Ministry of Oceans and Fisheries

PEMSEA

MOF/PEMSEA ODA Project

Reducing Marine Plastics in the East Asian Seas Region

Baseline Assessment Report on Marine Plastics in the Four ODA Project Sites in TIMOR-LESTE

Ministry of Oceans and Fisheries

PEMSEA

MOF/PEMSEA ODA Project

Reducing Marine Plastics in the East Asian Seas Region

Baseline Assessment Report on Marine Plastics in the Four ODA Project Sites in

TIMOR-LESTE

BASELINE ASSESSMENT REPORT ON MARINE PLASTICS IN THE FOUR ODA PROJECT SITES IN TIMOR-LESTE

August 2025

Published by Partnerships in Environmental Management for the Seas of East Asia (PEMSEA).

Suggested citation:
PEMSEA. Baseline Assessment Report on Marine Plastics in the Four ODA Project Sites in Timor-Leste. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 68 p.

ISBN 978-971-812-067-5

The activities described in this report were made possible with the generous support of the Ministry of Oceans and Fisheries, RO Korea through the MOF/PEMSEA ODA Project on Reducing Marine Plastic in the East Asian Seas Region.

About Us

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) is a regional coordinating mechanism for the sustainable coastal and marine development in the East Asian Seas Region.

PEMSEA Resource Facility
P.O. Box 2502, Quezon City 1165, Philippines
Tel: (+632) 8929-2992 Fax: (+632) 8926-9712
Email: info@pemsea.org
www.pemsea.org

Table of Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

AMH	-	AMH Philippines, Inc.
CBO	-	Community-based Organization
EEE	-	Electrical and Electronic Equipment
EPR	-	Extended Producer Responsibility
g	-	Gram
GDP	-	Gross Domestic Product
GIS	-	Geographic Information System
GNI	-	Gross National Income
HDPE	-	High-Density Polyethylene
HIES	-	Household Income and Expenditure Survey
INETL	-	Timor-Leste National Institute of Statistics
JICA	-	Japan International Cooperation Agency
KAP	-	Knowledge, Attitude, and Practice
kg	-	Kilogram
km	-	Kilometer
km^2	-	Square kilometer
KOICA	-	Korea International Cooperation Agency
L	-	Liter
LDPE	-	Low-Density Polyethylene
MOF	-	Ministry of Fisheries
MoU	-	Memorandum of Understanding
MPA	-	Marine Protected Area
MSA	-	Ministry of State Administration
NGO	-	Non-governmental Organization
NSWMC	-	National Solid Waste Management Commission
PACS	-	Plastic Analysis and Characterization Study
PEMSEA	-	Partnerships in Environmental Management for the Seas of East Asia
PET	-	Polyethylene Terephthalate
PMU	-	Project Management Unit
PP	-	Polypropylene
PPE	-	Personal Protective Equipment
PPIP	-	Project Preparation & Implementation Programme for Timor-Leste
PPP	-	Purchasing Power Parity
PRF	-	PEMSEA Regional Facility
PRIF	-	Pacific Regional Infrastructure Facility
PS	-	Polystyrene
PSA	-	Plastic Solutions Alliance

PVC	-	Polyvinyl Chloride
SBCC	-	Socio-Behavioral Change Communication
SIDS	-	Small Island Developing States
SMASA	-	Municipal Services for Water, Sanitation, and the Environment
SOPTASA	-	Public Service Works, Transport, Water, Sanitation and Environment
SPREP	-	Secretariat of the Pacific Regional Environment Programme
UN	-	United Nations
UNITAL	-	Oriental University of Timor Leste
UNTL	-	Universidade Nacional Timor Lorosa'e (National University of Timor-Leste)
USAID	-	United States Agency for International Development
USD	-	United States Dollar
WACS	-	Waste Analysis and Characterization Study
WaCT	-	Waste Wise Cities Tool
WGR	-	Waste Generation Rate

Acknowledgement

This publication is the result of the collaboration of the following:

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA):

- Ms. Aimee Gonzales
- Dr. Won-Tae Shin
- Mr. Hunguen Kim
- Ms. Gusung Lee

AMH Philippines, Inc.

- Dr. Maria Antonia Tanchuling
- Ms. Kayla Macadangdang
- Mr. Aerol Cedrick Treyes
- Ms. Darlene Joy Desacada
- Ms. Phoebe Sison
- Ms. Ma. Brida Lea Diola

Local Consultants and Coordinators

- Mr. Osaias Soares
- Mr. Rafael Pereira

Local government units (LGUs):

- Municipal Authority of Atauro
- Municipal Authority of Dili
- Municipal Authority of Liquiçá
- Municipal Authority of Manatuto

Executive Summary

Plastic pollution in oceans and rivers poses a significant threat to marine life and human health. Globally, an estimated 14 million tons of plastic waste end up in the oceans, comprising about 80% of marine litter (Asian Development Bank, 2024). Without targeted interventions, Small Island Developing States (SIDS), such as Timor-Leste (East Timor), will be severely affected by the environmental impacts of marine plastic pollution.

To address this urgent issue, the MOF/PEMSEA Project on Reducing Marine Plastics in the East Asian Seas Region was launched. This six-year, USD 9 million project covers ten municipalities and cities—six in the Philippines and four in Timor-Leste. The project aims to protect and improve the health and well-being of people and marine ecosystems by tackling the root causes of plastic pollution through coordinated actions and innovative solutions among key stakeholders, including governments, industry, civil society, and individuals.

The PEMSEA Resource Facility (PRF) serves as the Project Implementing Partner, working in collaboration with the Republic of Korea's Ministry of Oceans and Fisheries (MOF), which funds the project, along with national and local government partners across the ten project sites.

The project is designed to strengthen local governance and management of marine plastics and drive meaningful changes across project sites in line with national goals and global commitments, specifically supporting United Nations (UN) Sustainable Development Goal 14.1: to prevent and significantly reduce marine pollution from land-based activities, including marine debris, by 2025.

To achieve these goals, the project is organized into four main components:

1. Local governance on marine plastics management
2. Demonstration of best practices and innovative solutions in marine plastics management
3. Beach monitoring on marine plastics and litter
4. Capacity, awareness, and communication on marine plastics management

A critical part of the project is conducting a baseline study on plastic waste generation and composition at each project site. This baseline study will inform policies and activities for reducing the impacts of marine plastic pollution in each area.

This baseline assessment on marine plastics includes the conduct of Plastic Analysis and Characterization Study (PACS) and Knowledge, Attitude, and Practice (KAP) Survey, specifically focusing on key coastal areas in four municipalities in Timor-Leste – Atauro, Dili, Liquiçá, and Manatuto.

These components are designed to understand the specific dynamics of plastic waste generation and local community behaviors towards waste management as basis of project decisions and 10-year marine plastic management strategies and action plans, which will be developed, adopted, and implemented by local governments and stakeholders.

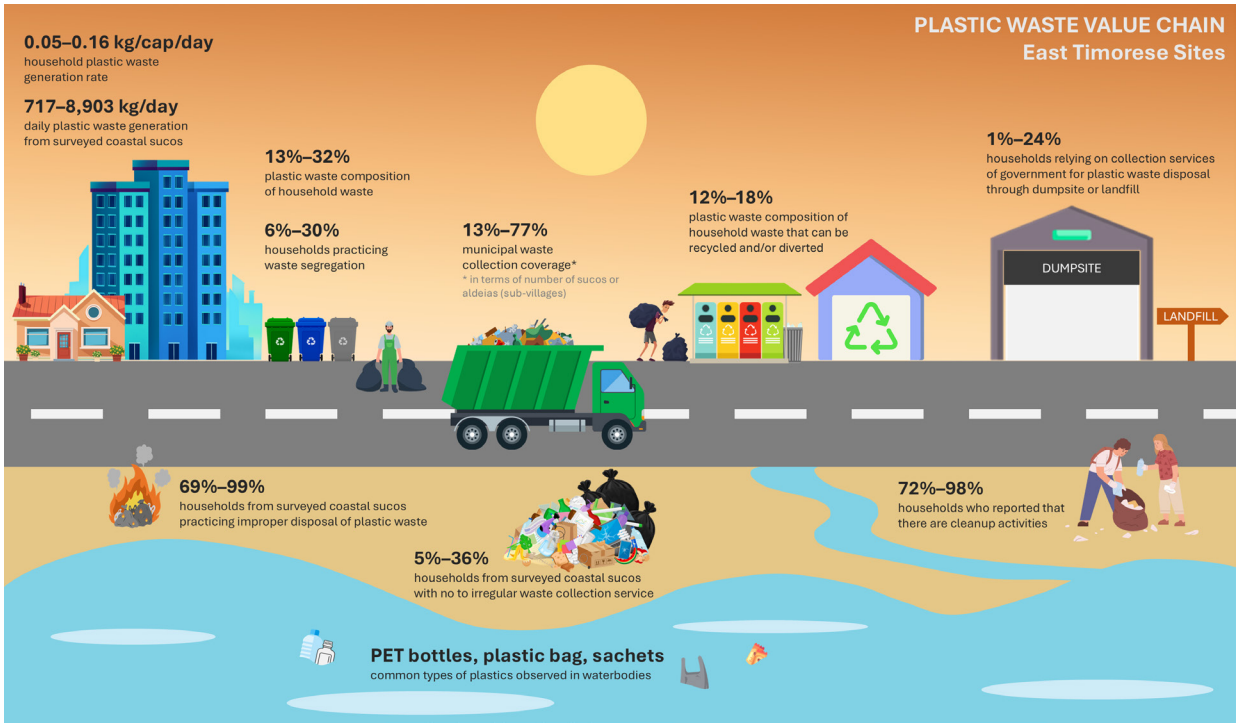
The analysis and characterization of waste from the surveyed coastal sucos of each site found that household and non-household sources generate about 3,345 kg/day to 48,268 kg/day, of which 717 kg/day to 8,903 kg/day kg/day are plastic waste. These results in general waste generation rates (WGRs) ranging from 0.33 kg/cap/day to 0.57 kg/cap/day, and plastic WGRs of 0.07 kg/cap/day to 0.18 kg/cap/day. Households contribute a significant portion of the generated waste in the surveyed coastal sucos, accounting for about 71% to 90% of the total waste, with a national household general WGR of 0.38 kg/cap/day and national household plastic WGR of 0.06 kg/cap/day. When projected to all the coastal sucos of the respective municipalities, the household plastic waste generation scales up to 1,031 kg/day to 8,108 kg/day. Common household plastic waste includes polyethylene terephthalate (PET) items, diapers and napkins, and polypropylene (PP) items.

Key results of the KAP survey highlight the community's practice of purchasing items in small quantities, often packaged in flexible plastic materials such as laminated sachets for snacks and personal care products, as well as PET bottles for beverages. The reliance on single-use plastics, particularly in an island community with limited access to resources such as potable water, contributes to the growing waste management challenge. While a national framework for solid waste management exists, the absence of localized regulations for municipal implementation does not translate to effective waste management at smaller scales. Low participation in waste segregation is primarily driven by the lack of policy mandating segregation at source, further exacerbated by the ongoing collection of mixed waste and the absence of separate bins. Despite reported daily waste collection, improper disposal methods persist, suggesting gaps in community awareness and inadequate information dissemination on existing collection systems. These findings further underscore the crucial need to strengthen social and behavioral change communication campaigns on proper solid waste management and enhance productive collaboration between relevant stakeholders.

The plastic waste value chain analysis across Timor-Leste sites reveals systemic challenges and opportunities in managing plastic waste from generation to disposal, emphasizing the need for integrated strategies to mitigate plastic pollution. About 13% to 32% of household waste comprises plastics, with a national average of 15. Moreover, a calculated national average of 12% represents plastics that can be recycled or reused, highlighting opportunities for significant plastic waste diversion. However, the presence of plastics in waste streams suggests the need for effective policy implementation. Waste management is further hindered by inadequate infrastructure, including designated bins for segregation and collection trucks. On a national scale, municipal waste collection covers only 44% of the surveyed municipalities, which may be attributed to limited vehicle availability and inaccessibility of some areas. Without regular

collection schedule, waste accumulates and leads to improper disposal and plastic pollution in local waterbodies. Furthermore, the absence of centralized recovery centers and engineered disposal sites also limits waste management alternatives, resulting in most collected waste ending up in unmanaged dumpsites. Ongoing efforts to reduce plastic pollution focus on improving waste diversion through environmental education and coastal cleanups, but sustained progress and significant impact requires stronger policies and its implementation, infrastructure, and stakeholder collaboration.

The findings of the synthesized national baseline assessment provide valuable insights that can assist local authorities, national government agencies, and relevant stakeholders in developing targeted policies and interventions. These strategies are aimed at improving solid waste management practices and reducing marine plastic pollution in coastal municipalities.



Plastic Waste Value Chain for Timor-Leste Sites

Priority Issues and Key Recommendations for Timor-Leste Sites

ATAURO

Priority Issue 1

Collection

- Only 12 out of 19, or 63%, of the sub-villages are covered by the collection services of the municipality due to poor road conditions and limited availability of collection vehicles
- The lack of separate waste collection for different waste types leads to segregated waste being included in mixed waste
- Uncollected waste accumulates in public spaces, increasing the dependence of residents on improper disposal practices

Key Recommendations

- Procure additional collection vehicles, including compactor trucks for main roads and smaller vehicles (e.g., motorized tricycles or carts) for narrow streets, to improve collection frequency and service coverage
- Establish localized waste transfer points in sucos without regular collection service to provide temporary storage before transportation to the final disposal site
- Enforce separate waste collection for different waste types by equipping collection vehicles with designated compartments, utilizing transparent bins, conducting regular inspections, and training workers on handling unsegregated waste

Priority Issue 2

Disposal

- The municipality lacks an engineered disposal facility, leading to widespread improper waste disposal through open dumping, burning, and burying
- The open dumpsite in Suco Beloi heightens plastic pollution risks as wind and runoff easily disperse waste
- Poor road conditions may hinder waste transportation even if a disposal facility is built
- The absence of regulations and monitoring systems results in unregulated waste disposal across the municipality

Key Recommendations

- Conduct a feasibility study to identify suitable sites for a sanitary landfill, considering geography, accessibility, and environmental impact.
- Develop decentralized disposal approaches, including localized controlled facilities or material recovery centers, to reduce reliance on a single site.
- Implement interim containment measures at the dumpsite pending development for a sanitary landfill, such as fencing, controlled access, and periodic covering of waste, to minimize environmental contamination.

Priority Issues and Key Recommendations for Timor-Leste Sites

DILI

Priority Issue 1

Segregation

- Without a segregation policy, majority of the households do not practice segregation
- Poor design of common collection points, including unlabeled waste bins and uncovered brick-and-mortar structures, discourages segregation

Key Recommendations

- Develop a clear and comprehensive local policy on waste segregation, providing guidelines for community implementation
- Launch pilot programs in select sucos to demonstrate effectiveness and create a model for broader implementation.
- Improve waste collection infrastructure by redesigning garbage bins and brick-and-mortar collection points to be more intuitive and user-friendly. Implement color-coded and clearly labeled bins for specific waste types and design appropriate waste categories for brick-and-mortar collection points. Additionally, install barriers and covers to prevent waste spillage and contamination

Priority Issue 2

Collection

- Only 24 of 31 sucos, or 77%, have access to regular collection services. Uncovered areas rely on burning and dumping of waste into the open environment as alternative forms of disposal
- Waste is primarily gathered from common collection points, which may be seen as inconvenient for certain households, leading to practicing improper disposal methods
- There is no separate collection for each waste type, resulting in the continuous collection of mixed waste

Key Recommendations

- Optimize waste collection efficiency and expand service coverage based on community needs by conducting route assessments and time-motion studies to ensure equitable distribution
- Implement a hybrid collection system that combines frequent door-to-door service in high-density areas with well-maintained common collection points to enhance accessibility and reduce improper disposal
- Enforce separate waste collection for different waste types by equipping collection vehicles with designated compartments, utilizing transparent bins, conducting regular inspections, and training workers on handling unsegregated waste

Priority Issues and Key Recommendations for Timor-Leste Sites

LIQUIÇÁ

Priority Issue 1

Collection

- The majority of the sucos are not covered for regular collection service, leading to practicing improper disposal methods
- Only one collection vehicle is used by the municipality government, resulting in infrequent collection

Key Recommendations

- Increase waste collection capacity by acquiring additional and suitable vehicles, ensuring timely and consistent waste collection, particularly in underserved sucos.
- Enhance waste collection efficiency by optimizing schedules based on community needs, conducting route assessments and time-motion studies to ensure effective service distribution and operational cost efficiency.
- Introduce phased implementation of waste segregation at the source by gradually establishing separate collection schedules for varying waste types, supported by infrastructure investments such as color-coded bins and targeted community awareness to improve compliance.
- Develop community-based waste collection programs to complement municipal services. Training local groups to manage collection in underserved areas can help bridge service gaps and promote community responsibility in waste management.

Priority Issue 2

Recovery

- There are no recycling facilities in the municipality, resulting in the majority of recyclable plastics ending up being disposed of
- The limited awareness on potential income opportunities from solid waste leads to low community engagement in waste recovery initiatives

Key Recommendations

- Establish a pilot community-based recovery and recycling initiative at the local level, focusing on plastics and other high-value materials
- Explore potential partnerships with recycling facilities or organizations in nearby municipalities to facilitate collection and processing of recyclables
- Enhance community awareness and participation through social and behavioral change communication (SBCC) initiatives, integrating waste recovery education into existing community programs and encouraging households to engage in waste diversion activities

Priority Issues and Key Recommendations for Timor-Leste Sites

MANATUTO

Priority Issue 1

Collection

- The majority of the sucos are not covered for regular collection service, leading to practicing improper disposal methods
- Only one collection vehicle is used by the municipality government, resulting in infrequent collection

Key Recommendations

- Increase waste collection capacity by acquiring additional and suitable collection vehicles, ensuring timely and consistent waste collection, particularly in underserved sucos
- Enhance waste collection efficiency by optimizing schedules based on community needs, conducting route assessments and time-motion studies to ensure effective service distribution and operational cost efficiency
- Introduce phased implementation of waste segregation at the source by gradually establishing separate collection schedules for varying waste types, supported by infrastructure investments such as color-coded bins and targeted community awareness to improve compliance
- Develop community-based waste collection programs to complement municipal services. Training local groups to manage collection in underserved areas can help bridge service gaps and promote community responsibility in waste management

Priority Issue 2

Disposal

- Burning of waste, along with improper forms of disposal such as burying in the ground, have become the primary form of disposal due to the lack of regular collection
- An open area along the highway serves as the municipality's disposal site. As an uncontrolled facility, essential environmental measures are lacking, increasing risks of plastic leakage. In addition, burning waste is commonly practiced to reduce the volume of dumped waste

Key Recommendations

- Expedite the planned construction of a sanitary landfill by maintaining good communication with involved stakeholders and continuously monitoring the progress of the project. Implementing phased construction may allow partial operational use while completion is underway.
- Implement immediate containment measures, including fencing, controlled access, and regular covering of waste, at the existing dumpsite to reduce waste dispersal and environmental contamination.
- Conduct regular inspections and strengthen public awareness on proper waste disposal through SBCC activities, along with an effective segregation, collection, and recovery system.

Various plastic wastes found during beach monitoring activities in the coasts of Dolok-oan, Dili.

1 Introduction

Plastic pollution in oceans and rivers poses a significant threat to both marine life and human health. In Timor-Leste, which lies adjacent to Indonesia, plastics are estimated to make up 13% of its total waste stream. In 2010, about 20.7 metric tons of plastic waste were leaked into the waters around the country, which is projected to rise to 64.2 metric tons by 2025 (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023).

To address this urgent issue, the MOF/PEMSEA Project on Reducing Marine Plastics in the East Asian Seas Region was launched. This six-year, USD 9 million project involves ten municipalities and cities — six in the Philippines and four in Timor-Leste. The project aims to protect and improve the health and well-being of people and marine ecosystems by tackling the root causes of plastic pollution through coordinated actions and innovative solutions among key stakeholders, including governments, industry, civil society, and individuals.

The PEMSEA Resource Facility (PRF) serves as the Project Implementing Partner, working in collaboration with the Republic of Korea's Ministry of Oceans and Fisheries (MOF), which funds the project, along with national and local government partners across the ten project sites.

The project is designed to strengthen local governance and management of marine plastics and drive meaningful changes across project sites in line with national goals and global commitments, specifically supporting United Nations (UN) Sustainable Development Goal 14.1: to prevent and significantly reduce marine pollution from land-based activities, including marine debris, by 2025.

To achieve these goals, the project is organized into four main components:

1. Local governance on marine plastics management
2. Demonstration of best practices and innovative solutions in marine plastics management
3. Beach monitoring on marine plastics and litter
4. Capacity, awareness, and communication on marine plastics management

A critical part of the project is conducting a baseline study on plastic waste generation and composition at each project site. This baseline study will inform tailored policies and activities for reducing the impacts of marine plastic pollution in each area. Under the first component, the project has initiated the development of a baseline assessment

on marine plastics in Timor-Leste, which includes the conduct of Plastic Analysis and Characterization Study (PACS) and survey on Knowledge, Attitude, and Practice (KAP) at four coastal municipalities (**Figure 1**).

The national baseline assessment on marine plastics aims to provide a comprehensive overview of the quantity and type of plastic waste generated and its potential contribution to marine pollution, through the analysis of solid waste management across the Timor-Leste sites. The key findings of PACS, KAP surveys, and other supplementary data will guide the development of targeted interventions and sustainable strategies, in collaboration with local government units, to effectively address marine plastic pollution.

The specific objectives of this national baseline assessment are the following:

- Determine the waste data—per capita waste generation and waste composition—of coastal communities focusing on the three selected local sucos in each site through the conduct of Plastic Analysis and Characterization Study;
- Document the current solid waste management system in the study areas, with particular focus on plastics;
- Identify the plastic value chain and the possible leakage points in the study area;
- Conduct Knowledge, Attitude, and Practice survey on household solid waste management; and
- Synthesize the findings from local baseline assessments to establish the national baseline assessment on marine plastics.

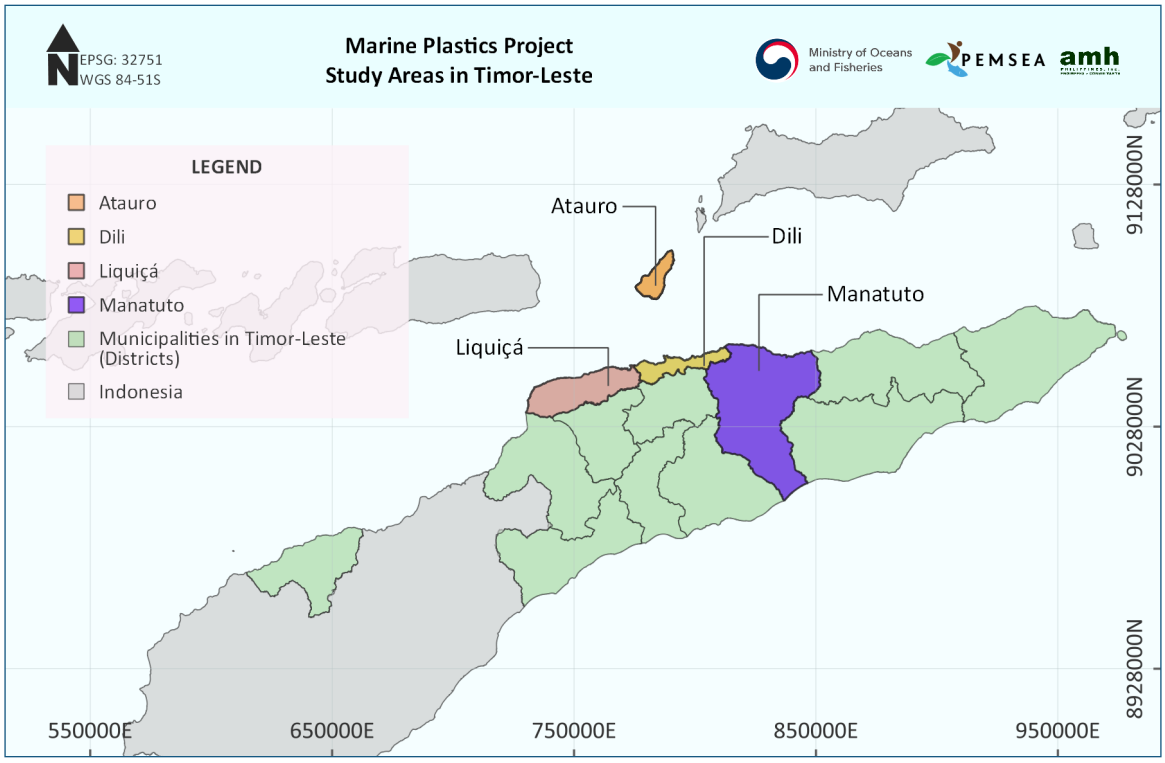


Figure 1. Study Areas in Timor-Leste for Reducing Marine Plastics in the East Asian Seas Region Project

National Profile 2

Timor-Leste is part of Timor Island located in the Southeast Asian Region. It is geographically positioned at about 9,017,954 Northing and 800,002 Easting based on World Geodetic System 1984 Universal Transverse Mercator Zone 51S. The country is surrounded to the north by the Ombai and Wetar Straits, part of the Banda Sea, and to the south by the Timor Sea. There are 14 municipalities in Timor-Leste, 12 of which are located along the coast due to its island geography. The municipalities are further divided into 67 administrative posts and 452 sucos (INETL, 2023).

A. Demographic Profile

Timor-Leste had a recorded population of 1,341,737 in 2022, with an average annual population growth rate of about 1.8% from the census period of 2015 to 2022. The population density of the country is about 90 persons/km^2, based on a total land area of about 14,950 km^2 (INETL, 2023).

Considering the population and population growth rate of the country, the population of Timor-Leste in 2024 was projected to reach approximately 1,390,474, with about 86% or 1,193,119 people estimated to reside in coastal municipalities.[1]

B. Economic Profile

In 2022, the total gross domestic product (GDP) of Timor-Leste was $3.205 billion based on current prices, where $1.533 billion is from oil-related GDP,[2] while $1.672 billion is sourced from non-oil-related GDP (INETL, 2023). The non-oil-related GDP is primarily divided into agriculture, manufacturing and construction, and services. The manufacturing and construction sector contributes about 53% of the non-oil-related GDP (**Figure 2**). The leading contributors to non-oil-related GDP are mining and quarrying at 47.3%, public administration at 17.1%, and agriculture, forestry, and fishing at 10.1%. As a low-income country, Timor-Leste recorded a gross national income (GNI) of $3.285 billion in 2022 (INETL, 2023), with a per capita GNI of about $2,448.[3]

1 Population estimation is based on that definition that a coastal municipality is an area in which its boundaries, or a portion of its boundaries, include coastlines, as identified using Geographic Information System (GIS) data.

2 Timor-Leste did not include oil as a local industry until August 2019. Following a new border treaty with Australia, oil-related activities were treated as part of the country's economy (INETL, 2023).

3 Per capita GNI is calculated based on recorded population of 1,341,737 in 2022 (INETL, 2023).

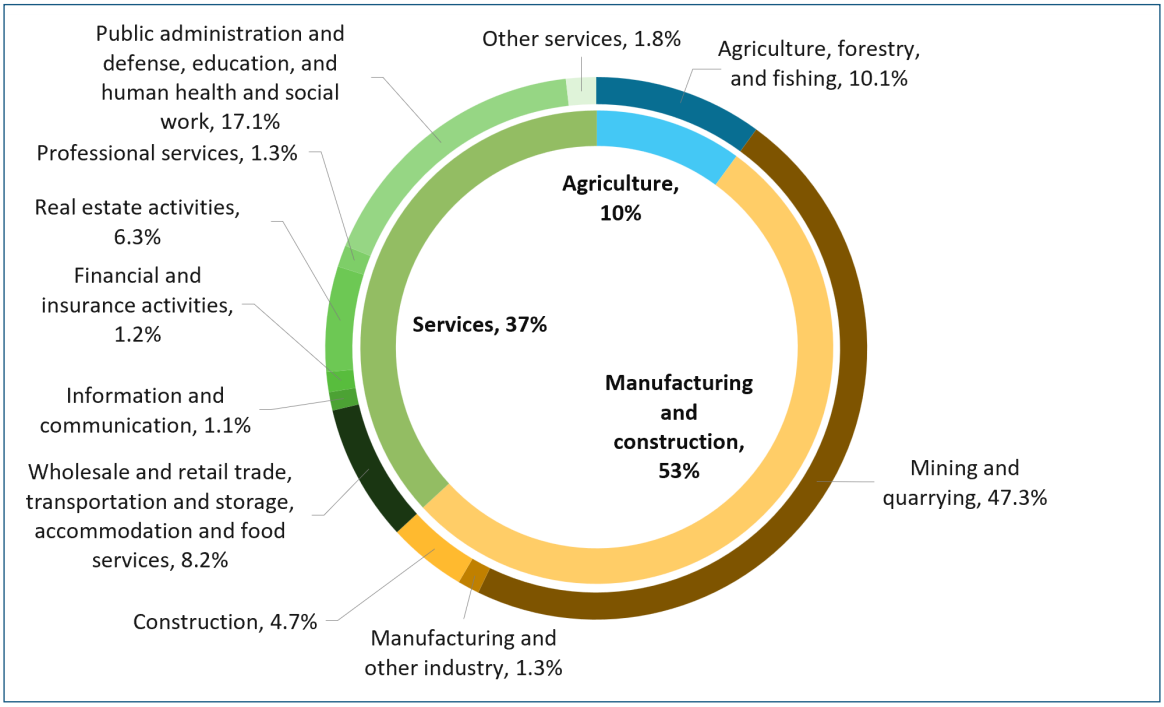


Figure 2. Timor-Leste's Non-Oil-Related Gross Domestic Product Share by Sector in 2022 (INETL, 2023)

In 2011, the Household Income and Expenditure Survey (HIES) revealed that the average monthly household income in Timor-Leste is $377.73, while monthly household expenditure averaged $297.28. A significant portion of household expenditure at about 66.9% was spent on food, and 14.5% was allocated to housing (Ministry of Finance, 2012). In 2022, approximately 36% of the working-age population of 15 years and older, was part of the labor force, with 2.9% of this group being unemployed (INETL, 2023). The proportion of the employed population living below the international poverty line remains a concern, with 29.7% earning below $2.15 per day based on 2017 Purchasing Power Parity (PPP) in 2023 (Asian Development Bank, 2024). The country recorded a Gini coefficient of 0.287 in 2014, indicating a relatively lower level of income inequality compared to other countries in the region (The World Bank Group, 2024).

C. Coastal Areas and Waterways

Timor-Leste has a coastline stretching about 783 km (INETL, 2024), with coastal waters covering approximately 75,000 km^2, including its exclusive economic zone. These waters form part of the Coral Triangle, the world's richest marine eco-region, which contributes to Timor-Leste's marine biodiversity (National Biodiversity Working Group, 2015). The country has designated marine protected areas (MPAs), such as Atauro MPA, covering 132.52 km^2, and Samba Sembilan MPA in Liquiçá which spans about 83.72 km^2 (Coral Triangle Center,

2023). Additionally, the Nino Konis Santana National Park, the country's first national park established in 2007, is also declared as a protected area. The national park covers both terrestrial and marine areas, with about 556 km^2 located within the Coral Triangle, supporting the rich biodiversity of the region (Ministry of Agriculture and Fisheries, 2009).

The country is divided into 12 hydrologic units, comprising of 29 main river systems. These units are grouped based on climatological and physiographical similarities, as well as their proximity to adjacent river basins. While Timor-Leste has over 100 rivers, only 29 of them are considered perennial, with 12 located in the north and 17 in the south. The North Laclo River, the country's longest river, stretches about 80 km and drains into the Wetar Strait in the Municipality of Manatuto. The Loes River, meanwhile, has the largest catchment area of 2,184 km^2, in which about 9% extends to the province of East Nusa Tenggara in Indonesia. The Loes River discharges into Ombai Strait between the borders of Bobonaro and Liquiçá (Ministry of Public Works, 2019).

Many rivers in Timor-Leste are polluted with sewage and waste from households and small industries due to a lack of basic sanitation. A large portion of the population relies on these rivers for domestic uses, such as washing clothes and bathing, which increases the risks of disease outbreaks (Ramos, 2014).

D. Profile of the Local Sites

A summary of the demographic, geographic, and economic profiles of the four study areas is shown in **Table 1**.

Atauro classifies all its sucos as coastal, indicating extensive exposure to marine areas. Except for Dili, all project sites are engaged in agriculture and fishing. Dili, as an urban center, is focused on government services and tourism, while Atauro, an island municipality, also thrives on tourism as a key part of its economy.

Dili has the largest population among the project sites, with about 47% of these living in coastal sucos. Atauro and Liquiçá have the largest population share residing in coastal sucos, at 100% and 62%, respectively.

The project sites are surrounded by river systems, offering essential water sources that sustain major livelihoods. The Comoro River, the largest catchment area in Dili, serves as a crucial water supply for both industrial and domestic needs. The Loes River and Laleia River systems are key to supporting vital economic activities, particularly in fishing and agriculture. These expansive catchment areas hold significant potential for large-scale water resources, contributing to the long-term sustainability of the communities' needs.

Table 1. Summary Profile of Project Sites

Profile	Atauro	Dili	Liquiçá	Manatuto
Total Number of Sucos	5	31	23	31
Total Number of Coastal Sucos	5 (100% of total)	13 (42% of total)	11 (48% of total)	9 (29% of total)
Total Population (2024)	10,607	342,510	87,378	52,089
Total Population in Coastal Sucos (2024)	10,607 (100% of total)	162,168 (47% of total)	54,275 (62% of total)	20,618 (40% of total)
Income Index	Not Available	0.522	0.410	0.406
Major Economic Activities	Agriculture, Fishing, Tourism	Government Services, Finance, Trade, Tourism	Agriculture, Fishing, Livestock	Agriculture, Fishing, Livestock
Major Waterbodies	Banda Sea	Banda Sea, Comoro River	Banda Sea, Loes River	Laclo River Basin, Tukan and Sahen River Basin, Laleia River Basin, Banda Sea, Timor Sea
Length of Coastline	~62 km	~51 km	~61 km	~53 km

National Context and Background of Solid Waste Management

3

A. Policies and Regulations

1. General Waste

Regulations on solid waste management were first established through Decree-Law 3/2012, entitled Legislative Authorization on Environmental Matters, which provides legal authorization to the government of Timor-Leste to create legislation aimed at the protection of the environment (SPREP, 2020).

Building upon this foundation, Decree-Law 26/2012, Basic Law on Environment, establishes governmental responsibilities on effective solid waste management framework including waste collection, transportation and storage, processing, reduction, re-use, and recycling. It emphasizes the duties of public entities and institutional and industrial producers in managing these components of their generated wastes. In addition, this law defines the role of the State in the creation and maintenance of landfills, and the establishment of appropriate treatments for domestic, commercial, and industrial wastewater and sewage effluents (SPREP, 2020).

Solid waste management at the municipal level is reinforced by Decree-Law 3/2016, Statute of Municipal Administrations, which grants municipal administrators the authority to develop and manage water and solid waste systems within their jurisdictions in coordination with the Ministry of Public Works, Transportation, and Communications (SPREP, 2020).

Further strengthening these laws, Decree-Law 2/2017, Urban Solid Waste Management System, approves the urban waste management mechanism in the Municipality of Dili and the remaining 12 municipalities. Under this law, municipalities are required to guarantee that waste generated does not exceed 1,100 L per producer, from domestic and non-domestic sources, and that there exists sufficient collection of waste. This law defines different types of waste including urban green waste, cited in Article 6 as waste from cleaning the gardens of households and public green spaces, and recoverable waste, defined in Article 7 as all types of waste that can be separated and can be transformed into a useful end-product such as packaging materials, paper and cardboard, glass items,

and electrical and electronic equipment (EEE). Article 31 specifies that e-waste collection occurs upon request, at a set time and location, and requires payment. To ensure compliance, fines ranging from USD 50 to USD 115 apply for violations like improper disposal or interference with collection (SPREP, 2020).

Other complementary decree-laws on solid waste management are summarized in **Table 2**.

2. Plastic Waste

The Decree-Law 37/2020 for the Disposal, Import and Production of Bags, Packaging and other Plastics is the country's primary law addressing the management of plastics, covering the vital components of plastic manufacturing, importation, and disposal (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023).

Salient features of the document include prohibiting the use and distribution to the public of single-use plastics that are non-recyclable and are not oxo-biodegradable or oxo-degradable, including cups and lids for disposable cups, cutlery, disposable plates and cups, meal trays, drinking straws, other various packaging for food, bottles for beverages not exceeding 0.5 L in capacity, and garbage bags (Food and Agriculture Organization, 2020). The Decree-Law also mandates that plastic products be manufactured according to good

Table 2. Complementary Decree-Laws Governing Solid Waste Management in Timor-Leste (SPREP, 2020)

Legislation	Brief Description
Decree-Law 33/2008: Hygiene and Public Order	Establishes policy measures regarding hygiene and public order in all urban areas such as not depositing waste in public spaces
Decree-Law 5/2011: Environmental Licensing	Requires environmental licensed holders to conduct a review of the Certificate of Environmental Impact and the Environmental Management Plan submitted to the Environmental Authority for projects which may significantly impact the environment
Decree-Law 5/2016: National System of Protected Areas (SNAP)	States that any abandonment of waste, and damage to protected areas is considered an infringement and is punishable with fines
Decree-Law 18/2004: Private Health Units	Establishes waste management, including collection, storage, and disposal of health-related waste, in private medical units, such as hospitals and clinics, or their subcontractors
Decree-Law 15/2019: Organic Law of the Secretary of the Environment	Establishes the National Directorate of Pollution Control, which covers the monitoring, evaluation, and development of policies related to pollution, and the National Directorate of Climate Change, which focuses on the policy implementation to reduce emissions from chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) gases
Decree-Law 38/2020: Creating the National Authority for Water and Sanitation (ANAS, I.P.)	Proposes the execution of a National Policy in Water Resources to ensure sustainable use and management

production practices to ensure they do not pose a threat to human health or result in hazardous waste at the end of their lifecycle.

To complement these measures, the legislation encourages the utilization of biodegradable or compostable materials instead as an alternative (Food and Agriculture Organization, 2020). Environmental taxes and fees are imposed on importers and purchases of the specified single-use plastics operating within Timor-Leste. The fee applies to single-use plastics and packaging, whether primary or secondary packaging, that are imported or purchased within the country. The environmental tax is applied to single-use plastics and packaging when these are imported into the country or when these are released for consumption, if produced locally. Furthermore, the accountability of the producers on their plastic products are highlighted in Article 6, where it is stated that any economic operators that develops and produces plastic materials are subject to the Extended Producer Responsibility (EPR) and must be responsible for the subsequent waste management of the returned plastic products (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023).

Key articles in the decree-law that are crucial in plastic waste management are summarized in **Table 3**.

Table 3. Articles in Decree-Law 37/2020 (Food and Agriculture Organization, 2020)

Article No.	Brief Description
Article 4	Ban on single-use plastics that are not biodegradable or compostable
Article 6	'Principle of Polluter Pays and Extended Producer Responsibility" application
Article 7	Redesign of plastic products for reuse
Article 8	Redesign of plastic products for recycling and energy recovery
Article 9	General safety requirements on manufacturing, processing, and distribution of plastic products
Article 10	Compliance with good manufacturing practices
Article 12	Establishing and maintaining effective quality control systems in economic activities related to plastics
Article 13	Maintaining documentation containing essential information on manufacturing procedures and processing that are relevant in the assessment of the safety of the product
Article 14	Appropriate and complete labelling of essential information, recycling potential, and use of plastic products
Article 15	Tracking of the production, consumption, and trade of plastic materials
Article 17	List of authorized substances in manufacturing plastic products such as monomers, additives, polymerization adjuvants, and macromolecules, with the exclusion of dyes and solvents
Article 18	Exemptions for unlisted substances in Article 17
Article 19	General requirements in the substances used in the production of plastic layer in single-use plastic materials and articles

Table 3. Articles in Decree-Law 37/2020 (Food and Agriculture Organization, 2020) (cont.)

Article No.	Brief Description
Article 20	Specific requirements in the substances used in the production of plastic layer in single-use plastic materials and articles such as, tolerable limits
Article 21	General restrictions on the released substances of plastic materials and articles
Article 25	Ban on problematic multilayers of plastics
Article 27	Declaration of quality and safety
Article 28	Provision of supporting documents by the producer confirming safety compliance of the manufacturing procedures and substances intended for release

Violations of the decree are subject to fines ranging from USD 100 to USD 1,000 for offenses related to Articles 4, 9, 10, 19, and 21. Violations of Articles 13, 27, and 28 carry fines between USD 500 and USD 5,000 (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023).

While the decree-law is progressive and addresses essential components of plastic management, gaps remain including unclear implementation guidelines and insufficient mechanisms for monitoring compliance, which makes it challenging for local communities to adopt (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023).

In 2018, the "Zero Plastic Timor-Leste" campaign was introduced. This initiative is a national commitment aimed at eliminating plastics in the environment by 2023 through promotion of programs on plastic waste such as bans on plastic bags, strengthening of information and education campaigns to the public, and the boosting of plastic recycling industry. In 2019, the Government of Timor-Leste signed a Memorandum of Understanding (MoU) with Mura Technology for the establishment of a chemical recycling plant. This partnership is foreseen to allow the creation of a sustainable and circular economy for plastic waste (Strom, 2019). On the other hand, the creation of a value-chain to reduce single-use plastics is spearheaded by the Plastic Solutions Alliance (PSA) by bringing together two big companies in Timor-Leste, Heineken and Caltech, a Timorese construction company. The program focused on improving plastic recycling through the development and promotion of upcycled plastic products while strengthening public awareness and education on plastic recycling, supported by several international and national organizations including the United States Agency for International Development (USAID), Mercy Corps, and Korea International Cooperation Agency (KOICA) (USAID, 2021). The two programs on plastic waste are claimed to be geared towards a "plastic neutral Timor-Leste" by 2030. There are currently no updates on the progress of "Zero Plastic Timor-Leste by 2023" campaign.

B. Functional Elements

1. Generation

While a comprehensive national waste audit has yet to be conducted in Timor-Leste, a waste audit was carried out in 2021 in the municipalities of Baucau and Covalima using the Pacific Regional Infrastructure Facility (PRIF) methodology. The audit covered urban, rural, and peri-urban areas across different income groups. The results indicated that household waste generation ranges from 0.25 kg/cap/day to 1.14 kg/cap/day, with plastic waste making up about 11% of the total household waste stream. Non-household waste, primarily from businesses, showed waste generation rates ranging from 1.6 kg/business/day to 15.8 kg/business/day, with plastic waste accounting for 19% of the total (SPREP, 2022). The average municipal waste generation rate of Timor-Leste, based on the waste audits, is estimated at 172 kg/cap/year or about 0.47 kg/cap/day (SPREP, 2023). Plastic waste constitutes about 6.63% of the overall municipal solid waste composition, excluding single-use plastics and other materials with plastic components (**Figure 3**).

A recent study further estimated that the per capita waste generation rate in Timor-Leste is at 0.53 kg/cap/day, with plastic waste generated at 0.06 kg/cap/day (Cottom, Cook, & Velis, 2024). These estimates were derived from machine learning models through a local-to-global approach.

2. Segregation

There is no national data available on waste segregation practices in Timor-Leste. The study conducted in Baucau and Covalima in 2021 revealed varying levels of segregation among households. In urban areas, all households segregate organic waste, but the majority do not separate recyclables such as cardboard, plastics, and metal cans. In contrast, most rural households segregate key recyclables, but less than half segregate organics (**Table 4**). The study also noted that the absence of recycling markets in the area made the purpose of segregation unclear, though it appeared to be linked to improving the efficiency of waste burning or, in some cases, recovering containers for repurposing (SPREP, 2022).

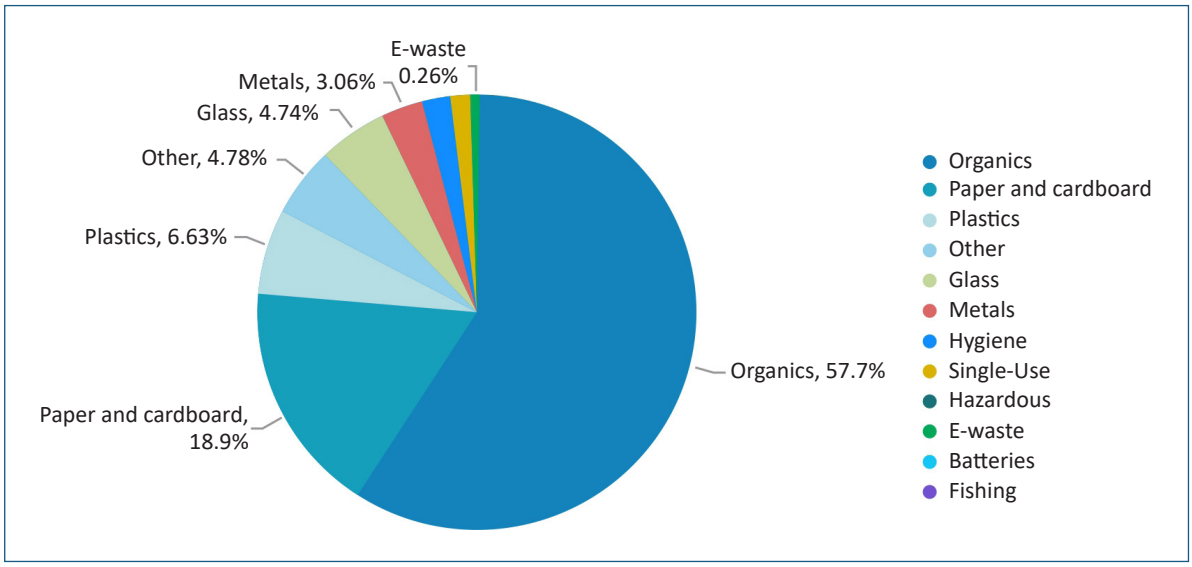


Figure 3. Timor-Leste Municipal Solid Waste Composition (SPREP, 2023)

Table 4. Levels of Household Waste Segregation in Baucau and Covalima (SPREP, 2022)

Material Type	Urban	Peri-Urban	Rural
Organics	100%	45%	48%
Cardboard and Paper	21%	47%	57%
Plastics	21%	50%	73%
Aluminum and Steel Cans	24%	65%	83%

A separate study conducted in 2018 involving 431 households in four administrative posts in Dili indicated that only about 46% of households practice waste segregation. The most segregated materials were organics, cans, glass, plastics, and paper. Organic waste was reused for animal feed by 31% of households and as fertilizer by 27%. Among the households that segregated waste, 72% sold cans (Da Costa & De Jesus, 2018).

Household waste and non-household waste are temporarily disposed of in bak sampah, which are communal brick-and-mortar waste containers that serve as collection points along roadsides near public spaces (Figure 4). These containers are usually not enclosed, making waste, especially plastics, susceptible to dispersal by natural elements such as wind. Despite efforts at segregation in some households and non-households, waste is often mixed at these communal waste bins.

Figure 4. A Communal Waste Bin, a Bak Sampah, in Dili (November 14, 2023)

3. Collection

Waste collection services in Timor-Leste are primarily managed by the Ministry of State Administration. In the Municipality of Dili, waste collection services are contracted by the Dili District Administration to private operators for the management of daily waste collection. The cost for the services is approximately USD 60 to USD 65 per truck per day, which covers vehicle rental, fuel, and staff costs. Waste is typically collected daily along communal collection points, but illegal dumping and burning remain widespread (Asian Development Bank, 2014).

In other adjacent municipalities, such as Atauro, Liquiçá, and Manatuto, waste is either collected directly from houses or at designated collection points, contained in sacks, plastic bags, or boxes. The frequency of waste collection varies depending on the necessity and resources of the municipality, with some areas having two trips per day of collection. Municipal solid waste is either collected by government-owned waste collection trucks or hauled by contracted private companies prior to disposal to their respective facilities. Due to limited road access and resources, some villages remain unreached by these waste collection services, forcing the community to resort to backyard burying and open burning. To address this problem, a few programs aiming to discourage improper waste disposal, such as the establishment of designated areas for waste management and

burying in households, were implemented by these municipalities.

In municipalities on the south coast and away from the Tibar dumpsite, formal waste collection systems are often absent. This situation forces communities to manage waste themselves through improper waste disposal practices, contributing to environmental challenges (Ray, 2021).

4. Recovery

The waste audit conducted in 2021 revealed a significant share of dry materials that can be potentially recycled. Composition of household and non-household municipal solid waste reveals generation of plastic, at about 6.63%, paper and cardboard, at 18.9%, and glass items, at 4.74% (SPREP, 2023). Collectively, these values present significant opportunities to invest in research and development of effective waste diversion efforts.

Currently, waste recovery efforts in Timor-Leste are primarily driven by private companies and small businesses that focus on recycling various types of materials. However, most of these initiatives are concentrated in Dili, where recycling operators focus on recyclable plastics, metals, glass, and paper (**Table 5**). These materials are repurposed into accessories, bags, and art objects, while some companies specialize in specific waste streams, such as aluminum and rubber tires, helping divert recyclable materials from disposal sites.

Aside from private-sector initiatives, broader national efforts have also been launched to address plastic waste. In 2018, the "Zero Plastic Timor Leste" aimed to eliminate plastics from the environment by 2023 through measures such as bag bans, awareness raising activities, and the development of a plastic recycling industry (SPREP, 2023). Complementing this, the Plastic Solutions Alliance (PSA) aims to minimize the use and improper disposal of plastic (Section III.A.2), focusing on educational programs, recycling bin installations, small business support, and the establishment of a commercial-scale plastic recycler (Morse, 2022). While these programs have contributed to plastic waste reduction, their overall impact has been modest, and the "Zero Plastic Timor Leste" campaign has not fully achieved its intended goals yet.

Table 5. Recycling Operators in the Municipality of Dili (JICA, 2024)

Company	Accepted Materials
Caltech	Plastic, glass, paper
Besi Tua, Unipessoal Lda.	Metal (focusing on aluminum)
HPC Scrap Metal Unipessoal Lda.	Metal
Mr. Miggy (individual dealer)	Metal
Reloka	Glass, paper, other waste (tires)
ENVAC	Plastic
Conservation International Timor-Leste	Plastic
Tiwomen Ecojewelry	Plastic

Recognizing the importance of long-term behavioral change, initiatives such as the "Green School" program was introduced to promote environmental awareness. The initiative was launched in 2016 through a collaboration of multiple stakeholders, including the national government, which incorporates practices such as upcycling and waste segregation into school curricula (Fátima, 2022; TATOLI, 2021). Initially implemented in Dili, Manatuto, Manufahi, Bobonaro, Covalima, and Liquiçá, the program expanded in 2022 to include Baucau, Lautem, and Viqueque (Fátima, 2022).

Despite various waste management efforts, significant gaps remain in assessing the waste recovery and recycling initiatives. Data on the total quantity of recyclable materials recovered by facilities remain limited, and the national recovery rate has yet to be calculated (SPREP, 2023). Moreover, while informal waste collectors play a crucial role in waste diversion by collecting, sorting, and reselling valuable materials, the lack of documentation on their operations makes it challenging to quantify their overall contribution to national recycling efforts.

5. Disposal

Timor-Leste mainly relies on uncontrolled facilities, such as open dumpsites, as its main form of waste disposal. Tibar dumpsite, located in Liquiçá and managed by the Dili District Administration, serves as the only formal landfill in the country of Timor-Leste (SPREP, 2022). The whole facility, servicing the municipalities of Dili and Liquiçá, spans 22 hectares and includes both an open dumpsite and a sanitary landfill under construction, with the operational dumpsite covering 11 hectares (JICA, 2024). The facility only accepts municipal solid waste. However, incinerated healthcare waste from national hospitals and community health centers in the municipality is disposed of in this facility as well. Plans to transform the open dumpsite into an engineered sanitary landfill, equipped with essential facilities for waste management and treatment, are currently underway (JICA, 2024).

In other municipalities across Timor-Leste, open and uncontrolled dumpsites are utilized as final disposal sites for municipal solid waste (**Table 6**).

The inconsistent waste collection results in communities resorting to environmentally unsafe practices of disposal such as burning, open dumping, and backyard burying. Despite existing regulations on landfill maintenance and urban waste management, the weak enforcement and poor infrastructure hinder effective implementation.

Table 6. Disposal Facilities in Timor-Leste (SPREP, 2022; JICA, 2024)

Location	Facility Name/Village	Facility Type	Ownership
Atauro	Beloi	Open dumpsite	Unknown
Baucau	Bahu; Trilolo	Open dumpsite	Unknown
Covalima	Haemanu	Pit disposal	Private
Dili	Tibar Dumpsite	Controlled open dumpsite	Government
Liquiçá	Tibar Dumpsite	Controlled open dumpsite	Government
Manatuto	Dolak-Wain	Open dumpsite	Government

Overview of Solid Waste Management of the Local Sites

4

A. Policies and Regulations

1. General Waste

There are no established policies for managing general waste in the local sites. However, existing decree-laws, including Decree-Law 26/2012, Decree-Law 3/2016, and Decree-Law 2/2017, provide a framework to guide each municipality in developing policies for the effective management of solid waste (Section III.A.1). Particularly in Dili, the Investment Strategy for the Management of Solid Urban Waste outlines the investments and policies that are needed to improve waste collection services in the municipality (SPREP, 2020).

2. Plastic Waste

Policies on plastic waste management are primarily established at the national level (Section III.A.2). While there are no documented policies addressing plastic waste at the local level, existing regulations and programs, such as Decree-Law 3/2020 and the Zero Plastic Timor-Leste campaign, provide a framework to help local communities in developing targeted plastic waste management actions with support from the national government.

B. Institutional Framework

1. Institutional Arrangement

At a national level, the Ministry of State Administration (MSA) is the office responsible for overseeing solid waste management, including developing infrastructure plans and policies, and providing technical and financial assistance for infrastructure developments at local level, as delegated to respective municipal authorities.

The Municipal Services for Water, Sanitation, and the Environment (SMASA) manages waste in the municipalities of Dili, Liquiçá, and Manatuto, while the Public Service Works, Transport, Water, Sanitation and Environment (SOPTASA) handles the waste management in Atauro.

Several key offices support the role and functions of MSA, ensuring the productive development and effective implementation of policies and programs related to solid waste management (**Table 7**).

Table 7. List of Relevant Offices Related to Solid Waste Management in Timor-Leste (JICA, 2024; SPREP, 2022)

Responsible Office	Role and Function
Ministry of Infrastructure	• Oversees the provision and maintenance of sanitation services in urban and rural areas • Working closely with MSA regarding solid waste management systems
Ministry of Economy and Development	• Manages pollution control and management of hazardous waste • Regulates private and commercial sector usage of sanitation services, goods, and installations
Ministry of Education	• Ensures the integration of hygiene and sanitation education into school curricula • Oversees the development and maintenance of sanitation facilities in schools
Ministry of Tourism and Environment	• Monitors hygiene and sanitation systems in tourist destination, commercial establishments, and industrial areas
Ministry of Finance	• Allocates and manages budget that aligns with national and local policies
Ministry of Social Solidarity	• Provides support and assistance to vulnerable communities in accessing hygiene and sanitation facilities
Ministry of Health	• Develops, evaluates, and implements policies related to sanitation systems at the national and district level • Establishes guidelines for medical waste management, healthcare access, and technical support

2. Facilities and Resources

Each municipal government in all sites maintains a few facilities and equipment (**Table 8**). However, the existing infrastructure remains limited, which poses challenges to ensure effective waste management.

Table 8. Facilities and Resources in Solid Waste Management in Timor-Leste Sites

Municipality	Component			Total Personnel in Various Roles and Offices
	Collection[a]	Recovery	Disposal	
ATAURO	• 1 Collection Truck	• No documented municipality-managed recovery facility or storage for recyclables	• Uncontrolled facilities (open dumpsites)	• No available data on total personnel

Table 8. Facilities and Resources in Solid Waste Management in Timor-Leste Sites (cont.)

Municipality	Component			Total Personnel in Various Roles and Offices
	Collection[a]	Recovery	Disposal	
DILI[b]	• About 8,000 waste bins • 145 Metal Containers for Skip • 16 Compactor Trucks • 10 Hook Lift Trucks • 3 Dump Trucks • 2 Container Washing Trucks • 2 Truck Mounted Vacuum Sweeper • 10 Motor Tricycles	• No documented municipality-managed recovery facility or storage for recyclables	• 1 uncontrolled facility (open dumpsite) • 1 sanitary landfill (ongoing construction)	• 195 total personnel
LIQUIÇÁ	• No available data on facilities and equipment	• No documented municipality-managed recovery facility or storage for recyclables	• 1 uncontrolled facility (open dumpsite) • 1 sanitary landfill (ongoing construction)	• No available data on total personnel
MANATUTO	• 1 Dump Truck (6 m^3)	• No documented municipality-managed recovery facility or storage for recyclables	• 1 uncontrolled facility (open dumpsite)	• 38 total personnel

[a] As of January 2025
[b] Data for Dili Municipality was gathered from the Final Report on Data Collection Survey on Solid Waste Management published by JICA (JICA, 2024)

The budget allocation for solid waste management sees a rising trend from 2023 to 2024 in all sites (**Table 9**). The increased budget in 2025 accounts for the rental of a vehicle truck in Manatuto, the purchase of cleaning equipment and a collection truck in Atauro and acquiring of waste bins and the hiring of additional personnel for waste management in Liquiçá. In Dili, the higher budget covers the purchase of 25 additional collection trucks and the establishment of a Project Management Unit (PMU) to oversee collection of waste, transport to the disposal site, and the construction and maintenance of waste facilities.

Table 9. Latest Budget Allocation for Solid Waste Management in Timor-Leste Sites

Municipality	Latest Budget Allocation (in USD)	
	2024	2025
Atauro	10,368	10,000
Dili	3,746,380[a]	4,229,898
Liquiçá	17,680	30,938
Manatuto	10,368	13,040

[a] From 2023 data (JICA, 2024)

3. Stakeholder Participation

The urban activities in Dili Municipality result in higher waste generation, requiring more stringent programs to prevent waste leakage. The municipality government actively collaborates with international non-governmental organizations (NGO) and community-based organizations (CBO) to develop and implement effective solid waste management programs. Academic institutions like Universidade Nacional Timor Lorosa'e (UNTL) and Oriental University of Timor Leste (UNITAL), through partnerships with the municipality government, serve as research centers to explore innovative technologies and sustainable methods to improve waste management in the municipality. Private recovery centers and recycling facilities play a crucial role in supporting the recovery and diversion of recyclables.

There may be less stakeholder involvement in the municipalities of Atauro, Liquiçá, and Manatuto due to limited accessibility. Since these areas are more isolated than Dili, efficient implementation and adoption of waste management solutions are hindered by logistical constraints and financial limitations.

C. Functional Elements

1. Generation

Besides Dili, there are no documented information on the average daily waste generation in the municipalities of Atauro, Liquiçá, and Manatuto.

A waste amount and composition survey in 2024 reveals that households in the urban areas in Dili reported a waste generation rate (WGR) of 0.71 kg/cap/day, while in rural areas, a household WGR is found at 0.57 kg/cap/day. Soil and dirt, at 22%, food waste, at 16%, and garden waste, at 13%, make up most of the waste generation in Dili. Recyclable plastics were found at about 8% (JICA, 2024).

In the remaining three local sites, plastic bottles, steel, and aluminum cans are the dominant non-biodegradable waste types generated with households, market, and hospitals as the primary contributors to the overall waste stream in the municipality.

2. Segregation

Currently, there is no existing segregation policy in all local sites. In Atauro, waste segregation is done to separate agricultural waste and garden waste intended for burning. In the other sites, mixed waste is continuously collected and delivered to their respective disposal sites.

3. Collection

Unserved areas for collection[4] on all sites pose a major challenge. In Atauro, waste collection covers four out of five sucos, reaching 12 of 19 sub-villages. In Dili, 24 of 31 sucos have access to collection. In Liquiçá and Manatuto, only 22% and 13% of the sucos, respectively, receive waste collection services (**Figure 5**).

Waste is usually placed in front of households and at communal collection points, which are open brick-and-mortar structures. Waste left outside homes is often contained in sacks, plastic bags, or makeshift containers such as boxes.

In Dili's new collection and transportation system which has been operational since August 2024, waste bins have been installed in various areas within the covered sucos, serving as common collection points. Collection from these bins has now become the primary method of waste collection in the municipality.

The infrequent collection, particularly in the municipalities of Liquiçá and Manatuto with two times a week and three times a week collection schedule, respectively (**Figure 6**), leads to environmentally unsafe waste disposal practices such as burning, burying in the ground, and dumping into the open environment. Moreover, while daily collection is implemented in Atauro and Dili, this does not guarantee that waste from all households is collected.

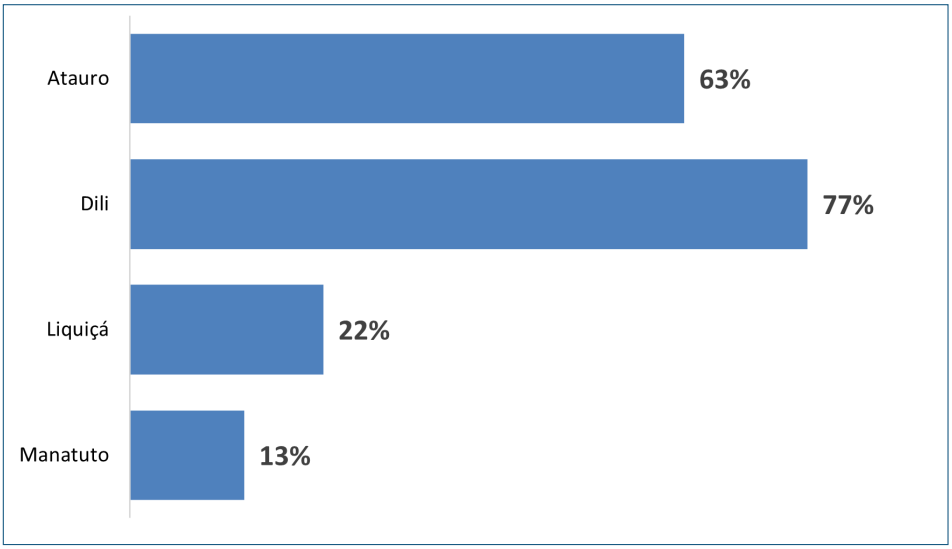


Figure 5. Collection Coverage in Timor-Leste Sites

[4] Collection coverage in this report refers to the percentage of sucos provided with waste collection services. This does not necessarily imply, however, that all residents in the covered sucos have access to the service, as collection vehicles may not reach all areas due to route limitations and other logistical challenges.

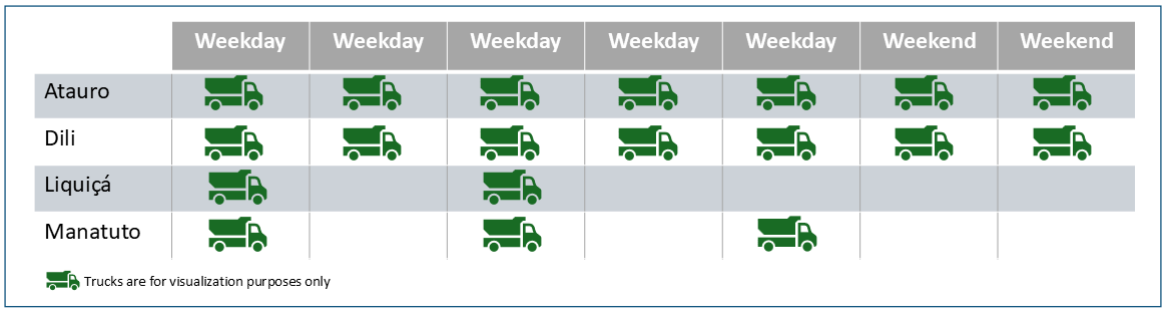


Figure 6. Waste Collection Schedule in Timor-Leste Sites

These collection challenges in local sites can be attributed to the limited number of collection trucks, as seen in Atauro and Manatuto. In Dili, the reliance on main collection points may be seen as inconvenient by some households, leading them to dispose of waste in the open environment rather than delivering their waste to the designated points. Additionally, the unsecured packaging of waste for collection increases the risk of leakage.

4. Recovery

All local sites face major challenges in recovering recyclable materials. There are no documented municipality-managed recovery and recycling facilities for common recyclables. Aluminum cans and metals are deemed materials of high value, which further limits potential to recovery other recyclables like plastics. In Atauro and Manatuto, informal waste collectors typically gather aluminum cans to sell in Dili. About 30 to 40 waste pickers are allowed to gather recyclables in Tibar dumpsite (Section III.B.5) (JICA, 2024). However, since steel and aluminum cans are seen as high-value materials, the focus of recovery is primarily on these items, leaving most recyclable plastics in the landfill.

In Dili, plastic recycling is concentrated at a single private facility, Caltech, which produces pavers and landscape boards from plastic, paper, and glass waste. Smaller private recovery facilities primarily sell their materials to Caltech. Caltech actively collaborates with the national government and private organizations in promoting the production and sale of recycled products.

A small step towards plastic recovery is the Green School Program, initiated by the Ministry of Tourism and Environment. Except for Atauro, this program is implemented in Dili, Manatuto, and Liquiçá (Section III.B.4), integrating environmental education into school curricula including recycling workshops, tree planting, and regular cleanups (JICA, 2024). One notable outcome is the repurposing of polyethylene terephthalate (PET) bottles into foundational eco-bricks, which are primarily used in schools.

The municipalities continue to face challenges in the recovery of recyclables, exacerbated by the absence of segregation policy and an inefficient collection system. The poor solid waste management infrastructure leads to most waste being discarded in landfills or disposal facilities, or left in the open, ultimately making its way into marine environments.

5. Disposal

All local sites rely on uncontrolled facilities for waste disposal. Wastes from the municipalities of Liquiçá and Dili are delivered to Tibar dumpsite, while Atauro and Manatuto, dump at Beloi Village and Lixeira Dolak Wain, respectively. Currently operating as an open dumpsite, Tibar dumpsite has been in operation since 1987 (JICA, 2024).

As open dumpsites, these facilities lack the essential environmental protection measures such as leachate collection and treatment, gas collection, stormwater drainage, and liner facility, which are necessary to prevent waste leakage into the environment. Due to low collection frequency and coverage, communities resort to improper forms of disposal such as burning, dumping into the open environment, and burying in the ground. These harmful practices not only worsen waste leakage but also heighten the risk of plastic pollution entering marine ecosystems.

Acknowledging the immediate need to address improper disposal practices, the Tibar dumpsite is being upgraded into a sanitary landfill. The upgraded disposal facility will have designated cells for municipal solid waste and hazardous waste. Additionally, future plans include establishing composting and sorting activities outside the landfill (JICA, 2024).

To address increasing waste generation and the growing demand for a sustainable and safe disposal facility, the Project Preparation & Implementation Programme for Timor-Leste (PPIP) launched a project for integrated solid waste management for collection, transport, and disposal. This initiative proposes the development of two regional sanitary landfills outside of Dili Municipality to supplement the Tibar dumpsite. One identified suitable site is located near the Baucau, which will then receive waste from Manatuto (PPIP, 2022). The current open dumpsite in Manatuto will be turned into a transfer station. As of April 2024, geotechnical investigations have been conducted at the proposed site in Baucau (PPIP, 2024).

Waste disposal areas in Dili.

Methodology 5

A. Plastic Analysis and Characterization Study (PACS)

The Plastic Analysis and Characterization Study (PACS) adopted the methods of the Waste Analysis and Characterization Study (WACS) guidelines from the National Solid Waste Management Commission (NSWMC) of the Philippines (NSWMC, 2020) and the Waste Wise Cities Tool (WaCT) by the United Nations Human Settlements Programme (UN-Habitat) with focus on plastics. Due to the unavailability of related methodology in Timor-Leste, leveraging on the established methodology from the Philippines ensure standardization and consistency in baseline assessments for both countries.

The most appropriate survey areas or the top three plastic pollution hotspots in the municipalities were selected based on discussions with local government officials, primarily considering the availability of resources and accessibility.

Waste generation is categorized into household and non-household sources. For household sources, the standard formula from the WACS guidelines was used to determine the number of households that can be sampled (**Equation 1**).

$$n = \frac{\frac{z^2 \cdot P(1-P)}{e^2}}{1 + \left(\frac{z^2 \cdot P(1-P)}{Ne^2}\right)}$$

Wherein,
n = representative number of households
N = total number of household generators per subcategory
z = 1.96 for 95% confidence level
P = 20% standard deviation = 0.20[5]
e = 10% margin of error for Highly Urbanized Cities (HUCs), 1st to 6th class municipalities[5]

Equation 1. Standard Formula for Sampling of Households (NSWMC, 2020)

The number of household samples for the three selected sucos[6] is calculated using ratio and proportion (**Equation 2**). However, adjustments were made based on the availability of resources, logistical convenience, and discussion with the municipal government and suco/village chiefs. An additional 10% contingency was included in case some of the cooperators were not able to consistently provide their waste during the PACS sampling period.

$$number_{barangay} = n \cdot \frac{number\ of\ households_{barangay}}{number\ of\ households_{three\ barangays}}$$

Equation 2. Computing for the Sample Size per Barangay

[5] The constants used in the Philippine sites based on the Philippine guidelines were utilized in Timor-Leste sites to adopt the same methodology and since a more accurate data is unavailable.

[6] A coastal suco is defined as a suco where its boundaries, or a portion of its boundaries, include coastlines. In this report, the classification of sucos as coastal sucos is determined using Geographic Information System (GIS) data.

For non-households, there must be at least one representative of the most dominant sub-categories. The recommended number of non-household samples for each category are summarized (**Table 10**) as adopted from the methods of WaCT to maximize the resources of the project (UN-Habitat, 2021). Fishing activities are prevalent in coastal communities; however, fish ports are not typically considered from the recommended sample size for non-households within the WaCT guidelines. The WACS guidelines were used to address this, as it provides the recommended unit for industries based on area (NSWMC, 2020).

The required materials for the PACS activity such as personal protective equipment (PPE), weighing equipment, tools for sample collection and sorting, health and sanitation kits, and other essential materials were procured. In addition, a local team consisting of a team leader, safety officer, logistics-in-charge, sorters, collection in-charge, recorders, interviewers, and photo-documenters, was formed for the conduct of PACS in the three identified coastal sucos.

A training session on PACS was held on November 15, 2023, to equip relevant local governments, national government agencies, non-governmental organizations, and interested youth groups from the partner sites with the necessary knowledge and skills for the implementation of PACS. The session aimed to orient participants with a comprehensive understanding of PACS procedures, protocols, and their respective roles.

Table 10. Sample Size for Non-Households

Type of Establishment (Generator)	Recommended Unit / Information Needed	Recommended Number of Establishments for Sampling	Comment
Hotel	Number of beds	2	Assessed separately from a shopping center or restaurant
Food Establishment	Number of tables/chairs (seating capacity)	2	-
School	Number of students	2	Assessed the canteen separately as restaurant
Office	Number of employees or square meters	2	Assessed the canteen separately as restaurant
General Store	Number of stalls or square meters	1	-
Market	umber of stalls or square meters	1	-
Health-Related Institution	Number of beds	1	-
Fish Port and Dock Area	Square meters	1	Added for the purpose of this marine plastic study

Following the national training, a local training session for the local PACS team was held a day before the start of the PACS activities. This training further honed their readiness and competence to enable them to contribute effectively to the execution of PACS. An orientation with the PACS household and non-household cooperators who agreed to participate in the study was also held on the same day as the local training. The aim of the orientation is to inform the cooperators about their responsibilities and the important instructions to remember. After the orientation, color-coded plastic bags were distributed to the cooperators. Additionally, the cooperators who failed to attend the event due to conflict on schedule were visited to provide them with their orientation materials and plastic bags for PACS.

The activity proper was conducted over three consecutive days, including a one-day trial or dry run prior to the actual PACS, to save on resources while still covering recommended variations in days such as a market day, a weekend, and an ordinary day or weekday (NSWMC, 2020). Each participating household and establishment were given a total of 12 color-coded plastic bags wherein three plastic bags were used each day to represent the different waste categories for the 4-day PACS. The plastic bags were collected every morning on the day after the waste has been generated. In the sorting area, the set of trash bags were sorted per source into categories and placed in respective containers. The sorted waste was disposed accordingly based on the agreed disposal plan.

Processing and analysis of data gathered during the 4-day PACS include the calculation of the household WGR, which represents the amount of waste that the average resident of a locality generates in a day (**Equation 3**). This WGR is used to estimate the total waste generation rate of the study area and the projected future waste generation amounts. The plastic WGR for each household is computed using the amount of collected plastic items from the sample (**Equation 4**).

$$WGR_{household}[kg/cap/day] = \frac{\sum collected\ household\ wastes\ [kg]}{\sum household\ members\ [cap]\ \mathbf{x}\ number\ of\ sampling\ days\ [day]}$$

Equation 3. Formula for Computing Household Waste Generation Rate (NSWMC, 2020)

$$PlasticWGR_{household}[kg/cap/day] = \frac{\sum collected\ household\ plastic\ wastes\ [kg]}{\sum household\ members\ [cap]\ \mathbf{x}\ number\ of\ sampling\ days\ [day]}$$

Equation 4. Formula for Computing Household Plastic Waste Generation Rate

The calculation for the non-household general waste WGR and plastic WGR follow a similar pattern as the household calculation by dividing the collected samples by the number of units and sampling days (**Equation 5** and **Equation 6**).

$$WGR_{non\text{-}household}[kg/cap/day] = \frac{\sum collected\ non\text{-}household\ wastes\ [kg]}{number\ of\ units\ \text{x}\ number\ of\ sampling\ days\ [day]}$$

Equation 5. Formula for Computing Non-Household Waste Generation Rate

$$PlasticWGR_{non\text{-}household}[kg/cap/day] = \frac{\sum collected\ non\text{-}household\ plastic\ wastes\ [kg]}{number\ of\ units\ \text{x}\ number\ of\ sampling\ days\ [day]}$$

Equation 6. Formula for Computing Non-Household Plastic Waste Generation Rate

From these preliminary equations, the total household WGR of a survey area is determined by multiplying the calculated WGR and the corresponding latest available population of the area (**Equation 7**) while the total non-household WGR is computed by getting the summation of the products of the calculated WGR and the respective total units based on the recommended units for the different non-household sources (**Equation 8**).

$$Waste\ Generation_{household}[kg/day] = WGR\ \text{x}\ Population$$

Equation 7. Formula for Daily Household Waste Generation

$$Waste\ Generation_{non\text{-}household}[kg/day] = \sum \left[WGR\ (kg/cap/day)\ \text{x}\ Total\ No.\ of\ Units \right]_{sub\text{-}category}$$

Equation 8. Formula for Daily Non-Household Waste Generation

The corresponding plastic waste generation for households and non-households can be quantified by the product of the corresponding daily waste generation and the calculated plastic composition (**Equation 9**).

$$Plastic\ Waste\ Generation\ [kg/day] = Daily\ Waste\ Generation\ (kg/day)\ \text{x}\ Plastic\ Composition\ (\%)$$

Equation 9. Formula for Daily Household and Non-Household Plastic Waste Generation

The total daily waste generation of the survey areas is the sum of the total household and non-household waste generation (**Figure 7**). It should be noted, however, that the non-household waste generation is limited to a number of establishments considered in this study, which may not reflect other types of non-household sources that may be operating in a survey area.

Weight for each waste category is recorded and expressed as a percentage of the total waste composition. Estimated percentages and values are rounded to the nearest whole number. In this case, when the values and percentages presented in this report are added together, they may not exactly match the subtotals and totals shown. Additionally, the national averages for PACS results were calculated as weighted averages based on population sizes of the surveyed coastal sucos.

B. Knowledge, Attitude, and Practice (KAP) Survey

Understanding the public's concern, socio-economic conditions, knowledge, and behaviors regarding household solid waste management is fundamental for developing effective interventions, as household waste constitutes a significant part of municipal solid waste. To gain insights into public perceptions and behaviors, a knowledge, attitude, and practice (KAP) survey is conducted. The survey results can support the efforts of policymakers and stakeholders in developing interventions that promote public participation to complement the improvement of waste management infrastructure (Badrum & Mapa, 2020; Treyes, et al., 2023).

The KAP survey, developed by AMH Philippines, Inc., involved households that have previously

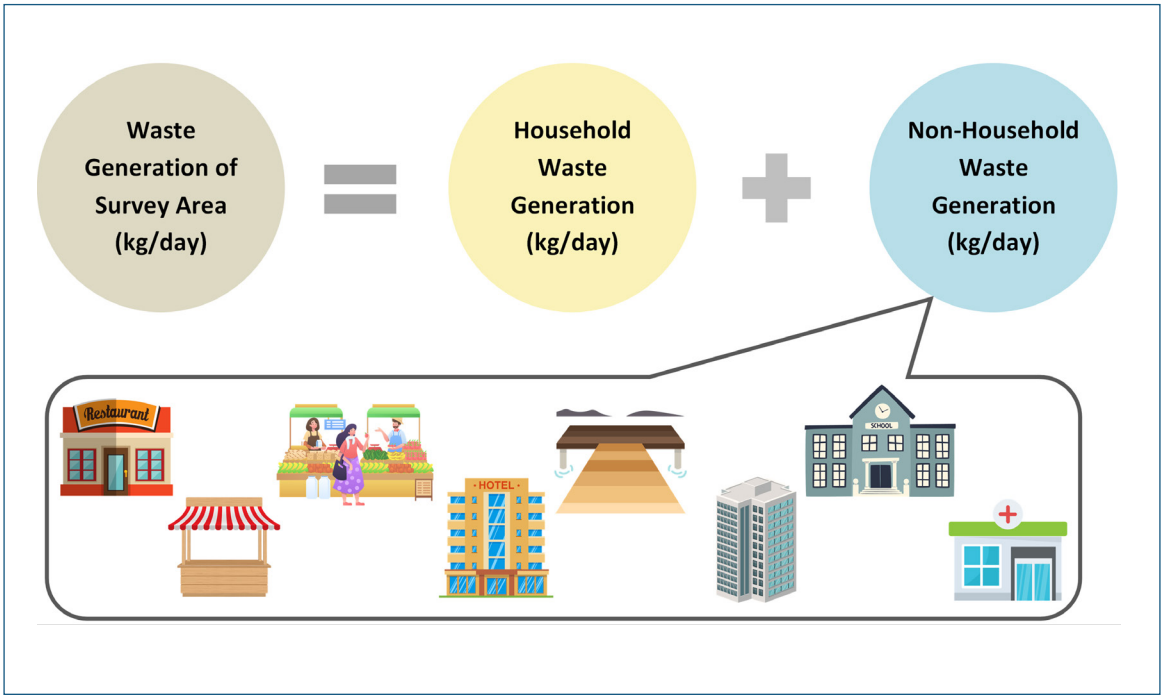


Figure 7. Calculation of the Total Daily Solid Waste Generation of a Survey Area

participated in PACS. Participants answered a structured questionnaire that collects demographic information and details on their waste management practices, such as generation, segregation, collection, recovery, and disposal. The questionnaire features a mix of closed-ended questions for collecting quantitative data and open-ended questions to gather qualitative insights. Data gathered through the survey is analyzed using descriptive statistics, which facilitate a detailed assessment of prevalent waste management behaviors and pinpoint areas that require attention, thereby guiding the development of targeted and data-driven waste management strategies.

The national averages were obtained through the weighted average from the KAP results of all project sites, in consideration of the population of surveyed areas.

Synthesized Results of Plastic Analysis and Characterization Study (PACS)

6

The analysis and characterization of waste in the three surveyed coastal sucos at each site revealed that the combined household and non-household WGR ranges from 0.33 kg/cap/day to 0.57 kg/cap/day. The primary categories of general waste include biodegradable waste, recyclables, and residuals with potential for recycling.

Specifically for plastic waste, the combined household and non-household plastic WGR in the surveyed sucos is reported to be between 0.07 kg/cap/day and 0.18 kg/cap/day. The plastic waste is mostly comprised of PET items, diapers and napkins, and polypropylene (PP) items.

The general weather conditions during the conduct of the study are clear and sunny skies, with some rainfall observed on one sampling day for Atauro and Manatuto.

A. Household Waste Generation and Composition

A total of 249 households consisting of 1,667 individuals were included in the survey from the four sites of Timor-Leste.

1. Generation

The average household waste generation rates across the surveyed coastal municipalities in Timor-Leste range from 0.27 kg/cap/day to 0.50 kg/cap/day (**Figure 8**). Among the sites, Manatuto exhibits the lowest WGR, while Atauro records the highest. The national average for household general waste generation, based on a weighted average from the four coastal municipalities, is calculated at about 0.38 kg/cap/day.

In a similar way, the plastic WGRs among the households show variation, ranging from as low as 0.05 kg/cap/day in Dili and Manatuto to as high as 0.16 kg/cap/day in Atauro. The national average based on the four sites is about 0.06 kg/cap/day.

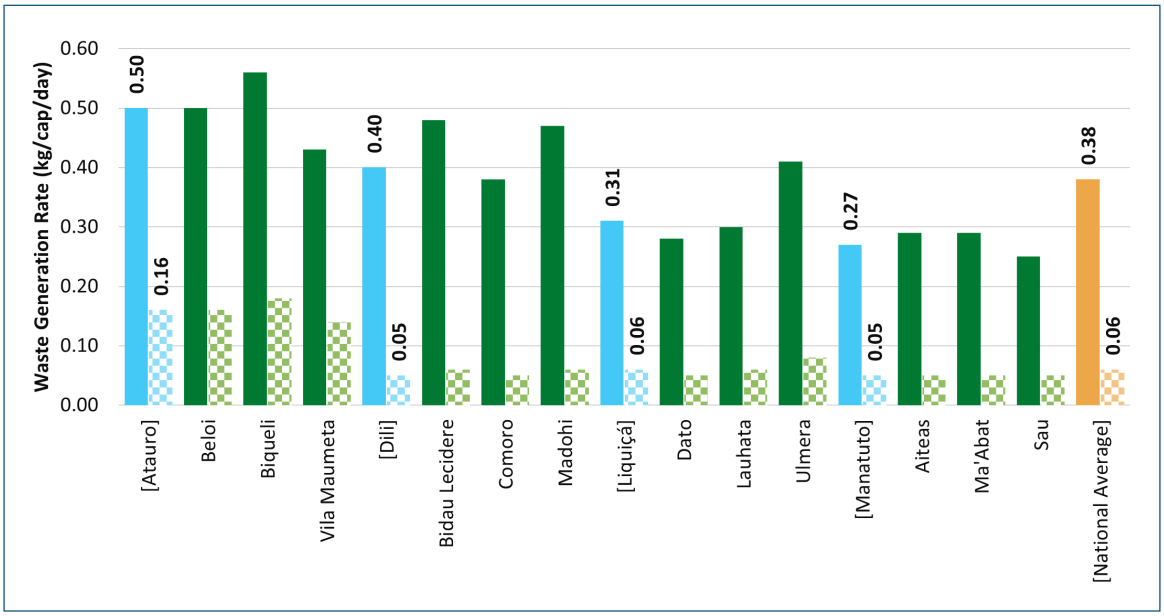


Figure 8. Household General and Plastic Waste Generation Rates (kg/cap/day) of Surveyed Coastal Sucos in Timor-Leste Sites

2. Composition

The general household waste composition across surveyed Timor-Leste sites shows that biodegradable waste is the dominant category in all locations except in Liquiçá, where recyclable waste is the most prevalent (**Figure 9**). Among the sites, Dili has the highest proportion of biodegradable waste at 64%. Recyclable waste constitutes between 21% to 44% of household waste, while biodegradable waste accounts for 58% to 64%. The weighted average based on these four sites indicates that biodegradable waste makes up about 55% of household waste, followed by recyclable waste at 26%, and residuals with potential for recycling at 11%. These findings underscore significant opportunities for waste recovery and diversion, particularly through improved recycling initiatives.

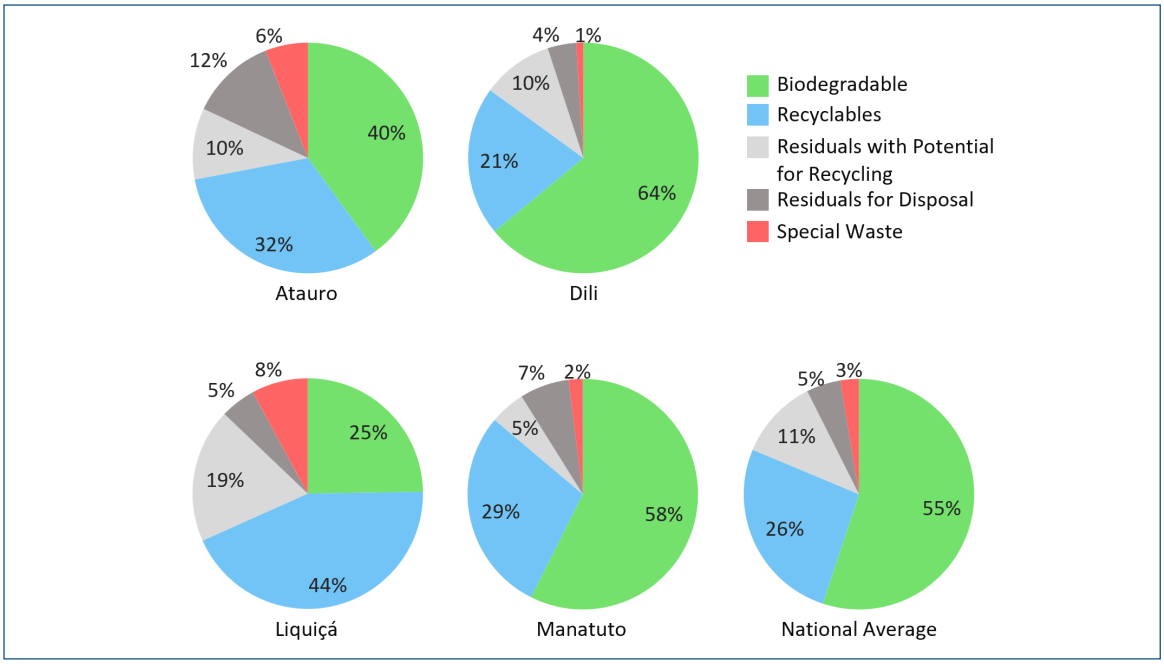


Figure 9. General Waste Composition of Household Waste in Timor-Leste Sites

The composition of plastic waste in household waste across surveyed sites varies, with plastic waste comprising 13% to 32% of the total household waste (**Figure 10**). Atauro has the highest plastic waste composition at 32%. In Atauro, Liquiçá, and Manatuto, recyclable plastics form the predominant category, while in Dili, residual plastics with potential for recycling are the most prominent. Nationally, the average composition of plastic waste is at about 15% of household waste, with recyclable plastics such as PET and PP, making up 7%. This is followed by residual plastics with potential for recycling, including single-layer and laminated sachets, accounting for 5% of the household waste.

Fisherfolk commonly reside along coastal areas, where they usually bring home their tools for fishing. In Manatuto, household-generated fishing-related waste, specifically fish nets, account for about 3% of household waste. Notably, PACS results in Atauro, Dili, and Liquiçá indicate that households do not generate any fishing-related waste. On a national level, the average contribution of waste from fishing activities is about 0.69% of household waste generation from coastal sucos.

B. Non-Household Waste Generation and Composition

A total of 32 non-households, which include 16 commercial establishments, 4 industries, and 12 institutions representing the surveyed coastal sucos from each municipality comprised the sampling population.

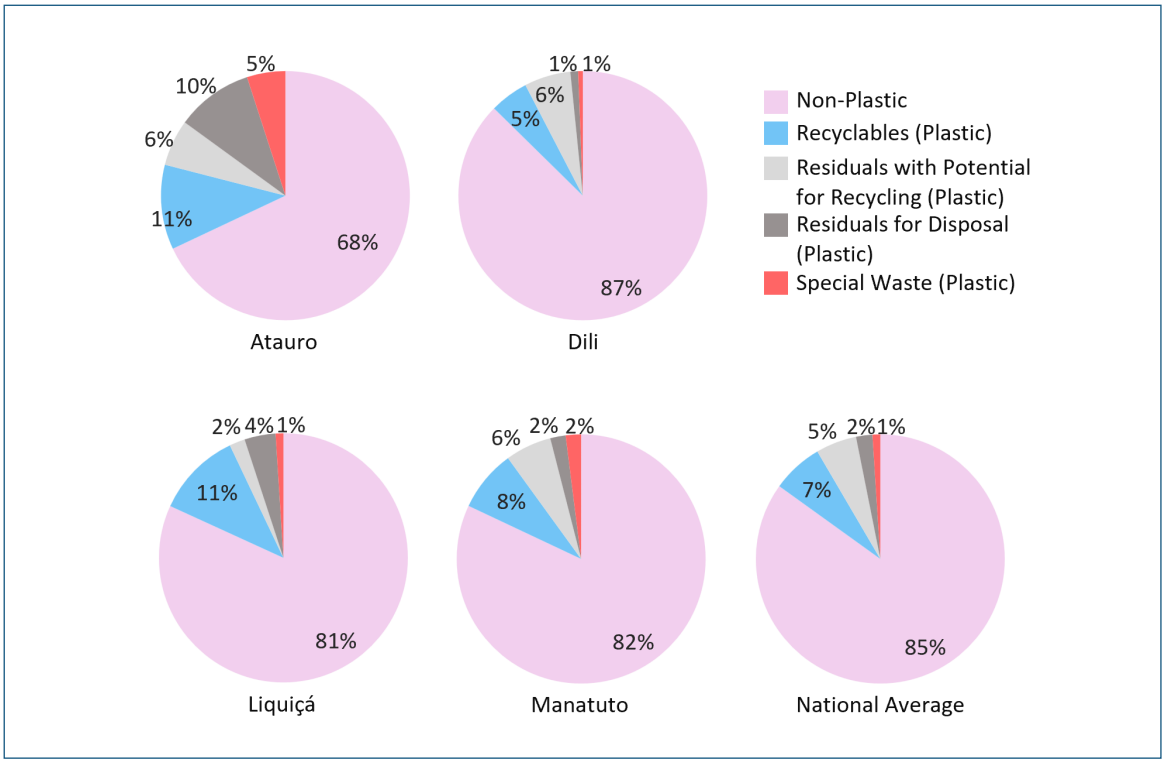


Figure 10. Plastic Waste Composition of Household Waste in Timor-Leste Sites

1. Generation

In the surveyed coastal sucos across the various sites, non-household waste generation varies significantly, ranging from 344 kg/day in Atauro to 13,960 kg/day in Dili (**Figure 11**). This variation in waste generation can largely be attributed to differences in the type and number of non-households. The selected sucos for sampling might have fewer non-households as compared with other sucos. The variability in non-household categories and differing levels of urbanization among municipalities preclude accurate projections of non-household waste generation at the municipal level, thereby making it impractical to calculate a national average from the data gathered at these sites.

Regarding plastic waste, non-households from surveyed coastal sucos generate between 81 kg/day and 4,432 kg/day. Dili generates the highest plastic waste from non-households among the sites. Commercial establishments are the primary contributors of plastic waste in Dili and Atauro, while institutions account for the majority of non-household plastic waste in Liquiçá and Manatuto. Notably, institutional waste is particularly significant in Dili which may be attributed to the concentration of government agencies, private offices, and educational institutions in the urban center of the country.

2. Composition

The composition of non-household waste in surveyed coastal sucos across Timor-Leste sites shows a diverse range of waste types (**Figure 12**). Biodegradable waste is the predominant waste category from non-households in all municipalities except in Dili, where recyclables account for the largest share. The proportion of biodegradable waste varies from 32% to 48%, and recyclables range from 37% to 46% of non-household waste.

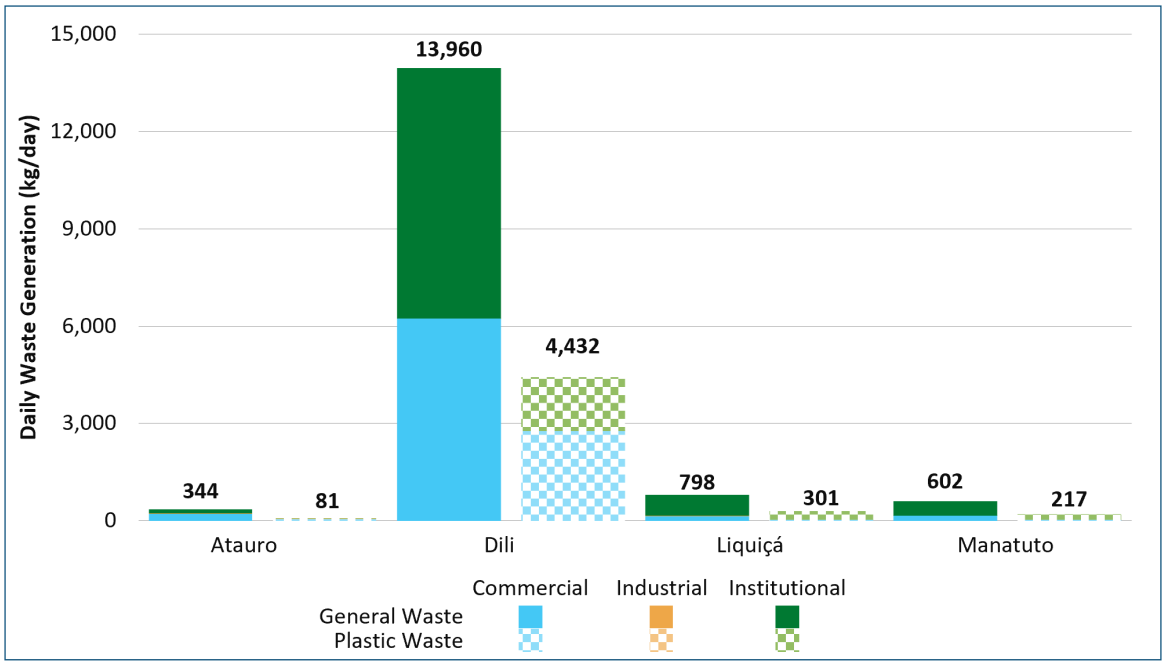


Figure 11. Non-Household Daily General and Plastic Waste Generation (kg/day) of Surveyed Coastal Sucos in Timor-Leste Sites

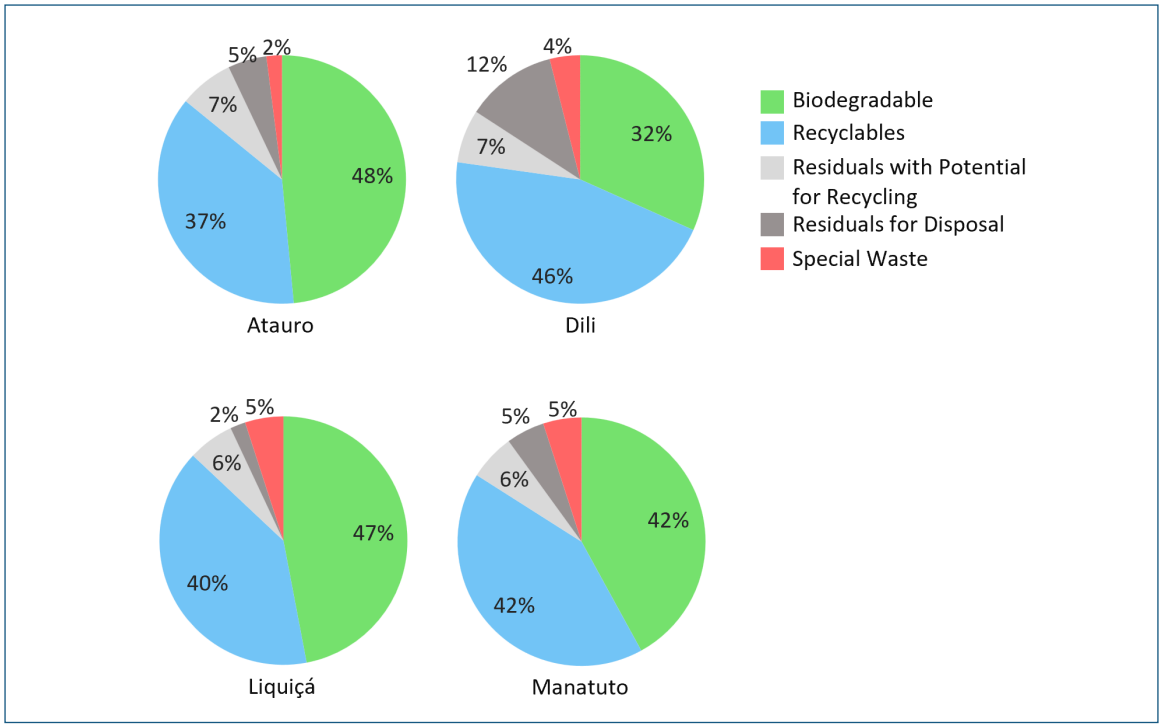


Figure 12. General Waste Composition of Non-Household Waste in Surveyed Sucos in Timor-Leste Sites

The composition of plastic waste in non-household sources across the surveyed coastal sucos in Timor-Leste varies significantly (**Figure 13**). Plastic waste constitutes about 19% to 26% of the total non-household waste. Among this, recyclable plastic waste, ranging from 11% to 13%, is the most substantial category in all municipalities. Residual plastics with potential for recycling range from 3% to 7%, representing the next largest portion of plastic waste. Residual plastics for disposal account for 1% to 4% of non-household waste.

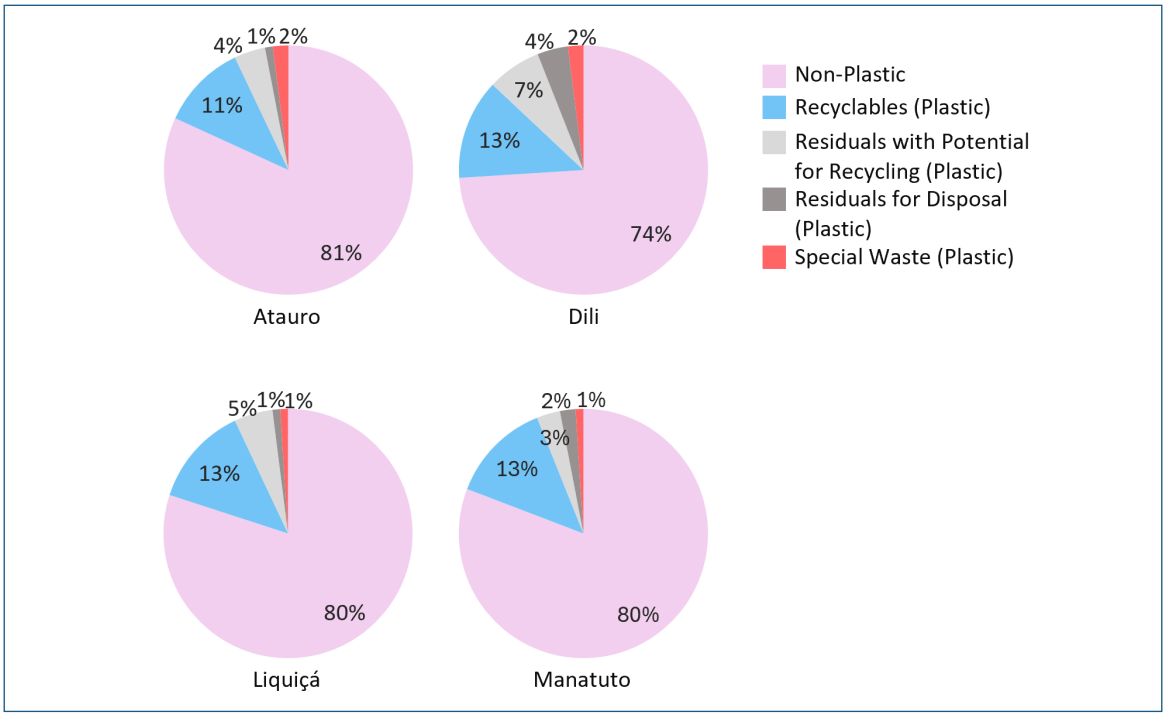


Figure 13. Plastic Waste Composition of Non-Household Waste in Surveyed Sucos in Timor-Leste Sites

C. Combined Waste Generation and Composition

1. Generation

In the surveyed coastal sucos in Timor-Leste sites, the total combined daily general waste from both households and non-households varies significantly, ranging from 3,345 kg/day in Manatuto to 48,268 kg/day in Dili (**Figure 14**). This wide range in waste generation is primarily influenced by the population and the size and type of non-household entities operating within these sucos. Notably, household waste comprises a substantial majority of the total municipal solid waste from the surveyed sucos of each site, accounting for about 71% to 90%. Additionally, the combined general WGR across the sites varies from 0.33 kg/cap/day in Manatuto to as high as 0.57 kg/cap/day in Dili.

In terms of plastic waste, the combined generation from the surveyed coastal sucos of Timor-Leste sites range from 717 kg/day in Manatuto to 8,903 kg/day in Dili. Additionally, the plastic WGR among these sucos varies from 0.07 kg/cap/day to 0.18 kg/cap/day. Notably, the highest plastic WGRs are observed in the surveyed coastal sucos of Atauro and Dili, each significantly contributing to the plastic waste generation in their respective areas.

2. Composition

The general waste composition of combined household and non-household waste in surveyed coastal sucos across various Timor-Leste sites presents variation in waste types (**Figure 15**). Biodegradable waste, which ranges from 40% to 52% of the total waste composition, is the most dominant category in all municipalities, except in Liquiçá, where recyclables account for the largest portion of the total waste at 45%.

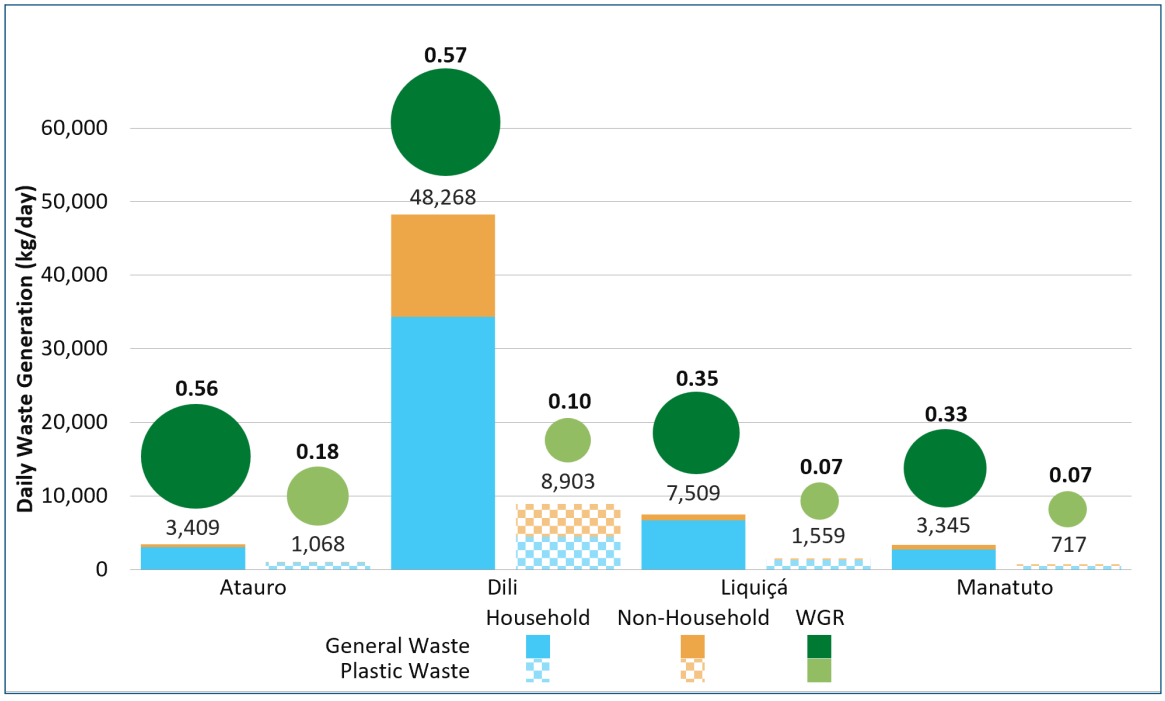


Figure 14. Combined Household and Non-Household Daily General and Plastic Waste Generation (kg/day) and Waste Generation Rates (kg/cap/day) of Surveyed Coastal Sucos in Timor-Leste Sites

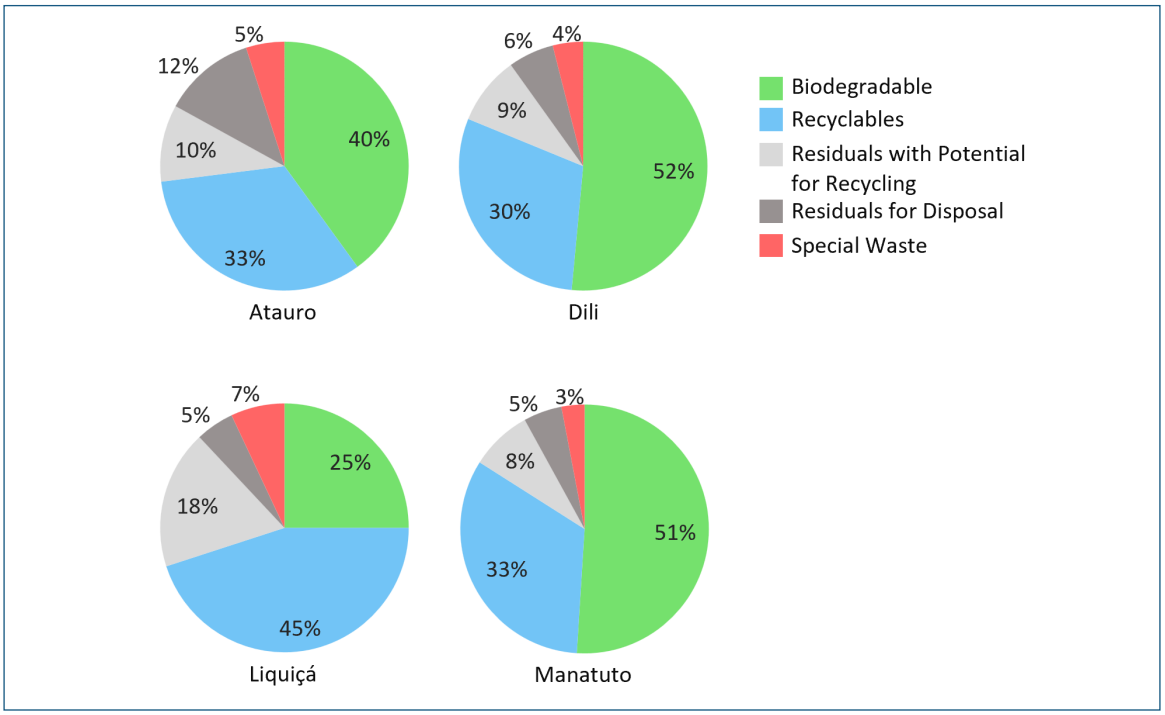


Figure 15. General Waste Composition of Combined Household and Non-Household Waste in Surveyed Sucos in Timor-Leste Sites

Plastic waste generated from the combined household and non-household sources across the surveyed coastal sucos varies at about 18% to 32% of the total waste (**Figure 16**). Recyclable plastics, which range from 10% to 12%, are the predominant type of plastic waste in all municipalities. Residual plastics with potential for recycling make up between 3% and 7%, while residual plastics for disposal range from 1% to 9% of the total waste. Special waste containing plastic components is relatively low, accounting for 1% and 5%.

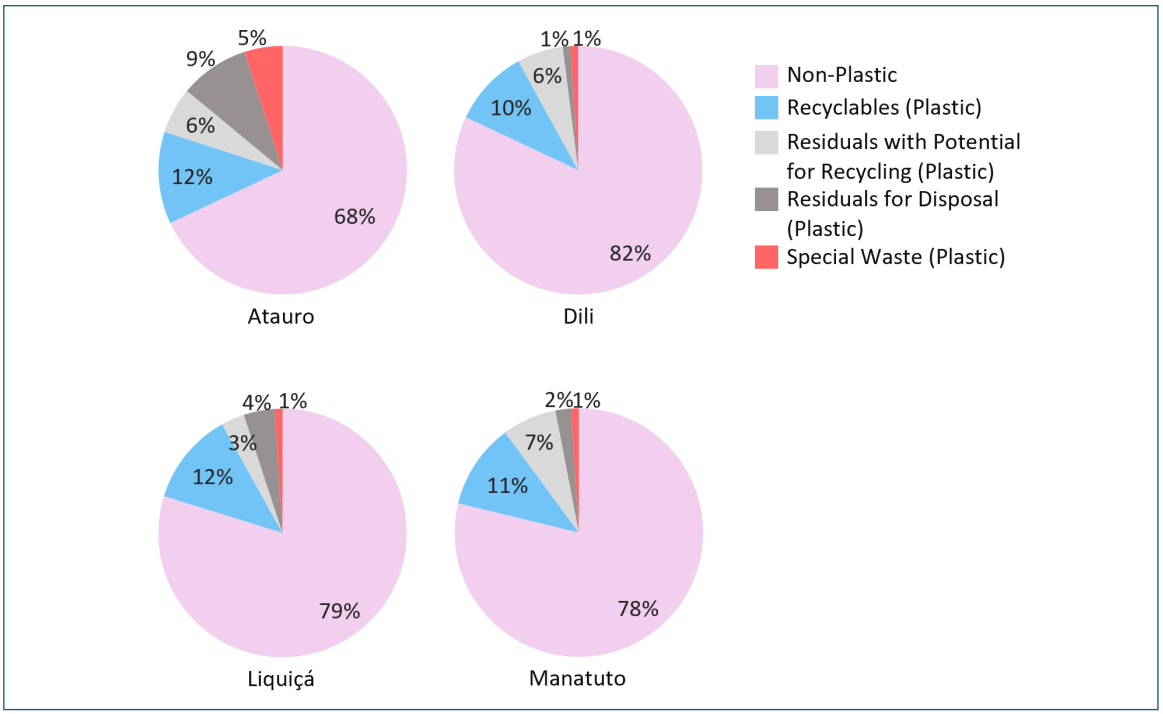


Figure 16. Plastic Waste Composition of Combined Household and Non-Household Waste in Surveyed Sucos in Timor-Leste Sites

D. Projected Household Waste Generation of Coastal Sucos

The average daily waste generation of households within the sampled coastal sucos can be projected to represent the waste patterns of households in other coastal areas within the corresponding municipality. This projection may be possible considering that the waste generated by households is consistent in a certain geographic environment as influenced by certain factors such as socioeconomic behavior, consumption patterns, and demographic characteristics. It is important to note, however, that the daily waste generation results for non-households may not be directly extrapolated to reflect the waste generation of non-households in other coastal sucos of a municipality considering the inherent variability across different non-household categories and areas.

The total household daily general waste and plastic waste are obtained based on the corresponding WGRs (Section VI.A.1) and the projected population of coastal sucos of each site (**Table 11** and **Figure 17**). The general waste generated by the households from these sites ranges from 5,342 kg/day to 65,559 kg/day, with plastic waste accounting for between 1,031 kg/day to 8,108 kg/day of the total general waste generated. Dili has the highest general and plastic waste generation, which can be attributed to its status as the capital of Timor-Leste, where major commercial areas such as markets and grocery stores are concentrated, leading to greater consumption of goods, and consequently, higher waste generation.

The composition of household waste can be treated to exhibit a similar composition of household waste from the surveyed coastal sucos, considering that they are representatives of the coastal sucos of each site.

Table 11. Daily Household Waste Generation of Coastal Sucos of Timor-Leste Sites

Municipality	2024 Population of Coastal Sucos	General Waste		Plastic Waste	
		WGR (kg/cap/day)	Daily Generation (kg/day)	WGR (kg/cap/day)	Daily Generation (kg/day)
Atauro	10,607	0.50	5,342	0.16	1,697
Dili	162,168	0.40	65,559	0.05	8,108
Liquiçá	54,275	0.31	16,850	0.06	3,257
Manatuto	20,618	0.27	5,612	0.05	1,031

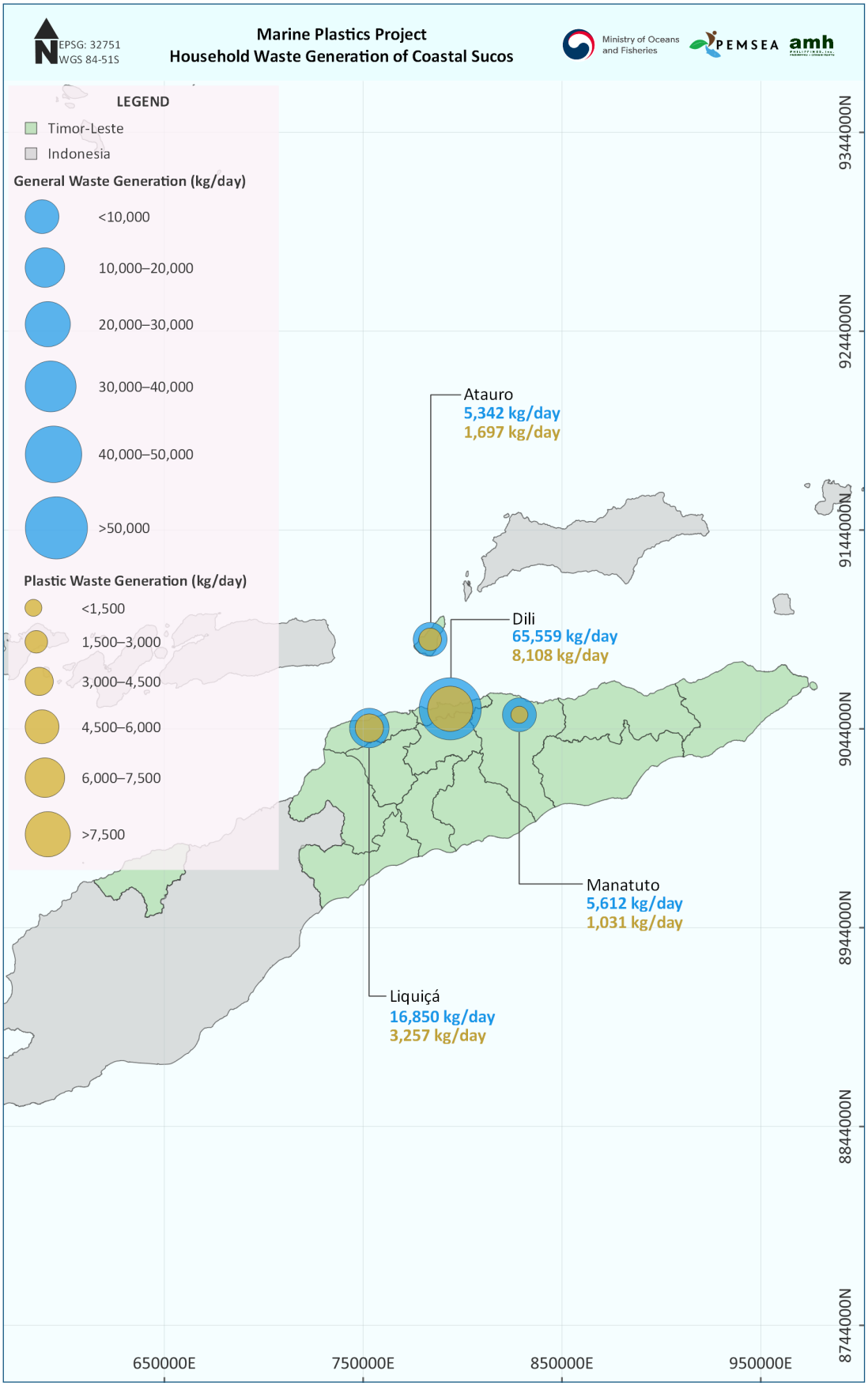


Figure 17. Household Waste Generation of Coastal Sucos in Timor-Leste Sites

Plastics Analysis and Characterization Study in 4 project sites in Timor-Leste.

Synthesized Results of Knowledge, Attitude, and Practice (KAP) Survey

7

Key findings from the KAP survey reveal community practices and perceptions regarding solid waste management. The absence of waste segregation policy results in the households not adopting segregation of waste at the source. Combined with the lack of separate waste collection and limited availability of segregation bins, mixed waste collection remains the usual method.

While most of the surveyed households affirm receiving daily collection services, site observations and interviews with local surveyors suggest a lower actual frequency. As a result, many households resort to improper disposal methods such as burning, open dumping, and burying waste.

With most of the respondents noticing waste accumulation in waterbodies and increasing environmental pollution over time, there is a clear need for a strong policy enforcement to prevent waste leakage and mitigate pollution.

A. Demographic Profile

Majority of the respondents in the priority municipalities are female (**Table 12**). Most of the respondents have lived within the priority sucos between 26 years to 50 years, except for the households surveyed in Manatuto, where majority resided within the area between 10 years to 25 years. A considerable length of residence in a location reflects strong familiarity with the environment and a deeper understanding of policy changes.

Table 12. Gender Composition of Respondents in the Timor-Leste Sites

Municipality	Male Respondents	Female Respondents
Atauro	17%	83%
Dili	41%	59%
Liquiçá	46%	54%
Manatuto	42%	58%

The size of households is crucial to understand the amount and type of waste generated. Most of the surveyed households from Atauro, Liquiçá, and Manatuto have 5 to 10 members, while respondents from Dili belong to larger households of more than 10 members. Regarding household monthly income, majority of the respondents in all sites receive less than USD 1,000.

The majority of the respondents purchase plastic products daily in Atauro, Dili, and Liquiçá. In Manatuto, most of the households buy plastic items more than once a week (**Figure 18**). Plastic products that are frequently bought are flexible plastic packaging such as laminated sachets of snacks and personal care items, and beverage containers like PET bottles.

B. Waste Management

Waste segregation is not practiced in all study areas (**Table 13**). In Liquiçá and Atauro, more than 80% of the households do not practice segregation, collectively at 94% and 83%, respectively. Slightly lower but significant values, at 70% and 73%, were observed to have not adopted the practice in Dili and Manatuto, respectively.

The high number of respondents who do not segregate are largely driven by the absence of a waste segregation policy. The continuous collection of mixed waste and the lack of separate bins further discourage households from adopting segregation practices.

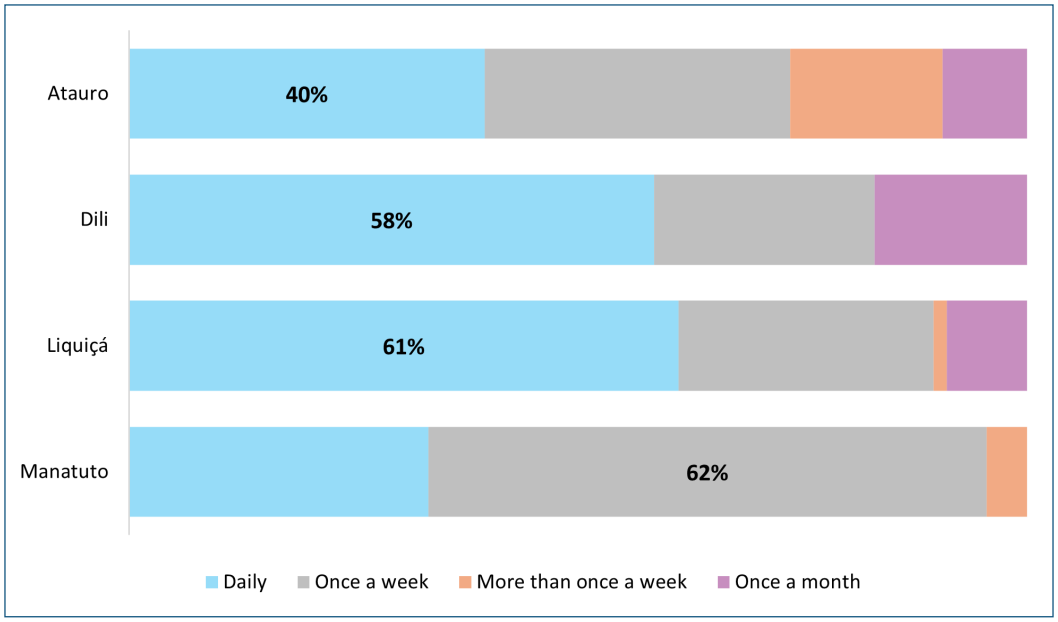


Figure 18. Frequency of Purchasing Plastic Products in Timor-Leste Sites

Table 13. Waste Segregation Practice in Timor-Leste Sites

Municipality	Practicing segregation	Trying to adopt the practice	Not practicing segregation
Atauro	17%	4%	79%
Dili	30%	24%	46%
Liquiçá	6%	3%	91%
Manatuto	27%	17%	56%

The majority of the respondents in all study areas affirm that they are receiving daily waste collection services (**Figure 19**). However, observations during the site visit and interviews with the local surveyor team suggest lower frequency (Section IV.C.3). Specifically, in Liquiçá and Manatuto, waste collection occurs only twice a week and three times a week, respectively. These inconsistencies in collection frequency suggest issues with information dissemination or lack of community awareness on the existing collection system in their respective sucos.

Due to the infrequent waste collection, households resort to other forms of waste disposal. In Dili, most plastics are dumped in open areas, while in Liquiçá and Manatuto, these wastes are primarily burned. In Atauro, plastics are both burned and openly dumped (**Figure 20**).

Similar disposal practices are observed for general waste management (**Figure 21**). In Dili, dumping in the open environment remains the predominant method of disposing of their general waste. Leftover food is typically reused as animal feeds in the other municipalities, while glass bottles are buried in the ground.

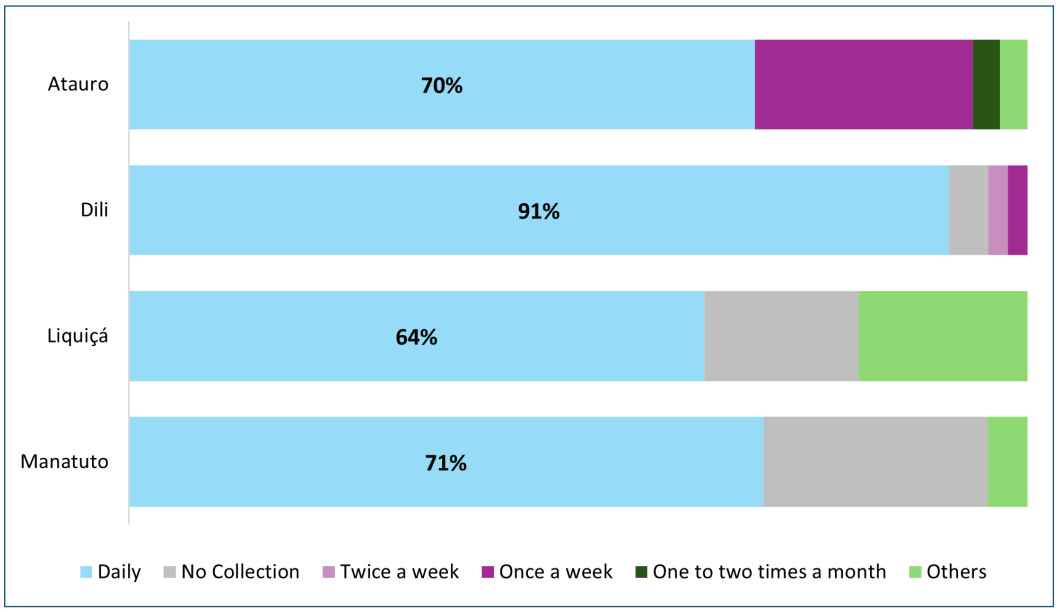


Figure 19. Frequency of Waste Collection in Timor-Leste Sites

	Atauro	Dili	Liquiçá	Manatuto
PVC	36%	50%	67%	80%
PET	37%	51%	55%	69%
LDPE	48%	53%	76%	85%
HDPE	42%	58%	64%	85%
PP	38%	46%	49%	70%
PS	45%	55%	70%	91%
PU	46%	62%	67%	74%
Laminated sachet	38%	57%	78%	85%
Other types of plastics	50%	65%	36%	67%

Burned Dumped in the open environment

Figure 20. Waste Disposal in Timor-Leste Sites – Plastic Waste

	Atauro	Dili	Liquiçá	Manatuto
Leftover food	70%	54%	33%	45%
Paper/cardboard	66%	61%	73%	81%
Glass bottle	48%	67%	33%	51%
Can	36%	60%	28%	39%
Paint	45%	77%	33%	26%
Medicine	45%	72%	42%	34%
Battery	44%	61%	34%	25%
Textile	62%	66%	51%	65%
Diapers/Napkins	62%	75%	49%	29%
E-waste	53%	69%	45%	32%

Burned · Dumped in the open environment · Reused · Buried in the ground

Figure 21. Waste Disposal in Timor-Leste Sites – General Waste

C. Environmental Status, Awareness, and Care

The KAP survey reveals that in Liquiçá and Manatuto, majority of the respondents have noticed the increase in environmental pollution in their areas over time. In Atauro, slight changes were observed while in Dili, an equal number of respondents reported noticing changes and not noticing any changes in their surroundings. Although findings show a variety of responses, collective summation of the results still lean towards observed increased environmental changes (**Figure 22**).

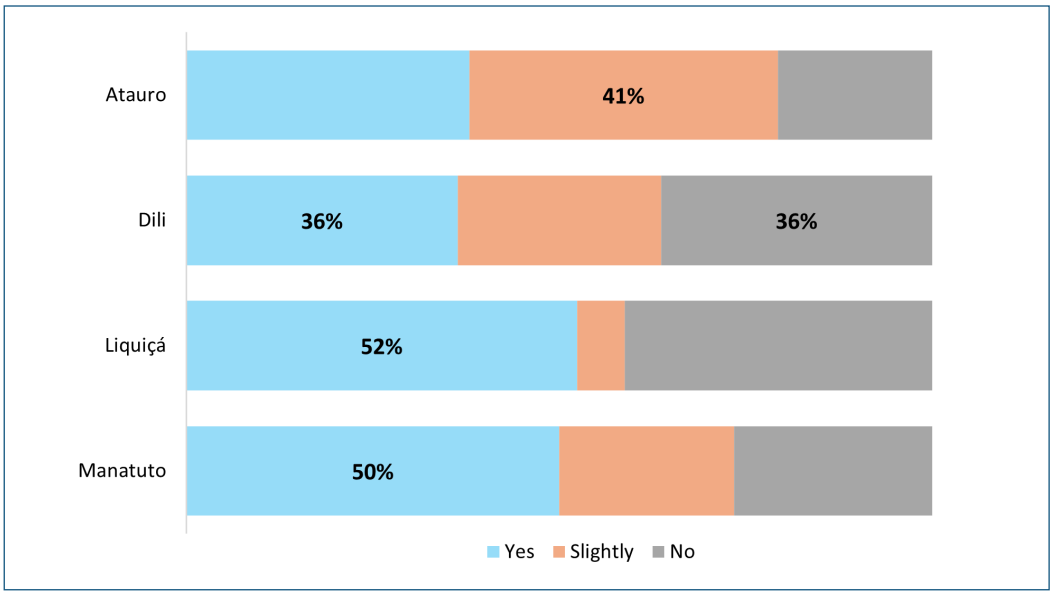


Figure 22. Perception on Environmental Pollution Increase Over Time

The majority of the respondents in the municipalities of Atauro, Dili, and Manatuto are aware of the income opportunities from solid waste, citing aluminum cans and metals as materials with significant value (**Figure 23**).

Regarding plastic-related policies, the majority of the respondents on all sites reported unawareness of existing regulations implemented in their respective municipalities (**Figure 24**). At a national level, Decree-Law No. 37/2020 address the safe management of plastics from manufacturing, importation, and disposal. While there are no official records that this law is implemented at a local level, this serves as a framework for plastic waste management in the municipality.

The few respondents who claimed awareness regarding policies on plastic waste management referred to general activities on managing solid waste, such as conduct of regular cleanups, sweeping efforts, and "no loitering" announcements.

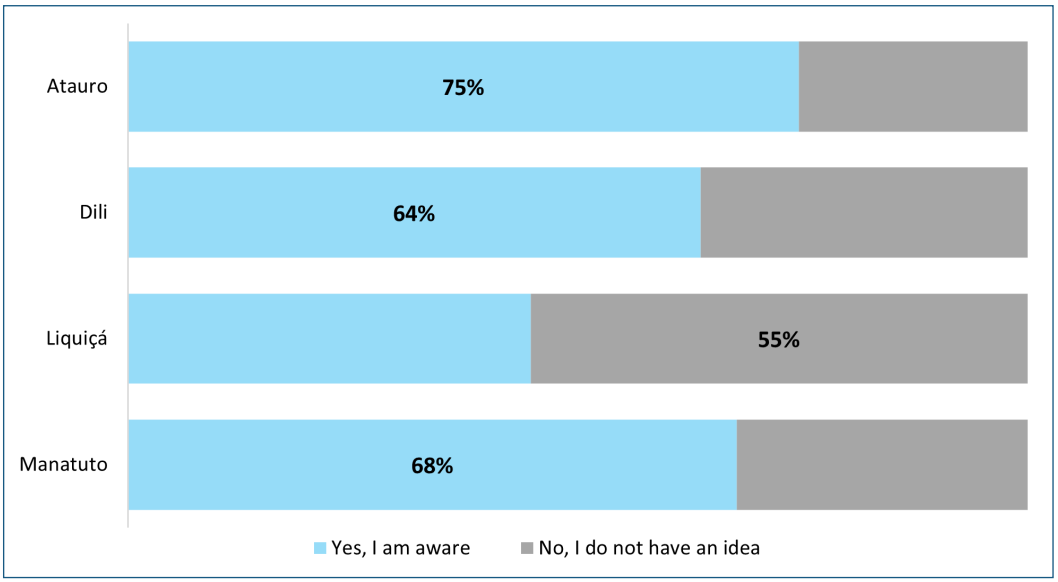


Figure 23. Awareness of Income Opportunities from Solid Waste

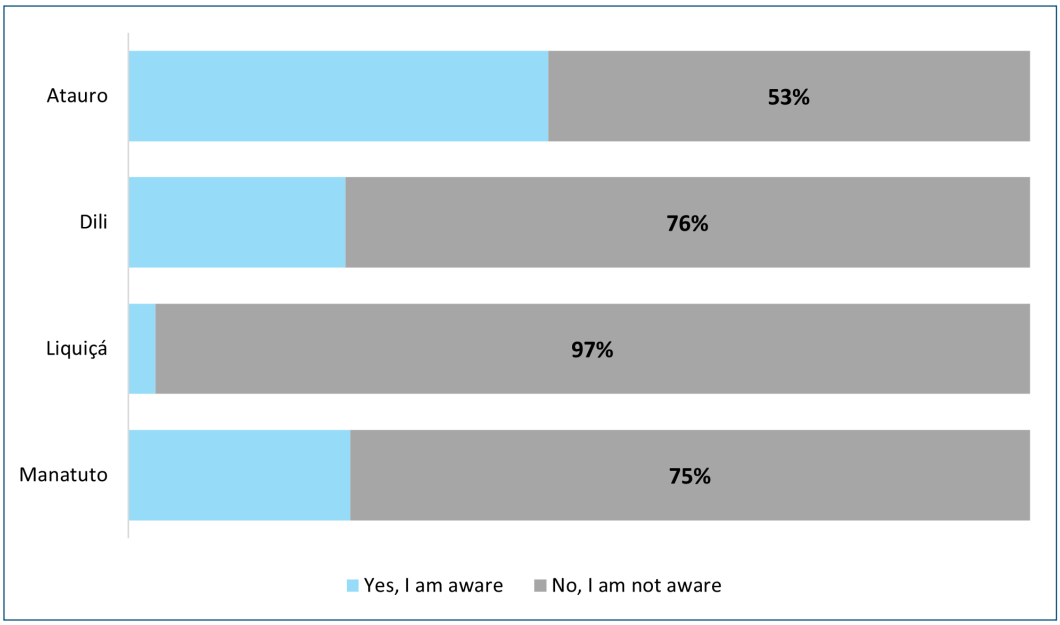


Figure 24. Awareness of Plastic-Related Ordinances

Most respondents in Atauro and Dili report observing waste in waterbodies near to them, with common items being plastic bottles, sachets, and garden waste such as leaves and tree branches (**Figure 25**). In Manatuto, a slightly higher number of respondents mention seeing waste in waterbodies, while in Liquiçá, most of the surveyed households cite that nearby waterbodies are generally free of wastes. The majority of the respondents confirm the conduct of cleanup activities in their respective areas (**Figure 26**).

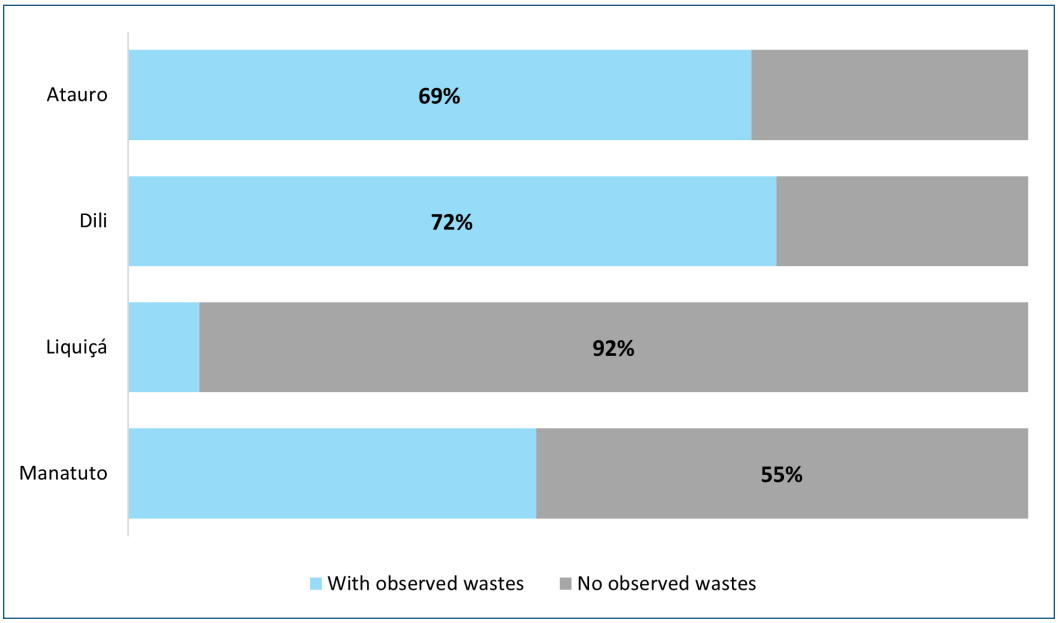


Figure 25. Observance of Wastes in Waterbodies

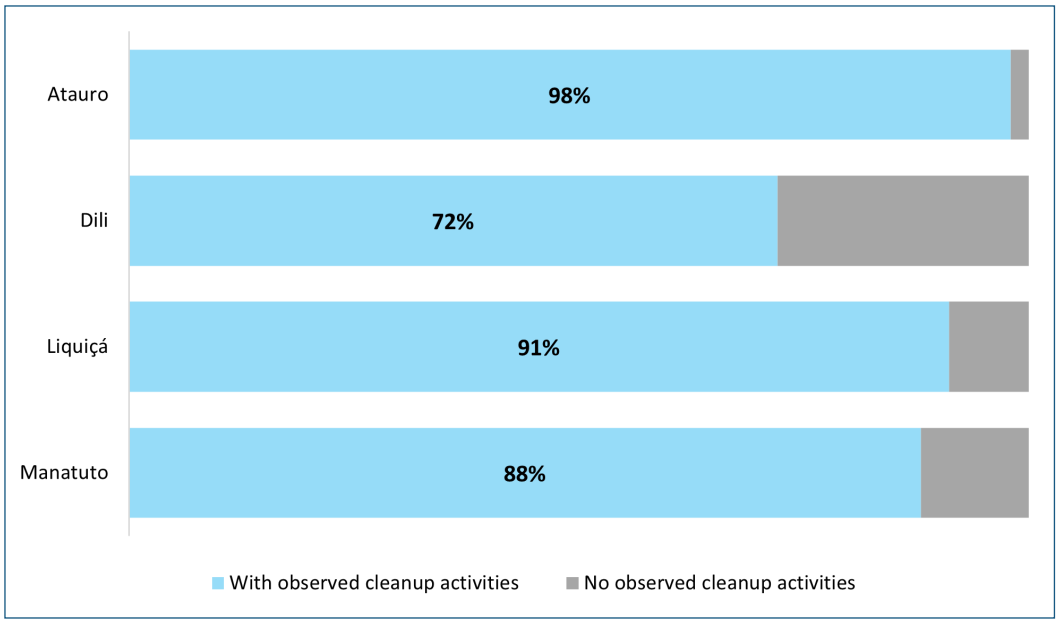


Figure 26. Observance of Conduct of Cleanup Activities

Plastic Waste Value Chain Analysis 8

The plastic waste value chain in selected coastal municipalities in Timor-Leste outlines the path of plastics from generation to disposal (**Figure 27**). This value chain highlights how challenges within the solid waste management system build up, with each stage contributing to the increased likelihood of plastic waste leaking into the environment.

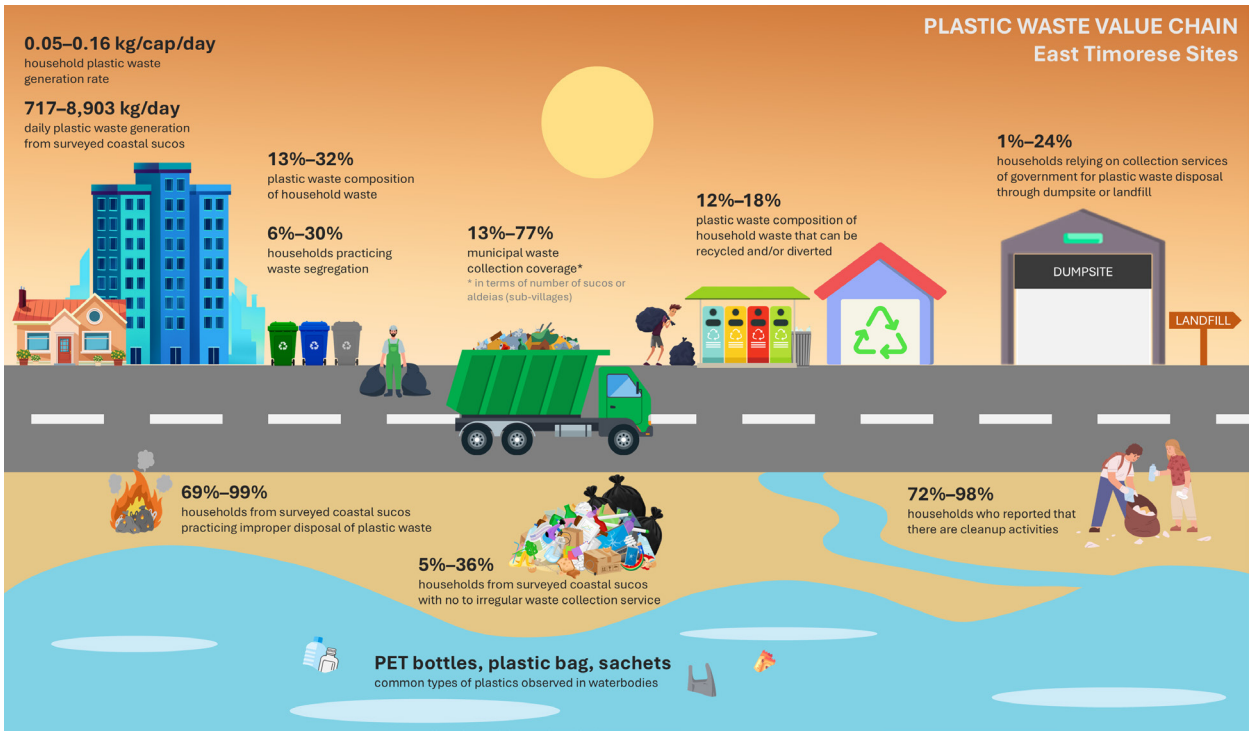


Figure 27. Plastic Waste Value Chain for Timor-Leste Sites

A. Generation

Plastic waste generation from combined household and non-household sources in the surveyed coastal sucos in Timor-Leste sites ranges from 717 kg/day in Manatuto to 8,903 kg/day in Dili (**Figure 28**). Household sources are the primary contributors to the total amount of solid waste generated, accounting for about 71% to 90%. Among the types of plastic waste, diapers and napkins (4%-9%), PET items (6%-8%), and PP items (2%-4%) are the most common across all sites. Other notable types of plastic waste include laminated sachets (≤3%), e-waste (≤3%), single-layer sachets (≤2%), plastic bags (≤2%), HDPE items (≤2%), and fish net (≤2%).

Plastic waste generated by households in Timor-Leste sites ranges from 0.05 kg/cap/day to 0.16 kg/cap/day, resulting in a national average plastic waste generation of 0.06 kg/cap/day (**Figure 29**). These rates translate into a household generation of plastic waste ranging from 500 kg/day to 4,471 kg/day in the surveyed sucos at each site and scale up to 1,031 kg/day to 8,108 kg/day across all coastal sucos of the municipality (Section VI).

Of the total household waste, plastic waste constitutes 13% to 32%, reaching a national average of 15% (**Figure 30**). Diapers and napkins (2%-10%), PET items (3%-8%), and PP items (1%-5%) are among the common types of plastic waste generated by household sources. Additionally, other plastics such as e-waste (≤4%), laminated sachets (≤3%), fish net (≤3%), single-layer sachets (≤2%), plastic bags (≤1%), expired medicine (≤1%), and cleaning chemicals (≤1%) are present in significant amounts, highlighting the widespread use of single-use plastics among households in these coastal sucos.

Figure 28. Combined Household and Non-Household Daily Plastic Waste Generation (kg/day) of Surveyed Coastal Sucos in Timor-Leste Sites

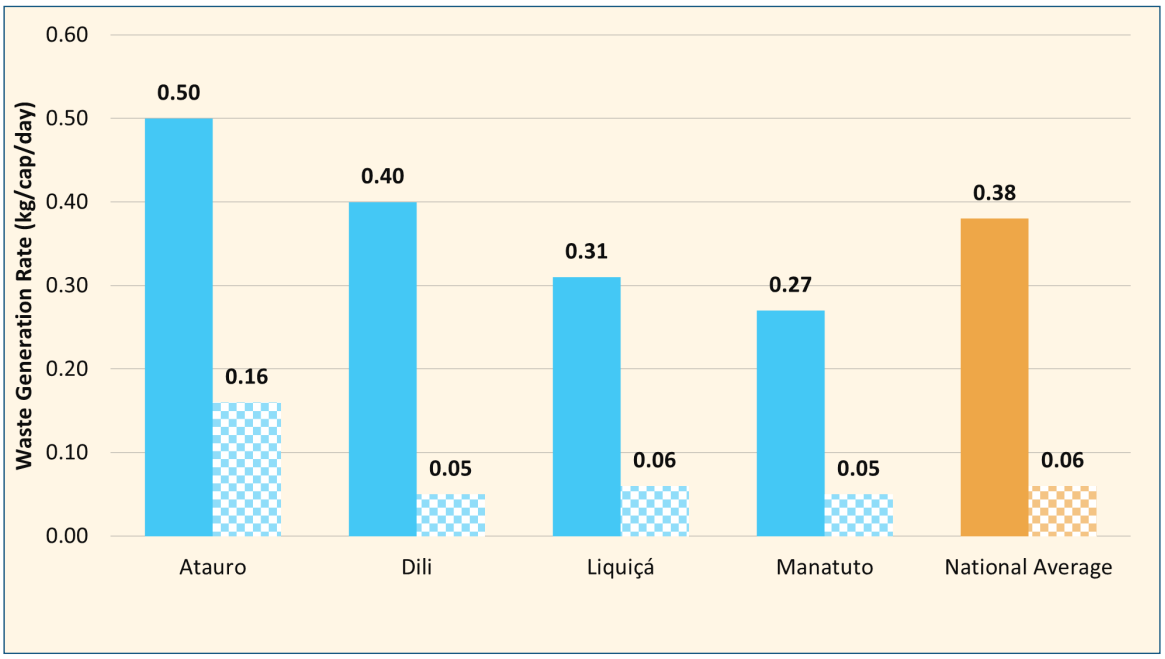


Figure 29. Household General and Plastic Waste Generation Rates (kg/cap/day) in Timor-Leste Sites

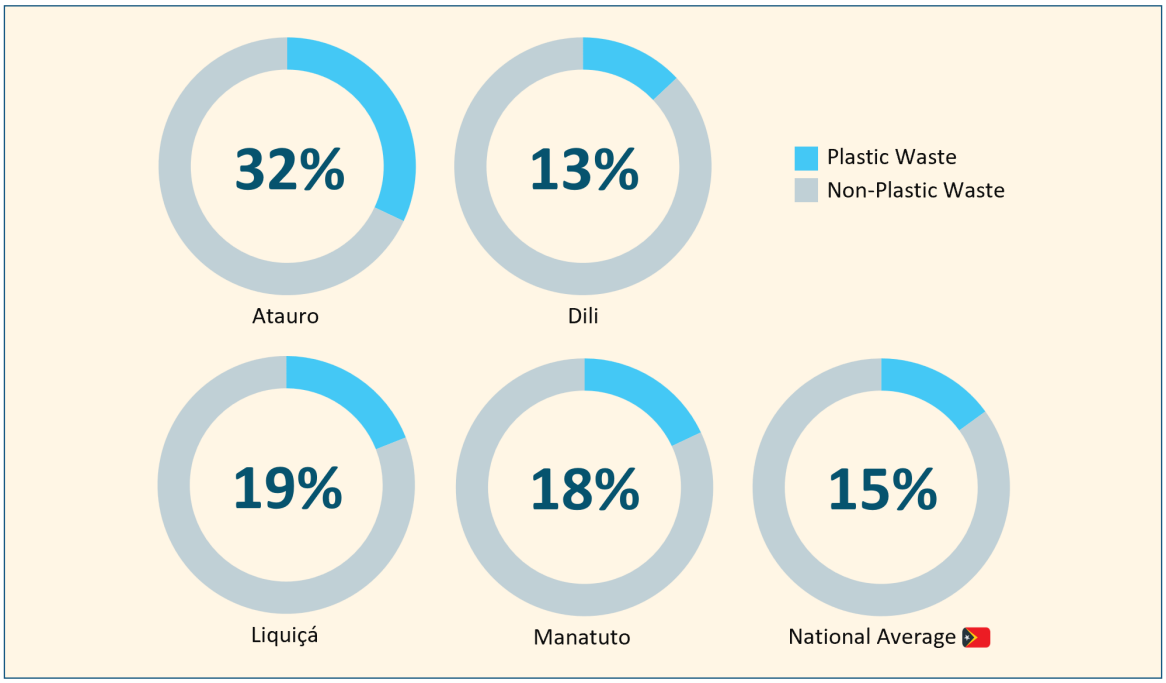


Figure 30. Plastic Waste Composition of Household Waste in Timor-Leste Sites

B. Segregation

In the absence of a waste segregation policy, majority of surveyed households in all study areas do not practice segregation (**Figure 31**). Without a policy, the collection of mixed waste and the lack of a separate collection schedule are likely to continue, households will not adopt the practice of segregation.

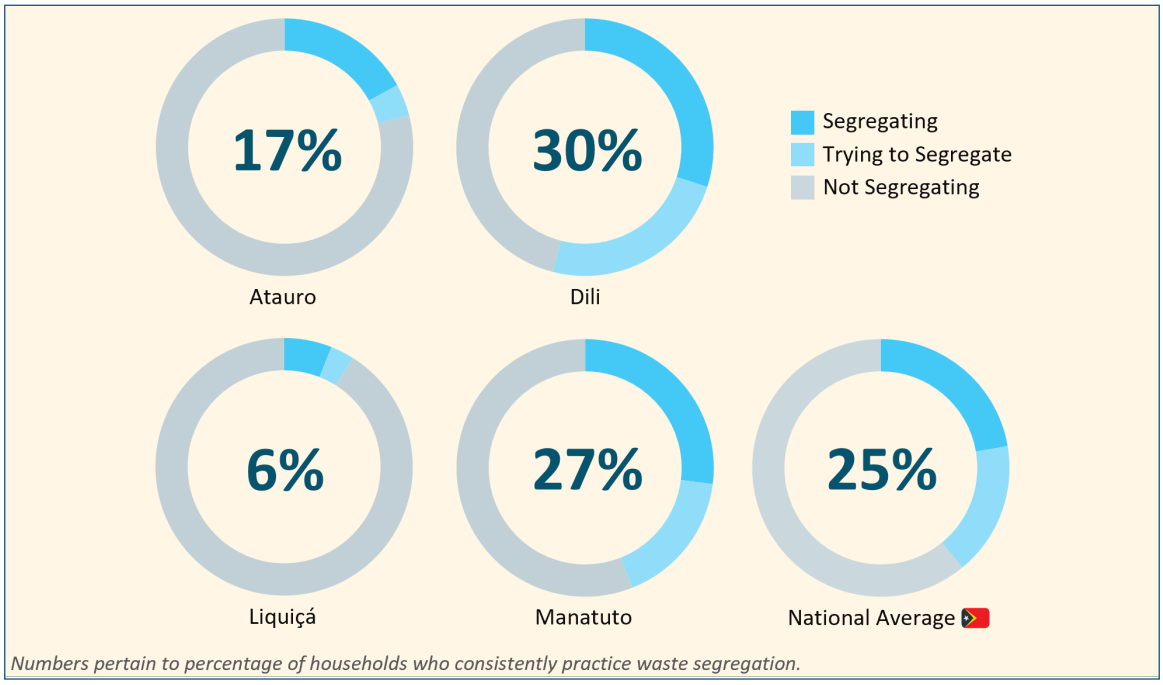


Figure 31. Waste Segregation Efforts of Households in Timor-Leste Sites

Waste bins, including the brick-and-mortar structures, that serve as common collection points present opportunities to promote segregation. Currently, these containers are unlabeled and often are open, further encouraging mixed waste to be disposed of (**Figure 32**).

Figure 32. Unlabeled and Uncovered Brick-and-Mortar Common Collection Points in Timor-Leste Site

The lack of designated waste bins is a significant challenge for segregation, resulting in waste contained in unsecured sacks, plastic bags, or used boxes. These observations across all sites lead to waste being left unsecured in the open environment, which increases the risk of waste leakage from natural events or disturbances.

The immediate implementation of a comprehensive segregation policy is essential. With an effective policy in place, key aspects of solid waste management would be enhanced, such as improved recovery rates for common recyclables, and reduction in the volume of waste sent to disposal facilities or improperly disposed of.

C. Collection

Unserved areas for collection are a major challenge in the local sites. The issue is highly evident in Liquiçá and Manatuto, wherein only 22% and 13% of the sucos have access to collection services. In Dili, 77% of the sucos are covered for collection, while only 12 of the 19 sub-villages in Atauro have their waste collected (**Figure 33**).

A national average of about 12% of the total households surveyed in the coastal sucos admitted to receiving irregular or no waste collection services (**Figure 34**). The lack of waste collection is most evident in Liquiçá and Manatuto, with 36% and 29% of households experiencing irregular to no services. Meanwhile, it is least evident in Dili and Atauro, with 5% and 6% of households reporting similar issues.

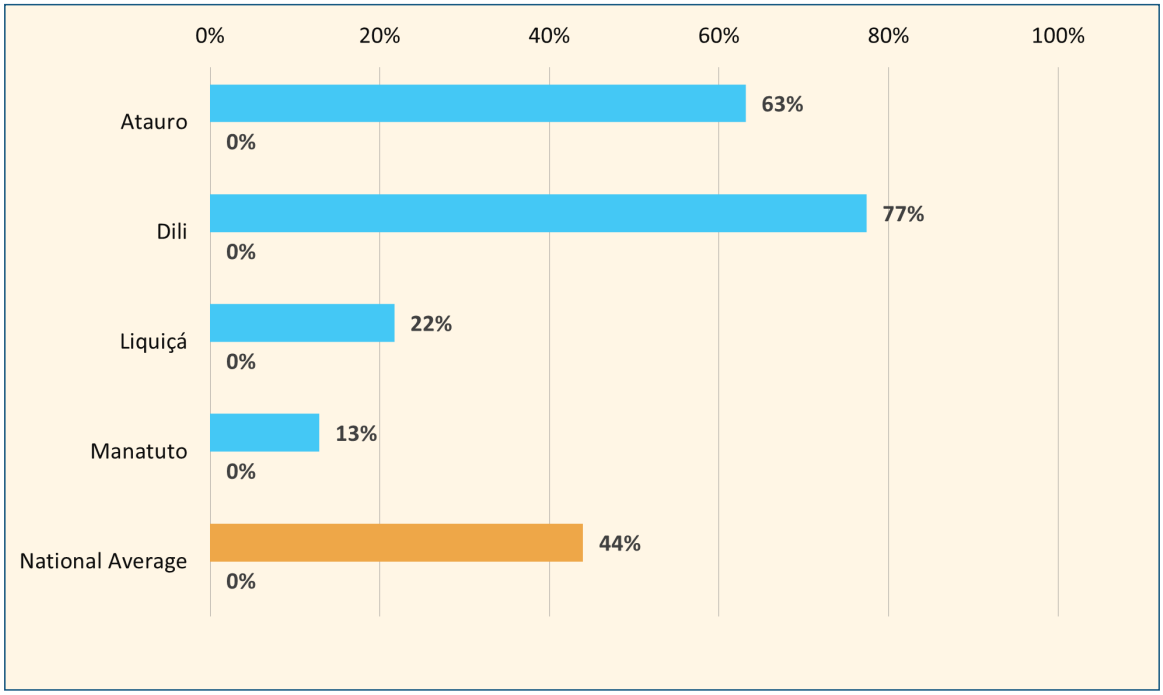


Figure 33. Municipal Waste Collection Coverage in Timor-Leste Sites

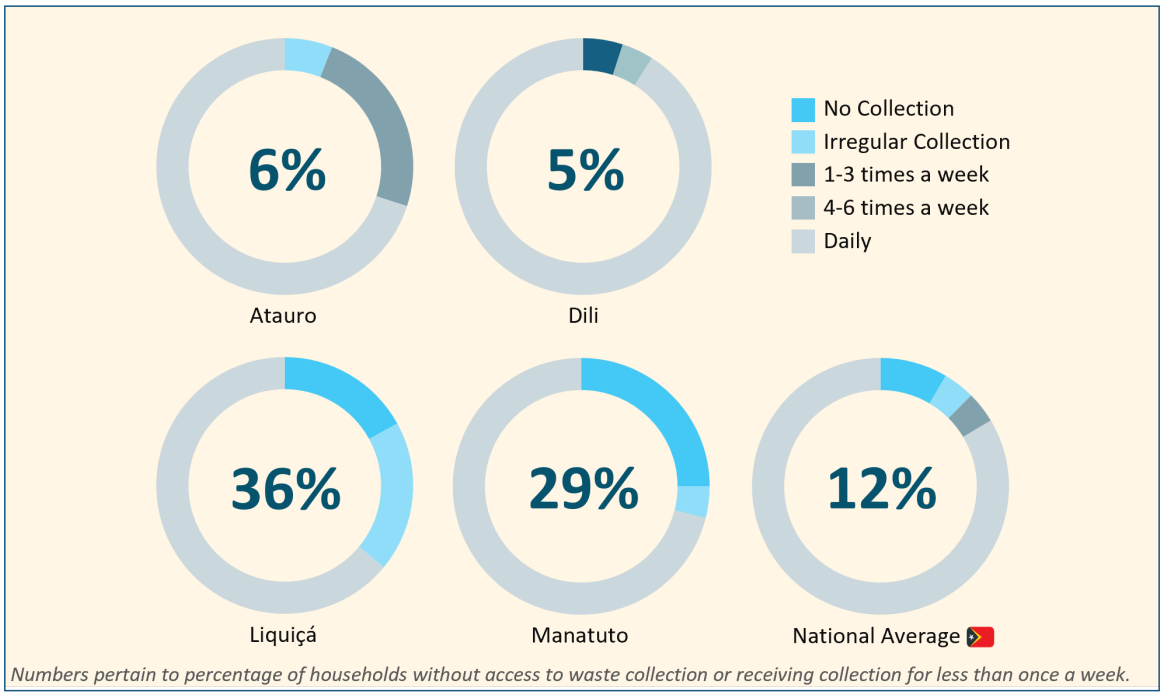


Figure 34. No Collection and Irregular Waste Collection at Surveyed Coastal Sucos in Timor-Leste Sites

As wastes are frequently left in front of households or disposed of at communal points, inconsistent collection leads to the accumulation of waste in public spaces, increasing the risk of waste leakage (**Figure 35**). Additionally, unreached areas with infrequent collection, often due to limited road accessibility, are more prone to resort to improper waste disposal practices.

In all the surveyed coastal sucos in Timor-Leste sites, the respective local government, with the help of private waste collection service providers, are responsible for waste collection services. These collected wastes are transported to the designated disposal facilities, which are typically in the form of open dumpsites.

Figure 35. Unsecured Waste in the Open Environment

D. Recovery

The PACS results show a substantial percentage of recyclable plastics, with a national average of 12%, that can be potentially diverted for recycling or reuse (**Figure 36**). However, the limited opportunities for recovery of recyclables and the inadequate recycling infrastructure pose significant challenges to achieving high diversion rates.

There are no municipality-managed recovery centers or recycling facilities to support initiatives for recovery. In Dili, plastic recycling is primarily managed by a single private recycling facility. However, the minimal demand for plastic recycled products is a major obstacle in maintaining sustainable production.

KAP survey shows that the majority of the respondents in Atauro, Dili, and Manatuto are aware of the potential income opportunities from solid waste. However, their preference for aluminum cans and general metal, which they deem as materials of high value, hinders the recovery of recyclable plastics. Conversely, most of the households in Liquiçá have limited knowledge on opportunities from recyclable materials (Section VII.C).

While the school and community programs on environmental education, which include activities on repurposing PET bottles (Section IV.C.4), help raise awareness about the importance of recycling, a more structured system for recovery and recycling is necessary to meet the municipalities' growing plastic recovery needs.

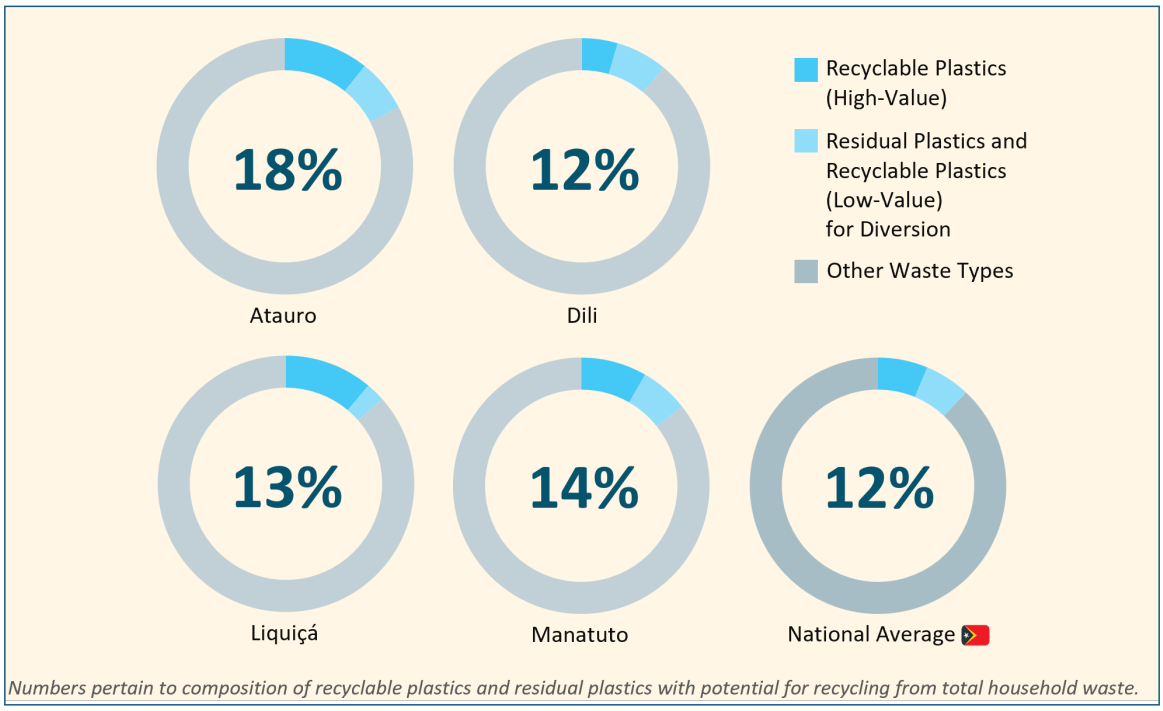


Figure 36. Plastic Waste Composition of Household Waste for Diversion in Timor-Leste Sites

E. Disposal

The disposal facilities in all sites are uncontrolled and lack essential environmental safeguards to prevent waste from leaking into surrounding areas (**Figure 37** and **Figure 38**). In Manatuto, the open dumpsite is located along the highway, without protective fences, allowing anyone to freely dispose of waste in the area. In Atauro, waste is not only deposited in the designated disposal facility but is also widespread in open spaces.

Figure 37. Waste in Tibar Dumpsite (November 21, 2024)

Figure 38. Open Dumpsites in Atauro (Left) and Manatuto (Right)

Due to inadequate waste collection system, evident by the infrequent service and areas left unserved, many households have adopted improper disposal practices (Sections VII.B), such as burning, burying in the ground, and dumping the wastes along roads worsening the plastic waste leakage situation (**Figure 39**). Additionally, burning waste at dumpsites in Manatuto and Atauro is a common practice used to reduce the volume of dumped waste, resulting in the emission of harmful gases.

Figure 39. Observed Burning and Dumping of Waste in the Open Environment

At present, the Tibar dumpsite is being developed into a sanitary landfill equipped with minimum containment measures (**Figure 40**). Similarly, geotechnical investigations were conducted in August 2024 to assess the suitability of a proposed sanitary landfill in Baucau that will receive waste from Manatuto Municipality (Section IV.C.5).

These key findings highlight significant and serious challenges in the waste disposal practices in the study areas. In resolving these issues, a thorough and coordinated approach is necessary, focusing on developing and implementing waste segregation policies, improving waste collection system, and ensuring better management of disposal facilities.

Figure 40. Ongoing Construction of the Sanitary Landfill in Tibar (November 21, 2024)

F. Plastic Leakage

Plastics have become deeply embedded in modern society due to their durability, lightweight nature, and affordability. Their widespread use has surged over recent years, contributing to convenience in various industries, but also creating significant environmental challenges. In Timor-Leste, despite the existence of a national framework for solid waste management, the absence of localized regulations for municipal implementation hinders effective waste management at smaller scales. This regulatory gap is evident in plastic waste management, as the existing regulation on plastic usage has shown a limited impact. The continued presence of plastics in waste streams underscores the need for more comprehensive policy coverage and stricter enforcement measures to effectively reduce plastic leakage. Additionally, the limited collection coverage and inconsistent services leave waste uncollected for extended periods. Without frequent collection, waste tends to accumulate, increasing the likelihood of improper disposal and plastic waste contaminating local waterbodies.

The absence of waste management infrastructure, such as municipality-managed recovery centers and engineered disposal facilities, further contributes to plastic pollution as households have limited alternatives for managing waste. While private recycling facilities and Green Schools diversion initiatives contribute to waste reduction efforts, these measures may not be sufficient and sustainable to address the scale of plastic waste management challenges. Without a more integrated and large-scale approach, recyclable plastics continue to enter disposal sites or leak into the environment.

Under the third component of the project, beach monitoring is conducted quarterly to track marine litter along a 100-meter survey line divided into 20 transects of 5 meters each, with 4 transects monitored per quarter. From the first to fourth quarter of 2024, a total of 15,094 pieces of marine litter weighing 385,957 grams were collected from six monitoring sites across the four coastal municipalities (**Table 14**). Of the total collected marine litter, plastics accounted for about 85% in terms of total quantity or 44% in terms of total weight, which highlights the significant amount of plastic waste leaking into the marine environment (PEMSEA, 2025). Based on the KAP survey, most respondents observe plastic waste in their local waterbodies including plastic bottles, laminated sachets, single-layer film/wrappers, and diapers.

Table 14. Results of Beach Monitoring by Number and Weight in Timor-Leste Sites from Q1 to Q4 of 2024 (PEMSEA, 2025)

City/Municipality	Monitoring Site	Marine Litter		Marine Plastics	
		By number (pieces)	By weight (grams)	By number (pieces)	By weight (grams)
Atauro	Leiwaha Akrema	6,688	171,962	6,021	61,992
	Petenua Beloi	5,172	70,478	4,717	47,138
Dili	Dolok-oan	943	32,608	844	24,719
Liquiçá	Keitahu	473	11,055	421	8,663
Manatuto[a]	Uma Caduac	1,388	92,302	594	25,905
	Uma Boco	430	7,552	292	2,932
TOTAL		**15,094**	**385,957**	**12,889**	**171,349**

[a] No available data for the 1st quarter of 2024.

Atauro recorded the highest collection of marine plastic litter with 109,130 grams, representing about 64% of the total records (**Figure 41**). Furthermore, 89% or 11,440 items of the total marine litter collected in the monitoring sites were identified as originating from domestic sources, which suggests the importance of proper waste management practices at the local level.

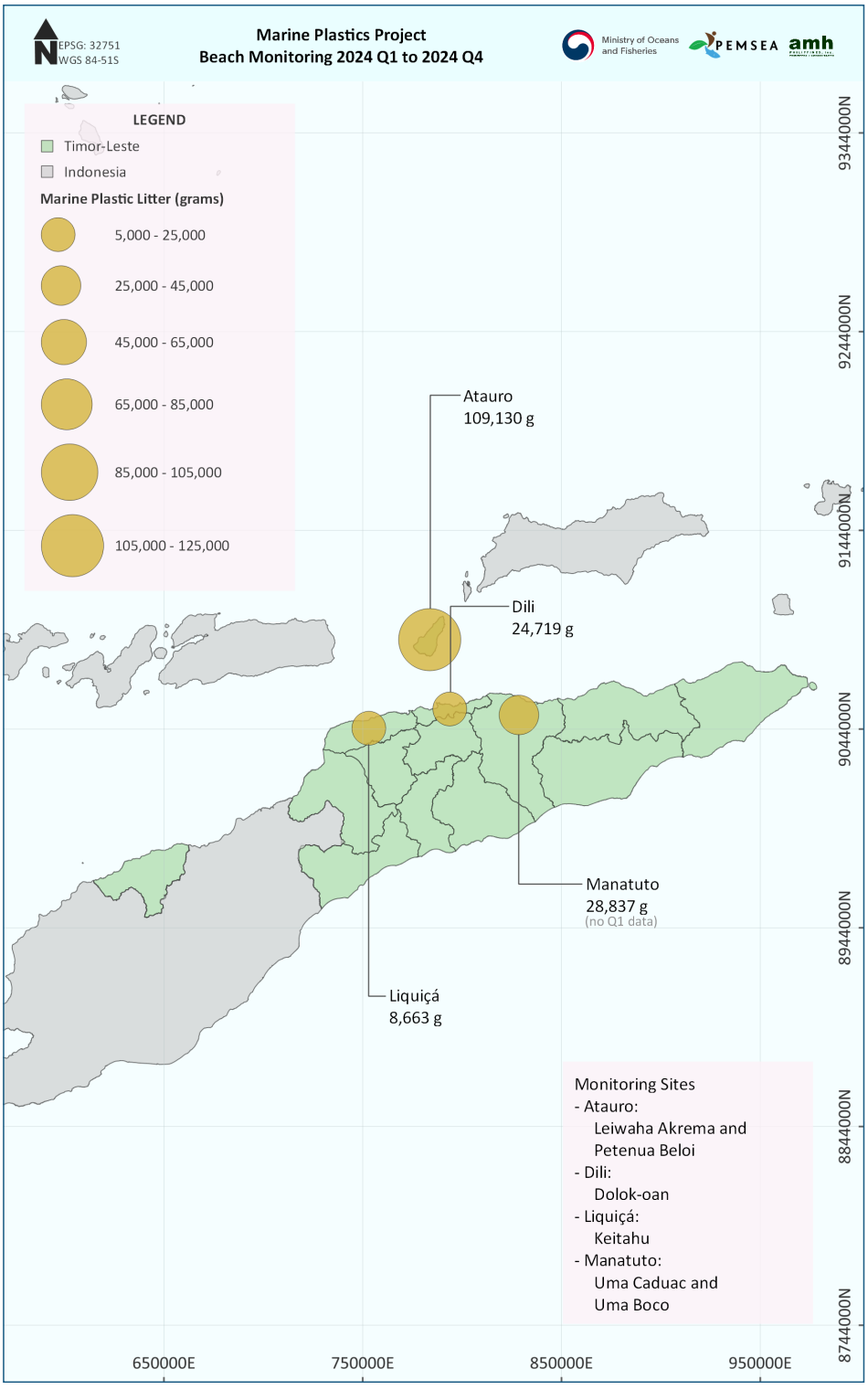


Figure 41. Marine Plastic Litter Recorded During Beach Monitoring from Q1 to Q4 of 2024 (PEMSEA, 2025)

G. Challenges and Limitations

All local sites face challenges with various aspects of their respective solid waste management framework (**Table 15**). Key findings from the baseline assessment in the four sites of Timor-Leste highlight critical issues throughout the entire waste management system, from generation to disposal.

Table 15. Key Challenges for Timor-Leste Sites

Component	Most Applicable Study Site	Challenges
Generation	All sites	• The combined daily general waste from both households and non-households range from 3,345 kg/day in Manatuto to 48,268 kg/day in Dili. Household sources account for the majority of the overall waste generation in all sites. Additionally, the combined general WGR is found between 0.33 kg/cap/day in Manatuto to as high as 0.57 kg/cap/day in Dili. • The daily plastic waste generation for both household and non-household sources ranges between 717 kg/day in Manatuto to 8,903 kg/day in Dili. Plastic WGR is found between 0.07 kg/cap/day to 0.18 kg/cap/day.
Segregation	All sites	• In the absence of a segregation policy, majority of households surveyed do not practice segregation, resulting in continuous disposal of mixed waste • The brick-and-mortar common collection points are unlabeled and often open, further discouraging waste segregation and increasing risks of waste leakage
	Dili	• The poor design of the installed waste bins fails to encourage communities to engage in segregation practices
	Atauro Liquiçá Manatuto	• The lack of separate waste bins or infrastructure hinders effective segregation practices
Collection	All sites	• The low collection coverage, ranging from 13% to 77%, is a major problem in the waste management of the study areas. Unreached areas often rely on improper disposal of waste such as burning, burying in the ground, and freely dumping into the open environment, as evident from the KAP responses. Moreover, not all smaller villages are reported to be collected in the covered sucos, worsening the situation on improper waste disposal practices.

Table 15. Key Challenges for Timor-Leste Sites (cont.)

Component	Most Applicable Study Site	Challenges
	Dili	• The primary method of collecting waste from the waste bins, serving as common collection points, may be viewed as inconvenient by some communities, discouraging them to deliver their waste to these common points.
	Atauro Manatuto	• Only one collection vehicle is utilized to gather waste, leading to infrequent collection.
Recovery	All sites	• There are no municipality-managed recovery and recycling facilities, significantly hindering effective recovery for recyclable plastics • The preference of private recovery centers on high-value materials, such as aluminum cans and general metal, limits the potential to recover substantial amount of plastics.
	Dili	• While Caltech contributes to diversion of plastics from disposal, other forms of recycling may be necessary to meet the municipality's growing plastic recycling needs.
	Liquiçá	• The limited awareness on income opportunities from solid waste leads to community engagement in waste recovery activities.
Disposal	All sites	• Uncontrolled facilities are utilized in all sites as their disposal facilities. These facilities lack the essential environmental measures to prevent waste from leaking into nearby surroundings. • KAP survey shows that improper forms of disposal, such as burning, burying of waste, and dumping in open spaces, have become the primary forms of waste disposal due to non-existent or infrequent collection. Moreover, burning is also practiced in designated disposal facilities to reduce volume of waste.
Plastic Leakage	All sites	• Observance of plastic wastes such as plastic bottles, laminated sachets, and single-layer films, remain prevalent in all study sites. • A total of 15,094 pieces of marine litter weighing 385,957 grams were collected from 6 monitoring sites across the four coastal municipalities from the four quarterly sampling of 2024. Of the total collected marine litter, plastics accounted for about 12,889 in terms of total quantity or 171,349 in terms of total weight based on the beach monitoring data.

Table 15. Key Challenges for Timor-Leste Sites (cont.)

Component	Most Applicable Study Site	Challenges
Policy and Implementation	All sites	• The absence of policies on waste segregation significantly impacts other aspects of solid waste management, resulting in inefficient collection, poor recovery, and improper disposal methods. • While there are national policies for general and plastic waste management, unclear guidelines on implementation and monitoring hinder effective enforcement at the local communities

PACS orientation in Liquica.

Key Recommendations 9

Based on the findings from the baseline assessment on marine plastics, a summary of key challenges, along with strategic recommendations, is presented in **Table 16**. These recommendations are developed to collectively address the priority challenges identified in the baseline assessment and enhance the effectiveness of waste management practices across the country, particularly at the selected sites.

Beach monitoring activities in the coasts of Dolok-oan, Dili.

Priority Issues and Key Recommendations for Timor-Leste Sites

ATAURO

Priority Issue 1

Collection

- Only 12 out of 19, or 63%, of the sub-villages are covered by the collection services of the municipality due to poor road conditions and limited availability of collection vehicles
- The lack of separate waste collection for different waste types leads to segregated waste being included in mixed waste
- Uncollected waste accumulates in public spaces, increasing the dependence of residents on improper disposal practices

Key Recommendations

- Procure additional collection vehicles, including compactor trucks for main roads and smaller vehicles (e.g., motorized tricycles or carts) for narrow streets, to improve collection frequency and service coverage
- Establish localized waste transfer points in sucos without regular collection service to provide temporary storage before transportation to the final disposal site
- Enforce separate waste collection for different waste types by equipping collection vehicles with designated compartments, utilizing transparent bins, conducting regular inspections, and training workers on handling unsegregated waste

Priority Issue 2

Disposal

- The municipality lacks an engineered disposal facility, leading to widespread improper waste disposal through open dumping, burning, and burying
- The open dumpsite in Suco Beloi heightens plastic pollution risks as wind and runoff easily disperse waste
- Poor road conditions may hinder waste transportation even if a disposal facility is built
- The absence of regulations and monitoring systems results in unregulated waste disposal across the municipality

Key Recommendations

- Conduct a feasibility study to identify suitable sites for a sanitary landfill, considering geography, accessibility, and environmental impact.
- Develop decentralized disposal approaches, including localized controlled facilities or material recovery centers, to reduce reliance on a single site.
- Implement interim containment measures at the dumpsite pending development for a sanitary landfill, such as fencing, controlled access, and periodic covering of waste, to minimize environmental contamination.

Priority Issues and Key Recommendations for Timor-Leste Sites

DILI

Priority Issue 1

Segregation

- Without a segregation policy, majority of the households do not practice segregation
- Poor design of common collection points, including unlabeled waste bins and uncovered brick-and-mortar structures, discourages segregation

Key Recommendations

- Develop a clear and comprehensive local policy on waste segregation, providing guidelines for community implementation
- Launch pilot programs in select sucos to demonstrate effectiveness and create a model for broader implementation.
- Improve waste collection infrastructure by redesigning garbage bins and brick-and-mortar collection points to be more intuitive and user-friendly. Implement color-coded and clearly labeled bins for specific waste types and design appropriate waste categories for brick-and-mortar collection points. Additionally, install barriers and covers to prevent waste spillage and contamination

Priority Issue 2

Collection

- Only 24 of 31 sucos, or 77%, have access to regular collection services. Uncovered areas rely on burning and dumping of waste into the open environment as alternative forms of disposal
- Waste is primarily gathered from common collection points, which may be seen as inconvenient for certain households, leading to practicing improper disposal methods
- There is no separate collection for each waste type, resulting in the continuous collection of mixed waste

Key Recommendations

- Optimize waste collection efficiency and expand service coverage based on community needs by conducting route assessments and time-motion studies to ensure equitable distribution
- Implement a hybrid collection system that combines frequent door-to-door service in high-density areas with well-maintained common collection points to enhance accessibility and reduce improper disposal
- Enforce separate waste collection for different waste types by equipping collection vehicles with designated compartments, utilizing transparent bins, conducting regular inspections, and training workers on handling unsegregated waste

Priority Issues and Key Recommendations for Timor-Leste Sites

LIQUIÇÁ

Priority Issue 1

Collection

- The majority of the sucos are not covered for regular collection service, leading to practicing improper disposal methods
- Only one collection vehicle is used by the municipality government, resulting in infrequent collection

Key Recommendations

- Increase waste collection capacity by acquiring additional and suitable vehicles, ensuring timely and consistent waste collection, particularly in underserved sucos.
- Enhance waste collection efficiency by optimizing schedules based on community needs, conducting route assessments and time-motion studies to ensure effective service distribution and operational cost efficiency.
- Introduce phased implementation of waste segregation at the source by gradually establishing separate collection schedules for varying waste types, supported by infrastructure investments such as color-coded bins and targeted community awareness to improve compliance.
- Develop community-based waste collection programs to complement municipal services. Training local groups to manage collection in underserved areas can help bridge service gaps and promote community responsibility in waste management.

Priority Issue 2

Recovery

- There are no recycling facilities in the municipality, resulting in the majority of recyclable plastics ending up being disposed of
- The limited awareness on potential income opportunities from solid waste leads to low community engagement in waste recovery initiatives

Key Recommendations

- Establish a pilot community-based recovery and recycling initiative at the local level, focusing on plastics and other high-value materials
- Explore potential partnerships with recycling facilities or organizations in nearby municipalities to facilitate collection and processing of recyclables
- Enhance community awareness and participation through social and behavioral change communication (SBCC) initiatives, integrating waste recovery education into existing community programs and encouraging households to engage in waste diversion activities

Priority Issues and Key Recommendations for Timor-Leste Sites

MANATUTO

Priority Issue 1

Collection

- The majority of the sucos are not covered for regular collection service, leading to practicing improper disposal methods
- Only one collection vehicle is used by the municipality government, resulting in infrequent collection

Key Recommendations

- Increase waste collection capacity by acquiring additional and suitable collection vehicles, ensuring timely and consistent waste collection, particularly in underserved sucos
- Enhance waste collection efficiency by optimizing schedules based on community needs, conducting route assessments and time-motion studies to ensure effective service distribution and operational cost efficiency
- Introduce phased implementation of waste segregation at the source by gradually establishing separate collection schedules for varying waste types, supported by infrastructure investments such as color-coded bins and targeted community awareness to improve compliance
- Develop community-based waste collection programs to complement municipal services. Training local groups to manage collection in underserved areas can help bridge service gaps and promote community responsibility in waste management

Priority Issue 2

Disposal

- Burning of waste, along with improper forms of disposal such as burying in the ground, have become the primary form of disposal due to the lack of regular collection
- An open area along the highway serves as the municipality's disposal site. As an uncontrolled facility, essential environmental measures are lacking, increasing risks of plastic leakage. In addition, burning waste is commonly practiced to reduce the volume of dumped waste

Key Recommendations

- Expedite the planned construction of a sanitary landfill by maintaining good communication with involved stakeholders and continuously monitoring the progress of the project. Implementing phased construction may allow partial operational use while completion is underway.
- Implement immediate containment measures, including fencing, controlled access, and regular covering of waste, at the existing dumpsite to reduce waste dispersal and environmental contamination.
- Conduct regular inspections and strengthen public awareness on proper waste disposal through SBCC activities, along with an effective segregation, collection, and recovery system.

While long-term improvements in solid waste management system and infrastructure are being explored, optimized, and developed, short-term interventions are also necessary to prevent further plastic leakage into the environment. From the baseline assessment, Atauro recorded the highest marine plastic litter, at 109,130 g. These beach monitoring results, along with data from other sites, highlight the urgent need for interventions aimed at stopping plastic litter from reaching the oceans. Capturing leaked waste through regular cleanup activities can help reduce immediate pollution, while installing trash traps at river outfalls prevent plastics from reaching marine ecosystems. Additionally, recovered plastics need to be sorted further to identify materials for recycling and for disposal, enhancing waste diversion efforts. To reinforce these efforts, SBCC strategies should be regularly conducted to promote responsible waste management at the community level. Strengthening policy enforcement and ensuring consistent implementation are equally crucial, as existing regulations must be upheld to sustain waste management improvements and prevent further environmental degradation.

To further combat the issue of plastic pollution effectively, it is recommended that the strategies be localized to reflect the specific needs and conditions of the communities. The approach of developing local plan of action on marine plastics and litter ensures that the solutions are tailored to the unique environmental and socio-economic contexts of different cities and municipalities in Timor-Leste. While national policies such as Decree-Law 37/2020 regulate plastic use, stronger enforcement mechanisms and localized implementation strategies are needed to improve waste collection, segregation, and recycling. Enhancing public-private partnerships is also crucial in strengthening plastic waste management, from collection to recovery and disposal. Additionally, integrating the objectives of national plastic waste management initiatives into local policies and action plans will help ensure long-term sustainability and effectiveness.

10 Conclusion

The key findings of the national baseline assessment on marine plastics in Timor-Leste offer significant insights that can support municipal governments, national government agencies, and other relevant stakeholders in formulating targeted policies and interventions. As an archipelagic country, these strategies are necessary for improving the overall solid waste management system which can reduce marine plastic pollution in the country, particularly at coastal municipalities. A collaborative effort involving all stakeholders—from the national government to the local communities—is essential for a comprehensive approach to address plastic pollution effectively.

Coasts of Kaitehu, Liquica.

References

Asian Development Bank. (2014, June). Solid Waste Management in the Pacific: Timor-Leste Country Snapshot. Asian Development Bank. Retrieved from https://www.adb.org/sites/default/files/publication/42661/solid-waste-management-timor-leste.pdf

Asian Development Bank. (2024). Poverty Data: Timor-Leste. Asian Development Bank. Retrieved from https://www.adb.org/where-we-work/timor-leste/poverty

Asian Development Bank. (2024). *Strengthening Regional Cooperation for Marine Litter Management in Indonesia, the Philippines, Thailand, and Viet Nam: Policy Analysis and Opportunities*.

Badrum, S. Y., & Mapa, M. T. (2020). Village-level knowledge, attitude, and practice (KAP) on solid waste management in Penampang, Sabah. *LPPM UPN "Veteran" Yogyakarta Conference Series. 1*, pp. 148-160. Research Synergy Foundation Press. Retrieved from https://www.researchgate.net/publication/346795775_Village-Level_Knowledge_Attitude_and_Practice_KAP_on_Solid_Waste_Management_in_Penampang_Sabah

Coral Triangle Center. (2023, December 27). CTC and UNTL Sign MoU to Promote Sustainable Management of Marine and Coastal Resources in Timor-Leste's Waters. Retrieved from https://www.coraltrianglecenter.org/2023/12/27/ctc-and-untl-sign-mou-to-promote-sustainable-management-of-marine-and-coastal-resources-in-timor-lestes-waters/

Cottom, J. W., Cook, E., & Velis, C. A. (2024, September). A local-to-global emissions inventory of macroplastic pollution. *Nature, 633,* 101-108. Retrieved from https://doi.org/10.1038/s41586-024-07758-6

Da Costa, Z. X., & De Jesus, B. B. (2018, May). *Urban Solid Waste Management in Dili. International Journal of Engineering Research & Technology (IJERT)*, 7(5), 48-52. Retrieved from https://www.researchgate.net/publication/342113291_Urban_Solid_Waste_Management_in_Dili_Community

Fátima, C. (2022, March 24). *SEA siap implementasi program 'Escola Verde' di tiga sekolah*. (A. Moniz, Editor) Retrieved from id.tatoli.tl: https://id.tatoli.tl/2022/03/24/sea-siap-implementasi-program-escola-verde-di-tiga-sekolah/

Food and Agriculture Organization. (2020, September 23). *Decree-Law No. 37/2020 regulating Sale, Import and Production of Bags, Packaging and other Plastic Objects*. Retrieved from https://www.fao.org/faolex/results/details/fr/c/LEX-FAOC198631/#:~:text=Decree%2DLaw%20No.-,37%2F2020%20regulating%20Sale%2C%20Import%20and%20Production%20of%20Bags%2C,Packaging%20and%20other%20Plastic%20Objects.

INETL. (2023). *Timor-Leste National Accounts 2003-2022*. Dili: Timor-Leste National Institute of Statistics (INETL). Retrieved from https://inetl-ip.gov.tl/2023/09/08/timor-leste-national-account-2003-2022/

INETL. (2023). *Timor-Leste Population and Housing Census 2022: Main Report*. Dili: Timor-Leste National Institute of Statistics (INETL). Retrieved from https://timor-leste.unfpa.org/sites/default/files/pub-pdf/final-main-report_tlphc-census_2022.pdf

INETL. (2024). *Timor-Leste in Figures 2022. Timor Leste National Institute of Statistics (INETL)*. Dili: Planet Printing. Retrieved from https://inetl-ip.gov.tl/2024/07/01/timor-leste-in-figures-2022/

JICA. (2024). *Data Collection Survey on Solid Waste Management in Dili Municipality for Reducing Marine Plastic Waste in Timor-Leste: Final Report*. JICA and Nippon Koei Co., Ltd.

Ministry of Agriculture and Fisheries. (2009). Nino Konis Santana National Park: The First National Park in TImor-Leste. Dili, Timor-Leste: Darwin Initiative. Retrieved from https://www.darwininitiative.org.uk/documents/DAR15022/18403/15-022%20FR%20Ann10h%20NKS%20National%20Park_brochure_english%20A2.pdf

Ministry of Finance. (2012). *Timor-Leste Household Income and Expenditure Survey 2011*. Dili: Timor-Leste National Institute of Statistics (INETL). Retrieved from https://inetl-ip.gov.tl/2023/02/21/household-income-and-expenditure-survey-2011/

Ministry of Public Works. (2019). *Simplified Environmental and Social Impact Statement: Branch Road Section of Dili-Ainaro Road*. Dili. Retrieved from https://documents1.worldbank.org/curated/pt/330461556256923877/pdf/Environmental-and-Social-Impact-Assessment.pdf

Morse, M. (2022, August 12). *The Plastics Solutions Alliance: A Recycling Value Chain in Timor-Leste*. Retrieved from https://ideas.darden.virginia.edu/p3-plastics-solutions-alliance

National Biodiversity Working Group. (2015). *The National Biodiversity Strategy and Action Plan of Timor-Leste (2011-2020)*. Retrieved from https://www.cbd.int/doc/world/tl/tl-nbsap-v2-en.pdf

NSWMC. (2020). *Waste Analysis and Characterization Study (WACS): A standardized and mandatory guide for Philippine local government units and solid waste management practitioners*. Quezon City, Metro Manila.

PEMSEA. (2025). *Marine Plastic Data Center*. Retrieved 2025, from Sea Knowledge Bank: https://easmarineplastics.seaknowledgebank.net/charts

PPIP. (2022, June 3). *PPIP SWM Workshop Sanitary Landfill Site Selection*. Retrieved from ppi-programme.net: https://www.ppi-programme.net/2022/06/03/ppip-swm-workshop-sanitary-landfill-site-selection/

PPIP. (2024, April 30). *Timor Leste Solid Waste Management project – Geotechnical Study of Landfills*. Retrieved from ppi-programme.net: https://www.ppi-programme.net/2024/04/30/timor-leste-solid-waste-management-project-geotechnical-study-of-landfills/

Ramos, P. d. (2014). *Aspectos fisicos do Timor Leste [Physical Aspects of Timor-Leste]*. Retrieved from https://petgeoudesc.wordpress.com/wp-content/uploads/2014/08/informativo-09-2014-setembro-joc3a3o1.pdf

Ray, A. (2021, May 24). Burning ambition: Timor-Leste's waste management problem. DevPolicyBlog. Retrieved from https://devpolicy.org/burning-ambition-timor-lestes-waste-management-problem-20210524-2/

SPREP. (2020). *Assessment of Legislative Frameworks Governing Waste Management in Timor-Leste*. Secretariat of the Pacific Regional Environment Programme (SPREP).

SPREP. (2022). *Waste Audit Report: Timor-Leste. Secretariat of the Pacific Regional Environment Programme (SPREP)*. Retrieved from https://www.sprep.org/sites/default/files/POLP/Timor-Leste-Waste-Audit-Report-FINAL.pdf

SPREP. (2023). *Plastic Pollution Prevention in Timor-Leste: Gap Analysis of Current Legislation, Policies, and Plans*. Secretariat of the Pacific Regional Environment Programme (SPREP). Retrieved from https://library.sprep.org/sites/default/files/2023-05/plastic-pollution-laws-legislation-timor-leste.pdf

SPREP. (2023). *Timor-Leste National Waste Audit Analysis Report. Secretariat of the Pacific Regional Environment Programme (SPREP)*. Retrieved from https://pacwasteplus.org/wp-content/uploads/2023/08/Timor-Leste-National-Waste-Audit-Analysis-Report.pdf

Steenhagen, E., Fuller, S., Farrelly, T., Borrelle, S., & Rengal-Goncalves, A. (2023). *Plastic Pollution Prevention in Timor Leste: Gap Analysis of Current Legislation, Policies, and Plans*. Apia: Secretariat of the Pacific Regional Environment Program (SPREP). Retrieved from https://library.sprep.org/sites/default/files/2023-05/plastic-pollution-laws-legislation-timor-leste.pdf

Strom, M. (2019, May 17). *Agreement to build a recycling plant using Australian technology*. Retrieved from https://www.sydney.edu.au/news-opinion/news/2019/05/17/timor-leste-aims-to-become-world-s-first-plastics-neutral-countr.html

TATOLI. (2021, October 25). USAID-Canossian School launch Green School Initiative Helps Keep Timor-Leste Clean. Dili, Timor-Leste: TATOLI Agência Noticiosa De Timor-Leste. Retrieved from https://en.tatoli.tl/2021/10/25/usaid-canossian-school-launch-green-school-initiative-helps-keep-timor-leste-clean/11/

The World Bank Group. (2024). Gini Index of Indonesia, Philippines, and Timor-Leste. Retrieved from https://data.worldbank.org/indicator/SI.POV.GINI?end=2023&locations=ID-PH-TL&start=2001&view=chart

Treyes, A. C., Osorio, E., Tanchuling, M. A., Andal, M. D., Requejo, B., Inocencio, B., & Panopio, C. (2023). Socio-behavioral assessment of household solid waste management: The case of Barangay Calicanto, Philippines. *IOP Conference Series: Earth and Environmental Science. 1257*. Bali: IOP Publishing. Retrieved from https://iopscience.iop.org/article/10.1088/1755-1315/1257/1/012008

UN-Habitat. (2021). Waste Wise Cities Tool: Step by Step Guide to Assess a City's Municipal Solid Waste Management Performance through SDG indicator 11.6.1 Monitoring. UN-Habitat. Retrieved from https://unhabitat.org/sites/default/files/2021-10/Waste%20wise%20cities%20tool%20-%20EN%2013.pdf

USAID. (2021, December 6). *Timor-Leste: Paving the Way on Plastics Recycling*. Retrieved from https://urban-links.org/news/timor-leste-paving-the-way-on-plastics-recycling/

Ministry of Oceans and Fisheries

PEMSEA