceiling material	Install new ceiling sheets. Nail and fix them firmly so that there is no danger of it falling.
Available Ceiling Sheets	All ceiling sheets shall be replaced with new ones, and those that are in danger of severe rotting and dusting shall be discarded. Those that can still be used should be stocked.
Existing Nails	All nails that were securing the original ceiling material that remain in the ceiling framework should be removed as they will interfere with the securing of the new ceiling material.

Source: JICA Project Team

(a) Removal of Existing Nails and Ceiling Sheets

Working in pairs, the team will remove the existing ceiling material and nails.

(b) Measurement of the framework

The ceiling framework itself had also been distorted by leaks but was strong enough.

(c) Cutting out the new ceiling sheets

Cut out the ceiling material according to the dimensions of the framework.

(d) Placement of the new ceiling sheets

The ceiling sheets are nailed to the framework.

Source: JICA Project Team

Figure 7-22 Rehabilitation of Ceiling

Classrooms

Main Hall

Source: JICA Project Team

Figure 7-23 Post-Rehabilitation of Ceiling

7.4.6 Aftermath of the WS

On June 27, 2022, after the WS, the CMB hosted an opening ceremony to celebrate the reopening of the facility. The ceremony was attended by the mayor, the Councilor of the Education Department, the director of the Education Department, local voters, facility officials, children and their families who enrolled to join the facility, and participants of the WS, as well as CMB media.

While the WS on the roof, windows, and ceilings were being implemented, the CMB Education Department and the center officials began accepting applicants for reopening, and as of the day of the ceremony, there were 11 applicants for admission to the infantry center. The CMB Education Department and the director of the center believe that the unstable operation and the fact that the turn of the year is in January have had an impact on the low enrollment, but that the number of applicants will soon exceed the maximum of 125.

(a) Opening of the Ceremony

The ceremony itself consisted of words from the mayor, the councilor of the Education Department, and the JICA project team, followed by a tour of the facility.

(b) Students enrolled with their families

While the infantry center was closed, the parents left their children with acquaintances or rotated the caretakers in the community. (From an interview with a local family)

(c) Words from the Mayor

He expressed his strong interest in the rehabilitation of the facility followed by his apologies for the late reopening, and his joy that this ceremony could take place.

(d) Distribution of facility reopening notice

In order to raise awareness of the reopen, it was difficult for CMB alone to publicize the reopening therefore a pamphlet was prepared to publicize the reopening and distributed to neighborhood residents by the infantry center's teachers and WS participants.

Source: JICA Project Team

Figure 7-24 Opening Ceremony

The project team visited the facility in August 2022 to see the operation status. The team was able to confirm that very few leaks have occurred since then and see the infantry center back in normal operation. In the classrooms, recreational activities such as arts and crafts were conducted in classes separated by age group, and lunch was eaten side by side in the main hall. As of August, the number of enrolled children was 18.

(a) Recreational Activities

(b) Meals at the Main Hall

Source: JICA Project Team

Figure 7-25 Normal Operation of the Infantry Center

CHAPTER8 Survey of Environmental and Social Considerations Based on the Concept of Strategic Environmental Assessment

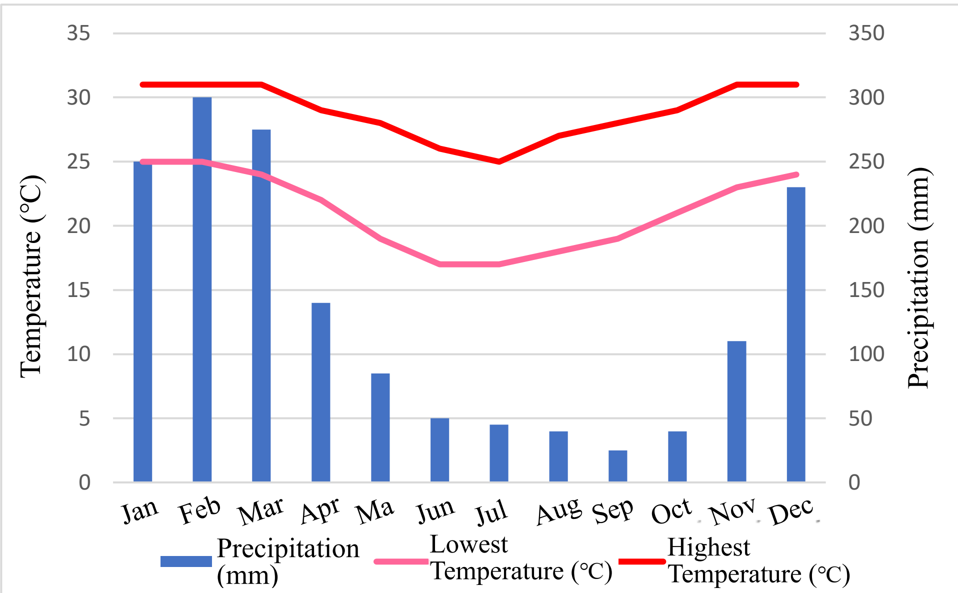
8.1 Regional Overview

8.1.1 Climate Characteristics

Figure 8-1 shows the average monthly temperature and precipitation in Beira.

The city has a tropical savanna climate with dry winters according to the Köppen climate classification. Due to its tropical-to-subtropical geographic characteristics and the influence of the warm Mozambique Current, there is a wet season (November–March) that is hot and rainy and a dry season (April–October) that is relatively cool with little rain.

The average annual rainfall from 1991 to 2020 was about 1,600 mm, the average annual maximum temperature is 28.9°C, and the annual average minimum temperature is 21.3°C.



Source: Climatestotravel.com

Figure 8-1 Monthly average temperature and rainfall in Beira（1991–2020）

8.1.2 Geomorphology

(1) Geographical Characteristics

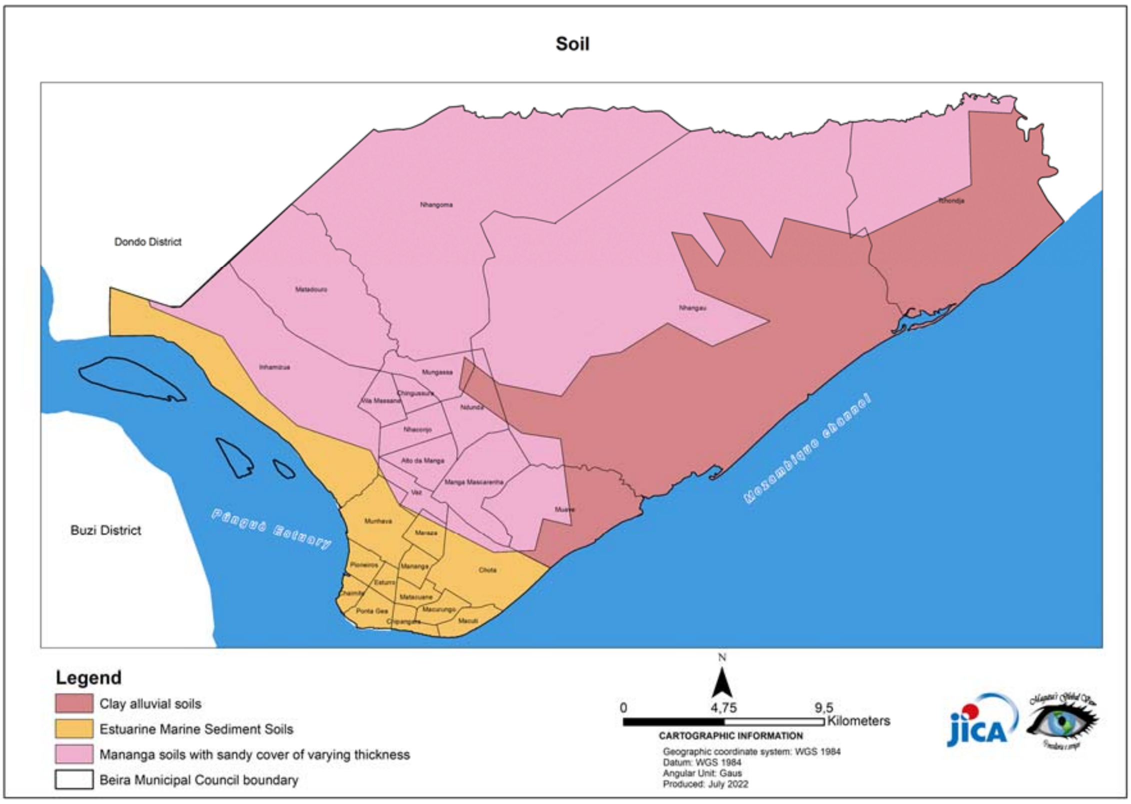
The topography of Beira and the surrounding area is dominated by extensive coastal plains with elevations ranging from 6 to 20 m, with very gentle slopes, rarely exceeding one degree of inclination. An alluvial plain formed by the Buzi and Pungwe rivers is located southwest of Beira. Some coastal areas have dunes and lagoons.

(2) Geological Characteristics

The coastal plain of Beira is thought to have formed from successive deposition of Pleistocene and

Holocene alluvial sediments.

The soils alternate clay and sandy sediments probably derived from river sediments that flowed into the gulf in the geologically distant past. This phenomenon has been confirmed along the coast of East Africa. The surface alluvium is mainly composed of sand, but originally clay alluvium dominated. The clay alluvium originates from old organic soils that formed in wetlands. This clay alluvium is impermeable and explains why Beira soils have poor drainage capacity.



Source: Prepared by JICA Project Team

Figure 8-2 Soil distribution of Beira city

8.1.3 Ecological Characteristics

(1) Flora

In terms of phytogeography, Beira is located in the Swahili-Maputaland regional transition zone, where more than 3,000 plant species have been identified. In addition, hundreds of endemic genera have been identified, including the genera *Stulhmania*, *Hymenaena*, and *Bivinia*. The area is dominated by three major plant communities: coastal mosaics, mixed wetlands (fresh and brackish water), and mangrove forests (salt water).

Vegetation in and around Beira is naturalized and dominated by non-native species of fruit trees, ornamental and erosion-control species brought in for urban expansion and resource development. A typical example is the casuarina (*Casuarina equisetifolia*), which has been extensively planted for erosion control along the dune shoreline.

(2) Fauna

Large mammal species are not common in and around Beira due to hunting and residential development. The fauna of urban Beira consists of species typical in urban areas, especially rodents (*Mus* sp., *Rattus* spp.) and domestic species such as dogs and cats. Bird species such as the Great Sparrow (*Passer motitensis*) and the pied crow (*Corvus albus*) are abundant in urban areas.

The numerous swamps, mangroves, and intertidal areas surrounding the city provide suitable habitat for a variety of bird species, including waders and terns. Common species include the Red Bishop (*Euplectes orix*), the little egret (*Egretta garzeta*), and the whiskered tern (*Chlidonias hybrida*).

Mangrove forests are home to a wide variety of organisms, representative species include crabs such as the mud crab (*Scylla serrata*) and the fiddler crab; prawns such as *Penaeus* spp., Indian white prawns (*Fenneropenaeus indicus*), and Japanese tiger prawns (*Marsupenaeus japonicus*); fish such as mudskippers (*Periophtalmus* sp.); and gastropods such as the truncated mangrove snail (*Ceritidea decollata*) and the giant mangrove whelk (*Terebralia palustris*).

The forested areas around Beira are a possible habitat for wildlife including rodents, small goats, and vervet monkeys (*Chlorocebus pygerythrus*).

8.1.4 Social Environment

(1) Population

According to the 2017 census, Beira has a population of 592,090, with a population growth rate of 3.3% since 2007. The male/female ratio is about even, but the largest age group is 0–9 years old and accounts for 27% of the total population.

Table 8-1 Population of the City of Beira (2017)

Location	Total Population (persons)	Population by sex (persons)		area (km2)	population density (person/km2)
		male	female		
Beira	592,090	295,362	296,728	630.6	938.9

Source: 2017 Census

Table 8-2 Population by Age in the City of Beira (2017)

Location	population (Person)	Population by age (persons)								
		0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Beira	592,090	160,713	140,658	130,565	72,003	39,602	25,417	14,171	6,073	2,888

Source: 2017 Census

(2) Education

There are 134 schools in Beira, which constitute 14% of all schools in Sofala Province. Of these, 104 are primary schools (80 public and 24 private) and 28 are general secondary schools (8 public and 20 private). There are also two public vocational schools (commercial and industrial) (INE, 2010).

Of the total Beira population, 28.3% have completed primary education, 25.7% have completed secondary education, and 0.6% have completed higher education. The remaining 45.4% have not completed their compulsory education (primary school).

(3) Drinking Water

Water supply coverage in the urban parts of Beira is high. Water service is provided by the water utility company (FIPAG), whose water supply network is approximately 942 km and consists of five distribution centers. There are 54,662 connections to FIPAG's water supply, of which 52,497 are for domestic use, 315 for communal taps, 1,782 for public and commercial facilities, and 68 for industrial premises. According to the 2017 census, about 80% of the population of the city uses tap water.

(4) Sewage

Beira is served by a sewage system, which consists of the following infrastructure facilities.

- Sewage network total length: 82 km
- 14 pumping stations
- 3 elevation stations
- 1 wastewater treatment plant

The wastewater treatment plant is located at the mouth of the Pungwe River and was constructed between 2008 and 2013, with operations beginning in 2012. The plant is located in an area that is highly sensitive to periodic fluctuations in water levels, such as tides and floods. It can serve 120,000 residents, but current only serves 16,000 households (about 45,000 people).

Informal settlement areas around densely populated urban areas such as Chipangara, Goto, Munhava and Macurungo do not have the infrastructure for domestic wastewater. Certain parts of urbanized residential areas such as Matacuane, Esturro, and Macurungo have toilets with running water and individual septic tanks.

(5) Housing

1) Unplanned Residential Areas

In areas without planned housing that can be urbanized, residents live in unsatisfactory housing conditions, in homes made of thatched roofs and mud walls, cement blocks, or adobe (dried mud) bricks, or in homes with earthen or cement pavement. The average home is usually only 20–30 m^2 with two rooms, and the kitchen, bath and toilet are outside. Many houses have only one window or none, and the house is overcrowded with family members. In densely populated areas, there isn't space to build a latrine, bury household waste, have a garden, or have space for children to play. Sanitary conditions are poor, and many houses have no running water. Such unordered housing occupies 60-70% of the inhabited areas.

2) Controlled Urbanization Zones

Chiveve and Manga are representative of controlled urbanized areas. They have up to 60 houses per hectare, making for low- and medium-density communities. The average house is over 40 m^2, and the majority of houses have one, two, or three bedrooms in addition to a living room, kitchen, bathroom, etc. Construction is cement block with concrete slab roofs, galvanized steel cladding, and ceramic tile flooring. Most houses benefit from basic urban infrastructure, including water and electricity supply, a sewage network, and a stormwater drainage network. However, less than 10% of all residential properties in Beira have these characteristics.

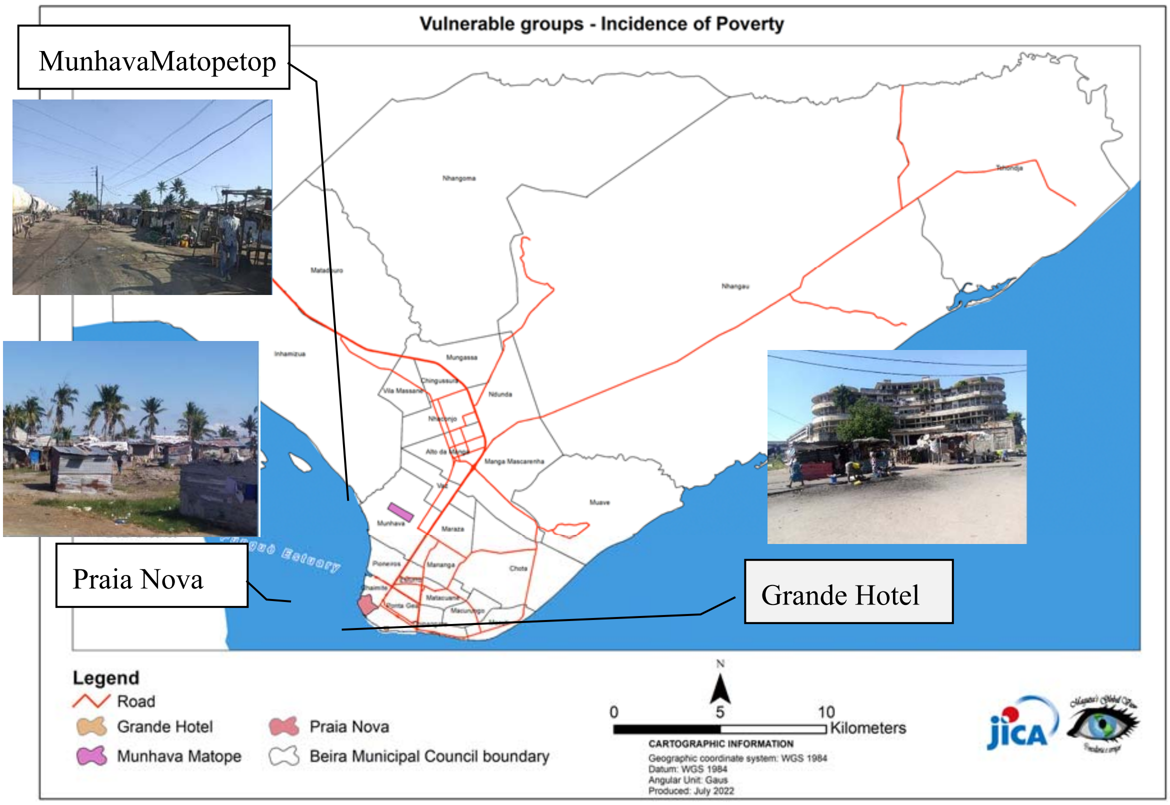
(6) Cultural Heritage

According to the Ministry of Land and Environment (2020:216), the city's history of growth has the main concentration of heritage buildings in the Chaimite, Ponta-Gêa, Palmeiras and Macuti districts. A literature review of Beira's history shows that 30 buildings were selected for conservation.

(7) The Socially Vulnerable

Most of the socially vulnerable are found in the informal settlements of Munhava-Matopé, Praia Nova, and Grande Hotel. Housing conditions are precarious (they fall outside territorial planning, environmental and basic services have poor sanitation, which is conducive to the breeding of disease vectors such as rats and various types of insects harmful to health) and residents have not secured regular income.

The Grande Hotel district is deteriorating, threatening the livelihoods of squatters. Displaced homeless children are also exacerbating the situation.



Source: JICA Project Team

Figure 8-3 Area where socially vulnerable community exists

(8) Indigenous Peoples

According to the World Bank Environmental and Social Framework (2007:75), indigenous peoples include "Sub-Saharan African historically underserved traditional local communities," "indigenous ethnic minorities," "aboriginals," "hill tribes," "vulnerable and marginalized groups," "minority nationalities," "scheduled tribes," "first nations" or "tribal groups."

Chapter 1, Article 1 of the Land Law Act (No. 19/97) aims to safeguard the common interests of a local community through the protection of residential land, agricultural land, fallow land, forests, culturally important land, meadows, water sources and areas for extension, with "local community" identified as "a group of families and individuals living in a territorial area at the level of a locality or below."

The inhabitants of Beira are strongly influenced by Western culture, and no indigenous peoples as defined in the World Bank's Environmental and Social Framework have been identified in the city.

(9) Gender

The family system in Beira is patriarchal or patrilineal,[1] with inheritances (including land ownership) passed down to descendants through the patrilineal line. Men are predominantly in a privileged position when it comes to managing resources, and they continue to make decisions for the family.

Women are economically weaker than men, partly due to their low levels of education. Illiteracy and lack of access to basic education make women more economically vulnerable.

In general, women are more likely to engage in unstable forms of employment or labor-intensive productive activities and spend much of their time managing power-intensive household chores. For example, women's labor is used to process energy-intensive agricultural products such as maize. Energy shortages and high-power rates negatively impact most income-generating activities and women's potential.

Women's labor is intrinsically linked to agricultural and fishing activities and constitutes 75% of the workforce in these activities[2].

(10) Children's Rights

Mozambique has been a signatory to the Convention on the Rights of the Child since 1990. After ratifying the convention in 1994, the rights of all Mozambican children are guaranteed, with a promise for a good start in life and to grow up healthy, to receive basic services such as an education, health, water, and sanitation, to co-exist with family and the community, and to participate in issues that concern them.

However, according to 2007 census data, while 16.0% of children do not have mothers, 7.8% do not have mothers, and 4.4.% do not have parents, which makes Beira a city with one of the highest rates of orphans in the country.

1 Mozambican women: culture, tradition, and gender issues in the feminization of HIV/AIDS, Volume 28, Institute of Gender Studies of the Federal University of Santa Catarina, 2020

2 Same as above

8.1.5 Environmental and Social Issues

Table 8-3 shows the major environmental and social issues in Beira City based on the regional overview.

Table 8-3 Major Environmental and Social Issues in Beira

Item	Issues
Air pollution	Exceedances of the total suspended particulate (PTS) limit of 150 μg/m³ (Decree No. 67/2010) were identified in the air quality monitoring campaign conducted by the Ministry of Land and Environment in 2014. Urban development, population growth, and increased traffic are thought to be contributing factors.
Water quality	A water quality analysis of public water sources (rivers, etc.) and wells by the JICA survey team showed that turbidity and nickel, manganese and phosphorus levels exceeded the standards at many water sampling points as compared to the Regulations on the Quality of Water for Consumption (Ministerial Diploma No. 180/2004).
Sewerage	The sewage treatment plant is located at the mouth of the Pungwe River, making it susceptible to flooding and storm surges. Currently, only about 45,000 people (about 8% of Beira's population) have sewage treatment services. Even at full capacity, the existing sewage treatment plant can serve only about 120,000 people (about 20% of Beira's population).
Waste matter	Waste management in Beira is implemented only in limited areas of the city, and it is estimated that about 70% of the urban population lives in areas that do not have access to waste management administrative services. It is assumed that illegal dumping and illegal incineration occurs-level in areas where waste management services are unavailable. Waste collected by the municipal waste disposal service in Beira is taken to the municipal dump about 7 km from the city center, which is located in a wetland of about 12 hectares in the Munhava-Matopé district (Dhama). The waste is not separated and is deposited as is. There are concerns about air pollution from spontaneous combustion, water pollution, soil contamination, odors, and infectious diseases.
Gender	In traditional family systems, men are given the right to manage resources and make decisions. A certain percentage of women do not enjoy the right to basic education, which contributes to their economic vulnerability. Women's labor is dominated by primary productive labor such as agriculture and fishing activities.

Source: JICA Project team

8.2 Environmental and Social Considerations Survey Based on the Concept of Strategic Environmental Assessment

8.2.1 Screening

A simple environmental and social impact study was conducted for each plan under consideration for this project. Screening results are shown in Table 8-4.

Table 8-4 Screening

Class	No	Evaluated Item	Infrastructure recovery /restoration plan	Land use plan	Public Facility Restoration and Recovery Plan	Disaster Response Plan	Livelihood recovery plan
Pollution Measures	1	Air Pollution					
	2	Water Pollution					
	3	Waste Materials					
	4	Soil Contamination					
	5	Noise and Vibration					
	6	Subsidence					
	7	Odor					
	8	Sediment					
Natural Environment	9	Protected Area					
	10	Ecosystem					
	11	Hydrology					
	12	Topography and Geology					
Social Environment	13	Resettlement and Land Acquisition					
	14	Poor people					
	15	Ethnic Minorities and Indigenous Peoples					
	16	Local Economy, such as Employment and Means of Livelihood					
	17	Land Use and Use of Local Resources					
	18	Water Use					
	19	Existing Social Infrastructure and Social Services					
	20	Social Capital and Local Will, Social Organizations such as Decision-Making Bodies					
	21	Maldistribution of Harms and Benefits					
	22	Intraregional Conflicts of Interest					
	23	Cultural Heritage, Religious Facilities					
	24	Landscapes					
	25	Gender					
	26	Children's Rights					
	27	Infectious Diseases such as HIV/AIDS					
	28	Labor Environment (including labor safety)					
Others	29	Accidents					
	30	Cross-Border Impacts and Climate Change					

Legend

Potential Positive Impact
Potential Neutral Impact
Potential Negative Impact

Source: JICA Project Team

8.2.2 Laws and Regulations Related to Each Plan

Table 8-5 summarizes the laws and regulations related to environmental and social considerations for each plan under consideration in this project.

Table 8-5 Laws and Regulations Related to Environmental and Social Considerations

Plan	Related Laws, etc.	Overview
Infrastructure Recovery and Reconstruction Plans	Regime for Licensing Private Construction (Decree 2/2004 of 31 March)	Article 1.1: Defines private businesses as all businesses in which persons other than the direct or indirect administrative bodies of the national and local governments are the respective owners. Article 5 (Licensing Rights): Unless otherwise specified, “the licensing of private works shall be the responsibility of the local authority or local administrative body, which shall be known as the licensing authority.” Article 6: Defines the licensing stages for private works as follows: Project approval Construction permits Supervision of construction Granting of license for use
	INGD internal regulation (Ministerial Diploma 66/2009 of 17 April)	The internal regulations of the National Institute for Disaster Management (INGD) include directions for a coordination process with the Reconstruction Coordination Office (GACOR) regarding the resettlement of disaster victims. While one of GACOR's responsibilities is to conduct regular monitoring of at-risk areas and update data on those at risk, there is no legal framework that stipulates that displaced persons must remain in resettlement areas.
	National Strategy for Adaptation and Mitigation of Climate Change (ENAMMC) 2013–2025, (39th Session of the Council of Ministers, 13 November 2012)	Strategic Goal III stipulates that the project will integrate the processes of public investment, regional planning, and financial protection from disasters, and address mechanisms and investments for the protection of developed infrastructure.
	Waterworks Law (Law No. 16/91, of 3 August)	Article 60 (Sanitary Obligations) “The owner of an existing building or a building to be constructed on a parcel on land in which a public domestic sewage collection system will be installed is obliged to connect the sanitary facilities to the said collection system and in this process ensure the flow of rainwater that cannot infiltrate will be captured without inconvenience. When the public sewage system is not considered to be available and its use will not be made, the owner of an existing or to-be-constructed building shall ensure that the domestic wastewater is directed to a facility that guarantees purification for each required case in accordance with the final wastewater treatment requirements. It is up to the Executive Council to set the required characteristics for the wastewater.”

Plan	Related Laws, etc.	Overview
Infrastructure Recovery and Reconstruction Plans	Sendai Framework for Disaster Risk Reduction 2015–2030	The expected outcome of the Sendai Framework is "substantial reduction of disaster risk and losses of lives, livelihoods and health, and in the economic, physical, social cultural and environmental assets of persons, businesses, communities and countries." Among the priorities of the framework are: Enhancing disaster preparedness for effective response and "Building Back Better" during the recovery, rehabilitation, and reconstruction phases. Investing in disaster risk reduction to enhance resilience. By 2030, strengthening disaster risk governance to manage disaster risk in the disruption of basic infrastructure and essential services such as health facilities and educational infrastructure.
	Environmental Law Act (No. 20/97 of 1 October)	Article 14 (Installation of Infrastructure): Defines important areas where environmental protection is required and which, due to their size and nature, infrastructure cannot be installed or made use of because it would damage the environment. Focusing on the EIA process, Articles 15–17 stipulate that an environmental license from the three relevant authorities is required for any activity for which the nature of location, design, or scale is likely to affect the environment. The issuance of an environmental license is to be subject to the findings of the EIA.
Land Use Plans	Land Use Act (No. 19/97 of 1 October)	Article 1 (Definitions): Deals with general definitions, including those for land use planning. Article 3: States that "the land is the property of the State and cannot be sold or otherwise alienated, mortgaged or encumbered," in accordance with the country's constitution. Articles 5–8: At the level of public domain lands, defines fully and partially protected areas.
	Land Law Regulations (Decree No. 66/98, amended by Decree No. 1/2003)	Article 20 (Registration): Defines the authority for registering information regarding the identification, provisional authorization, and revocation of authorizations for land use and benefit.
	Environmental Law Act (No. 20/97 of 1 October)	Article 14 (Installation of Infrastructure): Defines important areas where environmental protection is required and which, due to their size and nature, infrastructure cannot be installed or made use of because it would damage the environment.
	Regulations for the Prevention of Marine Pollution and Protection of Coastal Areas (Decree no. 45/2006)	Establishes a legal basis for the protection and conservation of the high seas, lakes, rivers, coasts, and areas constituting fragile ecosystems. It protects wetlands and mangroves and prohibits the discharge of pollutants into rivers and wetlands, uncontrolled fires, and the development of activities that would substantially alter the hydrological regime of these areas (Article 65). Infrastructure construction in partially protected areas related to water bodies should only be carried out in compliance with current standards and norms regarding environmental and landscape quality. In the case of fragile ecosystems (including mangroves), such work will only be allowed if special permits are obtained, and environmental laws and regulations are complied with (Article 67).

Plan	Related Laws, etc.	Overview
Land Use Plans	Land Regulation on Urban Soil (Decree 60/2006)	These provisions apply to legally existing municipalities and to any settlement or population concentration district organized by an urbanization plan. Article 5 (Characterization of the plans) The Land Use Plans in the towns, villages and human homeland plans or population agglomerations are classified as: a) Urban Structure Plan b) General and Partial Urbanization Plan c) Detailed Plans Urban Structure Plan – Establishes the space organization of the entire territory of the municipality or population and parameters and rules for their use, considering the current occupancy, the infrastructures and existing social equipment, and implements their integration in the structure of the regional space. General and Partial Urbanization Plan – An instrument of territorial management in the local sphere that establishes the structure and describes the urban soil considering the balance among many urban uses and functions, and defines the transportation, communications, electric power and sewage networks, and social equipment, with special attention to the zones of spontaneous occupancy as a social-spatial basis for the making of the plan. Detailed plan – Defines in detail the types of occupancy of any specific area of the urban center by establishing the concept of the urban space, providing for land uses and general conditions of buildings, the layout of the traffic ways, the features of the infrastructure and service networks whether for new or already existing areas, characterizing building facades and arrangements in open areas.
	National Land Planning Act (Law No. 19/2007, July 18)	Article 1 (Functions): Deals with the definitions for community, territorial planning, rural land, urban land, etc. Article 6 (Obligation to Organize Territory): Clarifies the entities authorized to promote, guide, coordinate, and monitor territorial planning in a clear manner. Article 10 (Territorial Planning Instruments). Defines territorial planning instruments at the national, state, provincial and municipal levels, as well as general territorial planning instruments. Article 13 (Authority to Prepare and Approve Territorial Planning Documents): Describes the competent bodies at various levels (national, provincial, prefectural, and municipal) for the preparation of territorial planning documents. Articles 21 and 22: All citizens, communities, legal entities, and public citizens shall have the right to full information on the contents and changes of regional planning documents. They also have the right to participate in the preparation, implementation, modification, and revision of regional planning documents, and to cooperate in regional planning activities. The community shall participate in the preparation of the regional planning document in coordination with the national local agencies and under the applicable laws.

Plan	Related Laws, etc.	Overview
Land Use Plans	Directive on Expropriation Procedures for Territorial Planning Purposes (Ministerial Diploma No.181/2010)	This directive on Expropriation Procedures for Territorial Planning Purposes, the guidelines, and global parameters within which expropriation procedures for territorial planning purposes must be submitted, has been approved by joint order of the Ministry of Coordination of Environmental Action, the Ministry of Finance, and the Minister of Justice. The purpose of this Directive is to establish expropriation rules and procedures for territorial planning purposes and to provide various stakeholders with guidelines to guide expropriation procedures.
	Technical Directive on the Process of Formulation and Implementation of Resettlement Plans (Ministerial Diploma No.156/2014 of 19 September)	In view of Decree No. 45/2004, this technical directive provides guidelines for governments and other stakeholders to align their plans for physical resettlement with the plans for socioeconomic processes with the aim of integrating forcibly displaced families and communities, restoring lost means of livelihood, and participating in local economic development. Given Decree 45/2004 on the environmental impact assessment process, Decree 10/2004 on economic activities, and Ministerial Diploma 181/2000 approving the directive on the expropriation process for territorial planning purposes, it provides technical directives for restoring lost means of livelihood and participating in local economic development.
Public Facility Recovery and Reconstruction Plans	Master Plan for Disaster Risk Reduction 2017–2030 (2017)	Strategic Goal IV: Strengthen immediate response capacity, rapid response, and resilient recovery and reconstruction
	Disaster-Resilient Housing Construction Guide (Ministry of Public Works, Housing and Water Resources and State Housing Directorate, 2020)	This guide elucidates the profile of the main climatic threats in Mozambique. It also highlights the following elements: - Technical requirements for disaster-resilient housing - Prerequisites for earthquake-resistant housing - Technical procedures for disaster-resilient housing - Costs and technologies - Strategies for dissemination in the community
	Guidelines on Resilience to Natural Threats, Environmental and Social Safeguards for School Buildings (Ministerial Diploma No. 122/2021 of 26 October)	Articles 8–11: Cyclone zoning, earthquake zoning, flooding/inundation zoning, drought zoning Article 12: Measures for new construction and expansion of schools Article 13 (Measures for consolidation or reinforcement) 1. “The reinforcement of school buildings dealt with in this deed focuses on improving the structure of buildings by applying resilient technical measures in order to increase their resistance to repeated natural threats." Article 14 elucidates measures for post-disaster reconstruction.” Article 18 lays out the responsibilities of the ministries that oversee the public works, housing, and water resources sectors. Article 19 addresses the responsibilities of contractors.

Plan	Related Laws, etc.	Overview
Disaster Response Plans	Constitution of Mozambique (2004)	Article 282 provides that "a state of siege or of emergency may be declared, in the whole or in part of the territory, only in cases of actual or imminent aggression, cases of disruption of or serious threat to the constitutional order, or in the event of a public disaster." Article 283 establishes the principle of proportionality for declaring a state of emergency, with "the duration and extent of the measures used shall be limited to what is strictly necessary for the prompt restoration of constitutional normality."
	Disaster Risk Management and Reduction Act (Law No. 10/2020 of 24 August)	Article 2: "This law establishes a legal regime for disaster risk management and reduction consisting of risk reduction management, disaster management, sustainable recovery for building human, infrastructure and ecosystem resilience, and adaptation to climate change." Article 45 1. "The rights of citizens in risk zones shall be: a) To assist in the evacuation of assets that may be at risk, at such times and under such conditions as the competent authorities may indicate; and b) The protection of evacuated assets and the faithful safekeeping of assets by competent authorities. 2. The most vulnerable people shall be entitled to special protection, which shall include: a) Priority in the evacuation and resettlement process. b) Special protection against any kind of abuse during emergency situations; and c) Continuing education. 3. People affected by disasters have the right to protection and social assistance in preventing or alleviating human suffering resulting from a disaster." Article 46. "The obligations of citizens in risk areas are as follows: a) To comply with the building regulations established by law. b) To comply with evacuation orders issued by the competent authorities; and c) To cooperate with authorities in the field of disaster risk management and mitigation."
	Regulations for Disaster Risk Management and Reduction (Decree No. 76/2020)	These regulations establish the rules and procedures for the applying the legal regime for disaster risk management and mitigation. "Article 31 (Mandatory Evacuation of High-Risk Zones) Governments may determine the conditions for the temporary or permanent mandatory evacuation of people and property located in high-risk zones. In situations of imminent danger, temporary or permanent mandatory evacuation of people and property may be decided by the Governor of the province in coordination with the Secretary of the province and in conjunction with decentralized organizations. In the event that a mandatory evacuation is decided upon under the conditions of the previous item, if proposed by the coordinating entity for disaster risk management and mitigation, this entity shall be obliged to coordinate the operations related to the mandatory evacuation of persons and goods.

Plan	Related Laws, etc.	Overview
		If the territory subject to mandatory evacuation measures coincides with the territory of the municipality, the national authority is obliged to supervise the operations referred to in the previous item in coordination with the Chairman of the Municipal Council. Priority for evacuation is given to all those who are most vulnerable, such as children, the elderly, the disabled, and pregnant women, and those who, due to their circumstances at the time, are unable to move on their own to participate in the evacuation. Governments may resort to coercive mechanisms to protect the lives and other rights of their citizens when there is refusal to evacuate."
Industry Restoration Plans	Strengthening women's economic empowerment	For the national legal framework, Mozambique's 1975 constitution substantiated the equality of men and women before the law and set forth the regulatory principles governing the rights, obligations and relations between men and women. These principles were addressed in the 1990, 2004 and 2018 constitutions–specifically Articles 67, 36 and 36 –and stipulate that men and women are equal before the law in all political, economic, social, and cultural spheres of life. In the same context, Articles 3 and 4 of the country's Family Law (10/2014) guarantees the protection of all family members and spouses and equality of rights and obligations. These principles were addressed in Article 3 and 5 of the new Family Law (22/2019), while Land Law 19/1997 also states that both men and women may be granted the right to the use of and to benefit from land (DUAT). Article 4 of the Environment Law (20/1997) guarantees to men and women the principle of equality of opportunity in access to and use of natural resources. Article 4 of the Spatial Planning Law 19/2007 guarantees the principle of equal access by citizens to land and natural resources, infrastructure, social facilities, and public services in both urban and rural areas. In 2019, the Prevention and Combat of Premature Unions Act (19/2019) and on Preventing and Combating Premature Marriage and the Civil Code–Inheritance Law, Volume V were approved for revision based on the rights of children and women. Existing programs and plans aim to alleviate poverty and minimize existing inequalities within the population through the implementation of various projects (PARPA8 I and II, Agenda 2025, Agenda 2030, etc.). The Gender Policy and Implementation Strategy (PGEI) was approved by the Council of Ministers in March 2006; PGEI provides the formal legal basis for the implementation of gender policies in the different branches of government.

Source: JICA Project Team

8.2.3 Environmental and Social Considerations

As indicated in the screening, environmental and social considerations were considered for each of the plans under this project. In line with the project implementation, the extent of how this consideration points will affect the planning or activities implemented in the project was examined. The result of the examination such as whether the activity is consistent with relevant laws and regulations, or if not, relevant what measures would be necessary is shown in Table 8-6.

Table 8-6 Environmental and Social Considerations in each Sector

Sector	Major Environmental and Social Impacts	Points to be considered
Infrastructure Recovery and Reconstruction Plan	Studies were conducted on the recovery and reconstruction of infrastructure in three sectors: countermeasures against storm surge, drainage, and road. The assessment of impacts of infrastructure projects were assumed to include air pollution, water pollution, noise, vibration, and other pollution countermeasures during construction; impacts on the natural environment, including protected areas and ecosystems during construction and service; and impacts on the social environment, including land acquisition/resettlement and unfair distribution of damage and benefits in compensation is not appropriate.	[Storm surge countermeasures] Project being developed to build a seawall jointly funded by the WB and Netherlands governments. Environmental and social impacts are being considered in accordance with Mozambique's national environmental impact assessment procedures. The environmental impact assessment confirmed that the environmental and social impacts and mitigation measures were properly considered, including consideration of supplemental mangrove planting as a compensatory measure since some mangrove forests will be cut down, and consideration of compensation for fishery-related personnel. The additional coastal protection measures proposed in this plan were considered to have an impact on the surrounding residents and the possibility of land acquisition/residential relocation due to the existing residential and commercial buildings and railroad tracks in place. In order to minimize these effects, an upright wall was adopted to minimize the impact of the project. [Drainage] Consideration on the drainage network, and retention pond, etc., which requires land acquisition/ resettlement was not considered under this project due to its overlap with the project funded under the support of World Bank and former RVO's [Road] This project considered countermeasures for coastal roads, and collapsed trees and utility poles, and preventive measures for pavement damage by heavy machinery was to improve the disaster resilience of city roads. Negative environmental and social impacts were not assumed. For the road heightening of Beira port access road and other improvements proposed in this project, land acquisition/ resettlement would be required. Therefore, the land use situation and the presence of residents was confirmed in the site visit. The surrounding land was marshy, and there were no houses or other structures. Basically, the land was considered non-production land, but since some of the land was used for agricultural purposes, it is necessary to consider compensation during the detailed study phase of the project in case it is considered.

Sector	Major Environmental and Social Impacts	Points to be considered
Land Use Plan	Risk map was formulated to support land use planning. In the risk map evaluation, when non-residential areas (areas with high risk) are to be established, social and environmental impacts were assumed, such as the occurrence of land acquisition/resettlement and unfair distribution of damage and benefits if compensation is not appropriate.	This project formulated risk map was by overlapping hazard maps, population, and assets. This risk map was used to describe areas where DRR measures are needed and to calculate the amount of damage, and no recommendations for land use regulation were made in the project period. Therefore, negative environmental and social impacts were not evaluated.
Public Facility Recovery and Reconstruction Plan	To support the formulation of public facility recovery and recovery plans, Bairro wise vulnerability was identified method for analysis and evaluation of how to prioritize the facilities to rehabilitate were proposed. No negative impacts on the environment and society were assumed in this plan, but positive impacts on existing social infrastructure and social services were assumed. The project team provided support for the recovery and reconstruction of public facilities through the request of counter parts.	This project stipulates that the role of CMB is to "leave no one behind, including the socially vulnerable" from the perspective of DRR, and proposes a plan for prioritizing facilities (ensuring that the socially vulnerable, especially the physically challenged, the elderly, and pregnant women, have evacuation center are accessible by foot and close to them) and for floor plan of facilities. In the pilot project, facilities where it does not require acquisition/resettlement was Selected and environmental and social impacts were not evaluated.
Disaster Response Plan	Support for the development of disaster response including evacuation plan, evacuation and DRR education was conducted in pilot areas and evacuation planning working group (WG) was established. No negative impacts on the environment and society were assumed, but positive impacts on existing social infrastructure and social services were evaluated.	Through the development of evacuation plans and the associated activities, DRR awareness and preparedness among the officials and citizens was increased and the importance of developing evacuation plans from disasters was recognized. DRR and public health education was conducted for students in the two schools. The Maraza Infantry Center, an important facility in the community to cares for children and should be repaired as soon as possible, was selected as the target of the disaster prevention workshop. Repairs were made to the cyclone-damaged roof and windows was rehabilitated which was not applicable for COVID-19 countermeasures and measures for corroded and fallen ceilings was conducted in the workshop.
Project for Fish Market Resilience	Study in scope of the livelihood recovery was conducted targeting the Praia Nova fish market. No negative impacts on the environment and society were assumed in this plan, but positive impacts on the poor and the local economy, including employment and means of livelihood, were evaluated.	The project introduction Kigumi techniques which allowed the evacuation of stalls before cyclones and storm surges, as well as the use of stalls to improve sanitation (i.e., improving the conditions of stalls being left on plastic or platforms for hours without wrapping or covering). In addition, the Kigumi trainings provided as vocational training opportunity for the participants. The increase in the demand for timber in Mozambique as a result of Kugimi activity is expected to have the effect of promoting employment not only in the forestry industry, but also in the industry of sawmilling, transportation, and processing.

Source: JICA Project Team

CHAPTER9 Implementation of pilot projects for the rehabilitation of public facilities

9.1 Objective of Pilot Project

The pilot project aims to help recover to the original facility function and achieve emergency evacuation venues or evacuation centers to be used at the time of disasters. It also intends to suggest project performance results as a viable model to the Beira Municipality and other regions through the execution of the project.

9.2 Site Selection for Pilot Project

9.2.1 Site Selection Policy

In the site selection process, the JICA Project Team confirms possible site use with the Beira Municipality in charge of facilities and the DPEDHS in order to set the site selection criteria and gain agreement from them. After the selected sites are evacuated in line with the criteria, highly evacuated sites are finally decided as the target pilot project site.

(1) Site Selection Criteria

Through discussions with Beira Municipality and the DPEDHS on September 27, 2019, the JICA Project team agreed to the following criteria for site selection.

Table 9-1 Site Selection Criteria

The following sites are excluded	
1)	Site located in hazardous areas of high tide or flood
2)	Site with repaired target facilities or with disaster damage unconfirmed at Cyclone Idai
3)	Site outside a 20-km radius from the Beira Municipality that JICA Project Team cannot operate disaster prevention activities
4)	Site unable to secure rescue tent setup space
5)	Site with bad accessibility
6)	Site where other donors have decided to provide support
7)	Site with facility function use, which has not built proper relations with regional communities
8)	Site that is predicted to be seriously damaged or difficult to recognize as a repair model for other regions in the future due to regions with special features

Source: JICA Project Team

(2) Candidate Site Evaluation and Selection of the Pilot Project Sites

In line with the selection criteria for the above sites, the sites, suggested by the Beira Municipality and the DPEDHS, were evaluated. The three sites in total have been selected as pilot project sites, including two sites out of education facilities that functioned as emergency evacuation venue or evacuation center at Cyclone Idai, and one site from administration facilities under the jurisdiction of the municipality (to plan two adjacent sites as one site). The following figure shows an evacuation table.

Table 9-2 Evaluation Table for Candidate Site in Pilot Project on Proposed Sites

Site Selection Evaluation Sheet: Facilities under the jurisdiction of Beira Municipality

Proposed Site Names		Evaluation Criteria							
		1	2	3	4	5	6	7	8
1	Road Maintenance Section Office and Workshop	△	○	○	○	○	○	X	X
2	Vehicle Maintenance Workshop	△	○	○	○	○	○	X	X
3	Beira Football Stadium	△	○	○	○	○	○	X	X
4	Marrocanhe Health Center	○	X	○	○	○	○	△	○
5	Manga Mascarenha Health Center	△	X	○	○	○	○	△	○
6	Centers for Women Victims of Violence in Vaz	△	X	○	○	○	○	△	○
7	Nhangoma Health Post	△	○	X	○	○	○	△	X
8	Váz Health Center	Ditto as No.6							
9	Muavi Community Center	○	X	○	○	○	○	○	○
10	Munhava Central Community Center	△	○	○	△	X	○	○	○
11	Chipangara Community Center	△	○	○	X	○	○	○	○
12	Maraza Nursery	△	○	○	△	○	○	X	○
13	Goto Community Center	△	○	○	X	△	○	○	○
14	Mananga Community Center	△	X	○	X	○	○	○	○
15	Tchantchim Community Center	△	○	○	X	○	○	○	X
16	Inhamízua Community Center	○	X	○	○	○	○	○	○
17	Macuti Miquijo Primary School	△	○	○	X	○	○	○	○
18	Vaz Primary School	△	○	○	○	○	X	○	○
19	Nhassassa Primary School	○	○	X	○	○	○	○	X
20	Nhacamba Primary School	○	○	X	○	○	○	○	○
21	Tchonja Bairro Office	○	○	X	X	○	○	○	X
22	Nhanssassa Health Post	This site is not identified							
23	Inhamízua Post Administrativo office	○	○	○	○	○	○	○	○
24	Chingussura Bairro Office	○	○	○	○	○	○	○	○
25	Maraza Bairro Office	△	X	○	○	○	○	○	○
26	Nhaconjo Bairro Office	○	X	○	○	○	○	○	○

Proposed Site Names		Evaluation Criteria							
		1	2	3	4	5	6	7	8
1	Ponta Gea Secondary School	△	○	○	○	X	○	○	○
2	Samora Moises Machel Secondary School	△	○	○	○	○	○	○	X
3	Mateus Sansão Muthemba Secondary School	△	○	○	○	○	○	○	○
4	Maguiguane Primary School	△	△	○	○	X	○	○	○
5	Esturro Primary School	△	○	○	○	X	○	○	○
6	EPC Macurungo	△	○	○	○	○	○	○	○

Source：JICA Project Team

Table 9-3 Pilot Project Sites

Pilot Project Site Name		Selection Date（MoU Conclusion）
	EPC Macurungo	October 4, 2019
	Mateus Sansão Muthemba Secondary School	October 20, 2019
	Inhamizua Post Administrativo Office and Chingussura Bairro office	October 18, 2019

Source：JICA Project Team

9.2.2 Target Facility in Pilot Project Site

When construction bids are solicited for the target facilities in the pilot project, if the bidding price exceeds the upper limit, the bid price should be adjusted by excluding low priority repair items from the plan. The priority should be given in the target project range to conclude the construction agreement within the expected bid amount.

As for the target facilities and the target project ranges in each site from December 2019 to January 2020, consultations were held separately with the Beira Municipality, the DPEDHS, and the DPSS to set priorities, as shown in the following table. The Priority A indicates an item to be executed surely in the project, and the Priority B means an item to be excluded from the target project if the bidding price exceeds the expected price. In an effort to coordinate the target range smoothly after bidding, the memorandum of understanding has been concluded with the above institutions under the jurisdiction of the facilities, based on the consultation results.

Table 9-4 Target Facility and Priority for Repair Menu in of Scope of Work for Pilot Project at Each Site (Part 1)

Target Pilot Project Site	Scope of Work	
	Priority A	Priority B
EPC Macurungo	Installation of 15 temporary classrooms made of tarpaulin, and tarpaulin roof sheet installation for four existing buildings with classrooms and one building with administration office and classrooms	N/A
	Repair and Construction: Roof repair for four existing buildings with classrooms and one building with administration office and classrooms. Construction of building with 15 classrooms including restroom and administration office, facility work for electricity and water supply and drainage and window repair	Ceiling repair, and repaint work for four existing buildings with classrooms blocks and of 1 building with administration office and classrooms
ESG Mateus Sansão Muthemba	Repair: Repair work for roof and window in two of three-story buildings, roof repair work for an administration office building and minor electric and plumbing works	Repair: Repaint work for two of three-story buildings and administration office building and repair work for restroom and shower attached to the gymnastic hall
PA Inhamizua e Sede de Bairro da Chingussura	Repair and Construction: Roof repair work for of two offices, installation of temporary restrooms and minor electric and plumbing works	Construction: Installation of warehouse and development of access pathway

Source: JICA Project Team

Japanese Government assisted some institutions for health workers in Sofala province. However, Cyclone Idai damaged them, which were repaired and reinforced the roof structure in this project.

Table 9-5 Target Facility and Priority for Repair Menu in of Scope of Work for Pilot Project at Each Site (Part 2)

Target pilot Project Site	Scope of Work	
	Priority A	Priority B
ICS Beira	Installation of five temporary classrooms made of tarpaulin, and tarpaulin roof sheet installation for female student dormitory and dining hall building	N/A
	Repair and Construction: Female student dormitory (five classrooms)	Repaint work for eaves soffit and wall
	Minor roof work for two buildings with classrooms	Repair work for window and door, and repaint work for wall
	Roof repair work for three buildings with classrooms	Repair work for window, door and ceiling, wall repaint work and electric work for equipment connected from the power distribution panel
	Roof repair work for dining hall building	Ceiling repair work, wall repainting work, and electric work for equipment connected from the power distribution panel
	Construction for five buildings with classrooms	Furniture

Target pilot Project Site	Scope of Work		
	Priority A	Priority B	Priority C
ICS Nhamatanda	Eaves enhancement: -Four dormitory buildings -Administration office building -Laboratory building -Two buildings with classrooms	Eaves enhancement: -Dining hall building -Laundry office building	Eaves enhancement: -Guardhouse building, -Restroom building -Residence for teachers

Source: JICA Project Team

9.2.3 Design Policy

This project designs repairs and reinforcement of roofs of damaged buildings, new construction of classroom blocks, and models of evacuation centers.

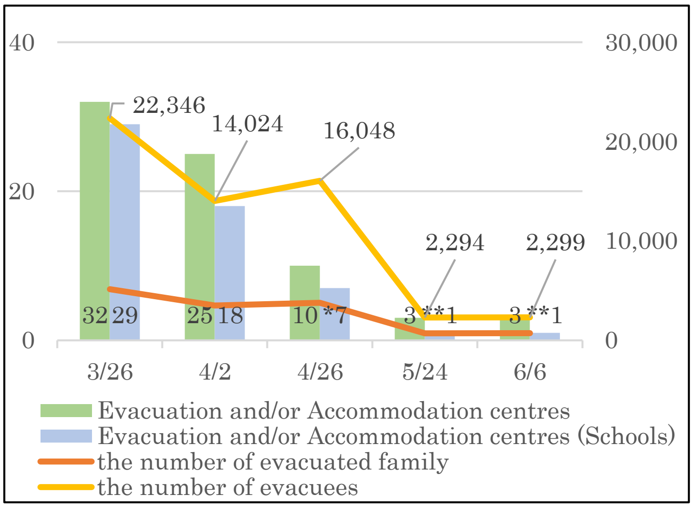
(1) Period of evacuation

In the case of Cyclone Idai, people have used many schools as evacuation places or evacuation centers[3], along with community centers and churches. And people accidentally choose these schools for evacuation.[4]

Since March 14 when the cyclone struck Beira, the number of evacuees in schools gradually decreased, from 22,346 on March 26 (two weeks after the landfall) to 2,294 people on May 24 (eight weeks after it).

3 Among the 30 evacuation center established after the landfall of Cyclone Idai, 29 was education facilities as of the situation two weeks after the landfall (DTM_mozambique-site-assessment-round-1)
4 22 schools were used as evacuation center accidentally (source same as above)

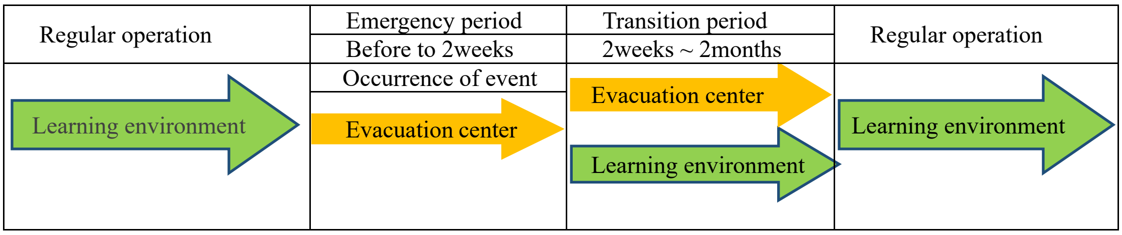
We can set the operation period until returning home or relocation to settlement as two months in case that we plan to use schools and public buildings for evacuation centers.



Source： JICA Project team created based on Displacement Tracking Matrix (DTM)

Figure 9-1 Changes in the number of emergency evacuation sites/centers, evacuees, and evacuation households in Beira, along a time frame

We need to design the schools to fulfil the double function of evacuation and education during the period shown as a below figure.



Source: JICA Project team

Figure 9-2 Required facility functions in the event of a disaster

(2) Design policy of new classroom blocks and evacuation centres

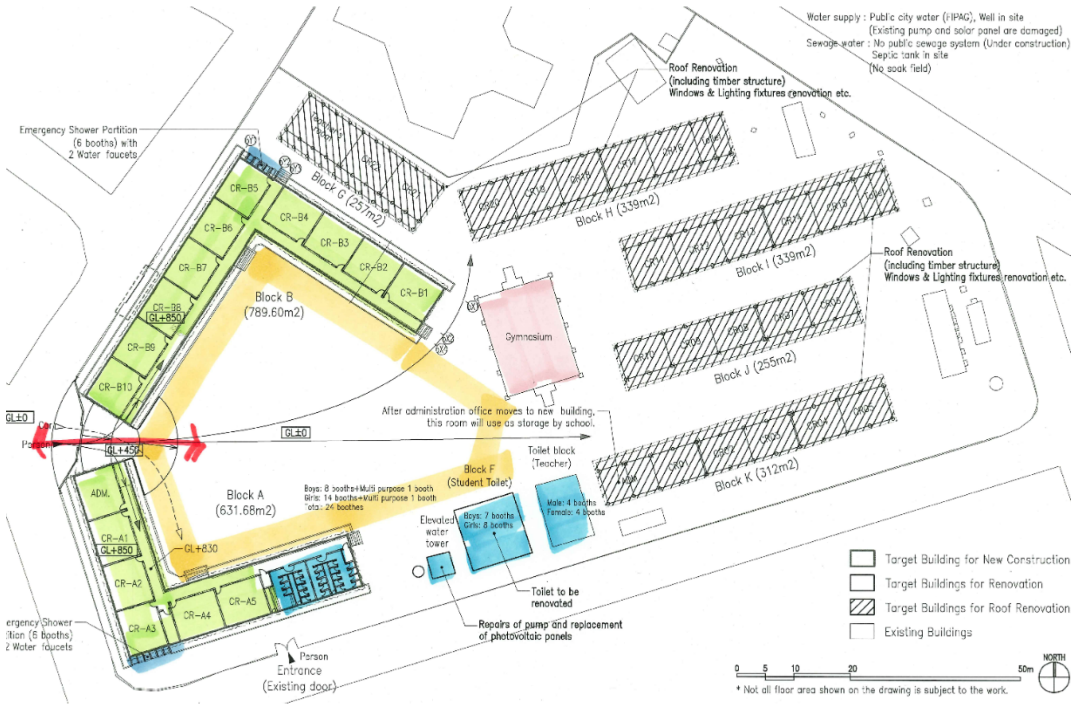
The three target sites have been used as evacuation centers for neighbors after being struck by Cyclone Idai in March 2019. We designed this pilot project by renovating and strengthening it to function as an evacuation center.

1) EPC Macurungo

In EPC Macurungo located among the main residence of Beira, old and small classrooms in the light structure were densely on the western of the premise or left side of the following map. They were demolished and rebuilt. The new classroom blocks are supposed to serve as temporary residences for evacuees for two weeks, marked in green on the map. The number of classrooms is fifteen, the same as demolished, and the blocks include the administration office and toilets. The entrance between two new blocks serves the automobiles of the aid teams. Evacuees can also use the project's other classroom blocks with reinforced roofs and repaired openings.

The area enclosed with classroom blocks, marked in yellow on the map, provides a space for evacuees' tents and delivery of supplies. The blocks are laid along the boundary walls to enlarge this area. A concrete floor of a basket court damaged on the roof by the Cyclone, marked in pink on the map, faces this area and serves as a cooking space for evacuees and supportive activities.

Evacuees can use the new and rehabilitated toilets and the shower booths behind the blocks, marked in blue on the map. This project also rehabilitated the damaged water tower by the Cyclone.



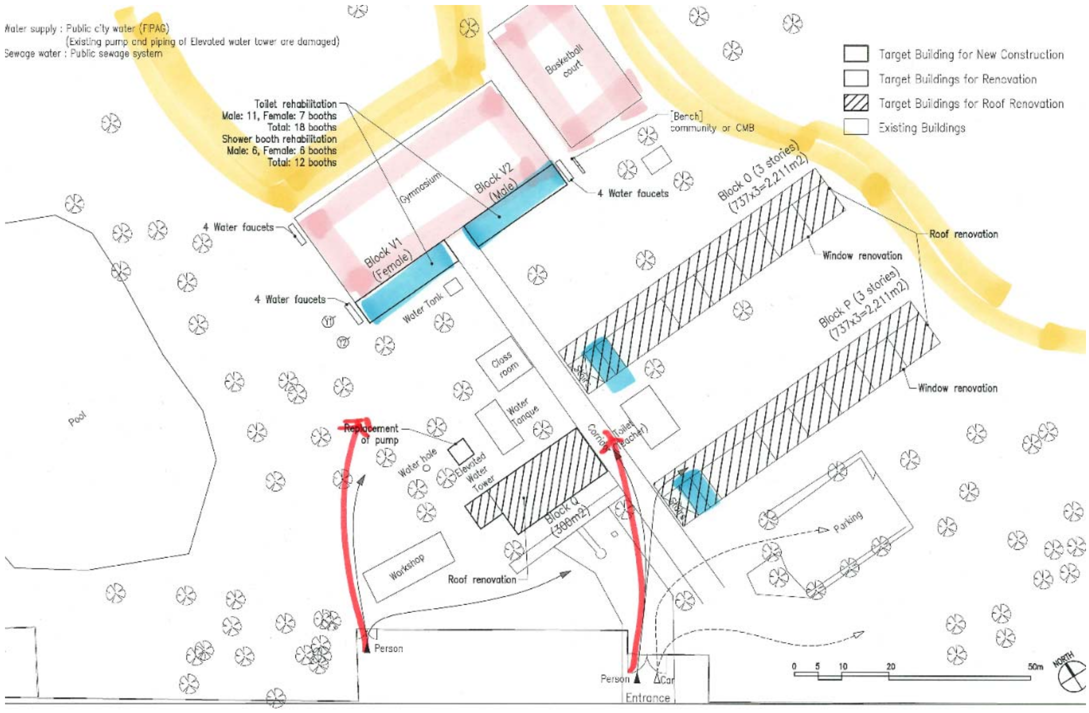
Source： JICA Project team

Figure 9-3 Layout plan for Macurungo Elementary School as an evacuation facility

2) ESG Mateus Sansão Mutemba

ESG Mateus Sansão Mutemba is in Bairro Esturoo in the main Beira. The main rehabilitation items are repairs and reinforcement of damaged roofs and windows and converting gymnasium shower blocks into toilets and showers for evacuees in blue on the following map. Evacuees can also use classrooms' toilets. Concrete floors of the gymnasium and a basket court serve as a cooking space and supportive activities.

Since the south and west of the premise can be flooded after cyclones, the north and east, marked in yellow on the map, are suitable for tents in evacuation.

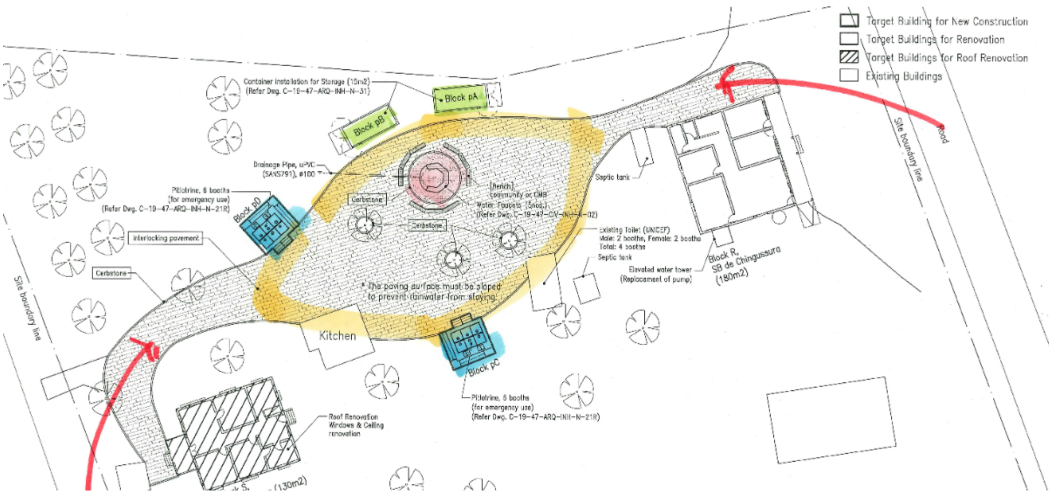


Source : JICA Project team

Figure 9-4 Layout plan for Mateus Sansão Mutemba Middle School as an evacuation facility

3) PA Inhamizua e Sede de Bairro da Chingussura

PA Inhamizua e Sede de Bairro da Chingussura, on the outskirts of Beira, has enough vacant space and toilets by UNICEF and good conditions as an evacuation center. To implement a disaster-prevention park proposed in 6.5.2 (3), 4) of Section 6, this project paved the space between two offices, which can serve as a park in peacetime and an area for evacuees. Underground concrete tanks on the south of the pavement can work as emergency toilets by installing sheds of steel pipes and plastic sheets, marked in blue on the following map. Containers on the north of the pavement, marked in green on the map, house sheds materials, other supplies, cooking ware or blankets. A circular concrete bench, marked in pink on the map, can serve as a cooking table for evacuees.



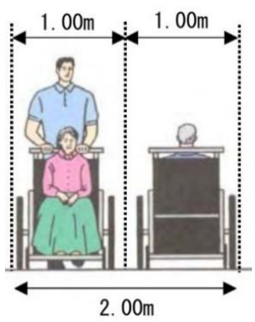
Source： JICA Project team

Figure 9-5 Layout plan as an evacuation facility for PA Inhamizua e Sede de Bairro da Chingussura

(3) Application Standards

In the process of working out facility plans, necessary standards are referred on the occupation area, and the number of installed hygienic equipment in the emergency or transition period to accept evacuees, including normal operation time and realistic figures needs to be set in accordance with the status in Mozambique.

Table 9-6 Reference Standards Applied Indicators for Design

<table>
<tr><th></th><th>Normal Operation Period</th><th>Emergency Operation Period</th></tr>
<tr><td>Corridor Width</td><td>Min. 1.8 m (1*)</td><td>2.0 m (2*)
As many evacuees come and go in the corridor at emergency, the dimension for public space is based instead of corridor width for the facility.</td></tr>
<tr><td>Slope Angle</td><td>Max. 6 degrees, approx. Less than 1/10 (1*)</td><td>Max. 1/12 to 1/15 recommended (3*)</td></tr>
<tr><td>Occupation Area/Person</td><td>1.30 sqm/p (4*)</td><td>Emergency period: 2.0 sqm (5*)
Transition Period: 2.3sqm to 4.0sqm (6*),</td></tr>
<tr><td>Water Supply Volume/Person</td><td>Student Teacher: 25 L/p (8*)</td><td>Emergency period: Evacuee 15 L/p (9*)
Transition Period: Evacuee 15 L, Student 3 L/p (9*)</td></tr>
<tr><td>No. of Users/Restroom</td><td>Student: 20 to 50 p (7*)
Female:25 p Male (urinal): 50 p (8*)</td><td>Emergency Period: 50 p (9*)
Transition Period: 20 to 50 p (9*)</td></tr>
<tr><td>Minimum Distance between infiltration inlet and groundwater source (well)</td><td colspan="2">30 m (4*)</td></tr>
<tr><td colspan="2">Source:
(1*) Decree 2008/53
(2*) Ministry of Land, Infrastructure, and Transport of Japan, 1st round-table discussion material on universal design of road
(3*) UNICEF, Access to School and the Learning Environment I – Physical, Information and Communication Webinar Booklet
(4*) Extracted from the specifications of the secondary schools planned using FASE by MINEDH
(5*) Examined based on physically required space for lying on the floor
(6*) Based on UNHCR Family tent (6~10pp) 23 sqm
(7*) MINEDH UNICEF Mozambique (2018), ‘Evaluation of the Design & Use of School Wash Facilities in Primary Schools in Mozambique’
(8*) 25L is calculated by adding 5L for potable water to 20L for flushing toilets. WHO (2009). ‘Water, sanitation and hygiene standards for schools in low-cost settings’ Edited by John Adams, Jamie Bartram, Yves Chartier, Jackie Sims
(9*) Sphere (2018), ‘The Sphere Handbook’ 2018 ed.</td><td>

Based on reference material (2*)</td></tr>
</table>

(4) Structural Standards

1) New Construction Buildings

The structural design of newly buildings aims to resist against natural disasters like Cyclone Idai, according to the Japanese structure standards, by using 60 m/s as standard wind from MINEDH’s standard design, 0.04 to 0.163 gal as seismic load from MINEDH’s seismic map, allowable soil bearing capacities by the geotechnical survey.

2) Rehabilitation Work

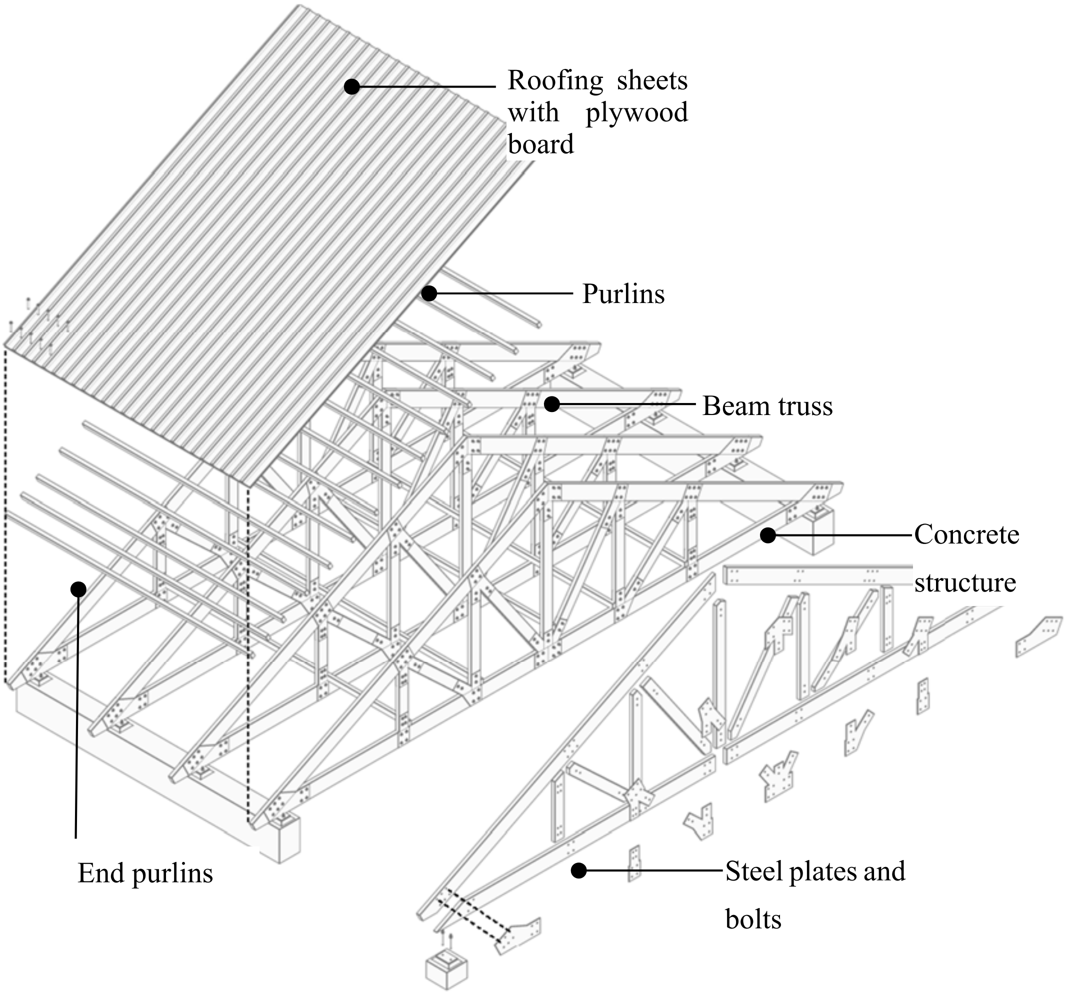
Since the damaged buildings’ structures are smaller than today’s ones, and some are decrepit, it is difficult to judge the structure's strength against earthquakes and storms. In principle, the project did not reinforce the concrete structures but upgraded the roof structures and the connections between both.

(5) Methodology for strengthening

1) Strengthening of roof

This pilot project includes renovating damaged classrooms by the cyclone and the new construction of classrooms to be demolished. In the renovation works, the remaining parts of the buildings were utilized to the maximum extent possible to strengthen the structure.
Cyclone damage was mainly concentrated on roofs, and the project also focused on roof toughening. The key points of retrofitting are as follows.

- The roof structure consists of roofing sheets, purlins, beam trusses and concrete beams. Upward forces by cyclones are transmitted first to the roofing sheets, then to the purlins, beam trusses and concrete frames. So, the individual structural elements and the joint method are essential.
- If the number of fasteners fastening the roof sheet to the substrate is small, the upward force on a single fastener increase, and if the upward pressure exceeds the pull-out force, the entire roofing sheets will scatter. It is essential to distribute the force applied per fastener by increasing ones.
- The upward forces are high at the roofing edges: eaves, roofs and ridges, where they often peel off and scatter. So, it is required to increase fasteners in these areas should be increased.
- Beam trusses are made in triangle geometry with timbers. Usually, trusses are joined with gang nails, but they can be torn off when mighty wind. So, in this project, steel plates and bolts were employed for joining.



Source: JICA Project Team

Figure 9-6 Structural elements and strengthening of roofing

- Timber trusses are employed for many classroom buildings, but some buildings have brick masonry triangle walls on concrete slabs in ESG Sansao Mutemba. In this case, concrete beams were reconstructed instead of masonry beams which could not resist upward forces without concrete reinforcement.

- Beam trusses are generally reinforced with braces in the longitudinal direction of the building to prevent them from collapsing. This design placed plywood panels under the roofing sheets to increase rigidity and create a simple structure without braces.

1) Renovations by sites

Renovation by sites is shown in the below table depending on the kind and degrees of damage. The new buildings were designed by Japanese structural practice using Cyclone Idai wind speed records, while the renovations were verified as far as possible.

Table 9-7 Renovations by site

	Roofing fasteners	Roofing sheets	Plywood panels	Purlins	Beam trusses	Remark
Macurungo						
Blocks A, B	○	○	○	○	○	New construction
Blocks G, H, I, J, K	○	○	○	○	○	
Nhamatanda						
Blocks nA, nB, nC, nE	○	○		△		
Blocks nD, nG, nH, nI, nJ	△			△		
Sansao Mutemba						
Blocks O, P, Q	○	○	○	○	○	Concrete beam
Block V						Only interior refurbishment
PA Inhamizua						
Block S	○	○	○	△		
ICS Beira						
Block E	○	○	○	○	○	New construction
Block L	○	○	○	△		
Block U	△	△				
Block M	△	△		○	△	
Block N	△	△		△		

○: Complete new works, △: Partial works or reinforcement

Source: JICA Project Team

9.2.4 Policy on Cost Estimate and Procurement

(1) Procurement of Construction Material and Workforce

1) Procurement of Construction Material

Construction materials manufactured in Mozambique are limited, ranging from gravels to aggregates, cement, concrete secondary products, and timber. Most other construction materials are imported from neighboring South Africa or EU nations or procured as processed products after raw materials are imported. Imported materials, which are commonly used in the local construction method, are usually distributed in the market. As the construction materials or equipment to be used in this plan satisfy the local specifications and are commonly used for standard school building construction, they can be easily procured locally. However, in order to procure necessary volume of roof truss (wood or steel frame) and doors or windows with no delay and meet a certain degree of quality, construction professionals with manufacturing and technological capabilities need to be chosen and used carefully. Furthermore, as the construction period is limited, procurement management is required to place an order for materials at proper timing and avoid construction delay.

2) Procurement of Workforce

Even though ordinary workers can be procured locally in Beira City, skilled workers and technical experts are generally based in the capital city, Maputo, and cannot be easily procured in Beira City. Therefore, in this project, the procurement from Maputo is primarily considered.

3) Applied Unit Cost

Based on unit costs calculated by local consultants, the JICA Project Team examines the adequacy of them to adopt as unit costs.

9.2.5 Policy on Construction and Repair Work

(1) Policy on Construction Schedule

Because the currently used facilities are to be repaired in the pilot project, their construction schedule needs to be examined to use the facilities continuously. Also, as the rainy season starts before construction work in this project, emergency measures are necessary to cover damaged roofs for repair work with tarpaulin material.

(2) Policy on Construction Supervision

Local resources are used as much as possible in order to use planning details, methods, and processes executed under this project to be used for other regions in the future. Therefore, construction work is supervised by local consultants. Before construction work starts, meetings are held with them to discuss construction supervision standards, organization structure, inspection form, meeting schedule, meeting minutes production, and communication with related persons. The JICA Project Team receives weekly and monthly reports from the local consulting firm’s head office to plan spot supervision at critical points.

(3) Policy on Local Constructor Selection

The project must complete the work within the determined period in terms of emergency, requires quality control and procurement of material in Maputo to meet the design grade for resilience, and severe site management to operate new construction and rehabilitation work simultaneously. Considering these requirements, the bidding took place for the 7a class construction firm registered in the MOPHRH.

1) Construction Firm Registration and its Classification

In Mozambique, construction firms, involved in public work projects, need to submit a registration to the MOPHRH and gain construction permits (commercial license: Alvará). The firms allowed to undertake permanent activities for the construction industry in Mozambique are as follows: (1) a construction firm based in Mozambique, (2) a foreign-affiliated construction firm registered in Mozambique that has been operating the business in Mozambique for ten or more years, and (3) a branch office or local business office of a foreign-affiliated construction firm, registered in the country where it was organized, that has been operating business legally for ten or more years after gaining a private business license in Mozambique.[5] The upper limit of construction values for the order is set based on the number of engineers, capital, financial status, and others. The registered contraction firms are categorized into seven classes, from 1a to 7a. The 7a class includes about 170 companies, if a group company, including subsidiaries or local offices, is counted as one.[6]

Table 9-8 Classifications of Contractor Registration in the MOPHRH

Class	Required minimum capital (1,000 MZN)	Maximum amount of contract (1,000 MZN)
1a	20	1,000
2a	50	3,400
3a	150	10,000
4a	500	20,000
5a	1,500	60,000
6a	5,000	200,000
7a	10,000	200,000 or larger (no upper limit)

Source: Ministerial diploma (Diploma Ministerial) 77/2015

Furthermore, local companies (eligible domestic bidder in Mozambique), stipulated in the Decree of Ministerial Cabinet no. 5/2016 (Decreto no Conselho Ministro) on public procurement, are defined as follows: (1) an individual with Mozambican nationality registered as an operator performing proper economic activities; (2) an individual with Mozambican nationality or a corporation organization based in Mozambique with 50% or more capital participation; and (3) an individual or an organization registered in Mozambique for five or more years, even if the majority of its capital is in foreign countries. The above three cases are treated as domestic bidders.

2) Evaluation Criteria Policy for Selecting Local Contractors

Based on the past project performance results in the MINEDH and the MISAU, a shortlist for 7a class construction firms is produced to select a favourable firm in a competitive price bid. The team structure for construction (chief engineer and workforce planning), implementation system including subcontractor or supplier, financial capacity, and ownership of material or equipment are also reviewed, together with interview surveys if needed. Thus, the final decision is made after ensuring the feasibility of proposals.

3) Policy on Bidding for Construction Works

In the bid process, the bid price submitted by a bidder with the first priority is evaluated. If the bid price exceeds an expected amount, the scope of work for bidding is adjusted in line with the facility priority accepted with each institution before the tender, and the contract value is determined within the expected

5 Diploma Ministerial No. 77/2015, Article 12

6 Construction firm registration is renewed annually. The number of 7a-class construction firms was 80 as of August 2014, but it increased to 174 as of January 2018. However, some foreign companies have closed, and some went bankrupt due to the economic recession, it is, therefore, difficult to accurately determine the number of registered.

bid price.

(4) Payment Policy

With the construction quality in mind, local consultants are paid on a work stage basis, and contractors are paid monthly on a piecework basis to avoid schedule delay with the shortage of operating funds.

9.3 Preparation and Emergency Works

(1) Sub-contract regarding the Pilot Project

To disseminate the outcomes in the pilot project in Mozambique, the task mentioned bellow was conducted by sub-contract to the local contractors.

1) Site Topographic Survey and Geotechnical Survey

The site topographic survey and geotechnical survey were conducted to precisely grasp site topography or soil bearing capacity and achieve precise design cost estimation for the target facility.

Re-commission contracts have been concluded with local survey companies to conduct a site survey and geological surveys in the three pilot project sites, including EPC Macurungo, by December 11, 2019. However, because as the two sites could not be selected except for EPC Macurungo within the contract period, and reconstruction work for ICS Beira is added to the follow-up project for facility function recovery. The contract with local survey firms was revised on December 2, 2019, to make the operation period for four sites in total, effective until January 11, 2020. The survey result is as the following table.

Table 9-9 Result of Geotechnical Survey

Site	Assumed soil bearing capacity
EPC Macurungo	62kN/m2, 0.75m from the ground level
ESG Mateus Sansão	21kN/m2, 2.0m from the ground level
PA Inhamizua e Sede de Bairro de Chingussura	16kN/m2, 0.75m from the ground level
ICS Beira	60kN/m2, 0.75m from the ground level

Source: JICA Project Team

2) Emergency Works for damaged roofs and classrooms

The project executed emergency works to provide shorten classrooms and other rooms in the target sites until the completion of the project.

a) Temporary Classrooms

For temporary classrooms until the completion of the project, the project provided fifteen temporary classrooms in EPC Macurungo and five in ICS Beira.

Figure 9-7 Temporary Classroom

External Appearance of Temporary Classroom

Class in Temporary Classroom

Source: JICA Project Team

b) Tarpaulin Sheets over Classroom Blocks

Five classroom blocks in EPC Macurungo, a dormitory and a refectory in ICS Beira were covered with tarpaulin sheets for protection against direct sunlight and rain.

Figure 9-8 Classroom with Tarpaulin Sheets

External Appearance of Temporary Roof

Internal Appearance of Temporary Roof

Aaerial view of EPC Macurungo:
Buildings in white indicate tarpaulin sheets and temporary classrooms

Source: JICA Project Team

3) Local Consulting Firm

A shortlist of consulting firms was prepared based on past experiences and the MINEDH evaluation. After the interview sessions, the team narrowed down three firms and selected Consultec - Consultores Associados Lda by Quality and Cost Based Selection (QCBS). Consultec provided professional service; Onsite survey to design, Cost estimation, Bid document production, Bidding support, Construction supervision, and Response from the users during the defect warranty period.

9.4 Other points in planning

- The objective of the pilot project is to propose its outcome as one of the models of an emergency evacuation center and/or accommodation center for evacuees that can be rolled out in Beira City and other regions. In order to accomplish this objective, the facility design in the project must be linked well with an evacuation plan to be operated. However, natural disaster risk management, including an evacuation plan, shall be considered not only by a single entity but by multi-stakeholders. Hence, one of the challenges is to form a working group with related parties to facilitate discussion, extract fruitful opinion, and cultivate ownership among the parties. Accordingly, once a working group is formed, it is expected that decision making can be more simplified, and consensus can be made efficiently and on time.?
- Since this project is aimed at renovation as well as new construction, it is expected that problems will be identified after construction starts, depending on the condition of the existing building. Thus, depending on the bid price at the time of bidding, it is necessary to secure a certain contingency by adjusting the construction target range and keeping the contract amount within the planned price.
- The well-finished building outfit strongly appeals to its completion of the renovation to the public. However, painting is the low priority in the pilot project, since strengthening the resilience of the buildings is the primary objective, and all the projects are planned within the budget limitation. Hence, there is a possibility that the amount of painting work is reduced in the scope of work, depending on the bidding price.
- Taking account of the undesired scenario indicated above, searching for other possible options is one of the agenda. It is an option to supply the paint by the JICA Project Team when the surplus of the budget for contingency measures is expected at the final stage of the construction works. In this case, the feasibility of the stakeholder mobilization, such as end-users and communities to paint the facilities, is also to be further considered.

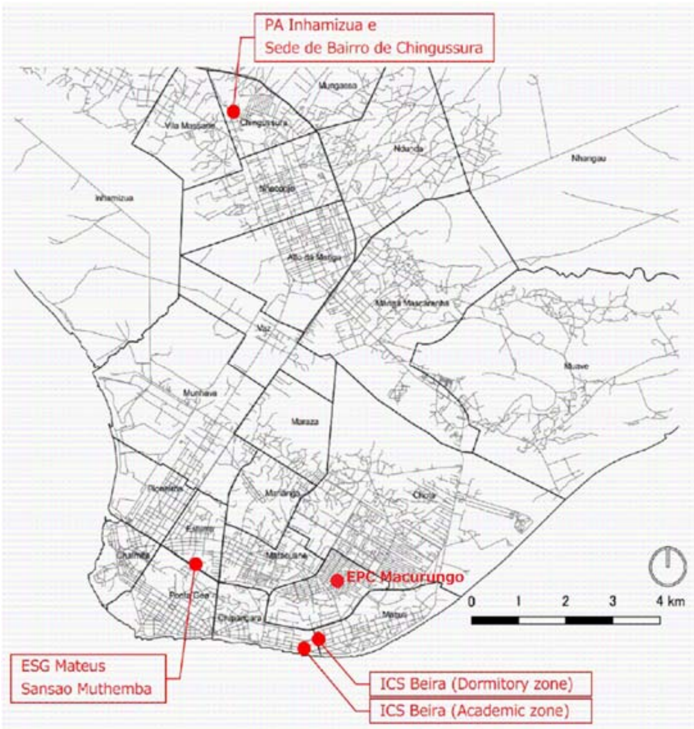
9.5 Outline of the works

The pilot project involved new construction and rehabilitation works at five sites in Beira and in the district of Nhamatanda, Sofala. Two contractors selected in the bidding held in December 2020 conducted the work, as shown in the following table.

Table 9-10 Outline of the works in the pilot project

	Contractor	Site	New building	Rehabilitation
Lot-1	TEC	EPC Macurungo	2 classroom blocks, 1,421m2	- Five blocks for resilient roof structure works - One for repairs of sanitary equipment
		CFS Nhamatanda	NA	- Three blocks for roofing sheets installation - Six blocks for reinforcement of roof
Lot-2	Beira Empreitadas	ESG Sansao Mutemba	NA	- Three blocks for resilient roof structure works and windows - Conversion from shower rooms to toilets
		PA Inhamizua	NA	- One block for resilient roof structure works and interior works - Temporary toilets, water supply and storages - Pavement
		ICS Beira	1 classroom block, 464m2	- Two blocks for resilient roof structure works and interior works - Three blocks for roof repairs and interior works

Source: JICA Project team



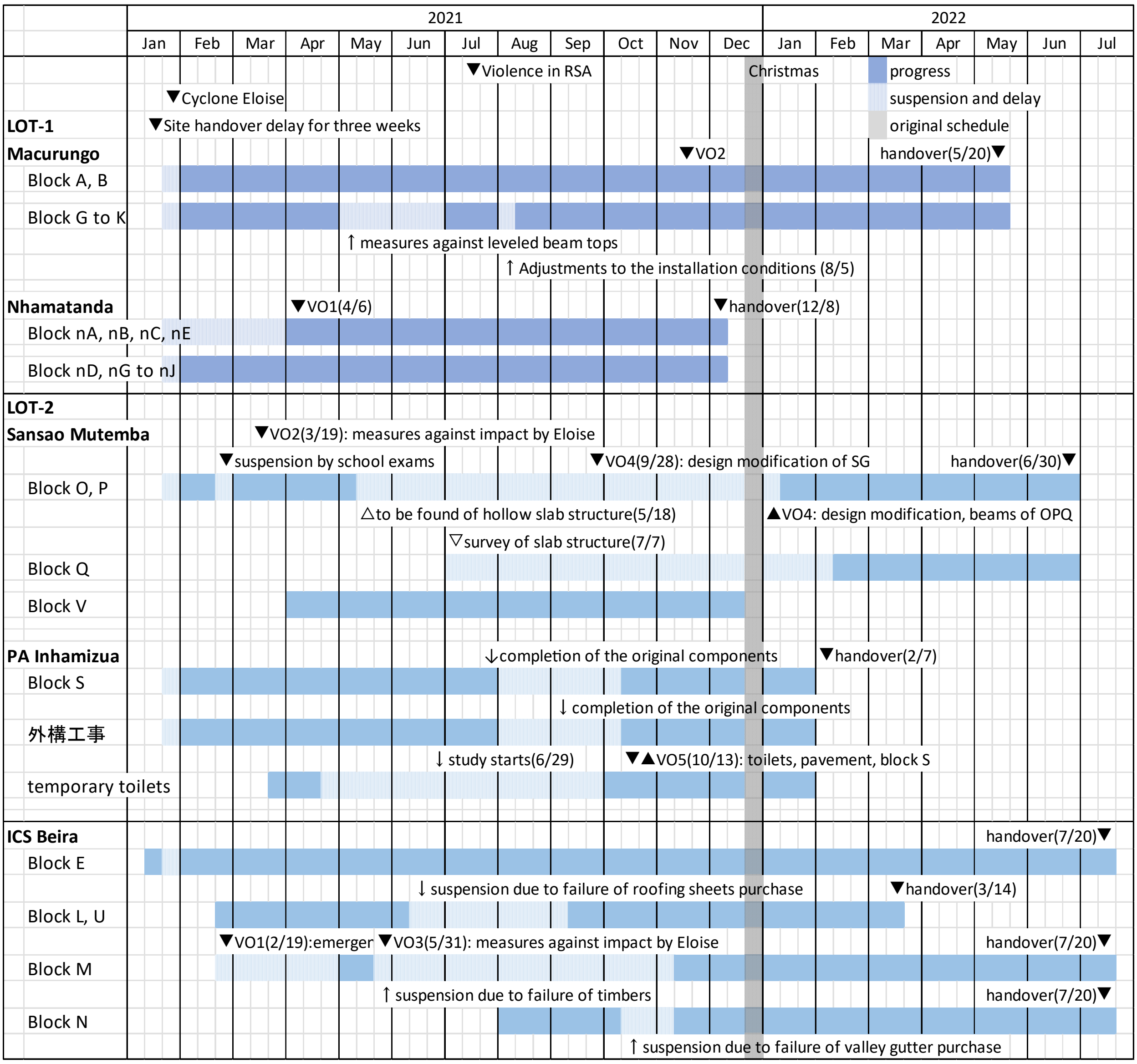
Source: prepared by JICA Project team

Figure 9-9 Site location

9.6 Work progress

Construction of the pilot project started in January 2020. Still, the start was delayed due to the impact by Cyclone Eloise, which hit Beira at the end of January, and assistance to the project sites. The procurement of materials for the project was also severely damaged by the COVID-19 in South Africa, which reduced production activities, affected transport due to high fuel prices and caused nationwide riots for political reasons, resulting in interruptions and delays in construction work. Furthermore, as the work was a refurbishment, structural problems were discovered after the existing structure had been demolished. The study and the procedure of the changes to these situations, which could not have been envisaged at the time of design, prolonged the suspension of construction.

The construction took about eighteen months which exceeds planned twelve months finally.



Source: Prepared by JICA Project team

Figure 9-10 Progress of construction works

The reasons for the delays and the situation are summarized in the table below.

Table 9-11 Details of construction delays

Site	Period	Duration	Contents
EPC Macurungo	Jan., 2021	3 weeks	Handover of the site delayed due to the school exams.
Whole project	Jan., 2021	1 week	Cyclone Eloise (landed on 22 Jan) crippled Beira, which took one week to recover.
ESG Sansao Mutemba	Feb. 2021	1 week	One-week suspension for school exams.
ESG Sansao Mutemba	-	?	Interior work can be conducted only on weekends, as the school use the classrooms weekday.
CFS Nhamatanda	Mar. to Jun., 2021	4 months	Construction work was effectively suspended due to delays of material procurement
EPC Macurungo/G	May to Jun., 2021	2 months	The top of the existing beams was not aligned, and the work was suspended due to the measurement and the study.
ESG Sansao Mutemba/OP	May to Jun., 2021	1.5 months	The slab was found to be hollow structure, and the work was suspended due to the measurement and the study.
	Sep. to Dec., 2021	4 months	The contractor couldn't look for a fabricator of steel beams in Beira, and the consultant decided to change into concrete beams.
PA Inhamizua toilet utilities	Jun. to Sep., 2021	4 months	The work was suspended due to groundwater, and the consultant changed the design.
ICS Beira	Jul.-Sep 2021-		Violence in South Africa (RSA) disrupted plant and social services, affecting the procurement of materials from RSA
ESG Sansao Mutemba/Q	Sep. to Dec., 2021	more than 4 months	Same as blocks O & P

Source: prepared by JICA Project team

9.7 Design modifications

The pilot project had a total of approximately JPY 37.1 million (excluding foreign exchange) as preliminary costs and remaining deposits as a result of a tender in November 2020. However, after the start of construction, in late January 2021, Cyclone Eloise hit the city of Beira and caused damage to the buildings covered by the project, resulting in additional repair works and approximately JPY 25.2 million[7] was spent in relation to Cyclone Eloise. In addition to this, the following design changes were made in response to situations that arose on site during construction.

7 Besides this budget, JPY 0.8 million was spent for the emergency rehabilitation for the roof of the dormitory building of ICS Beira and it was allocated from the ARPOC project general budget.

Table 9-12 Design changes

* Shading is the response to damage caused by cyclones.

	date	site	block	element	amount	balance
						37,078,108
Lot 2, VO1	19-Feb	ICSB	M	temporary roofing	806,562	
Lot 2, VO2	19-Mar	ICSB	L	ceiling	2,910,477	34,167,631
		ICSB	N	roof, ceiling		
		MSM	O, P	windows		
Lot 1, VO1	6-Apr	NHA	nA and etc.		11,402,884	22,764,747
Lot 2, VO3	1-Jun	ICSB	M	roof, interior	10,851,702	11,913,045
Lot 2, VO4		MSM	O, P, Q	roof, toilet	-612,574	12,525,619
Lot 2, VO5	13-Oct	INH	S, temporary toilet, pavement		3,901,662	8,623,957
Lot 1, VO2	15-Nov	MAC	Septic tank	structure	2,050,959	6,572,998
Lot 1, VO3	25-Feb	MAC	F	toilet pan	481,539	6,091,459
Lot 2, VO6	7-Apr	ICSB	U1, U2, M, N	roof, interior	1,858,775	4,232,684

Source: prepared by JICA Project team

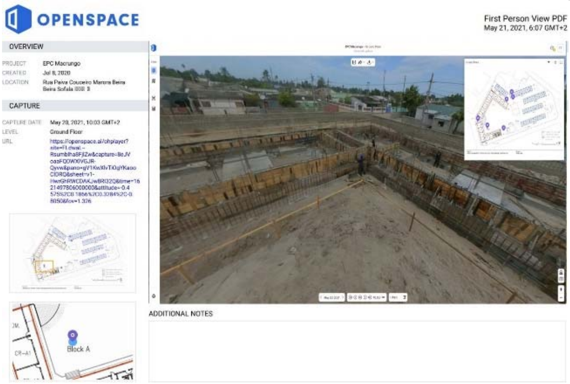
9.8 Consultant supervision structure

The consultant's supervision structure was as follows.

- A local consultant, Consultec Consultores Associados Lda, stationed two engineers in Beira to supervise the site: one engineer from January 2010 onwards. The project manager and assistant manager (AS) supported from Maputo and AS is responsible for material procurement, various procedures, and coordination of weekly meetings.
- Japanese consultant team assigned two Japanese engineers stationed in Japan for monitoring, attending weekly online meetings with the local consultant and both construction companies, checking site conditions, answering questions on material specifications and design, checking progress and process management through images, documents, and daily emails. They also conducted checks of monthly work progress, study, design and cost estimation of design modifications, assistance for revision of contracts. In addition, they conducted site visits for supervision.
- Japanese consultant team also assigned one local staff member stationed in Beira to take photographs and to liaise and coordinate with local authorities in Beira. In addition, one local staff in Maputo attended weekly meetings, took minutes, and answered questions, and coordinated with the local consultant.

The Japanese consultant used the images and documents shown in the following table as tools for remote supervision.

Table 9-13 Supervising tools

Tool	Frequency/ subject	Operational method
Image		
360° photos	1-4 times a week, by a local staff of Japanese consultant	Overall views of the sites are recorded by a specialized equipment and uploaded to a cloud server operated by OpenSpace.  Photos are checked by the Japanese consultant of the work progress and details.
Still photos	Same as above	Particular scene of the work is recorded by a normal camera and sent to the Japanese consultant via email. The photos are stored on a server and checked of the work progress and details when necessary.
Management form		
Weekly meeting	Weekly, by the local consultant	Regular weekly meetings are held to confirm the work progress and issues by the project manager and foremen of the contractors, supervisors and managers of the local consultant, and the Japanese consultant. Meetings are held on-line by Microsoft Teams from Tokyo, Maputo, and Beira, need one hour for each session of consultants, Lot-1, and Lot-2 contractors.
Minutes of meeting	Weekly, by the local staff	Minutes of meetings are prepared by the local staff and shared with attendees. The Japanese consultant confirm the situation by inquiries with the local consultant via email.
Work progress chart	Monthly, from Jan 2022 onwards, the Japanese consultant	Work progress charts are to check the progress compared to the planned schedule at the weekly meetings.
Material procurement schedule	Weekly, by the Japanese consultants and the local consultant	Material procurement schedules are updated for each material to share the status by consultants and contractors.
Weekly report	Weekly, by the local consultant	Weekly reports are prepared in the consultant's standard form.
Monthly report	Monthly, by the local consultant	Monthly reports are prepared in the consultant's standard form to be submitted to the owners of each site; the Provincial Education Department, the Provincial Health Department, and the Beira City.
Monthly summary	Monthly, by the Japanese consultant	The Japanese consultant prepare to organize the work progress, design modification, and prospects of the future to share within the Japanese consultant team.
Material approval letter	As needed, by the constructors	Material approval letters are attached with brochures and technical information, which are reviewed by the Japanese consultant for technical decisions based on the specifications and design intent.
Monthly work amount	Monthly, by local consultant and Japanese consultant	Local contractors submit them, which are checked by the local consultant and the Japanese consultant. The monthly work amount is agreed through discussions with contractors.

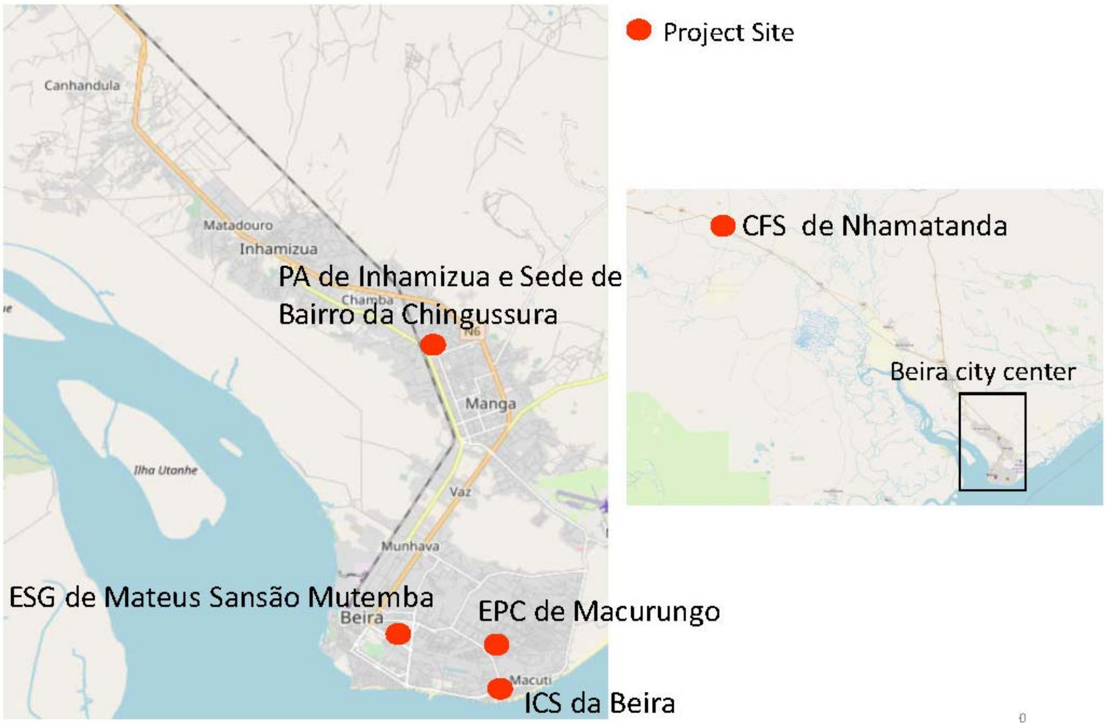
Source: prepared by JICA Project team

9.9 Location and site photo of the pilot projects

As a reference the location of the pilot projects for rehabilitation of public facilities and the photo from the sites are summarized in this section.

9.9.1 Location

The location of the pilot projects for rehabilitation of public facilities is as bellow.

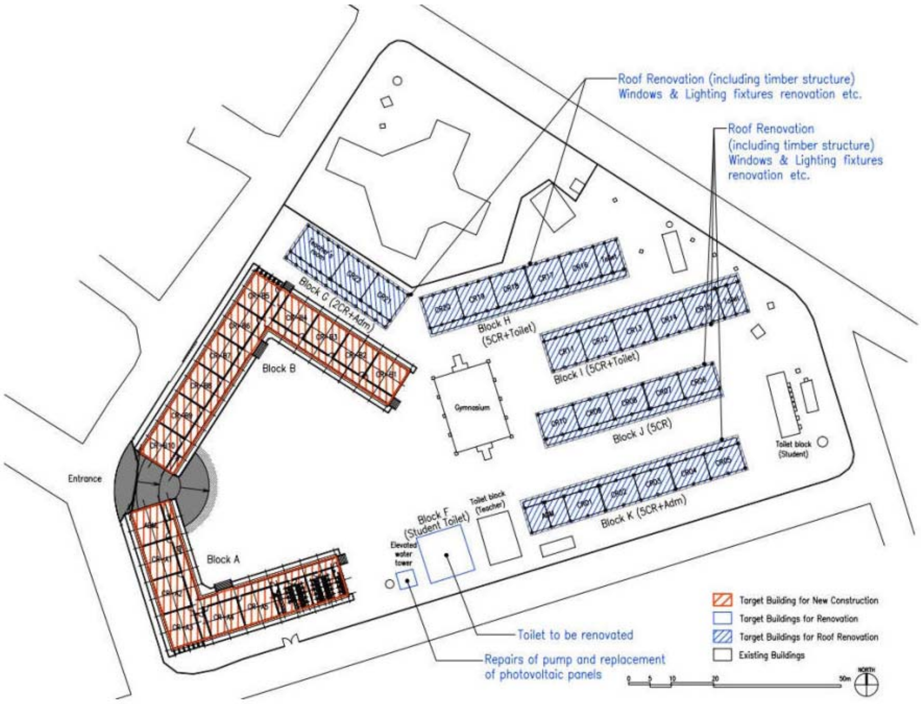


Source: JICA Project Team

Figure 9-11 Location map of the pilot projects for rehabilitation of public facilities

9.9.2 Site map and the photo of the site

(1) EPC Macurungo



Source: JICA Project Team

Figure 9-12 EPC Macurungo / site map

Source: JICA Project Team

Figure 9-13 EPC Macurungo / Site photo (before rehabilitation)

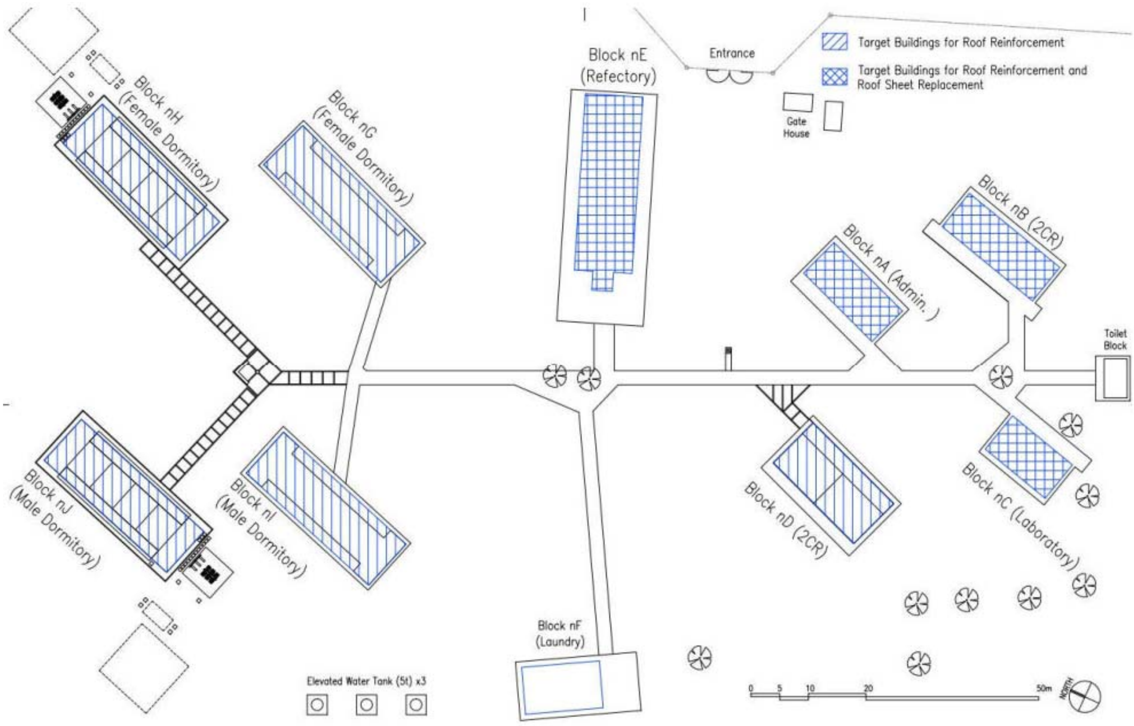
Source: JICA Project Team

Figure 9-14 EPC Macurungo / Site photo (after rehabilitation)

Source: JICA Project Team

Figure 9-15 EPC Macurungo / Site photo (after rehabilitation)

(2) CFS Nhamatanda



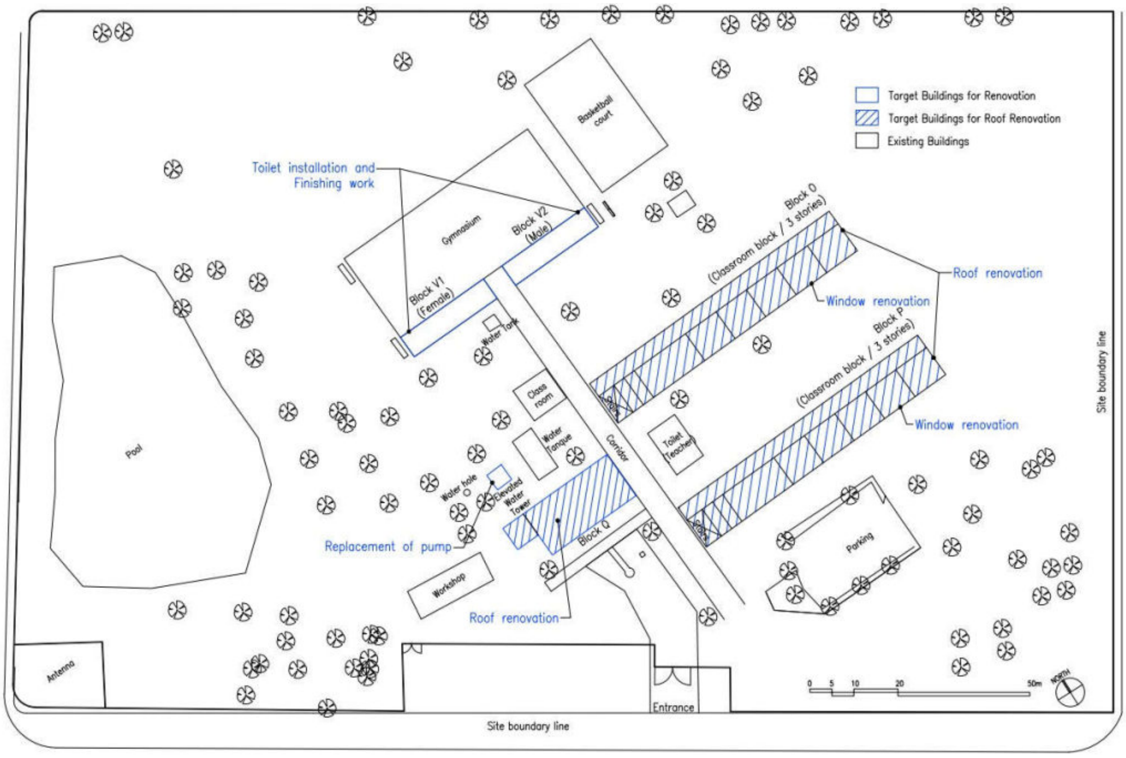
Source: JICA Project Team

Figure 9-16 CFS Nhamatanda / site map

Source: JICA Project Team

Figure 9-17 CFS Nhamatanda / Site photo (before and after rehabilitation)

(3) ESG Mateus Sansao Muthemba



Source: JICA Project Team

Figure 9-18 ESG Mateus Sansao Muthemba / site map

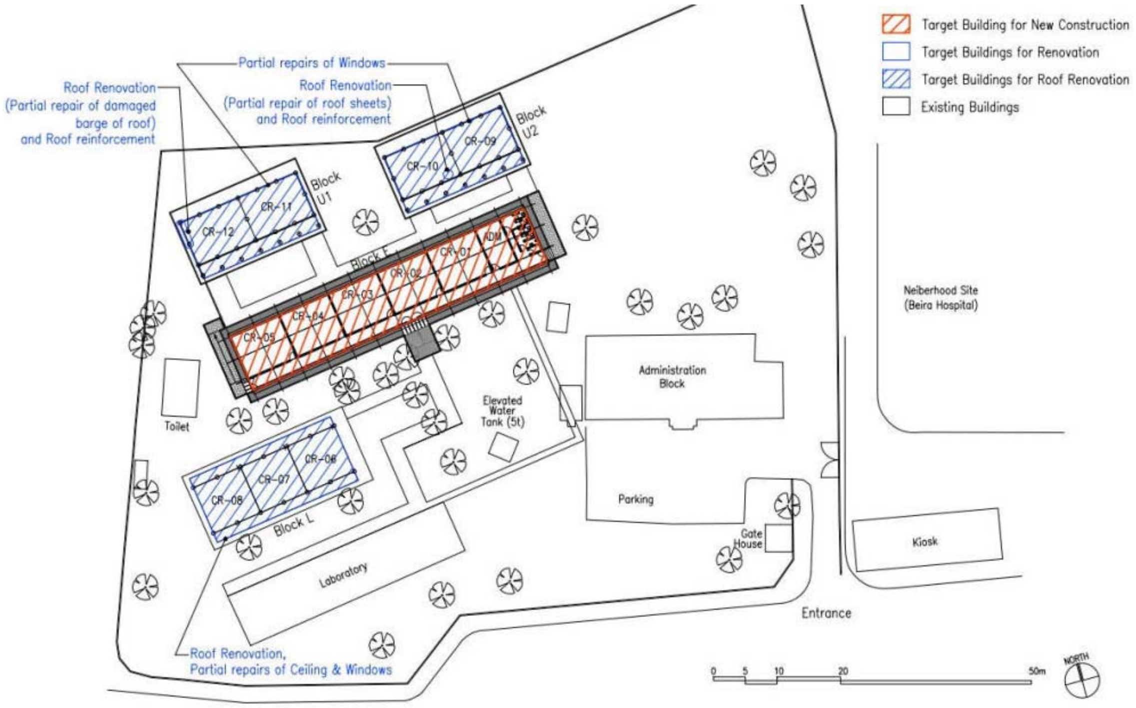
Source: JICA Project Team

Figure 9-19 ESG Mateus Sansao Muthemba / Site photo (before rehabilitation)

Source: JICA Project Team

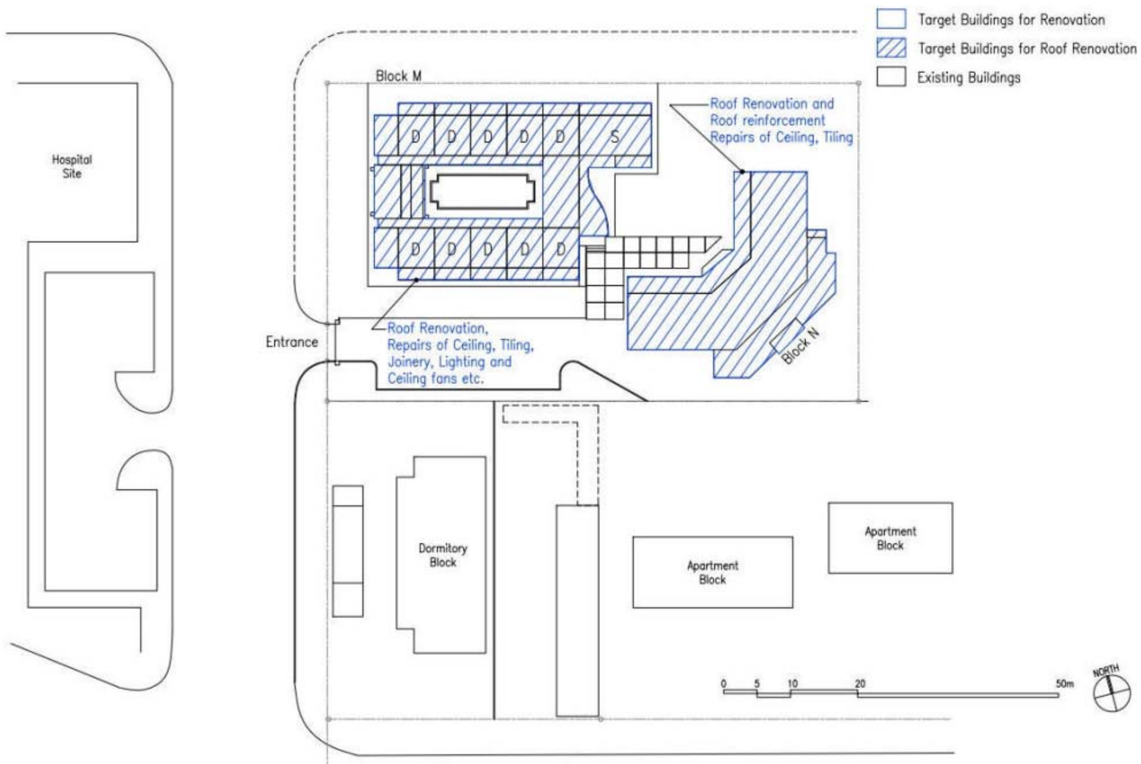
Figure 9-20 ESG Mateus Sansao Muthemba / Site photo (after rehabilitation)

(4) ICS Beira



Source: JICA Project Team

Figure 9-21 ICS Beira (Academic zone) / site map



Source: JICA Project Team

Figure 9-22 ICS Beira (Dormitory zone) / site map

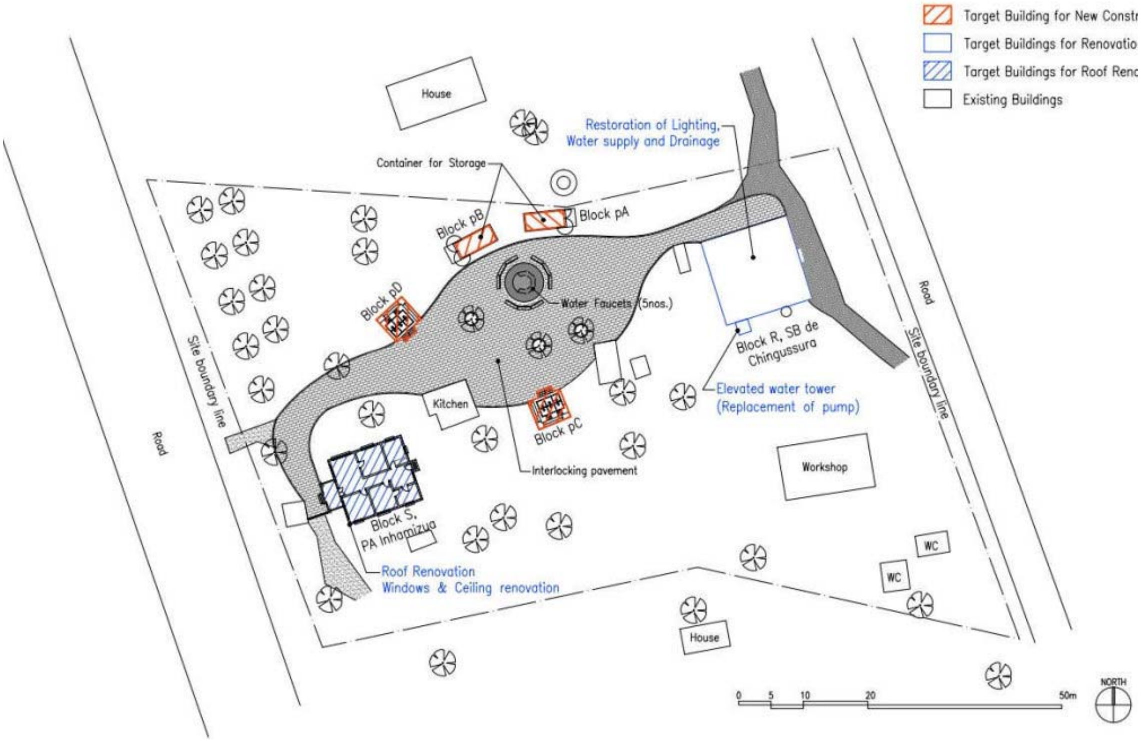
Source: JICA Project Team

Figure 9-23 ICS Beira / Site photo (before rehabilitation)

Source: JICA Project Team

Figure 9-24 ICS Beira / Site photo (after rehabilitation)

(5) PA Inhamizua e SB Chingussura



Source: JICA Project Team

Figure 9-25 PA Inhamizua e SB Chingussura / site map

Source: JICA Project Team

Figure 9-26 PA Inhamizua e SB Chingussura / Site photo (before rehabilitation)

Source: JICA Project Team

Figure 9-27 PA Inhamizua e SB Chingussura / Site photo (after rehabilitation)

Source: JICA Project Team

Figure 9-28 PA Inhamizua e SB Chingussura / Site photo (after rehabilitation)

CHAPTER10 Lessons Learnt and Suggestions for the Reconstruction and Resilience of Beira City

10.1 Overall picture of activities in this project

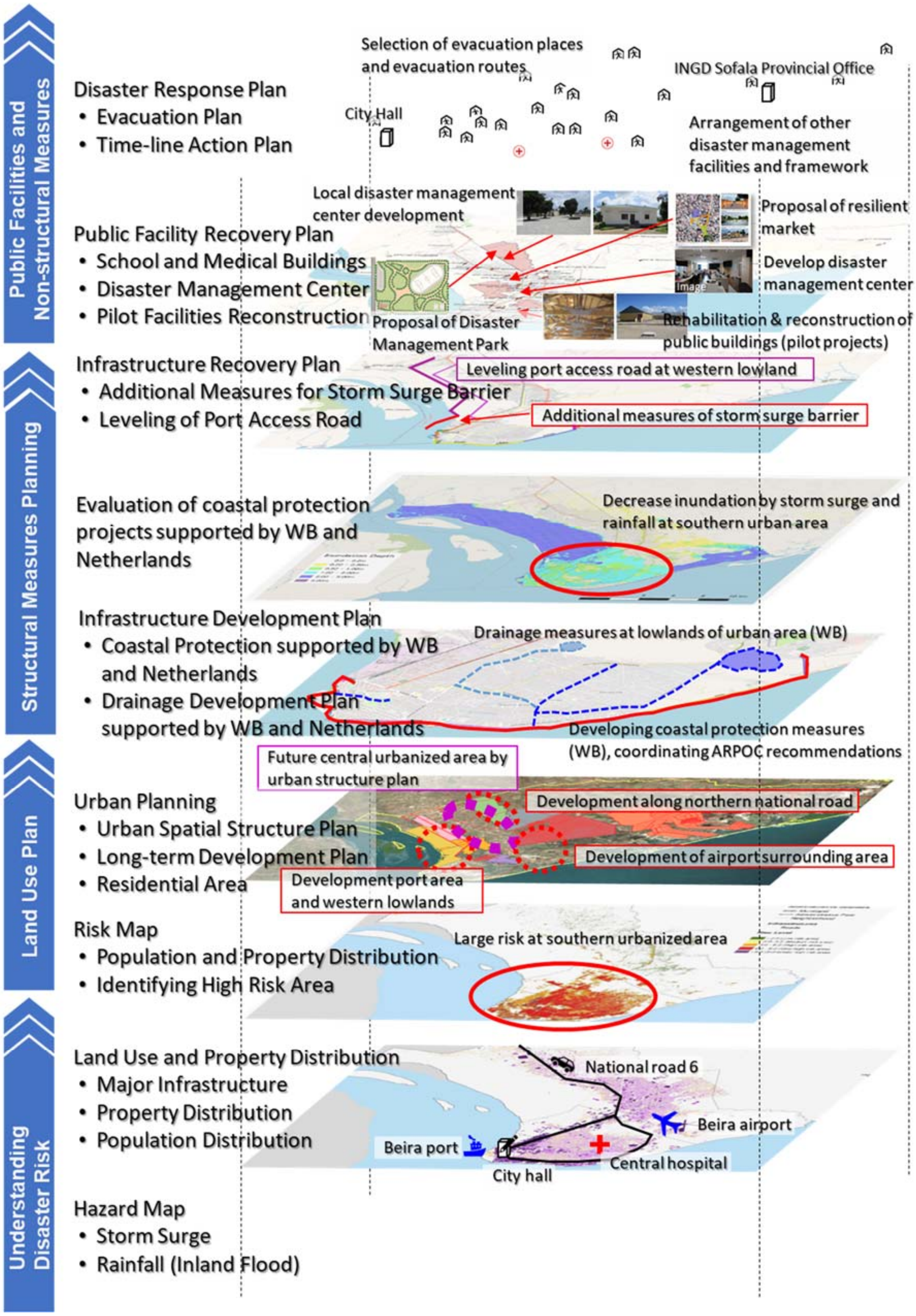
10.1.1 Summary of Outcome of the Project Planning Activities as the Action Plan for Reconstruction and Resilience Based on Hazard Map

After the disaster caused by Cyclone Idai, CMB developed the Beira Municipal Rehabilitation and Reconstruction Plan (BMRRP) with support from the Netherland government, UNHABITAT, and UNDP. However, BMRRP has not been able to include a concrete action plan. In addition, the BMRRP has identified sector-specific measures to be implemented in the future but has not been able to systematically be described the concept of BBB (Build Back Better) and the series of measures to prepare for possible future disaster risks such as cyclones, storm surges, and floods and achieve a society that is more resilient than before the disaster.

The project supported the preparation of a hazard map for Beira City as the basis for a recovery and resilience action plan which also considered possible future cyclone, storm surge, and flood disasters based on the experience and knowledge of Japan in disaster recovery and resilience. Based on the formulated hazard map the project also supported the develop of the recovery and reconstruction action plans in major sectors and compiled a list of counter measures to be implemented for recovery and resilience in the future. Since the Mozambican government is promoting project to develop coastal protection and drainage network in Beira with support from the Netherlands government, the World Bank, and other donors, the consideration in this project was done with good coordination with relevant institutions of the related projects. Through discussions and coordination with stakeholders, the hazard map formulated in this project was referred to and utilized in the examination of projects related to coastal protection, implemented by the Netherlands Government and the World Bank.

The figure in the next page summarizes the results of the project which considered recovery and reconstruction action plans by sector based on the hazard map. In the formulation of the hazard map in this project, simulation based on the worst-case scenario was also conducted, based on several scenario, counterparts such as GREPOC, INGD, CMB, other related agencies, and other donors could plan considering the worst-case scenario which could happen in Beira in the recovery and reconstruction process. In addition, based on the hazard map, risk map which incorporated land use and future development was also formulated. Moreover, not only the infrastructural intervention such as coastal protection measures, drainage network and construction of public facilities resilient to disaster, but also shift in the urban structure, such as promoting urban development in inland high areas was also envisioned. Thus, coordination with relevant institution was done emphasizing the importance of enhancing resilience, which is the ability to quickly recover from disasters.

On the other hand, while infrastructure intervention and urban planning to reduce disaster risks are being developed, many cyclones cause damage to the country every year, and many floods occur during the rainy season. Therefore, implementation of evacuation plans including timeline action plans as non-infrastructure measures for disaster response to further enhance the resilience was proposed and implemented in the project. As the shown in Figure 10-1, the consideration of recovery action plan was done by taking into consideration that preparedness against disaster cannot be achieved by one type of measure or by one single institution, and that it is necessary for structural measures and non-structural measures is done by complement each other. In addition, it was emphasized that not only the intervention by the public sector but also the participation of the citizens is necessary and it important to foster understanding among the relevant stakeholders through discussions in line with technical cooperation to the relevant institutions. The following chapters will describe the process and results of the consideration of recovery and reconstruction plan based on hazard mapping by sector.



Source: JICA Project Team

Figure 10-1 Process of consideration of recovery and reconstruction action plans by sector based on a hazard map

10.1.2 Model of resilience described through pilot projects

Due to Cyclone Idai, 176 administrative facilities were damaged in Beira City (source: BMRRP), and 1,372 schools and 89 health-related facilities were affected in Sofala Province (source: PDNA). The restoration of administrative and public facilities in Beira City and Sofala Province is mentioned as a short-term need in the PDNA. Furthermore, the BMRRP mentions the importance of the rehabilitation of administrative facilities following the Build Back Better (BBB) concept, aiming to create more resilient facilities than before the disaster and enhance resilience.

Therefore, in order to promote quick recovery of public facilities and to present a model for disaster-resilient development, this project targeted public facilities that are expected to be used as evacuation centers in the event of a disaster as a pilot project to enhance the resilience of the facility. In addition to making the public facility building itself more resilient to disasters, the pilot project site was selected from the point of view to utilize the facility in the community after its rehabilitation.

Three facilities were selected as targets of pilot project: Macurungo Primary and Mateus Sansao mutemba Secondary School, which have one of the largest numbers of students in Beira, and the Administrative Branch Office, which is under the jurisdiction of the CMB and used by residents for daily administrative procedures. In addition to the pilot project, the rehabilitation of two facilities damaged by Cyclone Idai, which were constructed under the grant aid project of JICA in the past, was also carried out under this project, a total of five facilities were rehabilitated in this project to construct a resilient public facility.

In the three facilities selected for the pilot project, evacuation plans were developed and evacuation drills, DRR, and public health education were conducted together with C/P institutions and local communities, aiming to establish a model of the disaster-resilient community utilizing the rehabilitated facilities.

10.1.3 Creation of reference materials and consultation with C/P for nationwide dissemination

In order to effectively apply the knowledge and experience obtained and lessons learnt from this project in future disaster risk reduction activities, reference materials have been developed. These materials outline the methods and processes for various initiatives, such as land use planning, infrastructure recovery and reconstruction planning, public facility recovery and reconstruction planning, evacuation planning, and the pilot project for resilient fish market, all based on hazard maps. With the expectation that these materials would be utilized for planning in areas outside of Beira City, they were compiled in collaboration with main C/P institutions, including GREPOC and INGD, as well as relevant central government institutions, in addition to the Beira City Council (CMB).

In relation to the creation of hazard maps, technical training was conducted within the project, focusing on the methods, processes, and considerations for developing hazard maps. A reference manual was compiled, taking into account the feedback from participants during these technical training sessions.

Table 10-1 provides a summary of the contents and anticipated applications of the reference materials and reference manuals prepared for each respective activity.

Table 10-1 Outline of the Reference Materials

Sector	Objective	Content
Hazard Map Creation	For officers of INGD and others relevant institution officer to understand the content of digital topographic map creation, hazard analysis, and hazard map creation and use it as a reference manual when creating hazard maps in areas outside of Beira city.	- Basic concepts and principles of hazard maps - Digital topographic map creation and GIS usage methods - Hazard analysis methods (Storm Surge, Inland Flood, and Flooding from Rivers) - Hazard map creation methods (Storm Surge, Inland Flood, and Flooding from Rivers)
Land Use Planning	For officers of Ministry of Land Environment and CMB to understand risk map creation and use it as a reference during land use planning discussions in Beira city and areas outside of Beira city.	- Legal system and organization related to land use planning - Risk map creation process - Explanation of method of evaluation of the disaster risk reduction effect and case studies related to structural measures
Infrastructure Recovery and Reconstruction Planning	For officers of Ministry of Public Works and CMB to understand the key points and knowledge of infrastructure resilience and use it as a reference for infrastructure development in Beira city and in areas outside of Beira city.	- Overview of infrastructure recovery and reconstruction projects in Beira city, focusing on roads and coastal protection - Content of proposals related to projects assumed to be effective when implemented from a resilience perspective - Explanation of key points when considering proposed projects
Public Facility Recovery and Reconstruction Planning	For officers of GREPOC, CMB and Sofala Province Education and Human Development Department to understand the priority selection methods, key points, and knowledge for public facility recovery projects and use them as a reference for public facility development in Beira city and areas outside of Beira city.	- Method of vulnerability assessment at the neighbourhood level - Priority ranking for public facility repairs based on vulnerability assessment - Priority ranking for the development of evacuation centers and disaster risk reduction or preparedness hub - Explanation of facility planning considering disaster utilization and resilience

Sector	Objective	Content
Evacuation Planning	For officers of Municipalities in Mozambique to be utilized for development of evacuation plans understand the background and methods of evacuation planning in Beira city and use it as a reference for evacuation planning in areas outside of Beira city.	- Importance and process of evacuation plans - Evacuation planning process (evacuation center selection, evacuation route selection, evacuation center operation plan, etc.) - Timeline action plan development process - Results of activity in Beira city
Disaster Education	For officers of INGD and school teachers to use as a reference materials to conduct disaster education for residents, primary school and secondary school students, promoting evacuation before cyclone landfall or approach.	- Basic knowledge of natural disasters - Explanation of situations caused by natural disasters - Methods for considering necessary measures during disasters - My Timeline creation process - Importance of sharing knowledge gained through disaster education with community and family - Points to note when using evacuation centers
“Kigumi” technique Training	Institutions responsible for vocational training, such as IFPELAC, use the reference materials in training for carpenters aiming to acquire “Kigumi” skills, promoting the spread of “Kigumi” technique.	- The history of “Kigumi” techniques - Characteristics of locally available timber - Types of wood joinery and finishes - Use of various tools - How to process each part - Measurements of parts (development diagram) - Creation of videos introducing tool usage, component processing methods, and assembly methods

Source: JICA Project Team

10.2 Good Practice Observed in the Project

The project was evaluated as a cost-effective project with significant results for Mozambique by GREPOC at the 4th JCC.

Specifically, compared to the support provided by the World Bank or the Netherlands Government, the contribution to the rehabilitation or reconstruction of infrastructure may not be large in terms of budget, but the project was highly regarded for contributing to the resilience of the region by effectively incorporating knowledge based on experience in Japan and other counties where supported by Japan which was a new concepts for Mozambique, such as promoting understanding of disaster risk through the creation of hazard maps and risk maps and reflecting them in various plans, utilizing public facility renovations as regional disaster risk reduction hub, and introducing "Kigumi" technique utilizing the existing resources of carpenters.

In addition, as indicated in "10.3 Commitment by C/P institution" the commitments of the related institution to disseminate and expand the project outcome to other areas besides Beira city was confirmed.

One of the main factors that led to the positive outcome was because the project utilized the growing momentum for reconstruction and resilience among the residents and local governments in the affected areas, the Mozambican government, and related institutions after the devastation caused by Cyclone Idai and specific factor could be summarized in 5 items as follows.

- The project has deepened the understanding of C/P institutions on the importance of developing action plans for recovery and resilience based on hazard maps.
- Importantly, the leaders in each institution who are responsible for recovery, reconstruction, and disaster risk reduction have understood the importance of reflecting the situation of hazard and risk in areas identified by the hazard and risk maps. Founded on their deep understanding, these leaders have spearheaded activities and promoted understanding within other related institutions, including community-based committees.
- The project has conducted the pilot projects for the restoration, reconstruction, and strengthening resilience of public facilities with close collaboration with relevant institutions which enabled efficient knowledge sharing and fostered understanding and relationship among relevant institution was smoothly developed.
- The project shared the Japan's experience in recovery and resilience through seminars and training programs, and discussed measures based on local conditions and challenges.
- The project also continued to implement the project remotely from Japan although in situation that trip of Japanese experts and locals' activities was restricted due to the COVID-19 pandemic.

10.2.1 Supporting the formulation of recovery and reconstruction action plans based on hazard maps and fostering its understanding and reflection to related plans

The project supported the preparation of hazard map for storm surge and flood due to heavy rain in Beira City, and as action plans based on hazard map, supported the development of an infrastructure recovery and reconstruction plan, public facilities recovery and r reconstruction plan, disaster response plan and implementation of pilot project for resilient fish market in Beira. In Beira and other areas in Mozambique, detail hazard maps for future cyclones and flooding events were not formulated. Therefore, through the formulation of hazard map in Beira and the series of activities and pilot projects to support the development of a recovery and reconstruction action plan based on the hazard maps, the process to visualize hazards through hazard analysis and mapping based on scientific analysis, and the planning process for structural and non-structural measures based on such analysis was the process and the importance was deeply understood by GREPOC, INGD, and other related institutions which was a major outcome of the project

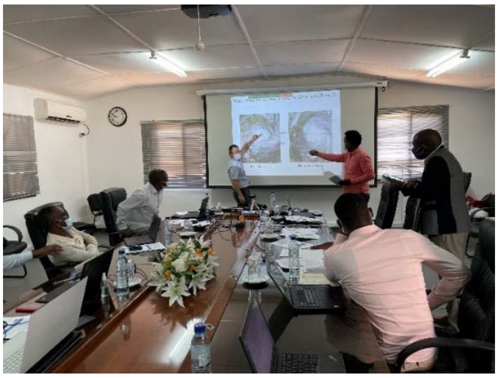
In addition to hazard maps formulation, the result of the hazard analysis was visualized in a way easy to understand by providing videos to show the inundation simulation result and risk maps that includes the idea of vulnerability and exposure and promoted awareness by distributing hazard maps printed in a poster size to all relevant institutions.

Furthermore, the measures to enhance resilience, such as visualizing the effect of structural measures to reduce the risk and the importance of non-structural measures for remaining risks (residual risks) was presented frequently through JCC, seminars, and events such as invitations to Japan, training in Japan, hazard map training, and other occasions. These activities helped to deepen the understanding of C/P institutions.

In regard to the reflection to related plans, the hazard map of Beira city formulated in the project was included in the Beira urban structure plan which is a legal bonded development plan, and INGD, CENOE and related institution is committed to promote the technical training program and expand the knowledge to other areas in Mozambique. Not only INGD and CENOE but MTA which have been involved in the discussion and training conducted in this project has committed to refer to the outcomes of the project and the project has contributed in mainstreaming DRR to other related institutions. Additionally, the project was implemented through frequent discussion and arrangement with international donors such as WB, Netherland government and DRR related institutions such as AIAS, the result of the hazard map formulated in this project was referred in the coastal protection project jointly funded by WB and the Netherlands government as an important input.

Handover of the Hazar Map to
the Executive Director of GREPOC

Handover of the Hazar Map to
the Mayor of CMB



Training on Hazard Map Formulation

Evacuation Planning Activities
Based on azard Map

Source: JICA Project Team

Figure 10-2 Activity to Enhance the Understanding on Hazard Map

10.2.2 Building Disaster-Resilient Communities through Pilot Projects

In the implementation of the pilot project, in addition to the strengthening of public facilities itself, measures and activities were implemented to strengthen the capacity of the community to respond to disasters. In the public facilities targeted as a pilot project evacuation management plan as an evacuation center was planned and evacuation drills was conducted, and in line with the activity DRR and public health education was also conducted.

(1) Strengthening Resilience of Public Facilities Targeted as the Pilot Project

In the pilot project, there were cases where renovation work was carried out on buildings damaged by cyclones, by using the existing structure which was not damaged and strengthening them as much as possible with some limitation, and in other cases the building was demolishing and newly constructed. The damage caused by cyclones was mainly concentrated on the roofs, and the pilot project implemented in the project also focused on strengthening the roofs.

The roof structure consists of roof sheets, rafters, beam trusses, and the lower structure (concrete frame). The upward force from strong winds such as cyclones first affects the roof sheets and is then transferred sequentially to the rafters, beam trusses, and the lower structure. Therefore, not only the individual structural elements but also the methods of connecting these elements are important, and a structure that takes this into account was implemented. The details are as described in "9.2.3 Design Policy: (5) Methodology for strengthening."

(2) Activities in public schools

With regard to enhancing resilience of the building, the Macurungo Primary School included the construction of new classroom building, and strengthening measures were implemented, such as strengthening the roof section and raising the building foundation. The fact that the damaged school building was renovated and newly constructed was favorably received by the local residents. By visibly showing the progress of reconstruction, it was also seen as a symbol of recovery in the city of Beira and contributed to building momentum for reconstruction and enhancing resilience.

The Mateus Sansao Mutemba Secondary School has a large facility located near an area that will be subject to inundation from the sea in the event of cyclone and is therefore expected to be used as an evacuation center. In the pilot project, toilets and shower rooms were made designed also to be used by evacuees, thus enhancing the functionality of the facility as an evacuation center.

Since both facilities are public schools, not only CLGRD but also teachers, students, and their parents, participated in the evacuation planning activity, DRR education, and evacuation drills. As a result of activities centered on the school involving the community, awareness of the importance of the facility as an evacuation center in the event of a disaster has been widely recognized.

At Macurungo Primary School, local residents have taken the lead in providing nighttime security after completion, and a sense of managing the facility as an important property of the community is being fostered. The project not only constructed the facility, but also used the facility to carry out activities involving local residents, thereby strengthened the local disaster management capacity. It is expected that related institutions will continue to cooperate with each other to ensure that the facilities are used effectively in the future, and that activities such as DRR education and improvement up the evacuation center management plans will be continuously implemented.

After Completion

The Roof was Rehabilitated in a Resilient Way

Handover Ceremony

Handover Ceremony was Accompanied by Embassy of Japan, GREPOC, INGD etc.

Students Studying in Rehabilitated Class Room

The Rehabilitated Class Room is Used as an Evacuation Center Before the Arrival of Cyclone

Source: JICA Project Team

Figure 10-3 EPC Macurungo Utilized by the Students and Community Members

(3) Activities in administrative facility

The administrative branch office supported by the project is a facility where the branch offices of the Chingsula district (Bairro) and the broader administrative district of Inhamizua (Administrative Post) is located, and residents in the surrounding area visit the place for daily administrative procedures. In addition, markets, churches, and private schools are located in the neighbor and serve as the center of the local community in the area.

The pilot project envisioned that the facility would serve as a local disaster management center and included construction of stockpile warehouse, temporary toilets, water taps, and a paved plaza. In order to properly use these facilities in the event of a disaster, it is important to establish a management system in which Bairro leaders responsible for the management and operation of the facilities and CLGRD work together. In addition, because of the small size of the administrative branch facilities, it is necessary to establish a role as an evacuation center in cooperation with surrounding facilities. Since the completion of the facility, the CMB has taken the lead in establishing a system of collaboration in the area, including consideration of holding regular events at administrative branch offices. In order to function as a local evacuation and disaster management center, it is important that administrative facilities are used and recognized as a local hub in non-emergency times and that a network of local residents to be established.

Paved Plaze Constructed

Container for Stock Pilling

Toilet Which can be Used in time od Emergency

CMB Mayor Joined the Handover Ceremony

Source: JICA Project Team

Figure 10-4 Situation of the Administrative Facility Rehabilitated

10.2.3 Building a model for disaster-resilient communities

(1) Strengthening disaster response capacity in the community

In the time of Cyclone Idai, pre-evacuation was not conducted, and it was one of the major factors that caused devastating damage. Therefore, in the disaster response plan activity, the concept of a timeline action plan and the idea of “My Timeline” methodology as a content of DRR education was introduced. These ideas are based on the experience in Japan to promote evacuation and effectively spread awareness of the importance of pre-evacuation from administrative institution to organization in the community.

In the event of a disaster, it is essential that all related agencies to work together to respond. The evacuation planning working group (hereafter referred to as "WG") was established involving 4 institutions: CMB, the local municipality, INGD Sofala Office, the central government agency in charge of disaster response, Sofala State Department of Education and Human Development, which has jurisdiction over public schools used as evacuation centers, and GREPOC as a coordinating institution. When Cyclone Chalane and Cyclone Eloise made landfall near Beira City in December and January in 2020, the CMB and INGD collaborated smoothly to conduct pre-evacuation in the coastal area, which showed the strengthened cooperation between the two institution which the projects contributed through continuous WG activities.

In addition, the CLGRD and School Disaster Prevention Council (CEGRC) in each district played a central role in the Bairro level evacuation planning working group and the evacuation center management working group respectively also involving students and the local communities. In addition, DRR and public health education was also conducted in the community which created a model for strengthening the community's ability to respond to disasters. Another notable outcome was that multiple activities that took place during the project period. For example, the WG led a briefing session on the development of Bairro-level evacuation plans in 16 bairros in Beira, and a meeting was held to explain the importance of the evacuation plan, including the timeline action plan to a higher level (Governor of Sofala Province and the Administrator of Sofala Province on) aiming to involving relevant agencies in the Sofala province.

In this project, the WG functioned as a cooperation body for CMB and INGD to work together, which enable to expand the model to other Bairros in Beira and also to the Sofala province level. In order to expand activities to other regions in Mozambique, it is important to establish a system of collaboration among local authorities, relevant institutions, CLGRDs, and other local actors, leaded by INGD provincial offices.

(2) Pilot Project for Resilient Fish Market

In the Praia Nova fish market area, which frequently suffers inundation along the coastline when cyclones approaches, Kigumi (Japanese Traditional Wood Joining Technique) stalls which can be assembled and disassembled were introduced and a timeline action plan was introduced for disaster response, and disaster response drills were conducted. To create the Kigumi stalls, training was provided to carpenters who usually make furniture and fixtures. In was recognized by relevant C/Ps, market officials, and users that the introduction of Kigumi stalls in the fish market allowed the stalls, which serve as stores, to be stored in a safe place before the cyclone approaches and minimize the loss to the market due to disaster and enhance the preparedness against Cyclone in the fish market.

When people managing small shops in the fish market suffer damage due to cyclones, it takes time for the local industry to recover. However, the fish market in Praia Nova originally had a habit of moving the market management office seasonally in reaction to the natural tidal situation. Therefore, instead of relocating the entire market, a way to prevent damage was considered by folding up the show stalls and storing them in a safe place when a cyclone to make landfall. In addition, given the potential of local carpenters mentioned above, the introduction of “Kigumi” technique was proposed for use as show stalls. This allowed for the introduction of a model to make shop stalls more robust and attractive than existing ones during normal times and could be disassemble and moved to a warehouse before a cyclone made landfall, enabling a quick recovery of market functions after the cyclone passed.

In order to conduct training on Kigumi and introducing the model, the Kigumi Working Group was held to discussions with many local stakeholders, including the fishermen's committee, fish market management committee, carpenters, IFPELAC a vocational training school with courses related to woodworks, commerce and industry department of CMB, construction department of CMB, CLGRC, GREPOC, INGD, and other institutions. During the two Kigumi training sessions, the participating carpenters successfully constructed10 Kigumi stalls (3.2 square meter) and a Kigumi Shed (20 square meter) with floor, walls, and roof. 10 of the Kigumi stalls is currently had been handed over to CMB and it has been leased to the show owners through the market management committee and are starting to be recognized by the community.

The carpenters who participated in the training have voluntarily established a Kigumi carpenters' association to meet this demand from related stakeholders such as users of the Kigumi stalls, GREPOC and CMB which is demanding for a used on the technique for furniture or housing based on the fact that Kigumi technique was acquired by the carpenters and the technique can be generally and widely used. By the Kigumi carpenters' association a wide variety of activities are underway, including the creation of publicity materials for Kigumi, holding exhibitions, sales, and enhancement of the technique. In addition, IFPELAC, a vocational training school, added Kigumi contents to its woodworking course calicular, which will be in operation from January 2023. Moreover, discussions are being carried out at the IFPELAC headquarters for nationwide expansion, and the dissemination and expansion of activities in line with the commitments agreed at the 4th JCC are steadily progressing. These could be observed as a notable achievement of the project.

This project has introduced a new technique and created an opportunity to take action for a larger-scale projects based on the Kigumi technique building up on the originally established woodworking local business. The Kigumi technique added value to the local business and contributed to enhance the resilience of the local community against disasters. In this way, it is important to promote activities that can be implemented by local organization and making maximum use of the technology and human resources that originally exist in the local community.

As a strategy for utilizing “Kigumi” technique, the mayor of Beira proposed creating a "Kigumi market" by introducing a significant number of stalls in the market inside Beira city. This would not only strengthen the market's overall disaster resilience and response and recovery capacity but also increase its attractiveness by creating a unified design and cleanliness, leading to market revitalization. To realize this model, long-term collaboration and continuous activities are needed, such as the formal establishment of a “Kigumi” carpenters' association, implementing order and sales activities, stable education to “Kigumi” carpenters by IFPELAC, creating demand for improved “Kigumi” technique, and promotion to donors in collaboration with institutions such as GREPOC. As for the improvement of carpenters' skills, the technology can be expanded and made more locally suitable by providing input on advanced techniques at the appropriate timing after the skills acquired in 2021-2022 have settled, been utilized, and permeated. This would increase the variety of structures and further broaden the technology's application.

10.2.4 Sharing of knowledge of reconstruction and resilience knowledges

In the project knowledge on reconstruction and resilience was shared through seminars and training opportunities at the milestones of the project to promote understanding among C/P institutions and enhanced the effective implementation of the project.

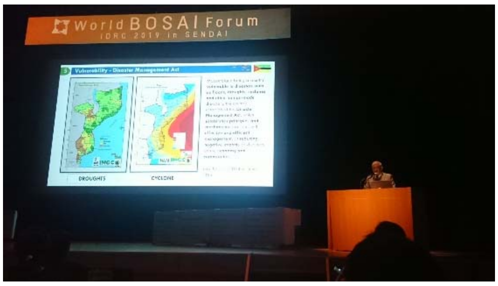
(1) Sharing of project objectives and outcome images

Invitation to Japan (November 2019) and the first seminar (January 2020) were held at the beginning of the project. In the invitation to Japan delegation from the central government visited Japan to observe the efforts of Japanese central government institutions and local government for reconstruction, DRR, and resilience, and in the World Bosai (DRR) Forum held in Sendai, Japan, Director General made presentation at a seminar where Deputy Mayor of Palo Town, who has experience in reconstruction projects from Typhoon Yolanda in the Philippines, the Director for Regional Economic Partnerships from BAPPENAS (National Development Planning Agency), who was involved in the reconstruction project from the Central Sulawesi Earthquake in Indonesia, the Deputy Director General and Technical Advisor from the Infrastructure and Peacebuilding department of JICA. In the session, participants shared their experiences in the Philippines and Indonesia, where JICA supported reconstruction projects based on Japan's knowledge on reconstruction and resilience. The points in how Japanese knowledge and experience was applied locally to suit each country's circumstances and what effects it had was shared.

In addition, in order to fully understand the knowledge related to Japan's reconstruction efforts, the participants from Mozambique visited Higashimatsushima City to learn the process of reconstruction project. In addition, in the 1st seminar held in Maputo, presentation by official from Higashimatsushima City who was engaged in the development of a recovery plan after the 2011 great east Japan earthquake and Tsunami was done. Through site visits and presentation, the seminar, knowledge on the importance of effectively combining structural measures and non-structural measures including evacuation plans and land use regulations to strengthen the resilience was shared.

The concept for reconstruction and resilience was shared to the director of GREPOC and other high-level officials of C/P institutions immediately after the project started including the results of other countries' efforts and achievement, so that C/P institution could recognize the importance of the concept of recovery and resilience which to be introduced through the project and it encouraged the C/P institutions to promote the project activities.

In projects supporting recovery and reconstruction, building relationships among different C/P institutions can be challenging since the sector involved in the consideration of recovery and reconstruction are broad and therefore needs to include variaety of C/P institutions. However, by implementing an invitation to Japan and the first domestic training shortly after the project began, communication among the main responsible individuals of each C/P insititution was promoted, facilitating collaboration among C/P insititution.



Presentation at the Workd Bosai Forum 2019

Experience of Other Countries was also Shared

Visit ti Higashimatsushima City in the Invitation to Japan

Presentation by the officer from Higashimatsushima City in the 1st Seminar

Source: JICA Project Team

Figure 10-5 Situation of Sharing the Knowledge and Outcome Image in the Early Stage of the Project

(2) Knowledge sharing to realize disaster resilient society

The 1st training in Japan was conducted in February 2020, and the 2nd training was conducted remotely in October 2021 connecting Japan and Mozambique and the Philippines. In the programs, the trainee observed detail efforts to contribute to the development of a disaster-resilient community, including the formulation of reconstruction plans based on disaster risks in the 2011 great east Japan earthquake and tsunami effected areas. such as Higashimatsushima City; disaster response efforts in Joso City in Ibaraki Prefecture and Edogawa City in Tokyo; local disaster response activities in the Neshinden neighborhood association in Joso City in Ibaraki Prefecture and NPOs, academia working in Katsushika City in Tokyo; and efforts to support recovery of livelihoods in Minamisanriku Town in Miyagi Prefecture and other areas of the 2011 great east Japan earthquake and tsunami effected areas in the Tohoku region. During the site visits, participants also participated in the lecture and presentation on the activities from a variety of perspectives, including central government institutions, local governments, NGOs, academia, private sector, and local communities.

Through the site visit, specific examples to enhance disaster-resilience was introduced, by providing a concrete image on the points to consider and the outcome to be achieved, it contributed to foster a common understanding among C/P institutions and strengthened the base of cooperation.

Visit to the "Neshinden" Community to Learn DRR activity in the Community Level

Visit to the Cabinet Office to Learn DRR Structure and System in Japan

Visit to Edogawa City to Learn the Structural Countermeasures Implemented

Visit to Joso City to Learn the Disaster Response Activityes and Prepardeness

Visit to the Memorial of the Flood in 2015 in Joso City

Based on the Experience of Visit to the Memorial in Joso City an Memorial was also made in Beira in the 1st year Anniversary
(Mayor in the Center with the CMB Directors who Attended the Training in Japan)

Source: JICA Project Team

Figure 10-6 Situation of the Training in Japan

(3) Consolidation and dissemination of knowledge in Beira to other areas

The 2nd seminar was held in November 2022, attended by representatives from the Bairros in Beira as well as administrative officials from the surrounding districts, to share the project's findings and discuss the project results and how to utilize in the future. Through the discussion, the result and findings on reconstruction and resilience in Beira were disseminate to a wide range of related institutions and necessary activities in the future after the completion of the project in order to realize a disaster-resilient city was discussed.

In addition, in order to promote the dissemination of the outcome of the project, the knowledge was shared with countries affected by cyclones and other weather-related disasters in Mozambique and the surrounding southern African region. Specifically, the case study of the activity in Beira was introduced at a workshop held in Mauritius in January 2022 as part of JICA's "Project Research for Disaster Prevention in Southern Africa" and received positive feedback from the participating countries as a useful case study. Eight countries participated in the workshop: seven countries belonging to the Indian Ocean and Southern Africa Disaster Risk Reduction Platform (Mauritius, Mozambique, Malawi, Zimbabwe, Madagascar, Comoros, and Seychelles), and Republic of South Africa also participated. In addition, the project outcomes were presented in the high-level meeting on the progress of reconstruction from Cyclone Idai in Sofala Province, organized by GREPOC having participation of the Prime Minister of Mozambique, the Minister of Public Works, Housing and Water Resources, the Governor of Sofala Province, the Mayor of Beira, and relevant international donors. The outcome of this project was presented in line with the reconstruction assistance projects by other donors. In the conference the project was highly evaluated as a cost-effective project for the resiliency of Beira City despite its small investment, and as a project that promptly provided support for the resiliency of public facilities and the surrounding area.

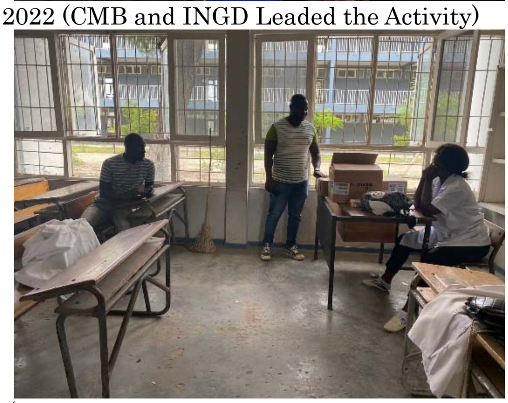
In addition, as a dissemination activity of the project outcome to the international community, including international donors, other international institutions, and government officials, the project team made a presentation on the importance of the approach of combining structural and non-structural countermeasures and the Japanese experience in non-structural measures including the outcomes and consideration done in the project at a meeting organized by the World Bank Tokyo DRM (Disaster Risk Management) Hub to exchange opinions between Japanese civil engineering consultants and experts from World Bank Headquarters. In addition, at the Asia-Pacific Ministerial Conference on Disaster Risk Reduction held in September 2022, the experience on how the lessons learnt in Japan from the reconstruction process from the 2011 great east Japan earthquake and tsunami and how it was introduced in Mozambique was introduced by the project team members.

In addition, the results of this project were reported to conferences in the professional field. In the 47th Symposium on Ocean Development held in June 2022 the result of the storm surge hazard maps consideration in Beira was presented. At the year 2021 conference of the Japanese Society for Disaster Recovery and Revitalization held on September 2021, the results of the evacuation planning study in Beira were reported. The activities for reconstruction, disaster risk reduction and resilience in Mozambique were widely shared to academic society in Japan.

In addition, simple and Easy-to-understand articles about the project's progress and achievements were posted on JICA's website and social media, in cooperation with the JICA Mozambique office to promote public relations activities through social media. Articles on major meetings, hazard map formulation, and progress on pilot projects were also posted on Beira's Facebook page, making the information widely available to the public. Disseminating project results in various ways at different levels, both domestically and internationally, contributes to the diffusion and expansion of outcomes.

Since Cyclone Idai, cyclones have continuously affected Mozambique and neighboring countries every year. In 2021, there were Cyclone Chalane and Cyclone Eloise, followed by Cyclone Ana, heavy rains in 2022, and Cyclone Freddy in 2023. In Beira, activities to minimize damage, such as evacuations before cyclones makes landfall were conducted. Mozambique and neighboring countries suffer significant damage from cyclones every year, and insights from activities in Mozambique and Beira can be utilized. Activities related to the dissemination and expansion of these efforts need to be continued by related institutions such as CMB and INGD.


Situation in the Time of Heavy Rain on March 2022 (CMB and INGD Leaded the Activity)

Situation in the Time of Cyclone Freddy on 2033 (Left: Situation of Cooking in the Evacuation Center, Right: Medica Support was also Provided to Inprove the Condition in Evacuation Centers)

Source: JICA Project Team

Figure 10-7 Situation of Evacuation after Cyclone Idai

10.2.5 Project implementation COVID-19 pandemic

In order to achieve rapid recovery of Beira city and the surrounding areas, the reconstruction to strengthen public facilities and other activities was continued even during the period the trip to Mozambique for the JICA project team was restricted due to the COVD-19 pandemic by establishing a means of remote communication.

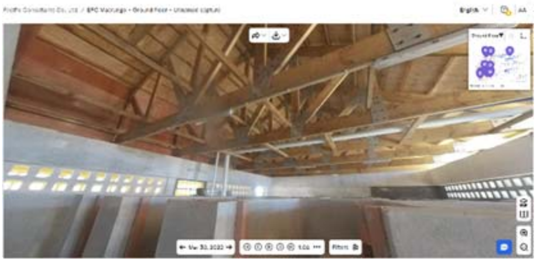
(1) Pilot project supervision conducted remotely

In this pilot project, Japanese personnel could not visit the sites after March 2020, when the design work was in progress, due to the COVID-19 pandemic. The bidding, conclusions of contracts and the construction work proceeded entirely with local resources until the Japanese consultant went to the site for supervision in September 2021.

Communicate with the consultants to conduct the design and support the bidding was done through emails and online meetings, the intentions of the design were not sufficiently shared between both parties. As a result, the Japanese consultant did most of the work. In addition, explanation on the field to improve the accuracy of the design was planned but because much on the occasion to check the site was restricted which caused unforeseen site conditions during construction, causing several construction interruptions and delays. Moreover, the interviews of candidate contractors were conducted online, which forced us to finalize the shortlist with less information leaving reservations about whether a contractor with the ability to carry out the work had been selected. The chance to explain the intentions of the design, which should be at the commencement of the work on site was not conducted.

On the other hand, it is considered an outstanding achievement that the building has been completed according to the drawings, although much of the bidding and construction supervision have been carried out only with local resources and remote supervision from Japan. Keys to successful remote supervision include, for example

- To establish a relationship of trust with a local consultant who is sincere, technically knowledgeable, and communicative.
- To understand local construction methods, materials, and standards, preparing clear design drawings so that local engineers can understand, and interpreting and explaining their design intent during construction.
- To respond promptly via email, online meetings, and social networking sites like WhatsApp. As the site is always moving forward, responding during long holiday periods is necessary.
- To assist local contractors to prepare construction plans, materials procurement plans, details of installation, and construction methods in consideration that they are not familiar to those works.



Roof Structure under Construction in EPC Macurungo

Foundation Structure under Construction in EPC Macurungo

Source: JICA Project Team

Figure 10-8 Image of the Online Software Utilized in Supervision Conducted Remotely

(2) Disaster response plans conducted remotely with the evacuation planning WG

The project was forced to conduct activities remotely from March 2020 to April 2021 due to restriction of trip to Beira of the JICA project team due to the COVID-19 pandemic. One of the challenges in remote response is that since the communication with the C/Ps is limited, it is difficult to build relationships and share knowledge. In the project, the first training in Japan was held in February 2022, just before the travel restrictions were implemented and the image of the outcomes aimed to achieve through activities related to disaster response planning was shared. In addition, the establishment of relationships between C/Ps and among C/Ps members and the JICA project team was effective.

The training in Japan had a particularly positive impact on the cooperation between C/Ps, leading to the result that the evacuation plan working group (WG) activities was promoted mainly by the participants of the first Training in Japan. This can be attributed to the fact that during their stay in Japan, participants from different institutions had discussions on how to proceed in the future, and they returned with a common understanding of the approach and the important points of evacuation planning.

In order to continue remote activities, various trial-and-error efforts were made to promote communication, such as holding regular WG meetings and maintaining close communication through local staff. In the situation that COVID-19 pandemic had forced other donor-supported activities to be interrupted, the continuation of activities remotely was highly appreciated by the C/P institutions.

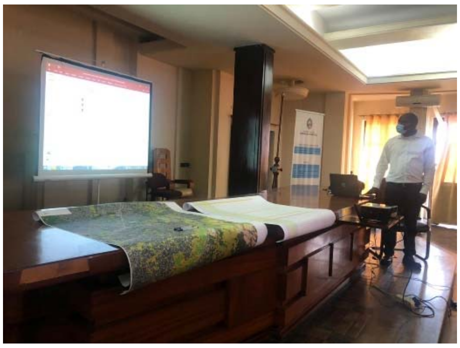
Keys to successful remote activity include, for example,

- Building relationships among C/P institutions and fostering a common understanding of the outcome of the project by utilizing opportunities such as training in Japan at the start of the project.
- Management of activity progress through regular WG meetings using an online conference system
- Securing a locally consultant which has the ability to deeply understands the project's activity and can appropriately communicate the purpose and intention of the activities to the C/P institution and follow up and promote the activities.


Online Discussion using Maps


WG meeting was Continuously Done Reguraly


Key Points of the Evacuation Planning was explained to the CLGRD participants from the JICA Project Team Menbers


Details of the Evacuation Planning was explained to the CLGRD participants from the WG members (CMB Director)

Source: JICA Project Team

Figure 10-9 Situation of Remote Activity for Evacuation Planning

(3) Kigumi training incorporating remote training

In September 2021 and June 2022, the project conducted a training program for local carpenter to learn traditional Japanese construction techniques of Kigumi. Originally, this technique was to be demonstrated in front of the participants and learned directly through observation, but due to travel restrictions imposed by the COVID-19 pandemic, the 2021 training was conducted remotely. In the preparation for the remote training, local carpenter, instructors from vocational training schools, related C/P institution, and people involved in the fish market where Kigumi techniques were to be used was invited to the working group in advance. By having a deep communication before the training, the working group was able to obtain a great deal of cooperation in making arrangements and preparing for the training. The educational materials were prepared in advance of the training, which helped the local carpenter to understand Kigumi, and videos and the detailed textbooks helped to convey a clear image of the techniques. In addition, the quality of the local lumber and lumber mills was not fully understood in advance, and content that was not originally planned had to be added suddenly during the training. However, camera placement and advance preparation with the local mercenaries were successful in anticipating such a situation, and the additional content was successfully taught.

The degree of mastery of the Kigumi skills of the local carpenter was demonstrated in the assembly and disassembly demonstrations held at the handover ceremony and in the workshops for users at the fish market and was evaluated as highly skilled by the C/P institution, vocational training schools, users, and the training participants themselves.

After the handover, based on the proposal of the local C/P institution and carpenters additional training was conducted face to face in June 2022 for a more difficult structure. The C/P institution including the mayor of Beira city, were so impressed with the Kigumi skills the local carpenters showed in this additional training, they decided to incorporate them into the curriculum of the vocational training school, and an association was voluntarily established by the woodworkers who learned woodworking.

Keys to successful remote activity include, for example,

- Building relationships with C/P related with the training, continue activities, and manage progress through regular WG meetings using an online conference system
- Utilization of local consultants who understand the objectives of this project of transferring the Kigumi technique which can appropriately communicate the purpose and intention of the activities to C/P institutions and follow up and promote the activities.
- Developing materials that will be used on site, such as videos and texts, and training consultants who fully understand the technical content and are capable of responding to basic questions.
- Maximize the use of local equipment and materials (cameras, laptops, smartphones, etc.), secure multiple internet providers and other backups, and establish a system for timely communication through email and SNS.
- Preparation of instructions and confirmation with local consultants for all possible situations, such as poor internet connection, power outages, teaching wood materials not yet procured, cancellation of events due to COVID-19 pandemic, etc.

Japan and Beira was Connected Online

Using Smart Phones Connected Online with Beira to Show the Detail Points Realtime

Participants in Beira Listening to the Explanation Done in Japan

The Detail Contents was Explaing based on the Textbook made before the Training and Explained by the Local Staff

Source: JICA Project Team

Figure 10-10 Situation of Remote Activity for Kigumi Training

10.3 Commitment by C/P institution

In addition to promoting the activities for action plan for recovery and reconstruction based on the hazard map of Beira City, the project team discussed and coordinated with related institution including GREPOC and CMB on the concrete actions to disseminate and expand the result of the activity for reconstruction and resilience of the Beira city as a model to other regions in Mozambique. The table below shows the expected roles of key counterparts for the dissemination and promotion of the results of the project as agreed with the related organizations.

In addition, in the 4th Joint Coordination Committee meeting held in November 2022, the contents by each of the related institutions have been agreed as a commitment (responsibility) for the implementation, dissemination, and expansion of the Beira city recovery and reconstruction Action Plan is shown in the table on the next page and thereafter.

It is important for the related institution is steady implementation each action listed in the table to enhance the reconstruction and resilience of Beira City. In addition, the implementation of the actions is important not only for Beira but also for other areas in Mozambique, to enhance the activity to formulate hazard maps for possible future disasters, and the consider counter measures for each sector based on these hazard maps. It is required for each related institution to strongly recognize the task to implement the actions to promote development of countermeasures for resilience and reduce disaster risks in high-risk areas in Mozambique as their important responsibility

In particular, institutions based in Beira City, such as CMB, INGD Sofala Provincial Delegate Office, and IFPELAC, are required to carry out continuous activities based on the knowledge obtained in the project. In addition, GREPOC as an institution to promote resilience through reconstruction in Beira City and Sofala Province, and INGD as an institution to promote disaster response and prevention, including budgeting for dissemination activities and coordination with central government institutions and international donors. For the expansion to other regions, central government institutions like the Ministry of Land and Environment (MTA), Ministry of Health (MISAU), and Ministry of Education and Human Development (MINEDH) are expected to use reference materials and try to disseminate their knowledge. INGD, in particular, is expected to take a leading role in understanding disaster risks and promoting activities for resilience, discussing the process and necessary activities for resilience, as well as the technical cooperation and budget allocation, including requests for support to international donors.

Table 10-2 Roles of Key Related Institutions for Dissemination and Expansion of Project Outcomes

Institutions	Expected Roles
CMB and other institutions in Beira city or Sofala provincial	- Formulate action plan of the "Beira Municipal Recovery and Reconstruction Plan (BMRRP)".
GREPOC	- Coordinate Implementation and dissemination of knowledge obtained through the project with related ministries and international donors.
INGD	- Coordinate Implementation and dissemination of knowledge obtained through the project with ministries related to Disaster Risk Reduction and Management.
MAEFP	- Since the duty of MAEFP is to supervise provinces, districts and municipalities across the country, the main role of MAEFP for the project would be to coordinate dissemination of lessons learnt from the project.
INGD, MTA, MOPHRH, MISAU, MINEDH	- Incorporate the lessons learnt from the project to be utilized in the activity, policy making or plans. - Dissemination of knowledge obtained through the project to other areas through provincial offices.

Source: JICA Project Team

Table 10-3 Commitments of Relevant Institutions for the Implementation, Dissemination and Expansion of the Recovery Action Plan for the City of Beira (1/3)

Sector	Outputs of ARPOC	Commitments
Hazard Analysis	**Activities:** Hazard Map utilized for municipal urban structural plan, evacuation plan and other DRR activities. Technical training for Hazard Map Formulation **Materials:** Reference Material for Hazard Analysis	**GREPOC:** Promote the importance of reconstruction for resilient society based on Hazard Map (until termination of its duty) **INGD, CMB:** Promote the importance of reconstruction for resilient society based on Hazard Map (2020 -) **INGD (CENOE):** Promote formulation of Hazard Map in other areas Spread knowledge through trainee of the technical training Utilize the reference material for the dissemination by technician
Infra- structure Planning (Coastal Protection, Road)	**Activities:** Inundation analysis including DRR counter measures **Materials:** Reference material for method of planning DRR countermeasures **Action Plans:** Technical advice and proposal of infrastructure to reduce residual risk	**CMB:** Refer to the technical advice and proposal in future investment plan Utilize the reference material for TOR formulation of future investment plan **GREPOC:** Refer to the technical advice and proposal in future investment plan (until termination of its duty) Promote the technical advice and proposal for future investment plan to related institutions such as MOPHRH (until termination of its duty)
Land Use Planning	**Activities:** Risk Map based on the Hazard Map **Materials:** Reference material for method of Risk Map analysis **Action Plans:** Technical advice on revision of the drafted Beira urban structure plan Recommendation document for reference on legal system on spatial planning	**CMB:** Incorporate the Hazard Map and Risk Map into Beira urban structure plan 2022-2032 (by December 2022) Utilize the Risk Map for future revision of Beira urban structure plan and detail plan **MTA:** Refer to the recommendation document for the on-going revision works of legal system on spatial planning **INGD, MTA:** Utilize the reference material to mainstream hazard analysis in land use planning in other areas

Source: JICA Project Team

Table 10-4 Commitments of Relevant Institutions for the Implementation, Dissemination and Expansion of the Recovery Action Plan for the City of Beira (2/3)

Sector	Outputs of ARPOC	Commitments
Public Facility Planning	**Activities:** Vulnerability assessment of public facilities (Bairro Basis) based on Hazard Map Consider prioritization of facility to be evacuation center **Materials:** Reference material for vulnerability assessment and prioritization **Action plans:** Plan to realize the proposal for DRR park in Inhamizua	**GREPOC:** Utilize the reference material in planning rehabilitation of existing facilities and new construction projects in Beira and other areas (until termination of its duty) Promote the coordination in realizing the proposal of DRR park in Inhamizua including the enhancement of DRR hub function (until termination of its duty) **CMB, INGD:** Utilize the reference material in planning rehabilitation of existing facilities and new construction projects in Beira and other areas Promote the coordination in realizing the proposal of DRR park in Inhamizua including the enhancement of DRR hub function **DPEDHS, DPSS:** Refer to the methodology of vulnerability assessment in other areas
Disaster Response	**Activities:** Evacuation plan and timeline action plan developed in Municipality level, pilot Bairro and Evacuation centers Evacuation drill, DRR education in 3 Bairros. **Materials:** DRR education material Reference material for evacuation planning **Action plans:** Plans to realize DRR hub function for resilient Beira city Plans to activate community activity in Bairro Chingussura	**CMB:** Disseminate "Timeline Action Plan" to all CLGRD (by December 2023) Continuously update the Municipality evacuation plan **INGD Sofala:** Disseminate "Timeline Action Plan" to provincial institutions in Sofala utilizing the reference material (by December 2023) Promote use of DRR education material to be used in activity with CLGRD **MINEDH Sofala:** Promote use of the DRR educational material in school activities Prepare to utilize schools as evacuation center in case of disasters **GREPOC:** Promote the continuous effort of Working Group Activities (until termination of its duty) **INGD:** Promote use of reference material for evacuation planning and DRR education material in other areas **MINEDH:** Promote use of the DRR education material for school activities as supplementary document for PEBE

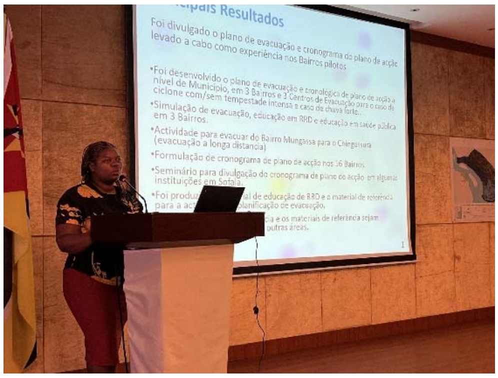
Source: JICA Project Team

Table 10-5 Commitments of Relevant Institutions for the Implementation, Dissemination and Expansion of the Recovery Action Plan for the City of Beira (3/3)

Sector	Outputs of ARPOC	Commitments
Disaster Resilient Fish Market	**Activities:** KIGUMI technique localized in Mozambique is developed KIGUMI Training for local carpenters and teachers 10 KIGUMI stalls installed in markets, and 1 KIGUMI shed made **Materials:** KIGUMI textbook Promotional Materials for KIGUMI technique **Action plans:** Official establishment of the Association of Technical Carpenters of KIGUMI Vocational training program in IFPELAC (Look ahead for future expansion to other districts)	**CMB:** Start preparation for the establishment of KIGUMI market **Association of Technical Carpenters of Kigumi of Sofala:** Establish the association **IFPELAC:** Implement the vocational program including KIGUMI manual and curriculum) Get approval KIGUMI program from ANEP and disseminate it to other areas **GREPOC:** Promote the continuous effort of the activities by the carpenters (until termination of its duty) **INGD:** Promote the continuous effort of the activities by the carpenters

Source: JICA Project Team

Discussion among the Participants



Presentation from INGD Sofala Delegate Office

Signing of the Minutes of Meeting

Group Photo of the Participants

Source: JICA Project Team

Figure 10-11 Photo from the 4th JCC

10.4 Lessons Learnt and Suggestions from the Outcome of the Project

10.4.1 Lessons Learnt

In the project, travel restrictions to Mozambique and restrictions of travel to Beira city due to the spread of COVID-19 led to the consideration and implementation of project activity remotely with advanced measures. As remote meetings using online conference systems are expected to increase in the future, insights obtained from the project will be useful. Firstly, while online communication is effective for regular situation checks and progress management, limitations exist in understanding the C/Ps comprehension levels and verifying the quality of activity results. It is important to note that remote interactions might not be suitable for activities such as knowledge sharing and technical transfer through training. Skill of local staff such as knowledge sharing, technical transfer, and communication with C/P is crucial for implementing activity remotely. In online training and workshops, with limitation in techniques such as explaining with drawings or adjusting explanations based on C/P's understanding while observing reactions, follow-up activity is necessary such as confirming understanding level after meetings. When preparing meeting materials, creative ways of presenting information, such as incorporating content explained non-verbally through gestures or joint work on maps in face-to-face meetings, into PPT materials and other documents using figures and text, are required. Therefore, considerable work before and after meeting are required. It is important to recognize the limitations of activity by only explanation by presentation, and it is difficult to provide enough guidance on the points of the activity online.

In the project, collaboration with international donors such as the World Bank and the Netherlands Government, which is implementing construction of coastal protection counter measure and drainage network was necessary. The information was continuously shared on technical content throughout the project which led to the hazard analysis results being reflected in the coastal protection projects funded by the World Bank and the Netherlands Government. However, in region of Southeast Africa, including Mozambique, long-term support has been provided by the World Bank, international organizations, and bilateral donors in the disaster risk reduction, recovery, and resilience sectors. Therefore, regular coordination with other donors is essential, not only for information exchange related to individual cases but also for aligning support items. Establishing a collaborative forum among the eight countries belonging to the Indian Ocean-Southern Africa Disaster Risk Reduction Platform and Republic of South Africa in addition, could be considered an effective activity for understanding each government's needs and coordinating among donors.

In the project, activities were carried out in Beira city, which was affected by Cyclone Idai. However, in the Record of Discussion (RD) the signature for the Mayor of Beira city was not included, and due to some political factors, support from local municipalities under the jurisdiction of MAEFP did not function adequately. As a result, CMB faced challenges in securing funds for domestic travel expenses for JCC and participation for training in Japan and for disseminating the project's outcomes. In disaster-affected areas, awareness of disaster risk reduction, recovery, and resilience is increasing, and inputs in these sectors effectively spreading. However, local governments need to quickly implement activities related to the reconstruction of affected people's daily lives and restoration projects and connect to rapid recovery. Consequently, in many cases, there is no room to secure a budget for activities related to strengthening disaster risk reduction systems and recovering livelihoods and local industries under the Build Back Better concept within the limited budget. In providing recovery support to such disaster-affected areas, establishing mechanisms for securing budgets by central government agencies and building support implementation systems in collaboration with other donors could be effective.

The project was initiated in September, 2019following on-site surveys by the JICA dispatch team immediately after the Cyclone Idai made landfall in April 2019 and on-site discussions in June for project component. As a fast-track development study-type technical cooperation project, and the swift support initiation was also evaluated from GREPOC. However, even after the finalization of the project, C/P institutions are still in recovering stage and continuous support for reconstruction is still needed. In particular, the recovery of regional industries and the development of new industries for Build Back Better (BBB) will take time, and continuous support is indispensable for disseminating the reconstruction and resilience models formulated in the affected areas to the whole country and neighboring countries with similar challenges. Therefore, based on the project's achievements, continuous support using various stakeholders and schemes, including technical cooperation schemes, is required.

10.4.2 Suggestion

The hazard and risk maps formulated in this project indicate that disaster risk is high in the southwestern part of Beira city, which is the current urban center of the city, and in the low-lying areas west of the Beira Airport. Mr. Daviz Simango, the former mayor of Beira city at the time the BMRRP was developed and a key person in building resilient Beira city, indicated that the direction of Beira's future development would be to promote inland development, and this policy is still followed today, with respect to the former mayor.

The hazard and risk maps presented in this project visualize the benefit of pre-disaster investment, including the construction of coastal protection in the southwestern part of the country where disaster risk is high, and indicated the need of measures to deal with residual risks. In addition, by reflected in future land use planning it will indicate the way for pre-disaster reconstruction planning that will promote development of inland areas with lower disaster risk. It is important to promote pre-disaster investment in DRR countermeasures and pre-disaster reconstruction through the use of science bead hazard and risk maps.

In addition, as a pilot project, this project aimed to strengthen the resilience of public facilities also expecting to be used as a DRR and disaster management hub managed by different C/P institutions and beneficiaries the C/P institutions was primary schools, secondary schools, municipal administrative facilities, and medical-related facilities. The implementation of project managed by various C/P institution could lead to mainstreaming DRR and resilience in Mozambique. On the other hand, although this project was not able to reconstruct of the facilities of public markets and fish markets, which are the foundation of people's daily lives, the pilot project for resilient fish market was able to show the model of how to make the fish markets resilient through the use of Kigumi technology and disaster response training, which show the way forward the development toward market revitalization utilizing Kigumi technique. It is also a point to implement the support in a cost-effective way not only by improving the area through infrastructural measures, but also by considering how to utilize the facilities after completion, by showing possible non-infrastructural countermeasures that can be implemented by local residents through their own efforts.

The outcome of the project has valuable findings not only inside Mozambique, but also in other countries. In particular, the southeast African region is the area where the cyclone originated in the southern Indian Ocean approaches, and not only island countries and coastal areas but also inland areas have been affected by disasters, and there are concerns that the effects of climate change may cause more severe disasters in the future. Therefore, the lessons learnt from the activity in Mozambique of identifying disaster risk through scientific evidence-based hazard maps and risk maps, the process of considering structural and non-structural countermeasures based on the recognition of disaster risks, and the fact that the damage in Beira was reduced through appropriate pre-evacuation in time of disaster after Cyclone Idai, are good examples for the southern African region. These findings have been recognized as useful by the countries involved in the Indian Ocean and Southern Africa Disaster Risk Reduction Platform, and the needs on sharing findings by visiting Mozambique activity sites was mentioned from these countries. In addition, meteorological information, disaster response including early warning and other information must be shared and coordinated in a real-time manner among the countries located along the path of cyclones that affect island countries, coastal countries, and even inland countries. Thus, the knowledge gained in Mozambique will be useful in the Southeast Africa region, and it is important to promote the development of cities and countries that are resilient to disasters throughout the region through collaboration.