Learning from Tropical Cyclone Seroja:

Building Disaster and Climate Resilience in Timor-Leste

December 2021

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

GFDRR
Global Facility for Disaster Reduction and Recovery

Contents

1818 H Street NW, Washington DC 20433

Telephone: 202-473-1000; Internet: www.worldbank.org

Cover image credits: Top left: Timor Skyview / Machel Silveira; right: Timor Skyview / Machel Silveira; bottom left and center: Timor Maps / Envato

Photo: Machel Silveira

Acknowledgements

This report was prepared by a World Bank team with technical contributions from the Government of Timor-Leste, data from the United Nations, and financial support from the Global Facility for Disaster Reduction and Recovery (GFDRR). It benefitted greatly from guidance received from representatives in the Ministry of Finance, Ministry of Agriculture and Fisheries, Ministry of Public Works, Transport and Communication, Civil Protection Authority, and the Ministry of Planning and Territory. The World Bank team is also grateful to partners in the United Nations Development Programme (UNDP), Food and Agriculture Association (FAO), Australian Government Department of Foreign Affairs and Trade (DFAT), Japan International Cooperation Agency (JICA), United States Agency for International Development (USAID), Mercy Corps, Oxfam, Care International, and Millennium Challenge Corporation (MCC) for their insights and sharing of information related to their respective disaster risk management and climate change engagements in Timor-Leste.

The World Bank team was overseen by Bernard Harborne (Country Representative for Timor-Leste) and Ming Zhang (Practice Manager, Urban, Disaster Risk Management, Resilience and Land in the East Asia and the Pacific region) and led by Jolanta Kryspin-Watson (Lead Disaster Risk Management Specialist) and Jian Vun (Infrastructure Specialist) with a team comprising Alief Aulia Rezza (Senior Economist), Jia Wen Hoe (Analyst), Keiko Saito (Senior Disaster Risk Management Specialist), Georgina McArthur (Policy Consultant), Asha Kambon (Recovery Consultant), Priscilla Phelps (Housing Consultant), Mateo Ambrosio (Agriculture Consultant), Marinos Skempas (Transport Consultant), Agus Sjamsudin (Transport Consultant), Mizan Bisri (Urban Resilience Consultant), Maria Isabel Alda Da Silva (Operations Analyst), and Nizia Maria Sarmento Lopes Da Cruz (Program Assistant). The team is grateful to Iwan Gunawan (Senior Natural Resources Management Specialist) and Swarna Kazi (Senior Disaster Risk Management Specialist) for their peer review of the report. Devan Kreisberg provided editorial support and Nuriza Saputra provided graphic design support.

Abbreviations and Acronyms

AAL	Average annual loss
ADB	Asian Development Bank
ASF	African swine fever
BBB	Build back better
BCTL	Banco Central de Timor-Leste
BMKG	Indonesian Meteorology, Climatology, and Geophysical Agency
CIGC	Crisis Management Center (*Centro de Integrado de Gestao de Crisis*)
CIGD	Inter-Ministerial Commission for Disaster Management
DA	District Administrator
DaLA	Damage and Loss Assessment
DDC	District Disaster Coordinator
DDMC	District Disaster Management Committee
DMA	Dili Metropolitan Area
DNMG	National Directorate of Meteorology and Geophysics
DNTPSC	Office of Land, Property, and Cadastral Services
DRBFC	Directorate of Roads, Bridges and Flood Control
DRM	Disaster risk management
ECLAC	UN Economic Commission for Latin America and the Caribbean
ENSO	El Niño Southern Oscillation
EWS	Early-warning services
FAW	Fall armyworm
FFGS	Flash Flood Guidance System
GBV	Gender-based violence
GDP	Gross domestic product
GoTL	Government of Timor-Leste
ILO	International Labor Organization
IMF	International Monetary Fund
IOD	Indian Ocean Dipole
MAF	Ministry of Agriculture and Fisheries
MHEWS	Multi-hazard early warning system
MOI	Ministry of Interior
MPWTC	Ministry of Public Works, Transport and Communication
MSSI	Ministry of Social Solidarity and Inclusion
NDC	National Disaster Coordinator
NDOC	National Disaster Operation Center
NDMD	National Disaster Management Directorate
NHP	National Housing Policy
PDNA	Post-Disaster Needs Assessment
RHTO	Disability Person Organizations (*Ra'es Hadomi Timor-Oan*)
SAMES	Timorese Central National Pharmacy
SAOFFG	WMO South-eastern Asia-Oceania Flash Flood Guidance
SDA	Sub-District Administrator
SISN	National Security Integration System
SPS	Sanitary and phytosanitary
STPNDS	National *Suco* Development Program
UNHCR	United Nations High Commissioner for Refugees
UNTAET	United Nations Transitional Administration in East Timor
VIII GoTL	Eighth Constitutional Government of Timor-Leste
WMO	World Meteorological Organization

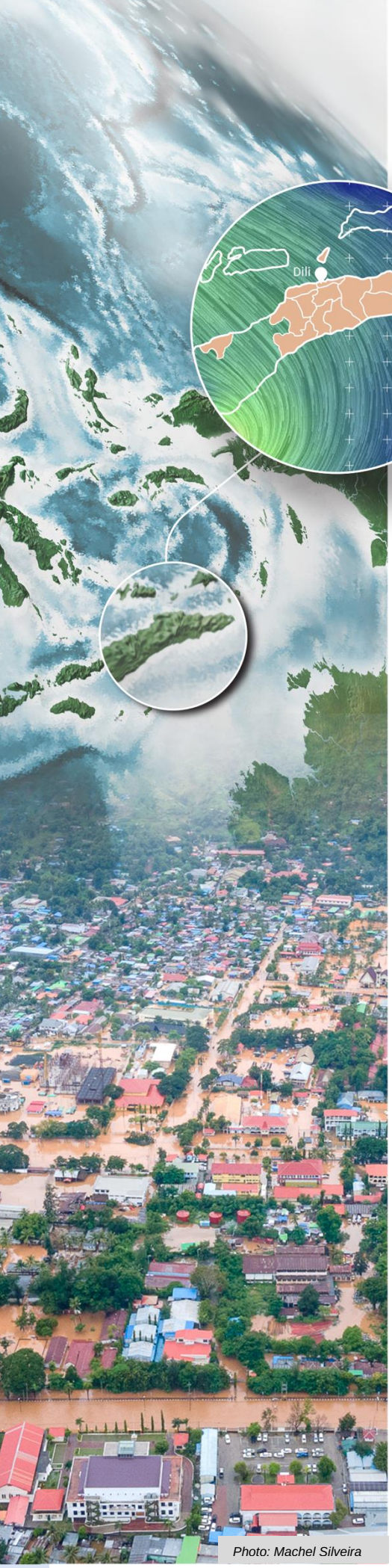


Photo: Machel Silveira

Executive Summary

Timor-Leste is a young,[1] small island state with a population of approximately 1.3 million that continues to be threatened by increasing disaster and climate risk. The dominant natural hazards are floods, landslides, tropical cyclones, droughts, earthquakes, and tsunami. Floods are the most frequent disaster, followed by droughts and storms. Timor-Leste is affected by both riverine flooding and flash floods, which result from heavy rains compounded by low soil permeability and rapid, excessive runoffs from high mountain range slopes to streams below. Climate change impacts as well as the La Niña and El Niño climate patterns further exacerbate floods, as well as droughts and cyclones.

Approximately 17 percent of Timor-Leste's population lives in Dili and the city is expected to continue growing rapidly to a projected population of 450,000 in 2030 – more than double the current population. Urban land in hazardous areas (such as flood-prone land in the city center) has been developed for residential use, and inadequate stormwater management and the reduction of permeable spaces increase the city's flood risk.

Tropical Cyclone (TC) Seroja impacted Timor-Leste with heavy torrential rains over a 24-hour period on April 4, 2021, with an average intensity of over 14 millimeters per hour and a peak intensity of over 70 millimeters per hour. The heavy precipitation and the country's natural topography led to flash floods, landslides, and liquefaction, causing significant damage. The disaster affected all 13 municipalities of Timor-Leste, caused at least 44 fatalities, damaged critical infrastructure such as roads, bridges, water supply infrastructure, schools, and health facilities, and impacted rural areas and agricultural assets.

This report is part of the World Bank's response to the Government's request for support in assessing damages as well as longer-term implications for disaster risk management. It will serve as inputs to a more detailed Post-Disaster Needs Assessment (PDNA) under development and could inform the methodology of future similar remote-based assessments. It is also a contribution to the policy dialogue with the Government and its partners about how to plan and invest more effectively to mitigate disasters in the future.

[1] The country registered its independence on May 20, 2002. Timor-Leste's independence resulted from the August 1999 UN-sponsored referendum.

Key Findings from the Impact Assessment on Selected Sectors

This impact assessment was carried out remotely due to COVID-19 travel restrictions. Collecting comprehensive and complete data sets was not possible. Nonetheless, from the available data, the report provides analysis to inform the Government's decisions on the recovery process, particularly to build back better. It also highlights key recommendations for medium- and long-term resilience building to strengthen disaster risk management in the country.

Findings of the remote-based assessment focus on three key sectors affected by TC Seroja: agriculture, infrastructure (specifically transport – i.e., roads and bridges), and housing.[2] They suggest that the cost of resilient recovery and building back better in these sectors could reach approximately US$422 million, which represents approximately 32 percent of projected Government expenditure for 2021. This figure is indicative of the expected magnitude of damages caused by TC Seroja and a prioritization of critical actions needed in the post-disaster recovery efforts since the full recovery costs are unlikely to be met. The damage[3] attributed to the three sectors is estimated at US$245 million. In addition, costs to build back better in the housing sector and transport sub-sector are an estimated US$118 million. Losses have been estimated for the Agriculture sector (mainly crop loss) and the Housing sector (rental income loss) at approximately US$15.6 million. Of that figure, loss in the Agriculture sector accounts for some 84 percent (US$13.1 million), with the remaining 16 percent accounted for by Housing (US$2.5 million).

Table A: Summary of estimated damage and recovery costs by sector

Sectors	Damage (USD)[a]	Build back better costs (USD)[b]	Total recovery costs (USD)[c]
Agriculture	$15,672,000	–	$28,723,000
Infrastructure (Transport)	$170,407,000	$75,315,000	$245,722,000
Housing	$59,396,000	$42,855,000	$147,795,000
Total	**$245,475,000**	**$118,170,000**	**$422,240,000**

Source: *World Bank staff estimates based on analysis of Government of Timor-Leste data (see report sections for assumptions made).*

Notes: *[a] Damage for housing sector includes cost of damage to household goods; damage for agriculture sector includes cost of damage to livestock sub-sector only. [b] Build back better costs for housing include settlement improvements, settlement restoration, and overhead costs. [c] Recovery costs for agriculture sector include restocking of animal herds, replanting of annual crops, and provision of feed and vaccines for animals; for housing sector, recovery costs include housing repair or reconstruction and build back better costs but not household goods replacement.*

It is important to note that all figures are likely to underestimate actual costs, as this assessment was conducted remotely due to the constraints of the COVID 19 pandemic, and access to data was limited.

In the wake of the dual shocks of TC Seroja and the COVID-19 pandemic, and based on the 9-percent decline in public expenditure in 2020, domestic revenue may continue to suffer from lower domestic economic

[2] Due to inconsistent levels of available data and information for the three sectors during the assessment period (July to August 2021), it was not possible to assess each sector to the same level of detail, with the agriculture and housing sector assessments able to consider damages, losses, and recovery needs; while the transport sector assessment focused more on damages.

[3] In the PDNA (Post-Disaster Needs Assessment) methodology, damage is defined as the economic value attributed to the total or partial destruction of physical infrastructure and assets as a result of a hazard, and is measured in current market prices. Loss is defined as the value of the change in flows as a result of reduced income or higher operational costs resulting from the disruption in the production of goods and services or access to goods and services caused by an event.

activity. In parallel, capital spending on infrastructure and housing will likely increase as a result of public transfers (e.g., construction activity and COVID-19 response) and disaster mitigation efforts. If that occurs, the fiscal deficit could increase from 26 percent in 2020 to between 34 to 38 percent of GDP in 2021, a level not seen since 2017. Limited data on the change in flows (loss) for all sectors of the economy meant it was not possible to assess change in some of the key macroeconomic variables, such as impacts of TC Seroja on GDP.

The impact of TC Seroja will be felt most by the poorest and most vulnerable people of Timor-Leste. Agriculture remains the main source of income generation in the country, with over half of the population engaged in subsistence agriculture (52 percent in 2014). The data suggest that significant hardship will be felt by affected populations as a result of the loss of livestock (used for household consumption) and the destruction of crops. Over 112,000 animals died and over 4,200 hectares of crop land were damaged. **In the Agriculture sector, damage to livestock is estimated to be US$15.7 million, and losses to be over US$13.1 million, with Manatuto, Bobonaro, and Baucau being the most affected municipalities.**


Photo: Machel Silveira

The estimated cost to repair and replace housing assets affected by TC Seroja is US$185 million, but could be well over US$350 million if a "build back better" approach is adopted.

According to information from the Government, more than 30,000 households were impacted by TC Seroja, including nearly 25,000 in Dili (more than 50 percent of all Dili households).[4] Of these, over 4,000 houses were seriously damaged or destroyed, including 3,300 in Dili, or around 8 percent of all households. **The estimated cost to repair and replace housing assets affected by TC Seroja is US$70 million, but could be well over US$150 million if a "build back better" approach is adopted** (e.g., safer housing, basic services restoration, and settlement improvements to reduce risk). In addition, household goods such as bedding, cooking utensils, tools, and electronics were likely damaged or lost when houses flooded, creating extra hardship for poor households. Replacement of household goods can be a significant financial burden. A conservative estimate for replacement of household goods is approximately US$13.4 million.

From March 29 to April 4, 2021, the flash floods, debris flows, and landslides heavily damaged the road infrastructure including 420 kilometers along five main corridors and considerable lengths along forty-two municipal roads across the country. Large volumes of surface water and debris flows eroded the road foundations, causing the pavements, bridges, embankments, and retaining walls to fail. A deteriorated road network lengthens travel times, raises vehicle operating costs, and further isolates rural communities. It also has a negative impact on livelihoods and basic services, including employment, health, and education. **The damage to roads and bridges is estimated at US$170 million. Reconstruction that incorporates improved standards to reduce disaster risk will cost an estimated US$245 million.**

[4] Government of Timor Leste, *Ciclone Seroja: Levantamento de estragos e necessidades (31 May 2021)*, (Dili: Unidade de Missão de Proteção Civil e Gestão de Desastres Naturais, 2021).

Recommendations for Resilient Recovery

The impacts of TC Seroja during the ongoing COVID-19 pandemic highlight the need for a multi-hazard approach to disaster and crisis management going forward. This report recommends an approach that integrates preparedness and response for natural disasters and for health emergencies. The COVID-19 pandemic has shown how health-related emergencies can multiply risks and change a country's risk profile. The national medical warehouse was damaged by the floods, which destroyed critical medication and supplies, while displaced people congregated closely in evacuation centers that lacked adequate infection control measures. Health-related infrastructure (including health facilities and storage warehouses) and evacuation centers need to be prepared, structurally and operationally, to withstand hazard impacts, address functional needs, and provide adequate sanitary measures.

TC Seroja brought attention to the need for clear communication on public health protocols during and in the aftermath of disasters, and of having adequate disaster and health preparedness strategies in place.

Recommendations for resilient recovery have been offered for each sector, and cross-cutting issues are addressed in the assessment. Highlights of those recovery recommendations are presented below and some of the short-term needs, such as housing repairs and road rehabilitation, are already underway.

In the **Agriculture** sector, short-term needs include: (i) distribution of seeds and inputs for replanting; (ii) restocking of animal herds and the provision of animal feed; and (iii) provision of required veterinary vaccinations and services. In the medium to long term, it is recommended that reconstruction efforts focus on reducing the vulnerability of the agricultural sector by improving farmers' access to formal markets; reducing the risk of post-harvest losses; strengthening extension services and information systems, climate and disaster monitoring, and early warning.

In the **Housing** sector, structural recommendations include: (i) repairing and reconstructing housing and potentially relocating households to safer locations; (ii) ensuring quality control of repairs and reconstruction; and (iii) placing a special focus on risk reduction on housing sites and in settlements. Non-structural recommendations include a call to strengthen capacity for conducting site assessments, train builders and homeowners, establish guidelines for those doing their own repairs, and rebuild and encourage community engagement in the reconstruction efforts and in disaster vulnerability reduction in general.

In the **Transport** sub-sector, recommended measures include: (i) rehabilitating key roads with temporary measures and restoring access to services and infrastructure; (ii) identifying, improving, strengthening, and maintaining bypass roads; (iii) designing new infrastructure based on comprehensive hydrological analysis and hydraulic calculations; (iv) identifying and restricting development in unstable and flood-prone areas; (v) establishing an early-warning system at key locations along the road network; (v) planning and executing reforestation and planting; and (vi) improving data collection, sharing, and damage estimates. The latter includes the development of a database that links information on damaged infrastructure to relevant cost data, which will enable the estimation of damage and reconstruction needs to be carried out more quickly and consistently across the country. There is also a strategic need to incorporate enhanced components into the design of reconstructed road infrastructure to ensure resilience in the future, especially in the face of a projected increase in the frequency and intensity of hydrometeorological hazards under climate change scenarios.

Strengthening Disaster Risk Management in Timor-Leste

This report recommends prioritized actions in four key focus areas: (i) the institutional, policy, legal, and regulatory environment; (ii) hazard- and asset-specific risk mitigation; (iii) multi-hazard early-warning systems; and (iv) emergency preparedness and response. First, increased efforts are needed to understand the country's risk profile and needs, which requires political leadership and commitment, improvement of disaster risk information and data, and investment prioritization and funding with associated monitoring and evaluation. Key priorities can then be identified in the four focus areas, informed by cross-cutting issues (social inclusion, institutional strengthening, and risk awareness) and supporting instruments (investment financing, contingency financing, resilience funds, and risk transfers).

A new Civil Protection Law has commenced in Timor-Leste.[5] The adoption of this important law will initiate the development of an updated disaster risk management (DRM) framework for Timor-Leste. Time is needed to evaluate if the law will be successfully resourced and implemented.

The Civil Protection Law and the broader DRM regulatory system needs to be monitored and adapted to the conditions in Timor-Leste, and must include complementary DRM-focused roles and responsibilities. For example, there is currently limited legislative provision for comprehensive DRM planning and policy, early-warning services, and post-disaster recovery coordination. There remains a need to develop an institutional framework for DRM that outlines the responsibilities and procedures across sectors and levels beyond the roles described in the Civil Protection Law, which is mainly focused on defense and national security.

Before the development of the Civil Protection Law framework by the Secretary of State for Civil Protection, DRM activities in Timor-Leste had been mainly associated with emergency response and implemented on an ad-hoc basis. For this reason, it is particularly important to monitor regulatory reforms, and to proactively reduce disaster and climate risk more systematically. Institutional arrangements for damage assessments and recovery planning must also be formalized to mitigate coordination failure and ensure a timely response.

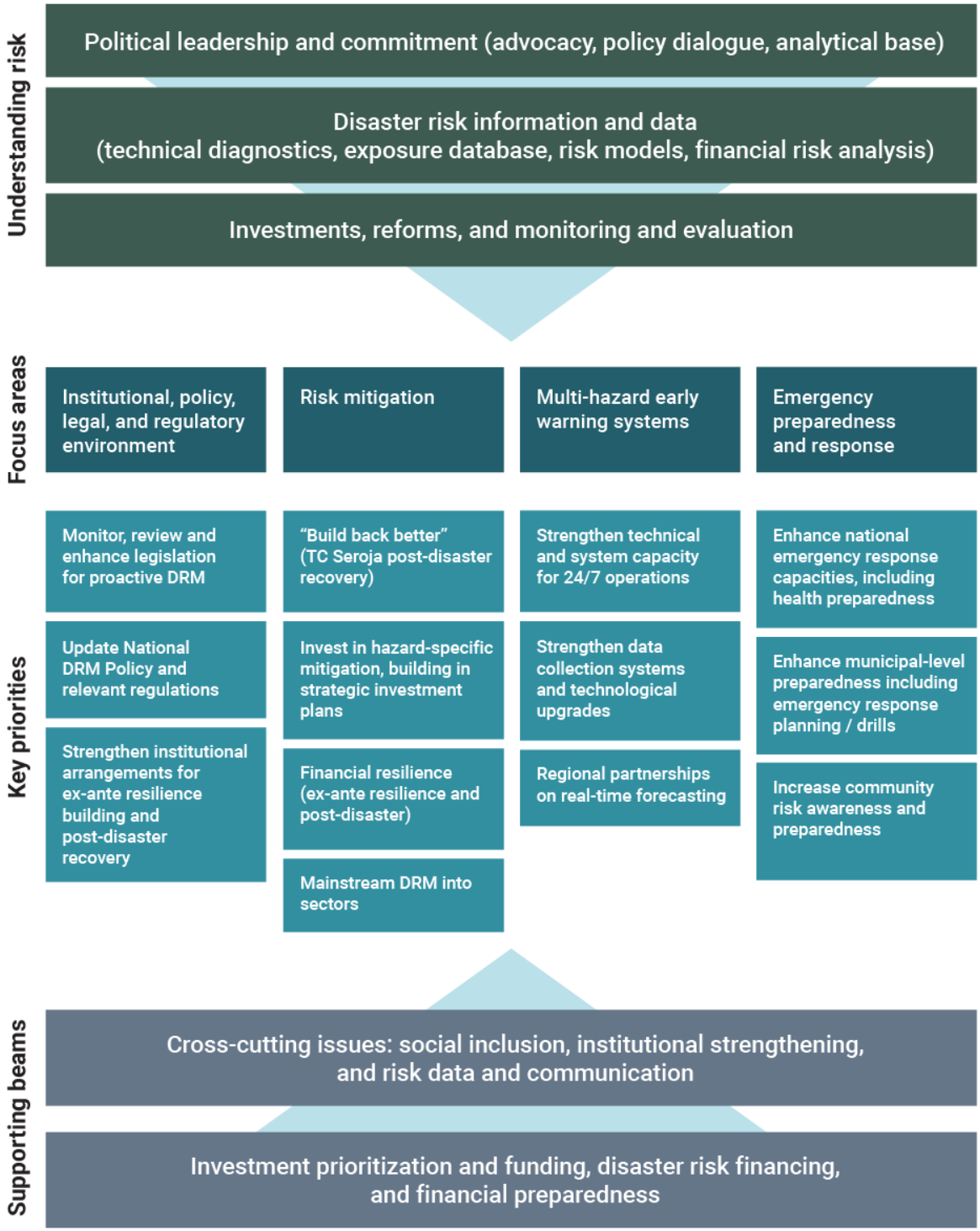
The VIII (Eighth) Constitutional Government of Timor-Leste acknowledges that early-warning mechanisms need to be implemented in conjunction with a legal framework for civil protection.[6] This report recommends assessing investment and capacity needs for hazard monitoring and early-warning operations (including equipment and instrumentation), and institutionalizing an Impact-Based Forecasting and Multi-Hazard Early Warning System. A baseline analysis should be conducted to identify high-priority investments for early-warning services and products. It is recommended that assessments be conducted to address challenges related to the current low visibility within the government of these services, lack of financial and human resources, limited facilities, instrumentation needs, and availability of technical skills.

Risk reduction investments are needed both in ex-ante resilience-building initiatives (such as critical infrastructure investments and implementation of the Dili Master Plan) and in post-cyclone recovery programs. Financial strategies also need to be explored to strengthen the government's preparedness for future impacts of natural hazards. These strategies could include budgetary instruments, contingent financing, and market-based instruments (such as sovereign risk transfers, public asset insurance, and private sector insurance schemes). However, financial instruments to fund preparedness should be complemented by investments and efforts to reduce disaster risk and thereby minimize the effects of future disaster shocks. Such measures would include mainstreaming DRM into sectoral budgets, policies,

[5] Lei N.º 12 /2020 de 2 de Dezembro.
[6] Government of Timor-Leste, "6.9 Defense and Security," *Program of the Eighth Constitutional Government*, http://timor-leste.gov.tl/?cat=39&lang=en#prog6.9.5.

processes, and guidelines; working with municipal authorities on risk information and emergency response planning; and strengthening and upgrading critical infrastructure and assets to withstand key hazards.

A proposed framework to strengthen DRM in Timor-Leste is presented below. Five immediate priorities might include: (i) updating the National Disaster Risk Management Policy; (ii) developing a baseline analysis to identify high-priority investments for early-warning services and products; (iii) applying risk reduction principles when "building back better" and in key development initiatives; (iv) exploring financial preparedness strategies for ex-ante risk mitigation investments and to respond more effectively to future disasters; and (v) conducting an emergency preparedness and response diagnostic to identify priority investments and capacity needs.



1. Introduction: TC Seroja

Photo: Machel Silveira

1.1 Timor-Leste's Disaster Risk Profile

1. The Democratic Republic of Timor-Leste is a young, post-conflict, small island state with a low-to-middle-income economy that relies heavily on oil and gas deposits; other major non-oil export commodities include coffee. The country obtained its independence in 2002 following decades of conflict that significantly damaged infrastructure and displaced thousands of people. The Government of Timor-Leste (GoTL) has an expanding development agenda that continues to be threatened by increasing disaster and climate risk.

2. Timor-Leste is vulnerable to natural hazards including floods, landslides, tropical cyclones, droughts, earthquakes, and tsunami, and is ranked 20th amongst countries of highest disaster risk.[7] The most frequent natural disasters are floods, followed by droughts and storms. Timor-Leste is affected by both riverine flooding and flash floods, which are the result of heavy rains, low soil permeability, and rapid excessive runoffs from high mountain range slopes to streams below. The La Niña and El Niño climate patterns also exacerbate droughts and floods, as well as cyclones. As the country lies between two tectonic plates and is situated along the Pacific "Ring of Fire," it is also exposed to earthquakes and tsunami.[8] Climate change is expected to exacerbate natural disaster risk, potentially resulting in heavier and more frequent rainfall, and harsher and longer drought conditions. Rapid urbanization and land degradation, particularly deforestation, will likely contribute to increased disaster and climate vulnerability.

3. Located south of the equator, Timor-Leste is in an area known for the frequent occurrence of tropical cyclones with damaging winds, rain, and storm surges. On average, eight tropical cyclones per decade pass within 400 kilometers of Dili, with most occurring between November and April. However, the impact of tropical cyclones is usually limited due to the country's proximity to the equator. The most recent tropical cyclones experienced in the country were Frances (2017), Marcus (2018), Lili (2019), and Seroja (2021). Historically, Timor-Leste has been impacted by tropical cyclones Esther (1983), Bonnie (2002), and Inigo (2003), along with Daryl (2006), during which crops and over 500 houses were destroyed by damaging winds and floods.

[7] Bündnis Entwicklung Hilft and the Institute for International Law of Peace and Armed Conflict, *The World Risk Report 2020* (Berlin: Bündnis Entwicklung Hilft, 2020), http://weltrisikobericht.de/english/.

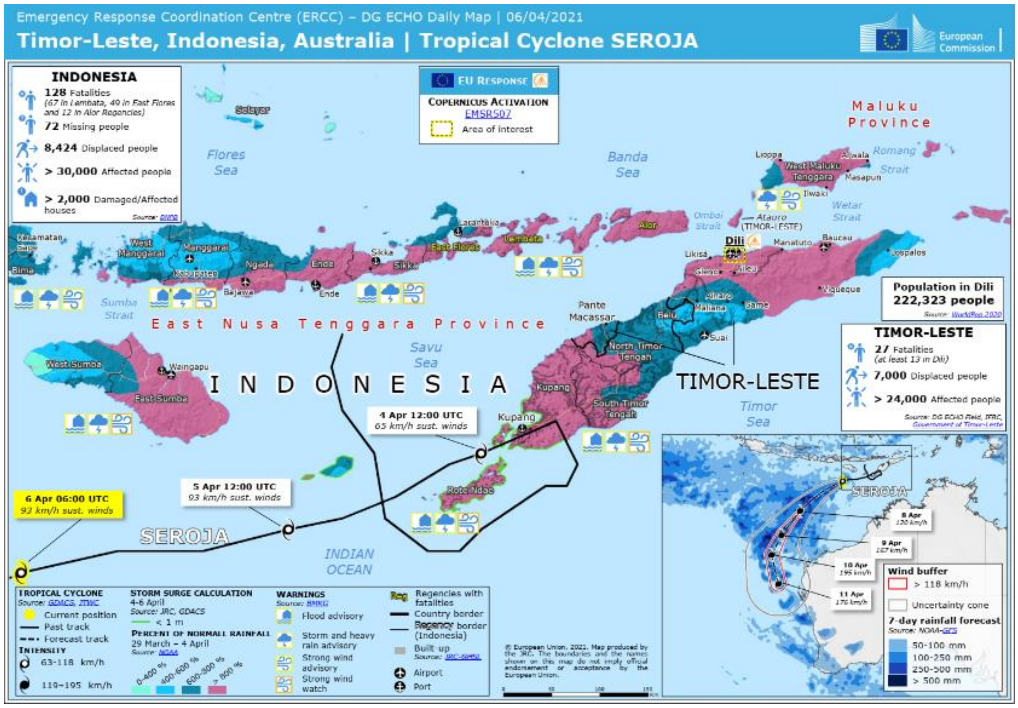
[8] Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI), "Country Risk Profile: Timor-Leste" (PCRAFI, 2011), http://pcrafi.spc.int/documents/247.

4. More than 17 percent of Timor-Leste's population is in Dili, and the city is expected to continue growing rapidly to a projected population of 450,000 in 2030 – more than double the current population.[9] Highly exposed areas such as flood-prone land in the city center have been developed for residential uses, contributing to the city's increasing flood risk, which is further exacerbated by inadequate drainage and the reduction of permeable spaces.[10] More than 10 percent of Dili's population is exposed to flood hazards, and more than 30 percent resides in the tropical storm zone. In addition, hazard monitoring and impact-based forecasting services for extreme weather events are limited, meaning communities are not adequately prepared to make informed decisions and take early action to protect their lives, livelihoods, and assets.

1.2 Event Description: TC Seroja

5. Weather disturbances surrounding the Sawu Sea from March 29, 2021, to early April 2021 resulted in the formation of Tropical Depression (TD) 99S on April 2, 2021, which strengthened on April 5 to form Tropical Cyclone (TC) Seroja (see Figure 1). TC Seroja first impacted Indonesia at a tropical storm level (with wind speeds up to 65 to 85 kilometers per hour) and attained peak intensity when it reached Australia (with wind speeds up to 120 to 130 kilometers per hour) on April 10. While TC Seroja did not make landfall in Timor-Leste, it brought heavy torrential rains and caused significant damage through secondary hazards in the form of flash floods, landslides, and liquefaction, which were exacerbated by the country's natural topography (see Box 1).

Figure 1: Map of TC Seroja's Path



Source: Directorate-General for European Civil Protection and Humanitarian Aid Operations (ECHO), European Commission 2021.

[9] General Directorate of Statistics (GDS) and United Nations Population Fund (UNFPA), *Timor-Leste Population and Housing Census 2015: Analytical Report on Population Projection, Volume 9* (Dili: GDS, 2018), https://timor-leste.unfpa.org/sites/default/files/pub-pdf/2015%20Population%20Projection%20Report_0.pdf.

[10] Fidelis Magalhães, "Lessons from the recent cyclone in Timor-Leste," Lowy Institute, May 19, 2021, https://www.lowyinstitute.org/the-interpreter/lessons-recent-cyclone-timor-leste.

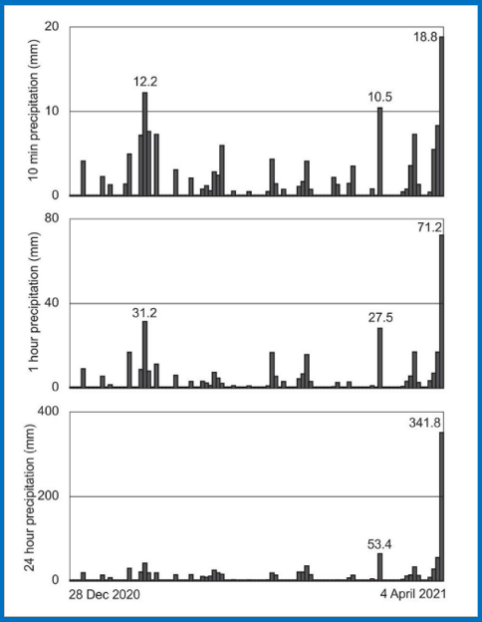
6. The flash floods and landslides affected 31,337 households, or approximately 178,621 people (including 13,099 households living below the national poverty line), across all 13 municipalities of Timor-Leste, causing 44 reported fatalities.[11] Dili, Viqueque, and Covalima were the most affected areas (see Annex 1).[12] Around two weeks after the disaster, the United Nations High Commissioner for Refugees (UNHCR) reported that more than 6,000 people were temporarily displaced within 30 evacuation facilities across Dili.[13] The floods caused severe damage to critical infrastructure such as roads, bridges, water supply infrastructure, schools, and health facilities, with the latter resulting in a loss of medicine, medical supplies, and personal protective equipment.[14] Crops including rice and other agricultural products were damaged by the floods in at least six municipalities; Aileu, Bobonaro, Ermera, and Manatuto were the most affected.[15] Access to water, electricity, and internet was also impacted.

Box 1:

Description of TC Seroja and underlying disaster risks

Due to TC Seroja's movements, the worst affected areas of Dili and Viqueque experienced a precipitation rate of more than 400 percent their normal average rainfall.[16] The 24-hour rainfall on April 4, 2021, was almost an order of magnitude higher than on any other day during the rainy season, with an average intensity of over 14 millimeters per hour and a peak intensity of over 70 millimeters per hour (see right).[17] The rain gauge at Dili's international airport recorded 341.8 millimeters of precipitation in just 24 hours. The West Pacific Monsoon, the Madden Julian Oscillation, and the La Niña climate phenomenon were also present when TC Seroja impacted Timor-Leste, contributing to the extreme increase in rainfall.

Precipitation rate in Dili city, December 2020 to April 2021



Source: National Directorate of Meteorology and Geophysics.

[11] Government of Timor-Leste and United Nations Resident and Humanitarian Coordinator for Timor-Leste, "Government of Timor-Leste and partners appeal for US$32 million to assist flood victims and early recovery," joint news release, June 1, 2021, https://reliefweb.int/report/timor-leste/government-timor-leste-and-partners-appeal-us32-million-assist-flood-victims-and.

[12] Data on households affected from the Timor-Leste Secretariat of State for Civil Protection, 15 June 2021.

[13] UN Resident Coordinator's Office (RCO), "Timor-Leste: Floods – Situation Report No. 6 (As of 21 April 2021)" (Dili: UN Timor-Leste, 2021), https://reliefweb.int/report/timor-leste/timor-leste-floods-situation-report-no-6-21-april-2021.

[14] UN Resident Coordinator's Office (RCO), "Timor-Leste: Floods – Situation Report No. 9 (As of 21 May 2021)" (Dili: UN Timor-Leste, 2021), https://reliefweb.int/report/timor-leste/timor-leste-floods-situation-report-no-9-21-may-2021.

[15] UN RCO, May 2021.

[16] NOAA estimate, reported in map dated April 6, 2021, by the Emergency Response Coordination Centre (ERCC), Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO) https://erccportal.jrc.ec.europa.eu/ercmaps/ECDM_20210406_TC-SEROJA.pdf

[17] See Duffy, Brendan, Oktoviano Vegas Tilman De Jesus, Mark Quigley, Lisa Palmer, Demetrio Amaral Carvalho, Josh Trindade, and Ian Rutherfurd, "Flooding And Landsliding In Timor-Leste: Linked Hazards In A Young Mountain Belt," Geo Down Under, April 12, 2021, https://www.geo-down-under.org.au/timor-leste-flood-disaster.

An underlying root cause of the flash floods in Dili is the topography of the northern parts of Timor-Leste, especially high-elevation catchment areas that drain into the low-elevation population centers of Dili and Laclo.[18] Dili is a part of Kaikoli flood plain; its low-lying areas consist of fine sediments through which water does not easily penetrate, resulting in inundation. Flood risk is further exacerbated by groundwater extraction, which is increasing the sinking rate of Dili city; by high-density urbanized areas; by urban drainage channels that are choked with sediment and urban waste; and by built infrastructure that has further reduced water absorption capacity. The effects of these vulnerabilities in Dili and other low-lying areas in northern Timor-Leste have been well documented in past flood events.[19]

Timor-Leste is also exposed to earthquakes and tsunami. Since the 17th century, there have been at least 50 powerful tsunamigenic earthquakes proximate to Timor-Leste, mostly generated by earthquakes with epicenters located at the transition of the East Sunda and Banda Arc Islands.[20] In 1992, the Flores tsunami generated a runup of 26.2 meters – the highest ever recorded by instrumentation – in nearby East Nusa Tenggara.[21] Given rapid urbanization and the increased exposure of assets, Dili Municipality remains highly vulnerable to seismic hazards.

7. In the aftermath of TC Seroja, crowded evacuation centers and the poor quality and conditions of housing settlements have exacerbated the risk of local COVID-19 transmissions, as well as the risk of other water-borne and vector-borne illnesses, acute respiratory infections, and skin diseases. Daily COVID-19 cases increased over the two months following TC Seroja, with the post-disaster situation likely contributing to the surge. The strict lockdown in Dili Municipality was suspended on April 9, 2021, in response to TC Seroja and the need for evacuation. The floods affected the National Health Laboratory, the Autonomous Service for Medicines and Health Equipment, the Timorese central pharmacy (SAMES), and the medical supplies depot where vaccines are stored, hampering COVID-19 containment efforts.[22]

8. The events in early 2021 highlight the need for a multi-hazard approach moving forward, one that integrates preparedness and response for natural disasters and health emergencies. The ongoing COVID-19 pandemic has shown how health-related emergencies can multiply risks and change a country's risk profile; TC Seroja highlighted the need for clear communication on public health protocols during and in the aftermath of disasters, and to have adequate disaster and health preparedness strategies in place. The national medical warehouse was damaged by the floods, destroying critical medication and supplies, while displaced people congregated closely in evacuation centers. Health-related infrastructure (including health facilities and storage warehouses) and evacuation centers therefore need to be prepared to withstand disaster impacts, address public health protocols such as physical distancing and infection control, and provide adequate sanitary measures.

[18] Duffy et al. 2021.

[19] See National Disaster Management Directorate, *A Comprehensive National Hazard Assessment and Mapping in Timor-Leste* (Dili: UNDP, 2012).

[20] Liu, Z., and Harris, R., "Discovery of possible mega-thrust earthquake along the Seram Trough from records of 1629 tsunami in eastern Indonesian region," in *Natural Hazards* 72:1311–1328, doi:10.1007/s11069-013-0597-y.

[21] Harris, R., and J. Major, "Waves of Destruction in the East Indies: the Wichmann Catalogue of Earthquakes and Tsunami in the Indonesian Region from 1538 to 1877," in *Geohazards in Indonesia: Earth Science for Disaster Risk Reduction*, edited by P. R. Cummins and I. Meilano (London: Geological Society, Special Publications, 2016), 9–46, doi:10.1144/SP441.11.

[22] UN RCO, May 2021.

1.3 Government Response

9. The Government of Timor-Leste allocated approximately US$2.2 million as a contingency budget for emergency support to affected populations. These funds enabled the rapid mobilization of critical items such as food and water, the rapid deployment of labor and reconstruction materials, and the implementation of temporary measures, such as sandbags for securing riverbanks and the preparation of temporary shelters.[23]

10. The Government also provided the Secretariat for the National Suco Development Program (STPNDS) with an additional US$1.5 million from the reserve fund and contingency fund of the Ministry of Finance. The funds were allocated for the rehabilitation of basic infrastructure affected by TC Seroja. The program has so far identified 36 initiatives to be supported. Additionally, the infrastructure fund includes a line item for the rehabilitation, maintenance, and repair of structures damaged by disasters, setting aside US$63.2 million (26 percent of the fund's total budget) for these activities. The sectors most affected by TC Seroja (such as agriculture, and water and sanitation) have been budgeted a total of US$77.0 million to restore normal operations.

11. On April 23, 2021, the National Parliament also approved the amendment of the 2021 General State Budget, increasing the allocation to the Contingency Fund from US$23.8 million to US$65.2 million.[24] As of June 2021, approximately US$15 million of additional humanitarian funding has been mobilized by donors, UN agencies, the humanitarian community, and the private sector (Figure 2).[25]

12. On April 16, 2021, the Ministry of State Administration requested assistance from development partners in the identification and assessment of the flooded areas, as well as advice in the areas of disaster risk reduction, livelihoods restoration, reduction of environmental vulnerability, and rehabilitation of flood-prone land for agricultural use. This report forms part of the World Bank's response to this request and also a contribution to the policy dialogue with the Government and other development partners about how to plan and invest more effectively to mitigate disasters in the future.

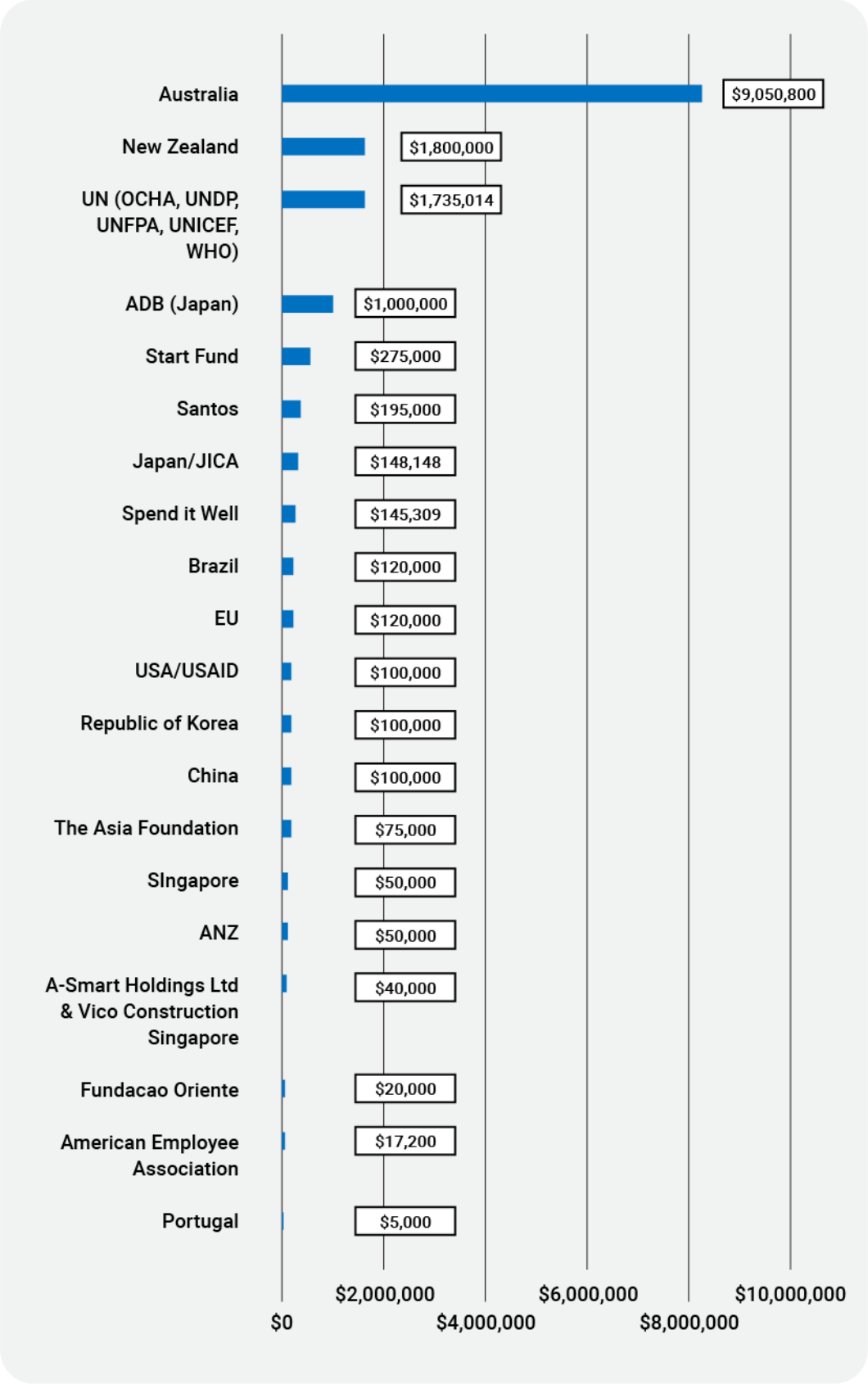
> "As of June 2021, approximately US$15 million of additional humanitarian funding has been mobilized by donors, UN agencies, the humanitarian community, and the private sector"

[23] Civil Protection and Natural Disaster Management Mission Unit, *Tropical Cyclone Seroja: Summary Survey of Damage and Needs Report* (Dili: UMPCGDN, May 2021)

[24] UN Resident Coordinator's Office (RCO), "Timor-Leste: Floods – Situation Report No. 7 (As of 28 April 2021)" (Dili: UN Timor-Leste, 2021), https://reliefweb.int/report/timor-leste/timor-leste-floods-situation-report-no-7-28-april-2021.

[25] UN Resident Coordinator's Office (RCO), "Timor-Leste: Floods – Situation Report No. 10 (As of 18 June 2021)" (Dili: UN Timor-Leste, 2021), https://reliefweb.int/report/timor-leste/timor-leste-floods-situation-report-no-10-18-june-2021.

Figure 2: Distribution of TC Seroja–related humanitarian funding



Source: UN RCO, June 2021.

Photo: Machel Silveira

2. Macro-Economic Context

2.1 Global Overview

13. As a result of the COVID-19 pandemic, global gross domestic product (GDP) fell by 4.9 percent in 2020, the largest contraction since the 2008/2009 recession.[26] In April 2020, the International Monetary Fund (IMF) predicted that the US economy would shrink by 5.9 percent and the Euro area[27] by 7.5 percent; this was revised downwards in June 2020 suggesting that the global economy would grow by 1.9 percentage points less than projected before the pandemic.[28]

14. The IMF warned that the adverse impact on low-income households was particularly acute, and endangers the progress made in reducing extreme poverty since the 1990s. The labor market, and low-skilled and informal-sector workers in particular, has been significantly affected. The International Labor Organization (ILO) estimates that close to 80 percent of the approximately 2 billion informally employed workers worldwide have been significantly affected. Income losses have not been shared equally, with women in lower-income groups bearing the brunt of the impact in some countries.

[26] International Monetary Fund, "World Economic Outlook, June 2021: A Crisis Like No Other, An Uncertain Recovery," (Washington, DC: International Monetary Fund, 2021).

[27] The Euro area, also known as the eurozone, comprises countries that use the Euro currency: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain.

[28] IMF, "World Economic Outlook, June 2021."

2.2 Regional Economic Overview

15. Economies in the Asia region saw a decline in consumption and investment during 2020, in line with global trends. Affected by domestic lockdowns and the global recession, South Asia posted the largest contraction of any region, largely as a result of an 8-percent fall in India's GDP. Southeast Asia's economy also shrank substantially, led by contractions of 9.6 percent in the Philippines and 6.1 percent in Thailand.[29] Among the ASEAN economies, Indonesia – Timor-Leste's main trading partner – experienced a comparatively smaller GDP contraction of 1.9 percent.[30] The Asian Development Bank (ADB) reported a decline in economic activity in Central Asia as commodity prices and remittances fell, while in the Pacific, plunging tourist arrivals drove the sub-region into recession. However, East Asia experienced growth in 2020, boosted by the fast rebound and 2.3 percent expansion in China.[31]

2.3 National Economic Overview

16. A combination of political uncertainty (in 2017–2018 and 2020), COVID-19, and TC Seroja have impacted an already fragile economy. In 2020, Timor-Leste's economy contracted as a result of the global economic slowdown caused by COVID-19, along with its internal state of emergency and the delayed passing of the 2020 state budget.[32] The change in preliminary non-oil GDP in 2020 was negative 8.5 percent in constant terms, compared with positive 1.8 percent in 2019. A significant plummet in investments was the primary driver of the negative economic growth.[33] This is the largest economic decline since Timor-Leste's independence. The country's economic performance in 2020 ended a "very anemic economic growth cycle in the last 4 years, as real GDP was, at the end of 2020, still below its value in 2016."[34] From 2014 to 2020, the headcount poverty rate is estimated to have increased by 5 percentage points.[35]

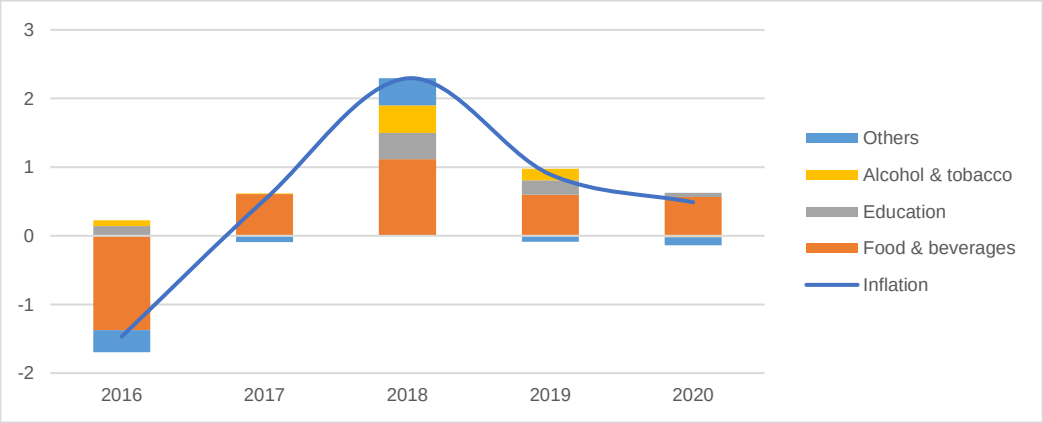
17. A key factor in GDP contraction was a major fall in public investment in 2020, along with the progressive reduction in oil revenues, the principal driver of growth in the economy. The Banco Central de Timor-Leste (BCTL) notes that future income from oil and gas reserves is now expected to be $200 million between 2021 to 2023, a reduction from the expected value in 2019 of $824 million.[36]

18. In terms of fiscal policy, 2020 was marked by a decline in public expenditure of 9 percent, and a corresponding reduction in the public deficit.[37] This was largely due to the decrease in public investment and a fall in expenditure execution rates (especially in goods and services and transfers), along with the decline in oil revenue, which accounts for 80 percent of total fiscal revenue.[38] Growing political instability in recent years, which resulted in difficulties approving and executing budgetary policies in 2020, also contributed to the observed economic performance.

---

[29] Asian Development Bank (ADB), *Asian Development Outlook 2020* (Manila: ADB, 2020).
[30] Central Bank of Timor-Leste, "Annual Economic Report 2020".
[31] ADB, *Asian Development Outlook 2020*.
[32] ADB, *Asian Development Outlook 2020*.
[33] "Timor-Leste Preliminary Non-Oil GDP 2020 Growth Rate," Announcements, Statistics Timor-Leste, updated March 2021, https://www.statistics.gov.tl/timor-leste-preliminary-non-oil-gdpe-2020-growth-rate/.
[34] Banco Central de Timor-Leste (BCTL), *Annual Report 2020: Timor-Leste and the Pandemic, Economic Resilience and the Global Challenges* (Dili: BCTL, 2021).
[35] World Bank Group, *Timor-Leste Economic Report, May 2021: Charting a New Path* (Washington, DC: World Bank, 2021).
[36] BCTL, *Annual Report 2020*.
[37] World Bank Group, *Timor-Leste Economic Report, May 2021*.
[38] ADB, *Asian Development Outlook 2021* (Manila: ADB, 2021).

Figure 3: Consumer Price Inflation



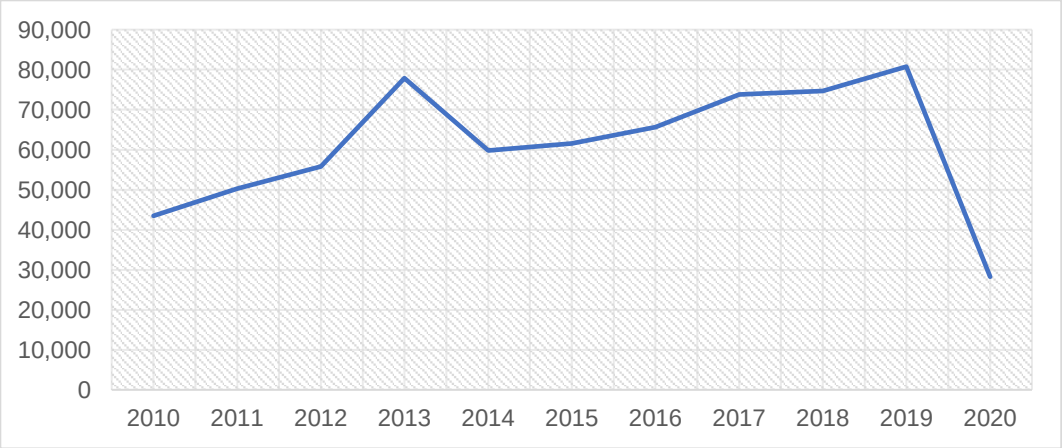
Source: Ministry of Finance, provided in World Bank Group, Timor-Leste Economic Report, May 2021.

19. Domestic inflationary pressures remained low and controlled throughout 2019 and 2020, with annual inflation rates trending downwards from 2 percent to 1 percent.[39] Consumer price inflation eased to 0.5 percent, despite higher international food prices (Figure 3). BCTL expects that the low and stable inflation scenario will persist in 2021 and 2022, based on the assumptions that the dollar will remain stable against most Asian currencies and that there will be moderate inflation in the economies of Timor-Leste's trading partners during the same period.

External Sector

20. The trade balance improved slightly in 2020. Imports declined by 19 percent, particularly because construction and travel services were impacted by the COVID-19 travel restrictions and economic downturn. Exports nearly halved, owing to limited travel services and lower coffee earnings.[40]

Figure 4: Total Overseas Travelers in Timor-Leste



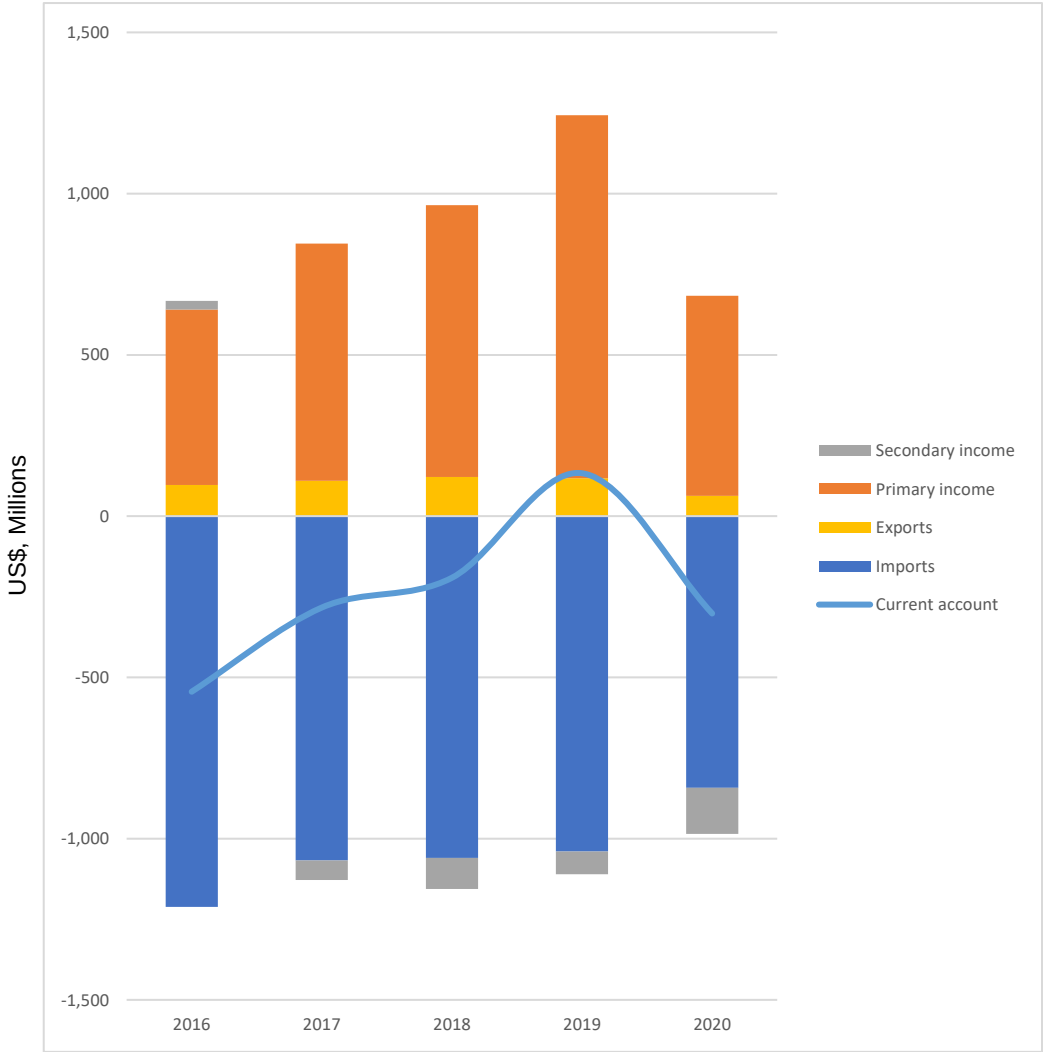
Source: Statistics Timor-Leste.

[39] BCTL, *Annual Report 2020*.
[40] BCTL, *Annual Report 2020*.

21. Figure 4 illustrates the precipitous drop in overseas travel to Timor-Leste between 2019 and 2020 due to COVID-19 and associated travel restrictions. It is expected that international mobility will continue to be restricted over the next two to four years, which will affect the country's tourism sector.[41] Any possible benefits from the gradual reopening of borders in the second half of 2020 would likely have been offset by the combination of a surge in COVID-19 in the early part of 2021 followed by the impacts of TC Seroja in April 2021.

22. Despite improvements in the balance of trade, Timor-Leste's current financial situation weakened in 2020 as a result of a lower primary income, as illustrated in Figure 5. After having recorded a surplus in 2019 for the first time since 2016, Timor-Leste's external current account recorded a deficit in 2020. The current account deficit was estimated at $302 million for 2020, having declined by $435 million compared to 2019, a reduction mostly explained by the fall in oil revenues. This deficit amounted to 19 percent of GDP in 2020, returning Timor-Leste's financial resources to the average levels recorded between 2016 and 2018. The current account is expected to remain in deficit in the medium term, especially as offshore petroleum production dwindles in the next few years before it ceases completely.

Figure 5: Current Account Balance Source: World Bank calculations



Source: Ministry of Finance.

[41] UN World Tourism Organization (UNWTO), "Impact assessment of the COVID-19 outbreak on international tourism", May 7, 2020m, https://www.unwto.org/news/covid-19-international-tourist-numbers-could-fall-60-80-in-2020

Economic Impact of TC Seroja

23. The economic impact of TC Seroja should be seen in the context of the continuing and uncertain impacts of COVID-19. In May 2021, the number of COVID-19 cases increased exponentially, in part because of the impacts of TC Seroja itself. The State of Calamity in Dili Municipality, originally declared on April 8, was renewed and extended until August 4.[42] On June 16, the Government lifted the mandatory confinement in Dili and the sanitary fence in the capital. As of June 18, under the national COVID-19 vaccination program launched on April 7, a total of 110,531 vaccine doses had been administered across all municipalities. Cumulatively, 11,100 cases of COVID-19 have been recorded in the country and 26 deaths were reported as of August 4, 2021.[43]

24. Table 1 presents the findings of the remote-based assessment of three key sectors impacted by TC Seroja: agriculture, infrastructure (specifically transport roads and bridges), and housing. The estimated damage for those three sectors alone total approximately US$245 million. Recovery costs total approximately US$422 million, which represents approximately 32 percent of projected Government expenditure for 2021. Loss of crops in the Agriculture sector and of rental property in the Housing sector amounts to approximately US$15.6 million. Of that figure, loss in the Agriculture sector accounts for some 84 percent, with the remaining 16 percent accounted for by Housing. It is important to note that all estimates are likely to represent an underestimation of total damages and losses because the COVID-19 pandemic prevented a comprehensive assessment from being undertaken, and key data sets were unavailable.

Table 1: Sectoral Estimates of Damages and Recovery Costs

Sectors	Damage (USD)[a]	Build back better costs (USD)[b]	Total recovery costs (USD)[c]
Agriculture	$15,672,000	–	$28,723,000
Infrastructure (Transport)	$170,407,000	$75,315,000	$245,722,000
Housing	$59,396,000	$42,855,000	$147,795,000
Total	**$245,475,000**	**$118,170,000**	**$422,240,000**

Source: World Bank staff estimates based on analysis of Government of Timor-Leste data.

> "Recovery costs total approximately US$422 million, which represents approximately 32 percent of projected Government expenditure for 2021."

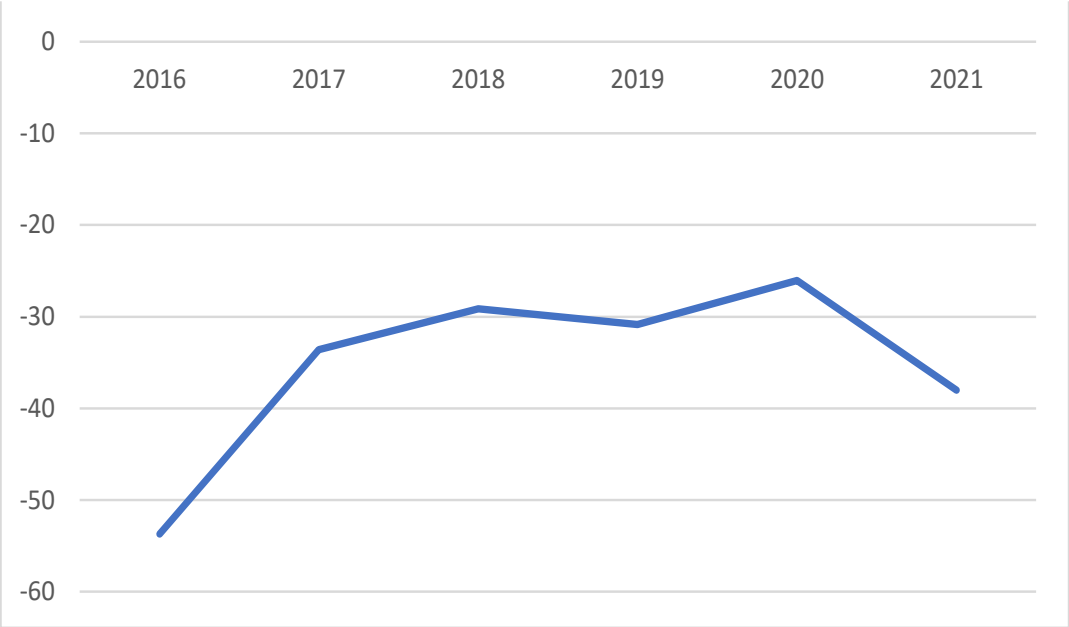
[42] Government Resolution No. 75/2021, May 31, 2021.

[43] Ensheng Dong, Hongru Du, and Lauren Gardner, "An interactive web-based dashboard to track COVID-19 in real time," *The Lancet* 20, no. 5 (May 2020): 533–544, doi:10.1016/S1473-3099(20)30120-1.

25. The damage and the cost of recovery are expected to affect the Government's fiscal position. While the initial 2021 budget marked a shift from 2020's short-term relief measures (i.e., humanitarian aid, basic food, water, blankets, shelters) to medium-term economic recovery activities, the events of TC Seroja necessitated a budget revision to refocus spending on early recovery interventions such as rehabilitation and maintenance (see section 1.3). Immediate and short-term economic impacts were sustained through delays to trade, receipt of medical supplies, and reduced access to travel observed at the Dili sea port and the President Nicolau Lobato International airport. In addition, due to the compounding impacts of TC Seroja and COVID-19, real GDP growth in the non-oil sector has been revised downward to 1.8 percent for 2021, compared to the initial 3 percent projected in October 2020. The slight positive growth that had been projected was expected after an estimated contraction of as much as 7.6 percent[44] for 2020, the largest decline seen since independence.[45]

26. TC Seroja compounds an already weak macroeconomic outlook. Domestic revenue may continue to suffer from lower domestic economic activity, while capital spending should increase as a result of public transfers and mitigation efforts.[46] The fiscal deficit may increase from 26 percent in 2020 to be around 31 percent of GDP in 2021 (Figure 6), a level not seen since 2017, as the Government engages in recovery spending in the infrastructure sector, rehabilitates agriculture, and supports repairs to the housing sector. Under current policies, fiscal and external sustainability are at risk in the long term. With the drying up of oil revenues and current fiscal plans, the Petroleum Fund could be fully depleted in two decades, placing the external sector in a weak position.[47]

Figure 6: Fiscal Balance as a Percentage of GDP



Source: Estimates based on Government of Timor-Leste data, provided in World Bank Group, Timor-Leste Economic Report, May 2021.

[44] International Monetary Fund (IMF), *Timor-Leste: 2021 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for Timor-Leste*, Country Report No. 2021/152 (Washington, DC: IMF, 2021).

[45] World Bank Group, *Timor-Leste Economic Report, May 2021*.

[46] The IMF noted that Timor-Leste's government spent 12.3 percent of non-oil GDP on COVID-19-related spending, including cash transfers to 334,000 households (IMF, *Timor-Leste: 2021*).

[47] IMF Country Report 21/152

3. Damage and Needs Assessment

Photo: Machel Silveira

3.1 Assessment Objective, Methodology, and Scope

27. This report draws on new and existing data, including data collected as part of a remote assessment from June to July 2021. The methodology applied assesses the extent or effect and impact of a shock on the economy and society. In particular, the data analysis is based on an approach originally developed by the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), called the Damage and Loss Assessment (DaLA).

28. For a disaster of a meteorological or hydrological nature, the methodology first calls for an assessment of the extent of damage to physical infrastructure and assets. This is followed by an examination of the change in flows (or loss) resulting from the disruption caused by the event to the production of goods and services, or to the access of goods and services, in all sectors of the economy. Because of the constraints presented by the COVID-19 situation, only three sectors of the economy could be examined: Agriculture, Infrastructure (the Transport subsector specifically), and Housing. Unfortunately, since data on the change in flows (loss) within economic sectors is scarce, it is not possible to ascertain change in some of the key macroeconomic variables, such as GDP.

29. Given the remote nature of the assessment, and travel and movement restrictions due to COVID-19, the assessment was limited in the collection of comprehensive data sets. Nonetheless, the report's analysis uses the available data to contribute to Government's decision-making for recovery in a timely manner.

Photo: Machel Silveira

3.2 Agriculture sector

Context

30. Agriculture is a key economic sector in Timor-Leste, making up 17 percent of GDP in 2020.[48] Agriculture also remains the main source of income generation, with over half of the population engaged in subsistence agriculture (64 percent in 2019), and a majority of poor households dependent on agriculture for their livelihood – particularly the 80 percent of poor households that live in rural areas.

31. The crop subsector contributes the most to total sector value-added, followed by livestock, while the contribution of fisheries and forestry is marginal.[49] According to the 2019 Agriculture Census,[50] agricultural land covered 219,250 hectares, of which around 98 percent is associated with 141,141 agricultural individual holdings (households) and merely 2 percent with institutional holdings. Around 90 percent of the individual holdings cultivate a mix of crops in their parcels, of which just over 60 percent (86,730 holdings) cultivate both temporary and permanent crops and less than 25 percent (32,804 holdings) cultivate only temporary crops. Only 10 percent (14,088 households) grew no crops and only raised livestock.

32. Thirteen crops account for around 70 percent of the total cultivated area,[51] and crop production is dominated by individuals growing their crops on small land holdings. The average size of household agricultural holdings in 2019 was estimated at 1.53 hectares. Rice production is

[48] This share represents a reduction from 25 percent in 2010. However, the decrease is not motivated largely by lower output, but by the substantial expansion of public expenditures, and the dependency of the Timorese economy on the public sector (BCTL, *Annual Report 2020*).

[49] World Bank Group, *Timor-Leste Economic Report, April 2019: Moving Beyond Uncertainty* (Washington, DC: World Bank Group, 2019).

[50] General Directorate of Statistics (GDS) and Ministry of Agriculture and Fisheries, *Timor-Leste Agriculture Census 2019: National Report on Final Census Results* (Dili: General Directorate of Statistics, Ministry of Finance, Ministry of Agriculture and Fisheries, 2020).

[51] These crops are: corn (18% of the gross cultivated area), rice (7.4%), cassava (7.4%), coffee (6.3%), coconut (5.8%), banana (5.4%), teak (4.2%), mango (3.6%), sweet potatoes (2.8%), papaya (2.4%), candlenut (2.1%), taro (2.0%), and areca nut (1.9%).

concentrated in a limited number of suitable areas in the lowlands, which provide 25 percent of the staple food production, while food imports help close the supply–demand gap.

33. In the livestock subsector, around 95 percent of Timorese agricultural households raise a mix of livestock and poultry for their livelihoods. According to the 2019 Agricultural Census, the total livestock and poultry stock amounts to 2.3 million heads, including 286,558 cattle, 453,444 pigs, 179,911 goats, 1,146,037 chickens, and 6,848 ducks. Fishing and aquaculture remain marginal activities; in 2019, 4,405 individual holdings (3.1 percent of agricultural households) combined their agriculture activities with fishing. Around 60 percent of those households engaged in fishing mainly for their own consumption, and only 25 percent did it mainly for sale. Only 3,632 individual holdings (2 percent of agricultural households) depended solely on fishing as an income-generating activity, and an additional 1 percent on aquaculture.

34. While Timor-Leste has the potential to develop a range of agricultural products for the domestic and export markets, the sector is underperforming. The country has a mix of agroecological zones, which enables the production of a wide range of food and cash crops, including coffee, forestry, coconuts, spices, and legumes. However, climatic, terrain, and soil conditions negatively affect the land's fertility and suitability for agriculture. The combined effect of the West Pacific Monsoon, the El Niño Southern Oscillation (ENSO), and the Indian Ocean Dipole (IOD) explains the variation in temperatures and rainfall levels in Timor-Leste. Climate change is projected to lead to a higher frequency and severity of extreme weather events, such as shorter and less predictable wet seasons and hotter dry seasons, directly impacting agricultural productivity.[52] Land degradation and land-use change caused by deforestation, inappropriate farming practices, forest fires, and over-grazing are expected to exacerbate the effect of those impacts. The rugged, erosion-prone terrain, poor soils, and varying, often unpredictable rainfall makes for challenging agriculture.[53]

35. Major constraints to agriculture production in Timor-Leste include the small size of landholdings (land available for crop production is only 1.53 hectares per household), farmers' restricted access to markets, poor access to credit (less than 1 percent of agricultural households have access to credit for the purchase of inputs and land), limited use of chemical inputs, difficult soil conditions (only one-quarter of land is suitable for agriculture), limited water availability for irrigation, and low investment in the sector.[54,55] All subsectors are dominated by subsistence farming, and farmers are strongly risk-averse. There have been some modest improvements in productivity and investments in value chains for horticulture and spice production. However, crop yields remain low compared to other Southeast Asian countries (averages of 0.2 tons per hectare for coffee, 2.3 for maize, and 3.1 for rice between 2016 and 2019;[56] see Figure 7), affecting dietary quality and food reserves during the lean season.

> "Agriculture remains the main source of income generation, with over half of the population engaged in subsistence agriculture"

[52] Food and Agriculture Organization (FAO, *Special Report – 2021 FAO Crop and Food Supply Assessment Mission (CFSAM) to the Democratic Republic of Timor-Leste* (Rome: FAO, 2021), doi:10.4060/cb5245en. World Bank Group, *Timor-Leste Economic Report, April 2019*.

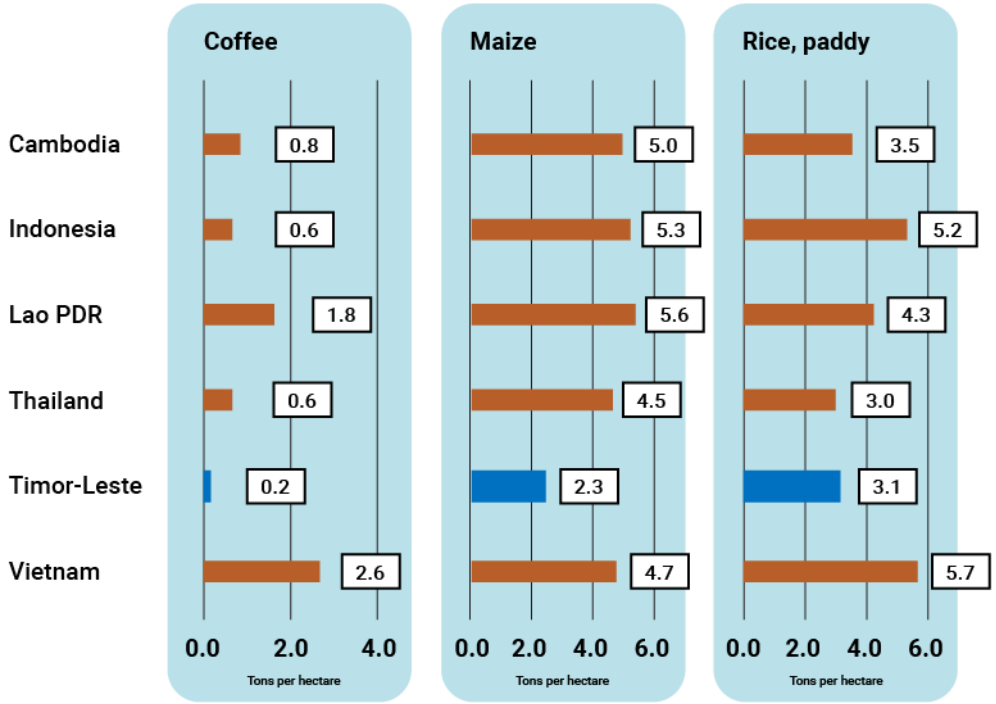
[53] Ministry of Agriculture and Fisheries (MAF), *Timor-Leste Agriculture Sector Review*, Sustainable Agriculture Productivity Improvement Project (Dili: MAF, 2019).

[54] BCTL, *Annual Report 2020*.

[55] World Bank, *Making Agriculture Work for the Poor in Timor-Leste* (Washington, DC: World Bank, 2019).

[56] Data from FAOSTAT (http://www.fao.org/faostat/en/), retrieved July 2021.

Figure 7: Average Crop Yields in Selected Countries in the East Asia and the Pacific Region (2016–19)



Source: World Bank estimates based on data from the Statistics Division of the Food and Agriculture Organization of the United Nations (FAOSTAT), retrieved July 2021.

36. The impact of public investments remains limited, and efficiency issues remain unsolved. The decreasing level of public investment in agriculture (in 2019, the Ministry of Agriculture and Fisheries' share of state budget was 0.7 percent) is not aligned with the importance of a sector that directly employs over half of the working population. Better coordination across ministries is needed to align public spending programs and policy objectives. For example, despite being the leading agricultural export commodity, in 2017 the coffee sector received only 5.6 percent of the total Ministry of Agriculture and Fisheries (MAF) budget for priority programs. Subsidies on food commodities and agricultural inputs may also discourage farmers from investing in and commercially producing rice and maize. Institutional efficiency also affects the budget allocation to municipalities, which should take into consideration each municipality's levels of needs and poverty, the size of the population, and staffing.

Impacts of TC Seroja

37. Per estimates made in July 2021, TC Seroja affected 4,230 hectares of crop land and caused 9,134 tons of crop losses valued at over US$12.5 million (Table 2). Out of that affected land, nearly 1,570 hectares were maize fields; 2,663 hectares were paddy fields. These areas represent 4.6 percent and 11.9 percent, respectively, of the cultivated area for those crops during the main growing season of 2020/21. Based on these damaged areas, the output losses are estimated to be 4,102 tons of maize (5.3 percent of the expected output for this season) and 5,032 tons of rice (13.5 percent). In value terms, the output losses are estimated to be US$5.5 million for maize (7.1 percent of the expected output value for this season) and US$7.1 million for rice (14.9 percent).

Table 2: Damaged Cropland and Output Losses

	Main agricultural season 2020/21			Impact of floods		
	Cultivated area (ha)	*Expected output (tons)*	*Expected output value (USD)*	*Affected area (ha)*	*Lost output (tons)*	*Lost output value (USD)*
Total (national)	**67,810**	**206,155**	**$239,102,099**	**4,232**	**9,134**	**$12,521,657**
Maize	37,281	85,626	$85,745,003	1,569	4,102	$5,465,230
Rice	30,529	120,529	$153,357,096	2,663	5,032	$7,056,427

Note: Cultivated area and output refer only to rice paddy and maize. The main cultivation season for maize takes place from October to April. Rice plantings start in December with the onset of the rainy season; cultivation continues until March, with harvest taking place between April and June. For maize, the secondary season runs from April through November, while the secondary season for rice, mostly irrigated, runs from June (planting) to December/January (harvest). Prices used are a national average and differ per province from 0.52 to 1.86 USD/kg for maize and from 0.98 to 1.54 USD/kg for rice.

Source: World Bank estimates based on data on damaged area estimated in FAO 2021 and Ministry of Agriculture and Fisheries data.

38. The hardest-hit municipalities are Manatuto (30.5 percent of the total damaged area), Baucau (29.4 percent), and Bobonaro (21.1 percent) (Table 3). These three municipalities alone were expected to account for around 40 percent of the crop production for the year 2020/21. Around 7,351 tons of their crop output are estimated to have been lost to the floods (80 percent of the total lost production), with a value of US$10.55 million (over 84 percent of the total lost production value).

Table 3: Damaged Cropland and Output Losses by Municipality

Municipality	Estimated crop production 2020/21[a]		Impact of floods[b]			
			Affected area		Lost output (tons)	Lost output Value (USD)
	Total (tons)	Share (%)	Total (Ha)	Share (%)		
Aileu	5,250	3.8	36	0.9	60	$79,750
Ainaro	6,630	4.9	29	0.7	91	$54,624
Baucau	25,100	18.4	1,245	29.4	2,424	$2,927,324
Bobonaro	22,260	16.3	895	21.1	2,214	$3,770,261
Covalima	17,370	12.7	165	3.9	349	$450,000
Dili	800	0.6	160	3.8	424	$618,945
Ermera	7,160	5.2	24	0.6	44	$62,400
Lautem	7,910	5.8	31	0.7	43	$54,886
Liquiça	4,940	3.6	150	3.5	387	$219,206
Manatuto	4,610	3.4	1,290	30.5	2,714	$3,853,607
Manufahi	8,530	6.3	12	0.3	25	$33,299
Oecussi	8,950	6.6	190	4.5	351	$388,674
Viqueque	16,890	12.4	5	0.1	9	$8,681
TOTAL	**136,400**	**100.0**	**4,232**	**100.0**	**9,134**	**$12,521,657**

Notes: Area in hectares, production in tons. [a] Estimated crop production includes paddy, maize, and root crops (in cereal equivalent according to FAO 2021). [b] Calculations on area, output amount, and output value refer to paddy and maize exclusively.

Source: Own estimates based on data on damaged area estimated by FAO CFSAM (FAO 2021).

39. Current estimates indicate that approximately 112,117 animals died as a result of the disaster, of which 22,278 were large animals (buffalos, cows, horses), 43,353 small animals (pigs, goats, sheep), and 46,485 poultry (chicken, ducks) (Table 4). The total figures represent approximately 5.2 percent of the estimated existing stock before the floods. The small animals were the most affected group in relative terms (8.2 percent of the existing stock), followed by the large animals (4.9 percent) and the poultry (3.9 percent). The lost animals are valued at US$15.67 million, of which large animals account for the largest share (US$8.94 million), followed by small animals (US$5.80 million) and poultry (US$0.93 million).

Table 4: Total Number and Estimated Value of Dead or Lost Livestock

Type of animal	Stock (2019)	Pre-disaster stock (2021)	Dead/lost livestock	Share of pre-disaster stock lost	Estimated value of dead/lost livestock (USD)
Large animals	413,176	450,279	22,278	4.9%	$8,938,902
Small animals	657,473	526,660	43,353	8.2%	$5,805,966
Poultry	1,152,885	1,177,877	46,485	3.9%	$927,482
Other animals	496,344				
TOTAL	**2,719,878**	**2,154,816**	**112,117**	**5.2%**	**$15,672,350**

Source: Based on World Bank staff estimates and 2019 stock estimates from the Timor-Leste Agricultural Census.[57]

40. The most affected municipality was Manatuto, in which over 40 percent of the pre-disaster stock of animals is estimated to have been killed or lost, followed by Baucau (5.3 percent), Bobonaro (2.5 percent), and Oe-cuse (2.2 percent) (Table 5). Of the total estimated value of dead or lost livestock, over three-quarters was in Manatuto (US$12.0 million) and over one-tenth in Baucau (US$1.6 million).

Table 5: Number and Estimated Value of Dead or Lost Livestock by Municipality

Municipality	Pre-disaster stock of livestock			Dead/lost livestock			Share in pre-disaster stock (%)	Estimated value of dead/lost livestock (US$)
	Large	Small	Poultry	Large	Small	Poultry		
Aileu	11,528	7,854	42,615	39	27	145	**0.3**	**19,650**
Ainaro	20,163	5,456	74,120	58	16	212	**0.3**	**26,372**
Baucau	40,321	92,959	180,715	2,120	4,887	9,500	**5.3**	**1,603,448**
Bobonaro	45,356	37,881	99,811	1,136	949	2,500	**2.5**	**582,009**
Covalima	43,591	47,388	90,584	801	871	1,665	**1.8**	**445,708**
Dili	3,384	25,760	38,959	54	415	627	**1.6**	**87,135**
Ermera	24,871	43,986	121,216	17	30	82	**0.1**	**11,780**
Lautem	57,807	41,368	79,947	235	168	326	**0.4**	**119,507**
Liquica	15,023	35,638	84,128	252	599	1,414	**1.7**	**196,459**
Manatuto	41,257	85,142	66,547	16,577	34,210	26,739	**40.2**	**11,992,928**
Manufahi	22,534	5,306	58,401	31	7	81	**0.1**	**13,934**
Oe-cuse	42,643	53,137	144,898	931	1,161	3,165	**2.2**	**560,921**
Viqueque	81,801	44,785	95,935	25	14	30	**0.0**	**12,499**
NATIONAL	**450,279**	**526,660**	**1,177,877**	**22,278**	**43,353**	**46,485**	**5.2**	**15,672,350**

Source: World Bank estimates using data from GDS/FAO/UNFPA 2018[58] *and GDS/MAF 2020*[59]

[57] GDS and MAF, *Timor-Leste Agriculture Census 2019: National Report on Final Census Results* (Dili: GDS, Ministry of Finance, Ministry of Agriculture and Fisheries, 2020).
[58] GDS, FAO, and United Nations Population Fund (UNFPA), *Timor-Leste Population and Housing Census 2015: Thematic Report Volume 12 – Analytical Report on Agriculture and Fisheries* (Dili: GDS, Ministry of Finance, 2018).
[59] GDS and MAF, *Timor-Leste Agriculture Census 2019*.

41. In Timor-Leste, livestock is usually raised for self-consumption, and occasionally as a source of income.[60] Based on estimates of how many animals raised for commercial purposes were killed, approximately 110,000 kilograms of meat were lost (Table 6). This output represents a loss of approximately US$343,000 in one year, or more than US$530,000 over three years. In relative terms, this loss represents around 13.1 percent of the expected meat production this year, and, in value terms, around 22.2 percent of the expected output value.

Table 6: Estimated Output Losses in Meat Production

Type of animal	Number of dead animals (heads)[a]	Estimated output loss (kg)	Estimated 1-year output value loss (USD)[b]	Estimated 3-year output value loss (USD)[c]
Large animals	19,280	46,699	93,398	280,194
Small animals	42,273	59,793	239,172	239,172
Poultry	46,285	3,090	9,940	9,940
TOTAL	**107,838**	**109,582**	**342,510**	**529,306**
Share of baseline (%)		13.1	22.2	

NOTES: Dead animals in heads, output in kilograms, output value in USD. [a] Horses, sheep, broilers, and ducks are excluded from these calculations. This explains the difference in the number of dead animals when compared with the previous table. [b] Based on US$2/kg for beef and buffalo meat, US$4/kg for pig and goat meat, and average of US$3.35/kg for chicken across municipalities (range between US$2.70 and US$6.10). [c] Three years are assumed, though large animals have varying maturation times.

Resilient Recovery

42. Based on these estimates, the total amount of damage and losses to the agriculture sector is estimated at over US$28.72 million (Table 7). Of this amount, US$15.67 million is damage to the livestock subsector and US$13.05 million is losses, broken down into US$12.52 million from the crop subsector and US$530,000 from the livestock subsector.

Table 7: Total Damages and Losses in Agriculture by Subsector

	Total agriculture sector impacts (USD)	Crop subsector (USD)	Livestock subsector (USD)
Damage	$15,672,000	–	$15,672,000
Losses	$13,051,000	$12,522,000	$529,000
TOTAL	**$28,723,000**	**$12,522,000**	**$16,201,000**

[60] Fordyce, Geoffry, *Enhancing Smallholder Cattle Production in East Timor – Final Report*, Project LPS/2009/036 (Canberra: Australian Centre for International Agricultural Research (ACIAR), 2017).

43. In aggregate, the most affected municipalities were Manatuto, with US$16.28 million in sector losses (56.7 percent of total agricultural losses); Baucau, with US$4.57 million (15.9 percent); and Bobonaro, with US$4.37 million (15.2 percent) (Table 8). For the crop subsector, this ranking remains mostly unchanged, with the three municipalities at the top accounting for over 84 percent of the losses. For livestock, the losses in Manatuto alone account for US$290,000 (nearly 85 percent of total losses in the subsector).

Table 8: Estimated Damages and Losses in Agriculture by Subsector and Municipality

	Total agriculture sector impacts		Crop subsector		Livestock subsector	
	Value (USD)	Share (%)	Value (USD)	Share (%)	Value (USD)	Share (%)
Manatuto	$16,280,921.70	56.7	$3,853,606.80	30.8	$12,427,314.90	76.7
Baucau	$4,575,367.30	15.9	$2,927,323.60	23.4	$1,648,043.70	10.2
Bobonaro	$4,371,218.20	15.2	$3,770,260.80	30.1	$600,957.40	3.7
Oecussi	$953,909.60	3.3	$388,674.50	3.1	$565,235.10	3.5
Covalima	$906,299.90	3.2	$449,999.70	3.6	$456,300.20	2.8
Dili	$708,537.10	2.5	$618,944.80	4.9	$89,592.30	0.6
Liquiça	$424,818.80	1.5	$219,206.30	1.8	$205,612.50	1.3
Lautem	$176,990.20	0.6	$54,886.00	0.4	$122,104.30	0.8
Aileu	$99,854.30	0.3	$79,750.30	0.6	$20,103.90	0.1
Ainaro	$81,674.70	0.3	$54,623.70	0.4	$27,051.00	0.2
Ermera	$74,418.80	0.3	$62,400.00	0.5	$12,018.80	0.1
Manufahi	$47,828.20	0.2	$33,299.30	0.3	$14,529.00	0.1
Viqueque	$21,472.30	0.1	$8,680.90	0.1	$12,791.50	0.1
NATIONAL	**$28,723,311.10**	**100.0**	**$12,521,656.70**	**100.0**	**$16,201,654.50**	**100.0**

Source: World Bank estimates.

44. Based on these estimates of damages and losses, reconstruction and recovery needs amount to approximately US$28.4 million (Table 9). This amount includes US$22.5 million for reconstruction needs and US$5.9 million for recovery needs.

Table 9: Estimated Reconstruction and Recovery Needs by Municipality

	Damages (USD)	Losses (USD)	Reconstruction and recovery needs (USD)
Aileu	$19,650.00	$80,204.30	$64,376.40
Ainaro	$26,372.40	$55,302.30	$62,848.60
Baucau	$1,603,447.70	$2,971,919.60	$3,645,576.80
Bobonaro	$582,009.30	$3,789,209.00	$2,543,034.20
Covalima	$445,707.60	$460,592.30	$848,830.90
Dili	$87,135.40	$621,401.70	$405,065.70
Ermera	$11,779.60	$62,639.20	$45,142.50
Lautem	$119,506.60	$57,483.60	$197,882.80
Liquiça	$196,459.40	$228,359.40	$385,664.30
Manatuto	$11,992,927.90	$4,287,993.80	$19,196,337.50
Manufahi	$13,934.60	$33,893.70	$35,316.60
Oecussi	$560,920.80	$392,988.80	$984,022.90
Viqueque	$12,498.60	$8,973.70	$22,028.90
NATIONAL	**$15,672,349.80**	**$13,050,961.40**	**$28,436,128.20**
Reconstruction needs			**$22,549,829.20**
Recovery needs			**$5,886,299.10**

45. The remainder of this section discusses some considerations for a resilient recovery program that should primarily support the government-led response in the aftermath of the disaster. Actions in the short term could include the distribution of seeds, fertilizers, pesticides, and other inputs for replanting during the 2021 off-season,[61] in addition to rehabilitation of land if required. Provision of hand tractors, threshers, and staple food processing could benefit groups of affected farmers to boost restoration of production in affected areas,[62] and the restocking of animal herds and delivery of animal feed and vaccination services could ensure ongoing production of surviving animals. Estimated reconstruction costs are US$22.55 million, primarily driven by the costs of restocking large animals, small animals, and poultry (Table 10). The recovery costs amount to approximately U$5.89 million for replanting activities in affected cropland and US$250,000 to provide feed and vaccines for animals.

Table 10: Summary of Estimated Short-Term Reconstruction and Recovery Needs

ACTIVITY ITEM	Cost estimate (US$)
Reconstruction	
Restocking of animal herd (large animals)	$12,709,450
Restocking of animal herd (small animals)	$8,449,248
Restocking of animal herd (poultry)	$1,391,131
Sub-total	*$22,549,829*
Recovery	
Provide seeds, inputs to replant annual crops	$5,634,746
Provision of feed for animals	$85,537
Provision of vaccines for animals	$166,017
Sub-total	*$5,886,300*
Total Reconstruction and Recovery Needs (short term)	**$28,436,129**

46. In the medium term, activities could target the restoration of seed and planting material stocks, on-farm investments, and the rehabilitation of private infrastructures affected by the disaster; additionally, they could include capacity-building activities and, in the long term, extension services, also related to farm and livestock management (Table 11). In Timor-Leste, the reparation and rehabilitation of irrigation systems and canals could be particularly relevant if cash-for-work programs are used to benefit farming communities in the 70 *sucos* that need external support.[63]

[61] This activity could target approximately the 3,000 most-affected farmers (FAO 2021).
[62] FAO, *2021 CFSAM*.
[63] FAO, *2021 CFSAM*.

Table 11: Potential Reconstruction and Recovery Actions in the Short, Medium, and Long Term

Short-term	Medium-term	Long-term
• Distribution of seeds and inputs for replanting • Restocking of animal herds • Provision of animal feed, vaccinations and veterinary services	• Restoration of seed and planting material stocks • On-farm investments and capacity building • Rehabilitation and rebuilding of private infrastructure (incl. storage facilities and animal shelters) • Rehabilitation of irrigation systems • Restocking animal herds and capacity building	• Increase productivity and diversification • Increase farmers' access to formal markets • Postharvest losses • Extension services and information systems • Pest and disease response management

47. In the longer term, better alignment of actions with policy goals could help ensure that emergency responses are consistent with larger-scale interventions. Maintaining food security, transitioning from subsistence to commercial farming, and ensuring environmental sustainability are defined as key goals for the agriculture sector in Timor-Leste's Strategic Development Plan 2011–2030.[64] The reconstruction and rehabilitation strategy should link interventions to these goals.

48. The most vulnerable populations and poor farmers will need to increase crop productivity and diversification to enhance food security and nutrition. Actions could include enhanced access to inputs, chemicals, mechanization, credit, and extension services, and support for farmers' groups.

49. Strategic commodities can promote agriculture-led growth, catalyzing the shift from subsistence to commercial agriculture. Actions contributing to this goal include improving agricultural productivity and incomes of small-scale food producers; positioning coffee as the main cash crop and Timor-Leste's main non-oil commodity export;[65] enhancing market access, which involves developing infrastructure and platforms to link farmers with transport and traders; agribusiness development; and a "concentrated rice bowl" approach. Government programs, such as *Cesta Básica* or the national school-food program (*merenda escolar*), offer opportunities to connect local farmers to institutional markets through local procurements.[66]

[64] "Our goals for the agriculture sector are to improve national food security, reduce rural poverty, support the transition from subsistence farming to commercial farming of crops, livestock and fisheries, and promote environmental sustainability and the conservation of Timor-Leste's natural resources" (Timor-Leste Strategic Development Plan 2011–2030).

[65] ADB, *Growing the non-oil economy: A private sector assessment for Timor-Leste*, Mandaluyong City, Philippines: ADB, 2015). Among the demanded on-farm investments, coffee plantations feature old and unproductive trees and grow canopies that are too tall to be harvested, with shade trees that block too much sunlight or no longer provide shade. Plantations also lack industrial crop cultivation, including weeding, pruning, planting and managing pests and diseases. Growers are reluctant to introduce these practices in their farm management.

[66] FAO, *2021 CFSAM*.

50. As the demand for meat consumption continues to rise, livestock also offers an opportunity to help alleviate poverty and benefit farmers as they transition away from subsistence into commercial raising of livestock. Investments in feeding, health, and structure management could enhance animal productivity. The impact of the African swine fever (ASF) and fall armyworm (FAW) outbreaks in recent years stress the need to reinforce national bio-security capacity and conduct rapid interventions in the field.[67]

51. To promote environmental sustainability, a climate-smart portfolio of activities for agriculture could include early-warning and surveillance systems, soil erosion mitigation plans and better watershed management strategies, and diversification of farming systems.

52. The public sector is expected to lead and enhance its capacity to facilitate the agriculture sector and trade environment and to deliver public services. Public investments in agriculture need to increase, with special attention to the rehabilitation of irrigation systems. Investments in capacity building should also target the Ministry of Agriculture and Fisheries staff and their stakeholders, including in the areas of training and extension, statistics, and information systems. Given the various pest and disease outbreaks in recent years, sanitary and phytosanitary (SPS) capacity and systems could be included in these capacity-building initiatives.

"Investments in capacity building should also target the Ministry of Agriculture and Fisheries staff and their stakeholders, including in the areas of training and extension, statistics, and information systems."

Photo: Machel Silveira

[67] The FAO (*2021 CFSAM*) recommends establishing a FAW early-warning system to test and disseminate on-farm FAW management practices, to conduct vaccination campaigns of livestock, and to restock bio-secure pens for farmers affected by ASF.

3.3 Housing Sector

Context

53. The population of Timor-Leste is approximately 1.2 million, comprising 205,000 households with an average household size of 5.8 persons. Around 70 percent of the national population is categorized as rural. Timor-Leste is an outlier in the East Asia region: Timorese household sizes are larger than elsewhere in the region, although declining in size nationwide, and the average urban household (6.4 persons) is larger than the average rural household (5.6 persons). Approximately 23 percent of the national population resides in Dili and 88 percent of Dili's population is urban.

54. For houses in both urban and rural areas of Timor-Leste, the most common type of roof is corrugated iron or zinc, followed by thatch or grass in rural areas. There is more variation in wall materials, with most rural houses using vegetative material (bamboo or palm trunk) or, less commonly, concrete or brick. In urban areas, walls are mostly concrete or brick. No data was found on the impact of natural hazards on housing built with local materials. However, the nationwide trend in housing construction away from the use of natural materials and toward concrete and brick, especially in urban areas, is considered an improvement in housing quality.[68] Whether this is an improvement in safety depends on the designs and construction practices employed, given the risk of earthquakes in the country and the damage that earthquakes can cause to poor-quality masonry. For this analysis, housing types were grouped into two categories: permanent (concrete or brick walls) and semi-permanent (other materials).

55. Drinking water is supplied to households from a variety of sources, most commonly a public tap in both rural and urban areas (31 percent for urban, 45 percent for rural), followed by water piped or pumped outdoors in urban areas (20 percent) and a river, lake, stream, or irrigation channel in rural areas (19 percent).

56. Housing and land-use policy and planning is the responsibility of the Ministry of Planning and Territory. The development of public utilities, urban planning, and housing-related projects falls within the mandate of the Ministry of Public Works, Transport and Communication (MPWTC).[69] The principal policy instrument for housing is the National Housing Policy (NHP), which was approved in 2007 (Government Resolution 10/2007[70]) and prepared with support from UN-Habitat.[71] The NHP envisions improved housing conditions, with particular emphasis on urban communities and poorer rural areas. It provides direction on institutional roles, regulations, housing and land rights, community participation, access to services, attention to vulnerable groups, and private-sector involvement.

57. Timor-Leste's high population growth has produced ongoing demand for housing that is largely being satisfied through informal housing production. Although the fertility rate is projected to slow considerably in the coming years, even the government's medium-fertility scenario shows

[68] GDS and UNFPA, *Timor-Leste Population and Housing Census 2015: Thematic Report Volume 8 – Analytical Report on Housing Characteristics and Amenities* (Dili: GDS, Ministry of Finance, 2018), https://timor-leste.unfpa.org/en/publications/2015-census-housing-characteristics-and-amenities-analytical-report.

[69] "Composition of the VIII Constitutional Government," Government, Government of the Republic of Timor-Leste, accessed 2021, http://timor-leste.gov.tl/?p=13.

[70] Government Resolution No. 10/2007, "Approving the National Housing Policy." Available at the Jornal da República de Timor Leste Online: http://www.mj.gov.tl/jornal/?q=node/1854.

[71] "Preparation of National Housing Policy," Timor-Leste, Projects, UN-Habitat Regional Office for Asia and the Pacific – Fukuoka, accessed 2021, https://www.fukuoka.unhabitat.org/projects/timor_leste/detail01_en.html.

the population increasing from 1.2 million to 1.8 million by 2050 because of the young average age. As such, the country will need an estimated 3,200 new housing units per year over the next 20 years, not including replacements for housing lost to or damaged by natural hazards.

58. The government's largest social housing intervention, the MDG Suco Program, ran between 2011 and 2015, with the goal of building more than 55,000 houses with solar energy and water and sanitation by 2015. In the first phase, 5,000 prefabricated houses out of a planned 9,000 were imported by a single foreign company. The program was discontinued when challenges related to design and occupancy were identified.[72] No new Government-sponsored housing development at scale appears to have been launched subsequently.

59. The legal framework for land rights in Timor-Leste has been a factor driving the development of informal settlements. The framework is complex and lacks clarity as the result of successive property regimes, customary land tenure systems, and the displacement, occupation, and destruction of land records in 1999.[73] Significant efforts have been made since then to establish a clear legal framework (including introduction of the Land Law in 2017), and a property land administration system, with limited success to date.

Impacts of TC Seroja

60. According to the GoTL, more than 30,000 households were affected by TC Seroja and the floods, fires, and landslides including nearly 25,000 in Dili (more than 50 percent of all Dili households).[74] The homes of over 4,000 of these households, including 3,300 in Dili, were seriously damaged or destroyed, displacing around 8 percent of all households (Table 12).[75]

61. Based on these figures, the cost to simply repair and replace housing assets affected by TC Seroja is calculated at **US$46.0 million, using the assumptions shown in** Table 13. These estimates do not include any costs for site improvements or rehabilitation of basic infrastructure.

62. Household goods were also lost and damaged due to wind and flooding from the cyclone. The replacement of items such as bedding, cooking utensils, tools, lighting, and electronics can constitute a significant financial burden for disaster-affected households. The total cost for replacement of household goods is estimated at **US$13.4 million** (Table 14). This assumes a replacement cost per household of US$350 when houses were lightly damaged and US$1,000 for more seriously damaged and destroyed houses.

63. Economic losses are the result of revenues lost and/or uninsured expenses caused by the disaster event. The need to absorb losses diverts resources from new economic activity. For the housing sector, losses are associated with lost rental revenue from displacement of tenants, and with out-of-pocket expenses such as the cost of temporary or transitional shelter.

[72] Pyone Myat Thu, "Revisiting the MDG Housing Program in Timor-Leste," DevPolicyBlog, Australian National University College of Asia and the Pacific, October 11, 2018, https://devpolicy.org/revisiting-mdg-housing-program-timor-leste-20181011.

[73] Shivakumar Srinivas and Keith Clifford Bell, "Timor-Leste: Securing Communal Land Rights and Enabling Development Investment—Challenges and Opportunities" (paper presented at the 2015 Annual World Bank Conference on Land and Poverty, March 23–27, 2015, Washington, DC), https://www.researchgate.net/publication/327111632_Timor-Leste_Securing_Communal_Land_Rights_and_Enabling_Development_Investment-Challenges_and_Opportunities.

[74] Government of Timor Leste, *Ciclone Seroja*.

[75] Another data source for Dili from April 2021 provided to the World Bank showed 24,820 homes with light damage, 553 with average damage, and 554 with total loss.

Table 12: Estimated Housing Damages by Municipality

Municipality	Houses with light damage	Houses seriously damaged or destroyed	Total households affected
Aileu	237	45	282
Ainaro	351	23	374
Baucau	128	106	234
Bobonaro	6	23	29
Covalima	240	59	299
Ermera	16	13	29
Lautem	25	3	28
Liquiçá	420	8	428
Manatuto	1,253	411	1,664
Manufahi	57	36	93
Oe-cusse	1,485	97	1,582
Viqueque	405	59	464
Total excluding Dili	**4,623**	**883**	**5,506**
Dili	21,444	3,348	24,792
Total	**26,067**	**4,231**	**30,298**

Notes: Data is as of April 2021.

Source: Columns 2 and 3 are based on Government of Timor-Leste, Ciclone Seroja *(2021). Numbers of houses to be reconstructed in alternative locations are estimates, except for Dili where the information on high-risk zones was provided.*

Table 13: Replacement Costs for TC Seroja-Affected Housing, by Category

	Houses with light damage	Houses seriously damaged or destroyed	Total units and replacement cost
Affected housing unit count	**26,067**	**4,231**	**30,298**
Permanent houses	10,505	1,087	11,592
Semi-permanent house	15,562	3,144	18,706
Repair/replacement cost			
Permanent houses	US$1,500	US$7,000	
Semi-permanent houses	US$750	US$3,500	
Estimated cost to replace/ repair housing	**US$27,429,000**	**US$18,613,000**	**US$46,042,000**

Source: World Bank calculations.

Table 14: Costs to Replace Household Goods, by Damage Category

	Houses with light damage	Houses seriously damaged or destroyed	Total household goods replacement cost
Affected households	26,067	4,231	
Cost to replace household goods per unit	US$350	US$1,000	
Total replacement cost	**US$9,123,450**	**US$4,231,000**	**US$13,354,450**

Source: World Bank calculations.

64. **Total damages are therefore estimated at US$59.4 million**, taking into account damage to both housing and household goods. Considering only the **displacement of tenants from rental housing, losses are estimated at US$2.47 million** over the year following the cyclone (Table 15).[76] For the average household size in Dili (6.5 persons), the average annual rental cost was calculated to be US$990.[77] The number of lightly damaged rental houses is estimated at 102 outside of Dili and 2,972 in Dili. They are assumed to require six months of repairs before they can be occupied by a new renter. Seriously damaged or destroyed rental houses are estimated to number 19 outside of Dili and 464 in Dili. It is assumed that they will take 24 months to repair or replace before they can be occupied by a new renter. **The total damages and losses are therefore estimated to be US$61.9 million**.

Table 15: Calculation of Rental Income Losses by Damage Category and Location

	Assumptions	Houses with light damage	Houses seriously damaged or destroyed	Total rental income loss
Excluding Dili:	2.2% of all affected			
Housing units affected		4,623	883	
Rental units		102	19	
Months vacant		6	24	
Rental income loss, excluding Dili	**@ US$800/yr**	**US$40,800**	**US$30,400**	**US$71,200**
Dili	13.9% of all affected			
Housing units affected		21,444	3,348	
Rental units		2,980	465	
Months vacant		6	24	
Rental income loss, Dili	**@ US$990/yr**	**US$1,475,100**	**US$920,700**	**US$2,395,800**
Total rental income losses				**US$2,467,000**

Source: World Bank calculations.

[76] Government of Timor-Leste and the World Bank Group, *Poverty in Timor-Leste 2014* (Washington, DC: World Bank Group, 2016), http://documents.worldbank.org/curated/en/577521475573958572/Poverty-in-Timor-Leste-2014. This is based on the following assumptions: (i) All those living in non-individual– or family-owned housing are assumed to be renters, paying in cash or in kind for their occupancy; based on this assumption, 4.6 percent of households nationwide are renters, including 13.9 percent of households in Dili; (ii) the rental value of the average house is the average estimated rental cost of the reference dwelling used in the Timor-Leste Surveys of Living Standards (TLSLS) (this dwelling has two rooms, good external walls, proper sanitation, and access to electricity; dwellings below this standard are considered poverty housing); (iii) for the average household size nationwide (5.8 persons), the average annual rental cost was calculated as US$800.

[77] This is likely understated, given the housing demand in Dili due to population migration and higher household income.

> A housing recovery strategy should consider the potential impact of future hazard events as well as the risk that has accumulated in the housing sector as the result of past events.

65. According to Government estimates (Table 12), as many as 2,558 affected households in Dili and 675 in other areas may need to relocate to alternative sites. These households are assumed to be a subset of those with seriously damaged or destroyed houses; therefore, the cost of reconstruction, "build back better" (BBB), site improvements, and overhead costs are included in the recovery cost calculations for these households. However, land acquisition and other relocation-related costs could increase the figures provided. Costs for temporary or transitional shelters and debris removal are not estimated, and those costs would need to be considered in developing a housing recovery strategy. Indirect costs from the loss of housing are not shown here, but these can be extensive, and increase in proportion to the length of time that people are displaced or living in substandard conditions. Indirect costs can result from: (i) loss of income from businesses run from the home and from lower workforce participation; (ii) additional health care costs due to substandard living conditions in shelters and damaged housing (a particular concern with COVID-19); (iii) reduction in school attendance leading to long-term human capital losses; and (iv) losses related to psychological impacts of displacement and gender-based violence.

Resilient Recovery

66. The GoTL could develop a post-TC Seroja housing recovery strategy that promotes a BBB approach.[78] This approach helps increase the effectiveness of the recovery process and ensure that people are more safely housed once it is complete. The strategy could also form the basis for longer-term resilience-building activities in the housing sector. Such a strategy should be aligned with national policies for housing, basic service provision, and urban development, and include both structural and non-structural interventions.

67. A housing recovery strategy would consider the potential impact of future hazard events as well as the risk that has accumulated in the housing sector as the result of past events. This means not only addressing structural vulnerabilities but also reducing community vulnerability by increasing disaster risk awareness and preparedness for future events. Respondents to a UNDP survey (conducted in late June 2021 on 1,037 affected households, with 860 respondents) identified the risks to which their housing was exposed as follows: floods (72 percent of households), cyclones (31 percent), landslides (28 percent), tsunami (23 percent), and earthquakes (17 percent). Table 16 summarizes the impact on the housing sector of winds, storms, floods, and landslides between 1992 and 2013: in total, nearly 16,000 housing units were affected during this time.[79]

[78] Building back better is defined in various ways. The World Bank identifies three aspects as the most critical: risk reduction, preparation to increase efficiency (to reduce the impacts of displacement), and inclusion. See Stéphane Hallegatte, Jun Rentschler, and Brian Walsh, *Building Back Better: Achieving Resilience through Stronger, Faster, and More Inclusive Post-Disaster Reconstruction* (Washington, DC: World Bank, 2018), https://openknowledge.worldbank.org/handle/10986/29867.

[79] Because formal counts are not always conducted, this is likely an undercount of housing units affected by hazard events.

Table 16: Natural Disaster Damage by Type of Event and Municipality (1992–2013)

	Winds		Floods		Landslides	
	Houses Destroyed	Houses Damaged	Houses Destroyed	Houses Damaged	Houses Destroyed	Houses Damaged
Aileu	3	7	2	8		15
Ainaro	38	1,415	5	310		95
Baucau	1	65		10	25	19
Bobonaro	61	30		15		10
Covalima		110	650	5,312		54
Díli	3	86	6	3,478	8	41
Ermera	3	306		168		1
Lautem		57		275		2
Liquiçá		30	1	56		
Manatuto	1	17		386	4	18
Manufahi	2	436	21	1,540		
RAEOA		43		73		2
Viqueque	17	210	1	23		
Total	**129**	**2,812**	**686**	**11,654**	**37**	**257**

Source: "Tabela 2 - Danos de desastres naturais por tipo de evento e município (1992-2013)" from Government of Timor-Leste, Ciclone Seroja (2021).

68. Economic constraints contribute to vulnerability and should also be addressed in the recovery strategy. The UNDP survey recorded that 85 percent of respondents needed to make repairs following TC Seroja but almost 60 percent of these repairs had not started as of late June 2021, because of a lack of funds for materials (64 percent), lack of funds for labor (39 percent), lack of available labor (21 percent), inability to reach the market (12 percent), and land-related issues (7 percent). In addition, the houses of 29 percent of respondents had damage from previous disasters that had not been repaired before TC Seroja struck, highlighting the cumulative impact of disasters, especially on poor and lower-income households.

69. In the absence of any external support, households will likely use their own resources for housing recovery, which could take several years (a four-to-seven-year timeframe is not unlikely) and use low-cost methods. This would result in housing built to lower safety standards that will make households vulnerable to future hazard events.

70. **The total cost of recovery and reconstruction using a BBB approach is estimated to be approximately US$147.8 million**. This includes: (i) housing repair, reconstruction, and risk reduction; reconstruction outside of high-risk zones; and site improvements, including rehabilitation of basic infrastructure services and site-related risk reduction; and (ii) overhead costs, including planning, community consultation and mobilization, communications, technical assistance, training of contractors and homeowners, and construction supervision (Table 20). Adequate overhead ensures quality outcomes and community participation (see box 2), and supports GoTL coordination with NGOs and other organizations involved in housing reconstruction, enhancing the quality and equity of interventions.[80]

[80] To date, several organizations, including local churches, have offered support for housing reconstruction. For instance, see Robin Gomes, "Timor-Leste Church helps rebuild homes after floods," Vatican News, May 5, 2021, https://www.vaticannews.va/en/church/news/2021-05/timor-leste-catholic-church-caritas-rebuild-homes.html.

Box 2:

The Power of Community Participation

The community should be engaged early in the recovery process, in accordance with clear and transparent procedures for their participation established in the housing recovery strategy. This is especially important for households whose houses were identified as candidates for potential reconstruction in safer areas from disaster risk perspective. Community facilitators can be mobilized and trained to engage and assist the disaster-affected population. This helps ensure that the reconstruction process is voluntary and ends in safe sites agreeable to those affected, which may include both larger greenfield sites, smaller infill sites, or both. Open, two-way communication with affected households is key to the success of the reconstruction efforts. For example, processes for identifying disaster-affected people and selecting beneficiaries should be supported by community facilitators and developed in consultation with potential beneficiaries to minimize exclusion and inclusion errors. Good data management is also important, as is dissemination of information through media that is accessible to target groups. Effective communications build goodwill and provide feedback to government, leading to more satisfactory outcomes.

Photo: Machel Silveira

Table 17: Build Back Better Housing Recovery Cost Estimates

	Houses with light damage	Houses seriously damaged or destroyed	Total
Housing repair/reconstruction cost	US$39,100,500	US$31,732,500	US$70,833,000
BBB incentives	US$19,550,250	US$3,173,250	US$22,723,500
Basic services restoration	US$8,341,440	US$2,200,120	US$10,541,560
BBB settlement improvements for risk reduction	US$7,559,430	US$2,030,880	US$9,590,310
Construction cost	**US$74,551,620**	**US$39,136,750**	**US$113,688,370**
Overhead (at 30%)	US$22,365,486	US$11,741,025	US$34,106,511
Total housing needs	**US$96,917,106**	**US$50,877,775**	**US$147,794,881**
Share of total needs	66%	34%	

Source: World Bank calculations

71. The figures in Table 17 are based on the following assumptions (including those below in Table 18):

(i) The number of housing units by category is consistent with Table 12 and Table 13.

(ii) For all houses with light damage, repair costs of US$1,500 per unit are assumed, for both permanent and semi-permanent houses.

(iii) For all seriously damaged or destroyed houses (whether they were semi-permanent or permanent), reconstruction costs of $7,500 per unit are assumed.

(iv) For all affected houses, a “BBB incentive” of 50 percent for houses undergoing repairs and 10 percent for houses being rebuilt is added to account for safer building practices.

(v) An allowance of US$320 or US$520 per unit (depending on the level of damage) is included for basic services restoration (water, sanitation, public lighting), and an allowance of US$290 and US$480 per unit is added for settlement improvements and site-related disaster risk reduction.

(vi) For those seriously damaged or destroyed houses that may need to be reconstructed in an alternative location, house reconstruction costs, BBB incentives, and basic services and site improvements costs are included. However, no land acquisition costs are included.

(vii) For all categories, a 30 percent factor is added for overhead costs, as described in paragraph 71.

Table 18: Assumptions Used to Develop BBB Housing Cost Estimates

	Houses with light damage	Houses seriously damaged or destroyed
Housing units per category	**26,067**	**4,231**
Housing repair/reconstruction cost per unit	US$1,500 (semi-permanent and permanent)	US$7,500 (semi-permanent and permanent)
BBB incentive per unit	50%	10%
Basic services restoration per unit	US$320	US$520
BBB settlement improvements-risk reduction per unit	US$280	US$480
Overhead (%)	30%	30%

72. The implementation of a housing recovery program is expected to take up to four years. At a minimum, such a program would include the development and dissemination of repair and reconstruction guidelines for households and affordable housing designs, provision of subsidies or in-kind support for the most vulnerable households, and quality control (supervision and inspections) for repairs and reconstruction activities being carried out by all households. Other activities during this period would include designing the financial strategy and identifying beneficiaries; mobilizing or training skilled labor; engaging and training households; finding land for, planning, and preparing alternative sites, where applicable; implementing site improvements; and ensuring the availability of quality materials. In the medium term, targeted risk mapping to confirm high-risk zones especially to potentially re-consider residential land uses would be useful, especially to inform the Government's social housing programs in safer areas that are less exposed to disaster risk.

> "The total cost of recovery and reconstruction using a BBB approach is estimated to be approximately US$150 million"

3.4 Infrastructure – Transport (roads and bridges)

Context

73. Roads are the primary mode of transport in Timor-Leste. The country has an extensive road network with a length of 6,941 kilometers, consisting of 1,427 kilometers of national roads, 812 kilometers of district roads, 1,975 kilometers of core rural roads. and 3,567 kilometers of non-core rural roads.[81] The main network corridor runs along the northern fringe of the country, from the border with Indonesia in the west, through the capital Dili, and then eastward to the second largest city, Baucau, and beyond (Figure 8).

74. The road network in the west, which serves a strong agricultural region, is reasonably dense. In the rest of the country, the road network consists of five north–south connectors linking the northern corridor across the mountainous spine to the east–west road along the southern coastal plain. These main road corridors are important, as they connect potentially promising agricultural areas and new oil industry–related developments along the southern coast to the main population and more developed areas along the northern coast. Much of this network is in poor condition, mainly due to unsuitable design, low quality construction materials, and underinvestment in maintenance. As a result, these roads have become even more vulnerable and are easily and heavily damaged by natural hazards – including those that result from extreme climatic events exacerbated by climate change, such as the TC Seroja–induced April 2021 floods. A 2015 survey[82] indicated that the condition of 13 percent of rural roads was good, 30 percent fair, 44 percent poor, and 13 percent very poor. A deteriorated road network lengthens travel times, raises vehicle operating costs, and further isolates rural communities. It also has a negative impact on livelihoods and key basic services, including employment, health, and education.

75. Timor-Leste's slope instability and frequent landslides also pose a challenge for the provision of road transport, especially in combination with poor road design. Steep terrain, ground conditions, and the local climate make slope instability a major problem. Additionally, the roads in Timor-Leste were not properly designed and lack sufficient drainage capacity. Combined with the shortage of maintenance funds, these factors have necessitated a focus on emergency repairs and not systematic maintenance.

76. The poor conditions of Timor-Leste's road infrastructure and the country's susceptibility to climate change and natural disasters make road safety measures of utmost importance for the wellbeing of road users. Improving the safety of road infrastructure is the responsibility of the Directorate of Roads, Bridges and Flood Control (DRBFC). Effective road maintenance is essential for reducing high exposure to climate change and natural disasters, as well as preventing high costs for rehabilitation and reconstruction. Although the road maintenance department has increased its capacity in past years and has managed a number of maintenance contracts, it still lacks the necessary capacity and resources to keep up even with the national roads alone, which have recently been upgraded. Periodic maintenance on national roads is rarely carried out and routine maintenance is done using one-year output-based contracts. Most of the maintenance budget is spent on emergency work.

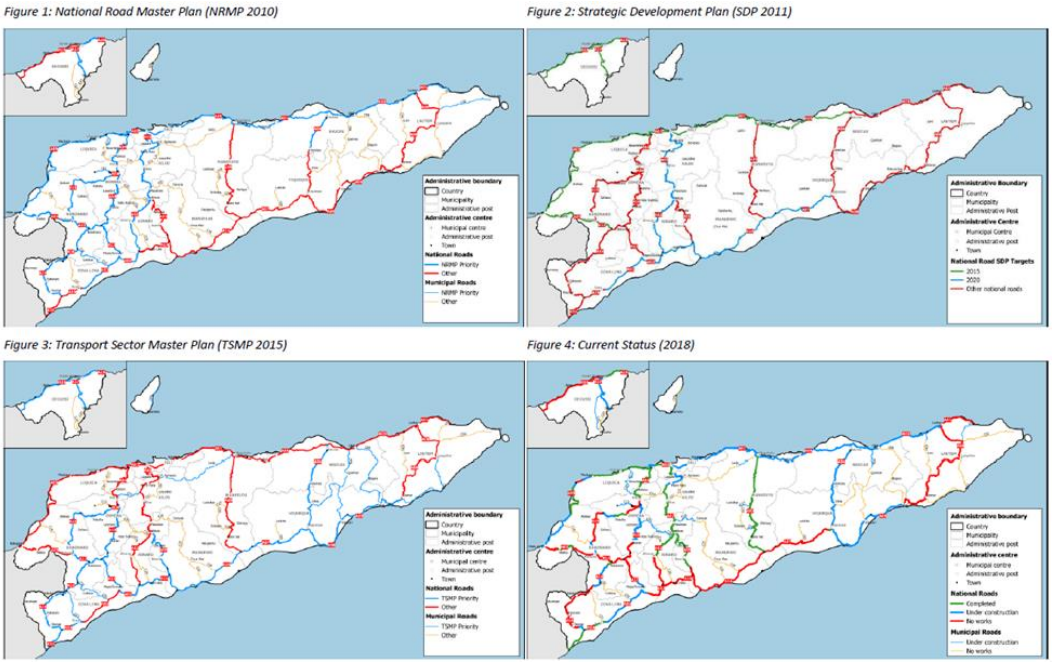
[81] Ministry of Public Works, Transport and Communication (MPWTC), *Rural Roads Master Plan, Investment Strategy 2016–2020* (Dili: MPWTC, 2015).

[82] MPWTC, *Rural Roads Master Plan*.

Impacts of TC Seroja

77. Heavy rains across the country from March 29 to April 4, 2021, resulted in flash floods, debris flows, and landslides, which heavily damaged the road infrastructure along five main corridors of loan-financed roads. Across the country, 420 kilometers of roads were affected. Large volumes of surface water and debris flows running down the slopes eroded road foundations, causing pavements, bridges, embankments, and retaining walls to fail (Figure 9).

Figure 8: Timor-Leste Road Network



Source: ADB Road Maintenance and Investment Strategy[83]

Figure 9: Sections of the Dili-Ainaro Road Eroded by Excessive Water and Debris Flow

Source: Ministry of Public Works, Transport and Communication Project Management Unit (April 2021)

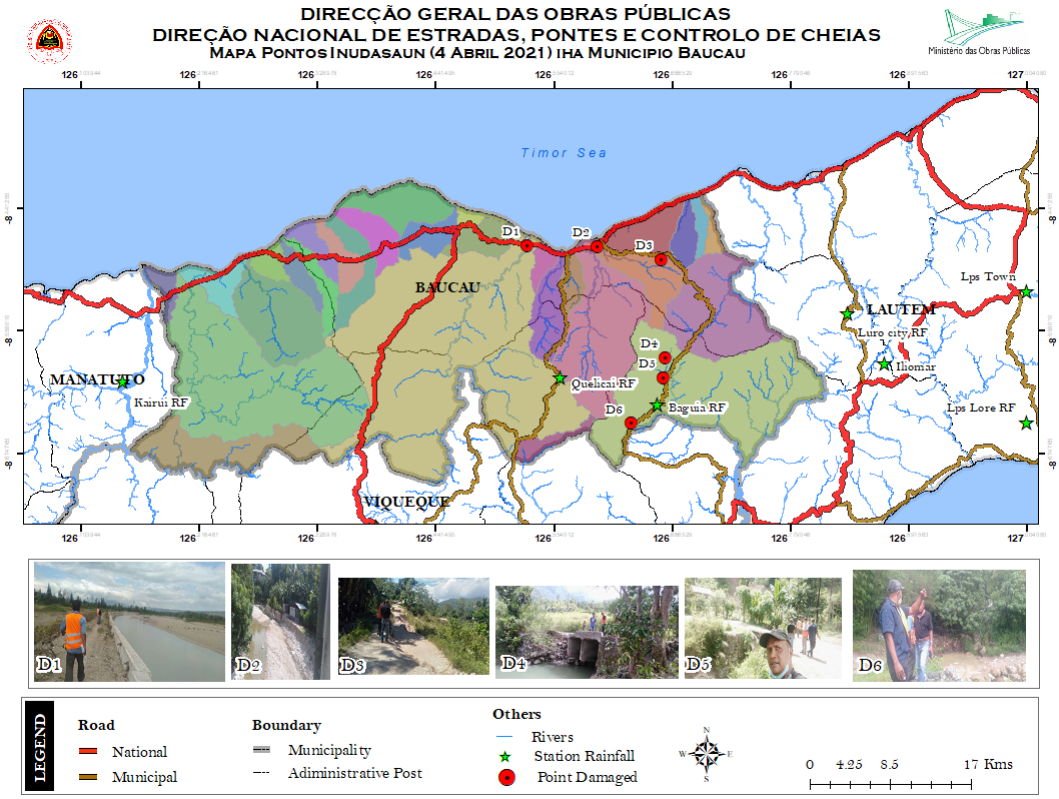
78. In hilly areas, the heavy rainfalls caused ground saturation and increased pore water pressures, which resulted in landslides and cut slope failures that damaged, blocked, and cut off roads (Figure 10). Considerable damage was reported in 12 municipalities across the country. A map of recorded road network damages in the Bacau municipality is shown in Figure 11. With respect to the municipal road network, 42 roads were heavily destroyed, including 23 bridges and many other structures such as retaining walls, culverts, and sidewalks (Figure 12).

[83] ADB, "Road Investment and Maintenance Strategy Workshop" – Summary of Findings (March 2019).

Figure 10: Sections of the Dili-Ainaro Road Severed (left) and Damaged (right) by Landslides

Source: Ministry of Public Works, Transport and Communication Project Management Unit (April 2021)

Figure 11: Road Network Damages in the Bacau Municipality



Source: Ministry of Public Works, Transport and Communication – Directorate of Roads, Bridges and Flood Control (April 2021)

Figure 12: Locations along Comoro Road (left) and Portugal Avenue in Dili (right) Damaged by Floods

Source: Ministry of State Administration[84]

[84] Government of Timor-Leste, *Ciclone Seroja: Levantamento de estragos e necessidades (31 May 2021)*, (Dili: Unidade de Missão de Proteção Civil e Gestão de Desastres Naturais, 2021).

79. **The estimated damage to the transportation sector is estimated to be at least US$170 million**. Costs were estimated by separately analyzing each instance of physical damage and then assessing the respective costs of replacement to the pre-disaster level of quality and efficiency. Table 19 shows the estimated damage to the transportation infrastructure caused by the heavy rains and floods, for the five loan-financed roads and for the road network of the 12 municipalities under review.[85]

Table 19: Transport Sector Damages: Roads

No.	Name of Road	Location	Road length (km)	Estimate value of damage (USD)
1	Maubara–Karimbala; Atabae–Mota Ain	North coast road from Indonesian border to Karimbala	53	$60,000
2	Dili–Ainaro	North–south road from Dili to Ainaro	115	$5,100,000
3	Ermera–Fatubesse; Aipelo–Bazartete; Bazartete–Tokoluli	North–south road from Aipelo to central Island (Ermera)	41	$1,900,000
4	Dili–Baucau	North coast road from Dili to Baucau	130	$175,000
5	Manatuto–Natarbora; Laclubar Jct.–Laclubar	North–south road From Manatuto to Natarbora	81	$2,100,000
6	Municipal roads	Aileu, Ainaro, Baucau, Bobonaro, Covalima, Dili, Ermera, Lautem, Liquica, Manatuto, Manufahi, and Viqueque Municipalities	–	$161,072,000
TOTAL				**$170,407,000**

Source: Based on data provided by the Ministry of Transport for loan-financed projects, and by the Ministry of State Administration and Ministry of Public Works, Transport and Communication for the road networks of the 12 municipalities.

80. The figures in Table 19 are preliminary and should not be interpreted as a definite assessment of damage. It may be the case that assets such as, for example, pavement, bridges, culverts, and retaining walls could not be technically evaluated in detail during the evaluation period. As such, these damage figures are likely to be a lower-bound estimate.[86] More accurate estimates will require site-specific investigations, monitoring for large landslides, and detailed engineering designs.

81. The affected road infrastructure should be restored and repaired based on build back better principles. Restoring the damaged roads to higher standards for disaster risk mitigation and climate resilience will enhance the capacity of the road network to withstand future natural hazards.

[85] It is assumed that the figures in Table 19 include emergency expenditures that the government may have already incurred for temporary road rehabilitation, as these cannot be separated from replacement costs.

[86] The remote nature of this assessment has presented considerable difficulties in data collection and communication with the local authorities, and COVID-19 restrictions prevented the physical inspection and assessment of the damaged portions of the transport network. The data sources available for this assessment were limited to those reports and relevant cost estimates provided by the MPWTC and its PMU for the loan-financed projects and those provided by the Ministry of State Administration in collaboration with the MPWTC for the road network of the municipalities.

Resilient Recovery

82. Transport infrastructure that requires reconstruction includes road pavements, embankments, cut slopes, and structures such as culverts, retaining walls, and bridges. Construction of additional and larger cross-drainage structures, including bridges on piled foundations to replace causeways and road embankments, will also be necessary where high water flows have been observed.

83. Other required recovery actions include slope protection and reinforcement work, the stabilization of landslide areas and improved drainage of hill slopes, and other work to strengthen roads and increase their drainage capacity to better protect them from flood and debris flows.

84. Table 20 shows the breakdown of the needs estimated for the transportation sector. Based on this breakdown, **a sum of at least US$75 million for building back better is recommended** (see Box 3), on top of the estimated US$170.4 million needed to return damaged assets to their original condition, **for total recovery costs of approximately US$245 million**. The cost estimate for building back better, which is approximately 44 percent of the estimated cost for the damages, takes into consideration the very high cost of construction materials in Timor-Leste and the observed relatively poor construction quality of most of the existing road network.

Table 20: Transport Sector Needs and Reconstruction Costs

No.	Name of Road	Damages (USD)	BBB needs (USD)	Reconstruction costs (USD)
1	Maubara to Karimbala and Atabae to Mota Ain	$60,000	$50,000	$110,000
2	Dili–Ainaro	$5,100,000	$2,400,000	$7,500,000
3	Ermera–Fatubesse; Aipelo–Bazartete; Bazartete–Tokoluli	$1,900,000	$1,200,000	$3,100,000
4	Dili–Baucau	$175,000	$35,000	$210,000
5	Manatuto–Natarbora; Laclubar Jct.–Laclubar	$2,100,000	$2,600,000	$4,700,000
6	Municipal Roads	$161,072,000	$69,030,000	$230,102,000
	TOTAL	**$170,407,000**	**$75,315,000**	**$245,722,000**

85. To restore connectivity and recover losses, and in the context of Build Back Better and Climate Resilience principles for road corridors, the following are recommended:

- Restore rural accessibility by repairing impassable roads, culverts, and bridges.
- Construct additional cross-drainage structures, such as well-designed culverts, including bridges to replace causeways and embankments where necessary.

- Build new bridge foundations on reinforced concrete piles by preference.
- Upgrade key routes with climate-resilient interventions based on hydraulic and geotechnical designs so they may better withstand potential future hazards, taking into account climate change considerations and data.
- For the construction of road embankments, use higher-strength material in combination with geogrid reinforcement and gabions for the side-slopes, together with slope protection and vegetation as required.
- Stabilize natural and excavated cut slopes. Include improved drainage and protective and reinforcement works, such as anchors and netting, as required in combination with nature-based solutions, such as planting and greening with native plants.
- Investigate, instrument, and monitor large and complex landslides affecting the road network and prepare detailed designs for their stabilization based on reliable geotechnical data.
- Improve and strengthen surface drainage arrangements alongside the roads.
- Where possible, engage local communities in the reconstruction of transportation infrastructure (e.g., filling of gabion boxes), particularly encouraging female workers to participate, and use locally available materials.
- Develop and implement resilient design and construction standards, maintenance routines, and budgets.

86. Based on international experience in recovery, several recovery principles can guide and form the basis for recovery planning:

Immediate-term recovery and reconstruction:

- Rehabilitate key roads with temporary measures (e.g., culverts, embankments, bridges) as soon as possible to reinstate better traffic flow and minimize high economic losses and discomfort of road users. It is important to restore access to services and infrastructure as quickly as possible, while incorporating “build back better” components into the temporary reconstruction efforts.
- Identify, improve, strengthen, and maintain other bypass roads to receive a portion of the traffic from the damaged roads until they can be fully rehabilitated.

Medium to long-term recovery and reconstruction:

- Improve data collection, sharing, and damage estimates by constructing a database that links information on damaged infrastructure to relevant cost data. This will enable the estimation of damage and reconstruction needs to be carried out more quickly, with less effort, and more consistently across the country.
- Incorporate enhanced components into the design of reconstructed road infrastructure to ensure future resilience, especially in the face of the projected increase in frequency and intensity of hydrometeorological hazards under climate change scenarios.
- The design of the new road infrastructure, including bridges, culverts, embankments, and cut slopes, should be based on a comprehensive hydrological analysis and hydraulic calculations, as well as geotechnical calculations, to ensure the structures and earthworks have adequate capacity to withstand future extreme climatic events.

- Conduct surveys, engineering geological mapping, ground investigations, and instrumentation and monitoring of large-scale landslides affecting the road transport network to obtain sufficient reliable data for detailed design preparation.
- Identify unstable and flood-prone areas in the vicinity of road corridors, restrict development and housing in these areas, and plan the relocation of residents from vulnerable land.
- Prepare a multi-hazard risk assessment of the road network, focusing on hydrological and geotechnical risks.
- Allocate adequate budget for the monitoring and maintenance of key transport infrastructure that will be reconstructed following the 2021 floods, as well as for existing infrastructure.
- Establish an early-warning system based on rainfall thresholds using data from rainfall stations to be installed at key locations along the road network.
- Raise communities' awareness of disaster risk along road corridors to increase their resilience and preparedness for future natural hazards.
- Plan and execute reforestation and planting of natural and artificial cut slopes along the road network.

Box 3:

"Build Back Better" and More Inclusive: Principles of resilient recovery and reconstruction

Post-disaster recovery and reconstruction presents an opportunity to "build back better," strengthening resilience to future natural disasters. As highlighted above, the rehabilitation and reconstruction of housing, agriculture, and transport infrastructure should meet updated structural design standards for resilience.

Integrate inclusive design standards into resilient construction and reconstruction of infrastructure. The exclusion of vulnerable groups in post-disaster recovery projects will create future barriers and social exclusion. Diverse groups should be involved in the entire life cycle of infrastructure development, from planning through monitoring. Post-disaster rehabilitation and reconstruction efforts may also include major civil works, which could increase the risks of gender-based violence (GBV) among the labor force; mitigation measures should be included in the procurement and management of civil works contractors.

Support community engagement in the recovery process. Communities should be engaged early in the recovery process, with clear procedures for participation outlined from the beginning. These efforts could include encouraging a participatory and voluntary process of relocation. Entrusting the community to make decisions is critical to building collective accountability.

4. Strengthening Disaster Risk Management

Photo: Machel Silveira

87. The remote impact assessment identified recommendations for recovery in the key sectors of agriculture, housing, and infrastructure (transport) as summarized below. Recovery offers an opportunity to build back better and strengthen resilience against similar events in the future. Yet resilient recovery is just one pillar of disaster risk management (DRM). The impact assessment process also provided a chance to examine opportunities to strengthen DRM capacities, risk knowledge and awareness, preparedness, stakeholder coordination, and other underlying factors that contribute to disaster vulnerability. The process can help identify recommendations to strengthen the institutional and policy framework, early-warning systems, longer-term risk reduction, and emergency preparedness and response.

4.1 Summary of Sector-Specific Resilient Recovery Needs

88. Recommendations for resilient recovery are detailed in section 3; a precis is presented here for ease of reference. The estimated damages to the three selected sectors could reach approximately US$245 million and the resilient recovery, incorporating building-back-better principle, could cost US$422 million, which represents approximately 32 percent of projected Government expenditure for 2021. The post-disaster recovery program will need to prioritize key areas of support to ensure a targeted program aligned with the available funding envelope. For example, a prioritization of critical buildings and infrastructure most vulnerable to future hazards could be prioritized for rehabilitation, reconstruction, and structural improvements. Recommendations for institutional arrangements for recovery are also highlighted in Box 4.

89. In the Agriculture sector, short-term needs include the distribution of seeds and inputs for replanting, the restocking of animal herds and the provision of animal feed, and the provision of vaccinations and veterinary services. In the medium to long term, reconstruction efforts should focus on reducing the vulnerability of the agricultural sector by improving farmers' access to formal markets, reducing the risk of post-harvest losses, strengthening extension services and information systems, and addressing the issue of land tenure.

90. Recommendations in the Housing sector include both structural and non-structural measures. Structural recommendations include the following: repairing and reconstructing home, and potentially reconstructing houses in safer locations, outside the identified high-risk zones[87]; ensuring quality control of repairs and reconstruction; and placing a special focus on risk reduction at housing sites and in settlements. Non-structural recommendations include: training to conduct building and site assessments; training of builders and homeowners; establishing guidelines for households doing their own repairs and rebuilding; and encouraging community engagement in project planning and monitoring.

91. In the Infrastructure (Transport) sector, long-term recovery measures include the need to improve data collection, sharing, and damage estimates, including by developing a database that links information on damaged infrastructure to relevant cost data, which will enable the estimation of damage and reconstruction needs to be carried out more quickly, with less effort, and more consistently across the country. There is also a need to incorporate enhanced components into the design of reconstructed road infrastructure to ensure resilience in the future, especially in the face of a projected increase in frequency and intensity of hydrometeorological hazards under climate change scenarios. The design of the new road infrastructure – including bridges, culverts, embankments, and cut slopes – should also be based on a comprehensive hydrological analysis and hydraulic calculations, as well as geotechnical calculations, to ensure the structures and earthworks have adequate capacity to withstand future extreme climatic events.

[87] This structural recommendation could include an updated risk mapping framework to assess the high-risk zones that provide guidance on permissible land uses in safer areas, including for residential uses.

Box 4:

Institutional Arrangements for Recovery

Institutional arrangements for a post-disaster recovery program need to be established early in the recovery process. It is recommended that a single responsible agency coordinates partners. The Government's recovery program following TC Seroja will likely involve various government line agencies, multilateral and bilateral development partners, NGOs, community organizations, and private-sector actors. In the immediate aftermath of the disaster, the State Secretariat for Civil Protection was the central focal point for coordinating the various partners and designate key areas for support. During the implementation phase, a dedicated task force or even an independent authority could enhance government and development partner coordination.

Information management for a post-disaster recovery program needs to be coordinated, transparent, and useful to disaster-affected populations. Early in the recovery process, different tiers of government and development partners will be collecting various data and carrying out various analyses. Information changes continuously, which may cause delays in the recovery process. For example, the numbers of disaster-affected people, affected people living in high-risk zones, as well as details of damaged assets and infrastructure, are constantly updated. A key recommendation is therefore the creation of a centralized information system, such as a collaborative electronical portal through which all data and information related to recovery activities is published, updated, and monitored regularly – and is available to the public. The portal could also include a feedback and grievance redress mechanism.

Photo: Machel Silveira

4.2 Context for DRM Recommendations

DRM Governance and Institutional Framework

92. DRM policy and legislative frameworks are underpinned by the National Disaster Risk Management Policy (2008), which was enacted following renewed global commitments to DRM after the 2004 Indian Ocean earthquake and tsunami. The Policy outlines the Government's vision for disaster management and lays out plans to develop DRM programs. In 2010, the National Adaptation Program of Action (NAPA) for Climate Change was also developed, along with a National Adaptation Plan for Climate Change (2011–2030), followed by the National Strategic Development Plan (2011–2030).

93. However, the National Strategic Development Plan does not include mainstreaming DRM as one of its development priorities, and the National Disaster Risk Management Policy is in the process of being updated and does not have a legislative underpinning. There remains a need for an institutional framework for DRM that outlines responsibilities and procedures across sectors and levels (see Box 5 on the historical decentralized DRM arrangements). In general, DRM activities in Timor-Leste are mainly limited to emergency response and are implemented on an ad-hoc basis, highlighting the continued need for a proactive approach to reduce disaster risk more systematically.

94. In December 2020, as VIII GoTL placed an increased focus on investment preparedness, institutional reform and contingency planning, the Secretary of State for Civil Protection drafted and published a decree-law, Lei da Proteção Civil ("Civil Protection Law").[88] The Civil Protection Law will be implemented in three phases. It establishes a staged Government Program of the VIII GoTL to incrementally build a comprehensive civil protection regime, which is to be included in the Orçamento ("budget process") concluding in October 2021. While it is not a comprehensive DRM legislation, the Civil Protection Law shapes the legal framework for some aspects of DRM, however key policy defining powers, discretions, and delegations of responsibility for national defence, internal security and civil protection, remain with other persons or bodies.[89] Article 17 outlines the process to declare a disaster situation. It also mandates that the National Civil Protection Authority provide funds for operational needs arising from emergencies or natural disasters, and calls for the creation of early-warning mechanisms for natural disasters. The Civil Protection Law, once implemented and funded,[90] will implement the key legal provisions required to establish the fundamental principles of civil protection. This will be a key opportunity to reduce fragmentation of DRM responsibilities between various agencies, including technical line agencies responsible for implementation and mainstreaming DRM strategies. It is anticipated that the Civil Protection Authority will be the coordinating body for all entities involved in civil protection operations, including at the regional, municipal, and *suco* level.

[88] Lei da Proteção Civil (Civil Protection Law), Law No. 12/2020 (2020).

[89] Lei de Segurança Nacional (National Security Law), Law No. 2/2010, Art. 1. (2010).

[90] The implementation of the law will require a number key implementation stages under phase 2, including the drafting of subsidiary guidelines on infrastructure, vehicle fleets, emergency warming equipment, a primary telephone system for emergencies, and standard operating procedures. Phase 2 is envisaged to be developed during 2021.

Box 5:

Historically Decentralized Arrangements for DRM in Timor-Leste

When it comes to DRM, Timor-Leste has historically relied on an intergovernmental working arrangement across ministries and departments:

(i) policy and implementation oversight by the National Disaster Management Directorate (NDMD), established during the time of the United Nations Transitional Administration in East Timor (UNTAET) and housed under the Ministry for Social Solidarity and Inclusion (MSSI);

(ii) preparedness-for-response through an intergovernmental arrangement under MSSI and its sub-national counterparts;

(iii) an overall Inter-Ministerial Commission for Disaster Management (CIGD)[91] tasked with conducting an annual review of national disaster risk reduction and providing technical and policy advice and resource allocation to the National Disaster Coordinator (NDC) and Joint National Disaster Operation Center (NDOC) during response operations; and

(iv) a Crisis Management Center (*Centro de Integrado de Gestao de Crisis*, or CIGC).

The INFORM Index[92] rates Timor-Leste's lack of coping capacity dimension at 6.2 (out of maximum 10), which indicates that certain key institutions and policy planning documents exist but have not been optimized.

Since the time of UNTAET, MOI and MSSI have held joint responsibility for disaster response. MOI was responsible for GoTL's early approach through its release of the National Disaster Management Plan,[93] which was transformed into a National Disaster Risk Management Policy by MSSI. MSSI was responsible for coordinating preparation and response for any emergency. The National Disaster Management Directorate (NDMD) sat under MSSI and was composed of the NDOC, the Departments of Preparedness and Formation, Prevention and Mitigation, and Response and Recovery, and disaster management committees at district, sub-district, and village (*suco*) levels. NDMD was responsible for providing disaster risk management coordination and technical support to the government and community; The NDMD released the National Disaster Risk Management Policy in 2008.[94]

[91] CIGD is composed of the Vice-Prime Minister (National Coordinator) and representatives of the Ministries of Social Solidarity; Foreign Affairs and Cooperation; Finance; Justice; Education; Health; Infrastructure; Commerce, Industry and Tourism; Economy and Development; Agriculture and Fisheries; and State Public Works. It also incorporates other government representatives, the Commanders of F-FDTL and PNTL, the Secretary General of Red Cross Timor-Leste (CVTL), and representatives of civil society and the UN.

[92] INFORM index, Disaster Risk Management Knowledge Centre (DRMKC), European Commission. Available at: https://drmkc.jrc.ec.europa.eu/inform-index.

[93] National Disaster Risk Management Plan (2005).

[94] National Disaster Risk Management Policy (2008).

The Crisis Management Centre (CIGC) was established as a specialized arm of the government under the supervision of the Prime Minister.[95] The CIGC was established to coordinate strategic development for prevention, mitigation, and resolution of threats, conflicts, catastrophes, and calamities. Its mission on its establishment was to coordinate, provide advice to, and consult with technical and operational directorates for activities conducted by entities involved in the National Security Integration System (SISN).

DRM response is decentralized, with the District serving as the core territorial unit for risk management, and coordination between the national and local levels is reportedly weak.[96] For example, the 2008 policy should be implemented by all districts, agencies and organisations as a guide for the development and maintenance of their own DRM arrangements, plans, and procedures; however, this appears to have not been thoroughly integrated.[97] District Administrators (DAs) serve as the District Disaster Coordinator (DDC) and are responsible for disaster response decision-making within the district. They coordinate on decision-making with a District Disaster Management Committee (DDMC), comprising district representatives of key government and non-governmental agencies. During an emergency situation, as part of a bottom-up response, DDMCs are expected to perform the following functions: (i) coordinate rapid assessment surveys of affected areas and analyze the results; (ii) coordinate district financial resources to provide the most effective response to identified needs; and (iii) recommend requests for national support, identifying the type, scale, and timing of the support, and the logistical information needed for effective delivery. At the sub-district level, the Sub-District Administrator (SDA) leads emergency and disaster risk reduction activities; within each village, the *Suco* Chief and village leaders oversee DRM.[98]

[95] Lei de Segurança Nacional (National Security Law), Law No. 2/2010, Art. 29 (2010).

[96] Vishalini Chandara Sagar, Alistair D. B. Cook, Tamara Nair, and Yen Ne Foo, *Integrating a Disaster Response Architecture in Timor-Leste*, NTS Report No. 8 (March 2018), S. Rajaratnam School of International Studies – RSIS (Singapore: Nanyang Technological University, 2018), https://www.rsis.edu.sg/wp-content/uploads/2018/03/NTS-Report-8-Integrating-A-Disaster-Response-final.pdf.

[97] Vishalini Chandara Sagar, Alistair D. B. Cook, Tamara Nair, and Yen Ne Foo, *Integrating a Disaster Response Architecture in Timor-Leste*, NTS Report No. 8 (March 2018), S. Rajaratnam School of International Studies – RSIS (Singapore: Nanyang Technological University, 2018), https://www.rsis.edu.sg/wp-content/uploads/2018/03/NTS-Report-8-Integrating-A-Disaster-Response-final.pdf.

[98] Asian Disaster Preparedness Centre (ADPC), *A Country Situation Report on Disaster Risk Assessment related Initiatives* (Bangkok: ADPC, 2013).

Multi-Hazard Early Warning Systems

95. The National Directorate of Meteorology and Geophysics (DNMG), under the MPWTC,[99] is responsible for providing meteorological, climatological, and seismological information to public and public–private entities. During the UNTAET period, the Bureau of Meteorology Australia provided meteorology services, and today continues to provide aviation observation and forecast information. DNMG also has a Memorandum of Understanding with the Indonesian Meteorology, Climatology, and Geophysical Agency (BMKG). Timor-Leste partners with the World Meteorological Organization (WMO); for instance, Timor-Leste is participating in the WMO South-eastern Asia-Oceania Flash Flood Guidance (SAOFFG) System.

96. Early-warning services (EWS) during the tropical cyclone season require 24/7 operations, as tropical depressions can be formed with minimal lead times. While EWS has been codified into national policy, implementation at the municipal, district, and *suco* levels has been slow in many districts. TC Seroja highlighted opportunities to clarify institutional responsibilities, strengthen capacity to issue impact-based warnings, respond to and relay alerts, and prioritize response.

97. Budget shortfalls, communications network limitations, transportation difficulties, and human resource shortages are some of the factors that constrain implementation of effective multi-hazard early warning systems (MHEWS). DNMG is challenged by limited technical capacity and insufficient human and financial resources. It is a small and new department with low visibility both internationally and within the government. Although Timor-Leste relies on agreements with various regional and international entities to receive hazard alerts, more investments are needed in observation and forecast systems, such as automatic weather stations and weather radar networks. Maintaining these systems also requires complementary support for technical training and increased financial capacity. DNMG has further highlighted the need for warnings to be delivered in a timely manner – including through non-technological means, as internet connections are unreliable – to prepare communities who may be affected by extreme events. There is also opportunity to develop accessible and targeted MHEWS products for diverse and vulnerable groups.

98. Institutionally, the MPWTC, while it houses the DNMG, is not part of the CIGD. In addition, CIGD's mandate, resources, technologies, and system are limited to earth observation, without a programmatic approach that would allow complete EWS capabilities.[100] In the past, development partner–supported efforts to establish a national-level MHEWS had been geared towards the NDMD; there has been little investment to strengthen the capacity of the upstream MHEWS chain.

99. Given the limited capacity and resources of DNMG, efforts to modernize MHEWS should use a phased approach. Practical steps moving forward should support high-priority areas that are essential for the most basic public services. Assessments may be conducted to identify potential technical support to address challenges related to low visibility within the government, lack of financial and human resources, inadequate facilities with limited space and internet connection, limited technical skills in areas such as observation, forecasting, and modelling, and sparse surface observation networks. Partnerships with national hydrometeorological services agencies in the region may also be strengthened.

---

[99] DNMG provides one-day, three-day, and seven-day weather forecasts. In the event of extreme events such as tropical cyclones, information is disseminated to the public through social media, TV, and radio, and DNMG works with the NDOC to disseminate information to focal points in 13 municipalities.

[100] See the Ministry of Transport and Communications website: http://www.mtc.gov.tl/mtc/index.php/en/services-dir/dgmtc/national-directorate-of-meteorology-and-geophysics.

4.3 Recommendations to Strengthen DRM

100. It is essential that all sectors integrate and institutionalize DRM measures into their plans, procedures, and operations to protect gains made during recovery following TC Seroja, and to strengthen preparedness and resilience to future natural hazards. The recommendations below are outlined under four focus areas: (i) the institutional, policy, legal, and regulatory environment; (ii) multi-hazard early warning systems; (iii) risk mitigation; and (iv) emergency preparedness and response.

Focus Area 1:
Institutional, Policy, Legal, and Regulatory Environment

- **Prioritize the development of a national regulatory framework on comprehensive DRM.** This would include key legal and regulatory provisions to outline clearer roles and responsibilities for DRM. The new Civil Protection Law establishes the core government and ministerial responsibilities and coordination bodies that will apply in times of a declared "calamity," and is a good step towards building a DRM regulatory framework; it is recommended that, once it is passed, the implementation of the Law be monitored.
- Over time, the DRM framework should be monitored for effectiveness and refined to address gaps and lessons learned from recent disasters. For example, there is currently a minimal role for the Civil Protection Authority to identify clear responsibilities among government ministries and humanitarian clusters on damage and needs assessments and the longer-term recovery planning process.
- DRM regulatory frameworks should lay a foundation for proactive steps to reduce risk, and not remain limited to provisions for emergency response and post-disaster recovery and reconstruction. Therefore, any future regulatory review should address apparent gaps and consider complementary requirements, including:
    a. formally establishing a Multi-Hazard Early Warning System based on Impact-Based Forecasting for Timor-Leste, and supporting priority products and information services
    b. adopting a National Disaster Risk Management Policy and Standard Operating Procedures for priority disaster management activities (e.g., post-disaster recovery)[101]
    c. clarifying responsibilities for ex-ante risk reduction activities and investments in resilience
    d. outlining disaster risk financing strategies and instruments suited to Timor-Leste's risk profile
    e. undertaking public awareness outreach
- **Update the National Disaster Risk Management Policy.** The National Disaster Risk Management Policy expired in 2012 and the revision process is ongoing. Responsibilities of the leading DRM ministry and agency should be articulated clearly.[102] Potential key policy directions include lessons learned from recent disasters (especially on cyclone preparedness and urban resilience), adaptation to the longer-term effects of climate change, and clarity in decision-making mechanisms.

[101] For example, a Standing Order on Disaster has been used as an institutional tool to manage institutional responsibilities at every stage of DRM in Bangladesh since 2019. Each ministry and agency ir own detailed work plan to perform their responsibilities and functions efficiently. https://reliefweb.int/report/bangladesh/government-people-s-republic-bangladesh-standing-orders-disaster-2019.
[102] Sagar et al., *Integrating a Disaster Response Architecture in Timor-Leste*.

> Over time, the DRM framework should be monitored for effectiveness and refined to address gaps and lessons learned from recent disasters.

- **Continue supporting and strengthening the new Civil Protection Authority.** Following the promulgation of the Civil Protection Law, the new Civil Protection Authority will coordinate and engage entities involved in civil protection operations, from the *suco* to the national level. There is a need to ensure a smooth, phased transfer of authority from existing agencies and to articulate the roles and responsibilities across the new Civil Protection Authority and other agencies. For instance, the Civil Protection Authority should be responsible for strengthening coordination and sharing risk information and knowledge.
- **Strengthen institutional arrangements for preparing post-disaster needs assessments and recovery planning.** Institutional and technical capacity should be enhanced for post-disaster assessments, especially for undertaking remote assessments (e.g., during health-related emergencies or for remote locations). Standard operating procedures outlining institutional responsibilities and technical methodologies could be prepared for rapid damage assessments. A post-disaster recovery framework could also be developed to outline the roles and responsibilities of government agencies, non-government organizations, and other partners following a disaster event, as well as communications protocol and monitoring and evaluation aspects.

Focus Area 2:
Multi-Hazard Early Warning Systems (MHEWS)

- **Identify resourcing for, and implement, the VIII Government's program[103] on early-warning mechanisms and weather information products.** In light of the current program to establish the legal framework for the Civil Protection Authority, it is recommended that the GoTL fund the delivery of early-warning operations and equipment management as this is a necessary focus area to be supported along with enhanced institutional arrangements.
- **Develop a baseline analysis to identify high-priority investments for early-warning services and products.** To strengthen public weather services, assessments can be conducted to identify potential technical support, with the goal of addressing challenges related to low visibility of DNMG within the government, lack of financial and human resources, limited facilities, instrumentation needs, and technical skills. The baseline would build on existing initiatives to develop MHEWS, particularly for flood early warnings in Dili Municipality, and consider roles and responsibilities for MHEWS under NDMG, Civil Protection, MAF, MPWTC, Institute of Petroleum and Geology, and other agencies responsible for upstream hazard monitoring and downstream dissemination and communication.

[103] Government of Timor-Leste, "6.9 Defense and Security," *Program of the Eighth Constitutional Government*, http://timor-leste.gov.tl/?cat=39&lang=en#prog6.9.5.

- **Update multi-hazard risk assessments.** Such an assessment would need to be supported by high-resolution geospatial data to determine priority hazards and geographical locations, and vulnerability information to inform a MHEWS platform.
- **Build capacity to ensure 24/7 operations for hazard monitoring.** At a minimum, full-time operations are required for early-warning services during the tropical cyclone season, as tropical depressions can be formed with short lead times. Simple, easy-to-maintain and inter-operatable decentralized early warning services that could run independently off the main power grid could be a feasible solution given limited resources. This could be applied through a phased approach starting with key hydro-meteorological hazards.
- **Strengthen regional partnerships on real-time forecasting.** Limited cyclone and flood warning capacities could be addressed by strengthening regional partnerships in early-warning services. Consider developing capacity-building initiatives with countries in the region on priority areas, such as the Flash Flood Guidance System (FFGS)[104] and impact-based forecast and warning services, which help to forecast what the weather will *do*, not just what the weather will *be*.
- **Strengthen data collection systems and explore technological innovation.** This includes supporting the development of Agromet 2.0. Agromet, the nationwide agro-meteorological data collection platform, has a mandate to collect agro-meteorological data and conduct analysis and dissemination, and is organized under the National Information and Early Warning System. Discussions for Phase 2, which would include an alert system, are ongoing.[105] The use of low-cost solutions, such as mobile phone technology for data collection, could also be explored.

Focus Area 3:
Risk Mitigation

- **Invest in risk mitigation when "building back better."** The TC Seroja post-disaster recovery program could provide opportunities to rebuild structurally stronger and more inclusive housing, infrastructure, and public spaces. Building and engineering designs for rehabilitated and reconstructed infrastructure should meet relevant codes for seismic, flood, and cyclonic hazards. Disaster risk awareness initiatives aimed at building owners and communities can help to build resilience and preparedness for future events.
- **Invest in integrated approaches to resilience-building.** Systematically reducing the cost and impact of disasters requires both engineered and non-engineered investments. For example, flood resilience investments in Dili Municipality should combine traditional measures in flood protection (e.g., dikes, river normalization, drainage improvement) with green infrastructure, nature-based solutions, and non-structural measures (e.g., early-warning services, risk-informed development controls, community awareness). There are also benefits in pursuing multi-purpose urban flood resilience investments that have multiple co-benefits (e.g., a drainage and flood control system incorporated into public spaces that are used for recreational purposes when there is no flood inundation).
- **In parallel to the establishment of the Civil Protection Authority, national-level actors such as MSSI can work more intensively with municipal authorities**, ensuring

[104] A FFGS provides forecasting and disaster management agencies with real-time information products that enable agencies to issue warnings about small-scale flash flooding. See https://public.wmo.int/en/projects/ffgs.

[105] Sustainable Solutions Timor-Leste, *Timor-Leste – Analysis and Recommendations for Developing and Strengthening Drought Early Warning Systems* (Dili: Sustainable Solutions Timor-Leste, 2017).

greater coordination and providing support on risk information and emergency response planning and drills.[106]

- **Support mainstreaming of DRM into sectoral policies and guidelines.** The reconstruction phase provides an opportunity to build back better in key sectors such as the agriculture, transport, and housing sectors, mainstreaming DRM concerns and activities into investment plans, guidelines, and activities.
- **Strengthen integration between health and disaster risk management and response.** COVID-19 has highlighted the cascading risk of biological and natural hazards. Damage to health facilities and interrupted health service delivery, disruption of access to safe water and sanitation and food, and population displacement due to disasters can raise the risk of disease spread and strain disaster response and health systems. Community-based disaster preparedness programs could incorporate preparedness for health-related emergencies.
- **Explore financial preparedness strategies that increase the ability of national and local governments to respond more quickly to disasters.** These strategies might include the creation of exposure databases and risk models, followed by the development of a national disaster risk financing strategy, which can incorporate a mixture of post-disaster financing instruments that provide GoTL with rapid liquidity to meet urgent financial needs for emergency response. Financial strategies should include investments in risk reduction priority areas to mitigate the costs of future disasters. They should also consider adaptative social protection for poor and vulnerable households (including targeted awareness-raising initiatives), and forecast- and impact-based early action.

Focus Area 4:
Emergency Preparedness and Response

- **Conduct an emergency preparedness and response diagnostic to identify priority short-term actions.** The emergency response to TC Seroja was limited by the absence of a national guideline and standard operating procedures pertaining to rapid disaster assessment, the lack of a national (and sub-national) disaster response framework, and the absence of a technically sufficient national (and sub-national) emergency operations center. These challenges demonstrate the need for a comprehensive assessment of gaps in emergency response.
- **Include gender and disability considerations in emergency preparedness and response plans.** Disasters disproportionately affect vulnerable populations such as women and people with disabilities. Female-headed households face greater challenges in accessing social services following a disaster, and displacement increases the risk of gender-based violence (GBV).
- **Consult with Disability Person Organizations (*Ra'es Hadomi Timor-Oan* – RHTO) to develop disability-inclusive training modules.** Increased advocacy work is needed between RHTO and DRM stakeholders to build capacities, knowledge, and understanding of disability inclusion constraints in ex-ante risk reduction activities and post-disaster recovery programs. This work could include preparation of accessible disaster preparedness materials, disability-inclusive guidelines for post-disaster housing and

[106] World Bank, *Implementation Completion Report: "Building Disaster/Climate Resilience in Communities along the Dili-Ainaro and Linked Road Corridors in Timor-Leste Project* (Washington, DC: World Bank, 2019).

infrastructure programs, and participatory planning approaches to risk reduction investment projects.

- **Raise awareness with the younger population on disaster and climate resilience.** School age children need to be informed of disaster risks, safety and mitigation efforts and are similarly vulnerable as other disadvantaged groups where displacement increases the risk of poverty and violence. Additional efforts to raise awareness and knowledge of disaster risk could be pursued in the national education curriculum through youth-targeted engagement activities.

101. A summary of the above recommendations to strengthen DRM, along with expected timelines and proposed prioritization, is presented in Table 21.

Table 21: Summary of DRM Recommendations

Focus Area	Action	Expected Timeline	Priority
Institutional, policy, legal, and regulatory environment	Monitor and review the developing DRM regulatory framework for effectiveness	2 to 3 years	**Very High**
	Update the National Disaster Risk Management Policy	1 to 2 years	**High**
	Strengthen institutional arrangements for preparing post-disaster needs assessments and recovery planning, and multi-sectoral disaster and climate risk reduction	2 to 3 years	**Medium**
Multi-hazard monitoring and early warning systems	Support funding for the delivery of early-warning operations and equipment management	1 to 2 years	**Very High**
	Update multi-hazard risk assessments	1 to 2 years	**Very High**
	Develop a baseline analysis to identify high-priority investments for public forecasting services and early-warning products	1 to 2 years	**Very High**
	Build capacity to ensure 24/7 operations for hazard monitoring	3+ years	**High**
	Strengthen regional partnerships on real-time forecasting	3+ years	**Medium**
	Strengthen data collection systems and explore technological innovation	3+ years	**Medium**

Focus Area	Action	Expected Timeline	Priority
Risk mitigation	Invest in risk reduction when "building back better" (TC Seroja post-disaster recovery program)	1 to 5 years	**Very High**
	Invest in hazard-specific mitigation, building in strategic investment plans (e.g., Dili Master Plan)	1 to 5 years	**Very High**
	Explore financial preparedness strategies that increase the ability of the government to strengthen financial resilience (ex-ante risk mitigation)	1 to 3 years	**Very High**
	Mainstream DRM into sectoral policies, guidelines, and regulations	3+ years	**High**
Emergency preparedness and response	Explore financial preparedness strategies that increase the ability of the government to strengthen financial resilience (post-disaster financing)	1 to 3 years	**Very High**
	Conduct an emergency preparedness and response diagnostic to identify priority short-term actions	1 to 2 years	**High**
	Work with municipal authorities on risk information and emergency response planning and drills	3+ years	**High**
	Strengthen integration between health and DRM preparation and response	1 to 2 years	**High**
	Include gender and disability considerations in emergency preparedness and response plans	2 to 3 years	**Medium**
	Consult with Disability Person Organizations (*Ra'es Hadomi Timor-Oan* – RHTO) to develop disability-inclusive training modules and build capacity of DRM stakeholders	2 to 3 years	**Medium**
	Raise awareness with the younger population on disaster and climate risk	3+ years	**Medium**

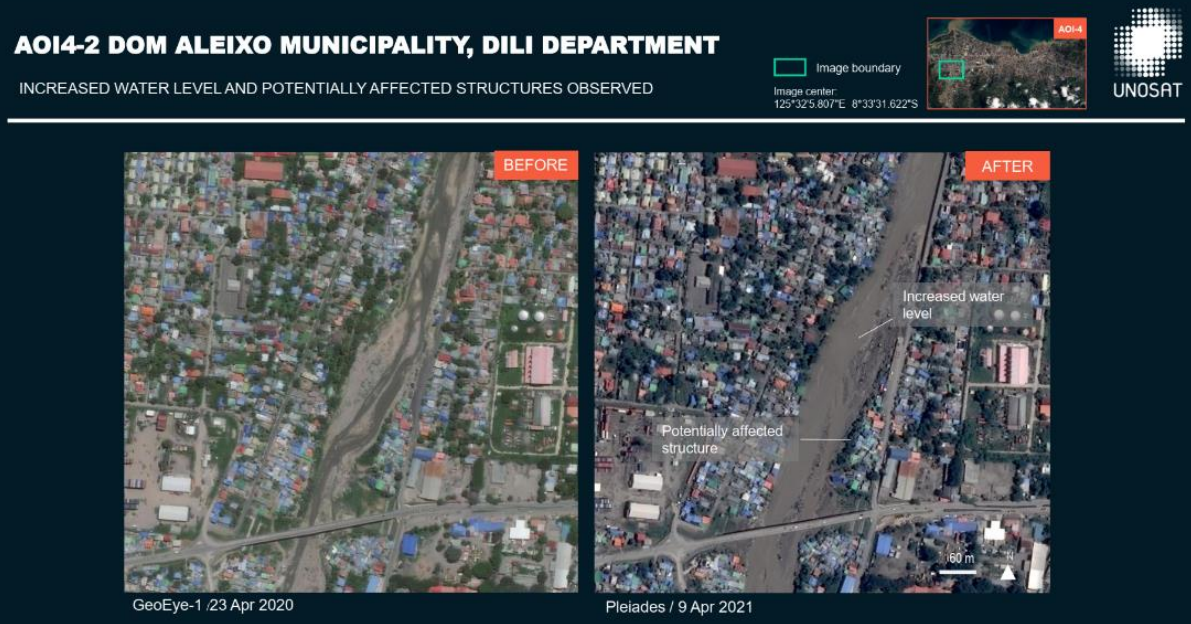
Annex: Urban Focus – Effects of TC Seroja in Dili

The Dili Metropolitan Area (DMA) consists of two municipalities, Dili and Liquica. Dili is further divided into four administrative posts or sub-districts (Vera Cruz, Nain Feto, Dom Aleixo, and Cristo Rei), while Liquica has one administrative post (Bazartete). As of 2020, an estimated 321,760 people lived in the DMA. Dom Aleixo is the most populated area, and a highly urbanized one, where key economic activities and infrastructure are located. The Comoro River, the largest river in Timor-Leste, passes through Dom Aleixo, which experienced damaging floods in 2010, 2013, and 2020.[107] TC Seroja triggered flooding, landslides, soil liquefaction, and changes in shorelines in parts of the DMA, particularly in key areas such as Dom Alexio, Cristo Rei, and Liquica.[108]

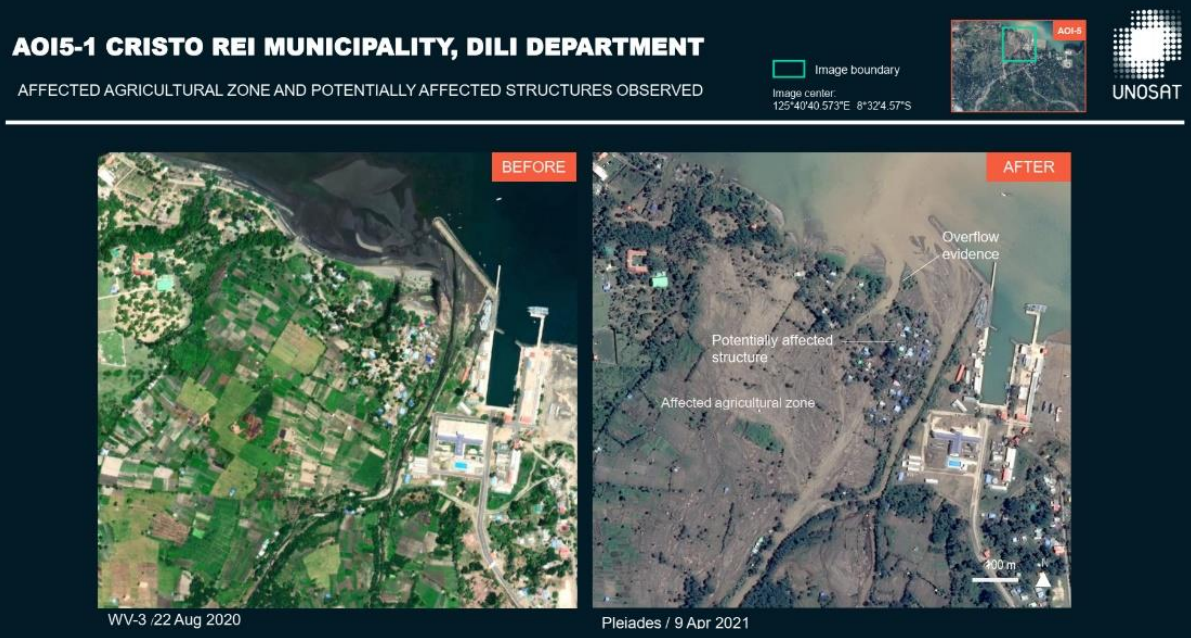
In Dom Alexio, satellite observation indicates significant damages downstream of Comoro River and in the Tasitolu Lake area, where the images suggest that more than 40 hectares was flooded and potentially more than 800 buildings damaged. The southern shoreline of Tasitolu Lake was pushed back by 220 meters. As can be seen in the figure below, the southern part of Tasitolu Lake is designated as a combination of protected natural areas and rural residential areas by the Dili Urban Master Plan 2030. The rural residential area has lower density in its sloped areas but is vulnerable due to its elevation.

Increased water levels are also clearly observable along the downstream section of Comoro River. The image below suggests that there was a small flood plain along the riverbanks, and buildings in this area were likely inundated by a combination of water and mud. Such effects can be observed on satellite images of the mid-stream and coastal areas in the northern part of Dom Alexio.

[107] See Corbafo et al, 2017.
[108] Maps based on satellite imagery analyses by UNOSAT, pending ground verification. See complete imageries here.



The northeastern parts of Cristo Rei, particularly the coastal areas, were affected by floods. Satellite imagery indicates that more than 100 hectares were inundated and potentially more than 400 buildings damaged. Flood water penetration was detected as far as 500 meters south of the shoreline. As can be seen from the image below, the agricultural zone in Port Hera was inundated by a mix of water and mud, and the sedimentation likely affected and disrupted community activities. The satellite images indicate that a naval base was also affected.



The hilly area or northwestern part of the Cristo Rei Administrative Post experienced landslides, with potentially 60 structures damaged. The damaged structures were scattered across Cristo Rei. The hilly areas of Vera Cruz in the Administrative Post were also affected by landsides, with three hectares affected and potentially 50 buildings damaged.

Note: *Satellite images in this annex are from the United Nations Satellite Center (UNOSAT) and United Nations Institute for Training and Research (UNITAR) "Preliminary Satellite Derived Flood Assessment in Dili and Liquica Departments" (April 9, 2021) and are for illustrative purposes only.*

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP