Ministry of Oceans and Fisheries

PEMSEA

MOF/PEMSEA ODA Project

Reducing Marine Plastics in the East Asian Seas Region

Regional Baseline Assessment on Marine Plastics in the East Asian Seas Region

PHILIPPINES AND TIMOR-LESTE

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REGIONAL BASELINE ASSESSMENT ON MARINE PLASTICS IN THE EAST ASIAN SEAS REGION (PHILIPPINES AND TIMOR-LESTE)

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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.

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List of Abbreviations and Acronyms

AMH	-	AMH Philippines, Inc.
ASEAN	-	Association of Southeast Asian Nations
CBO	-	Community-based Organization
CFC	-	Chlorofluorocarbon
COBSEA	-	Coordinating Body on the Seas of East Asia
DAO	-	DENR Administrative Order
DENR	-	Department of Environment and Natural Resources
DILG	-	Department of Interior and Local Government
EEE	-	Electrical and Electronic Equipment
EEZ	-	Exclusive Economic Zone
ENRMP	-	Environmental Natural Resources Management Project
ENRO	-	Environment and Natural Resources Office
EPS	-	Expanded Polystyrene
FCE	-	Final Consumption Expenditure
FIES	-	Family Income and Expenditure Survey
g	-	Gram
GDP	-	Gross Domestic Product
GIS	-	Geographic Information System
GNI	-	Gross National Income
HCFC	-	Hydrochlorofluorocarbon
HDPE	-	High-Density Polyethylene
HIES	-	Household Income and Expenditure Survey
HUC	-	Higly Urbanized City
IEC	-	Information, Education, and Communication
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
LGU	-	Local Government Unit
m^2	-	Square Meter
m^3	-	Cubic Meter
MARITES	-	Motherly Association for River Initiatives Towards Environmental Sustainability

MARPOL	-	International Convention for the Prevention of Pollution from Ships
MEP	-	Marine Environment Protector
MoA	-	Memorandum of Agreement
MOF	-	Ministry of Fisheries
MoU	-	Memorandum of Understanding
MPA	-	Marine Protected Area
MRF	-	Materials Recovery Facility
MSA	-	Ministry of State Administration
MSWMB	-	Municipal Solid Waste Management Board
NCR	-	National Capital Region
NGO	-	Non-governmental Organization
NPOA-ML	-	National Plan of Action on Marine Litter
NSWMC	-	National Solid Waste Management Commission
PACS	-	Plastic Analysis and Characterization Study
PD	-	Presidential Decree
PEMSEA	-	Partnerships in Environmental Management for the Seas of East Asia
PET	-	Polyethylene Terephthalate
Php	-	Philippine Peso
PMU	-	Project Management Unit
PP	-	Polypropylene
PPA	-	Philippine Ports Authority
PPP	-	Purchasing Power Parity
PRF	-	PEMSEA Resource Facility
PS	-	Polystyrene
PSA	-	Plastic Solutions Alliance
PUV	-	Public Utility Vehicle
PVC	-	Polyvinyl Chloride
RA	-	Republic Act
RAP MALI	-	Regional Action Plan on Marine Litter
RCA	-	Residual Containment Area
RCP	-	River Care Program
RDF	-	Refuse-Derived Fuel
SBCC	-	Socio-Behavioral Change Communication
SLF	-	Sanitary Landfill
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
SUP	-	Single-use Plastic
SWMP	-	Solid Waste Management Plan

UN OCHA	-	United Nations Office for the Coordination of Humanitarian Affairs
UNCLOS	-	United Nations Convention on the Law of the Sea
UNEP	-	United Nations Environment Programme
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

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- Municipal Government of Daanbantayan
- City Government of Dipolog
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Executive Summary

Plastic pollution in the ocean and rivers presents a serious threat to marine life and human health. In Southeast Asia, rapid urbanization and a growing economy results in the rapid increase of solid waste and marine debris generation. In 2015, it is reported that 275 million metric tons of plastic waste was generated worldwide, with significant contributions from the region (ASEAN, 2021).

Marine plastic pollution is a serious issue in the Philippines and in Timor-Leste. The Philippines is estimated to release approximately 356,371 metric tons of plastic waste into the oceans annually (Meijer, Emmerik, Van Der Ent, Schmidt, & Lebreton, 2021), while Timor-Leste is projected to contribute 64.2 metric tons by 2050 (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 cities and municipalities — 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, coastal communities 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 key towns and cities that serve project sites in line with national goals and global commitments, such as the 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

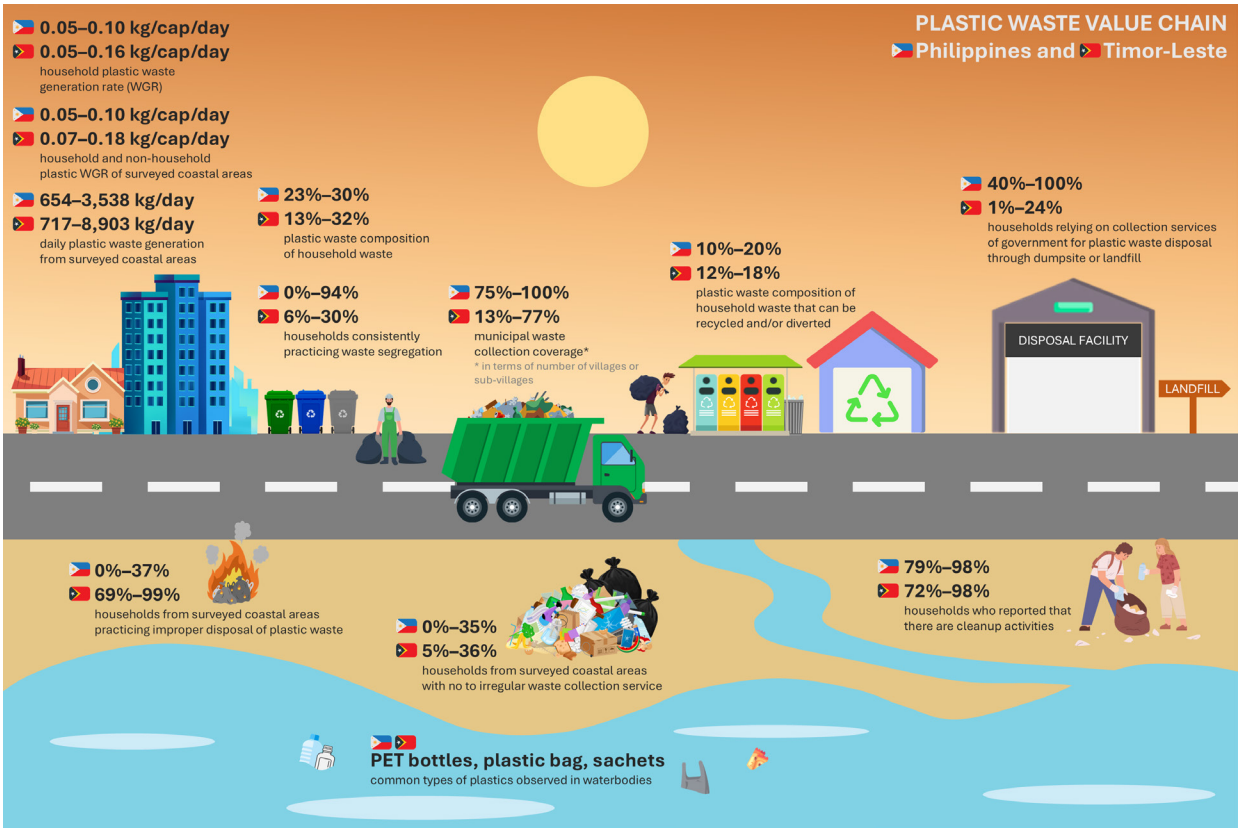
A critical part of the project is conducting a baseline study on plastic waste generation and composition at each project site. This baseline study will help inform and tailor policies and activities for reducing the impacts of marine plastic pollution in each area. As part of Component 1, the Plastic Analysis and Characterization Study (PACS) will provide essential data to guide project decisions and establish 10-year marine plastic management strategies and action plans, which will be developed, adopted, and implemented by local governments and stakeholders.

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 the six cities and municipalities in the Philippines: Bulan, Calbayog, Daanbantayan, Dipolog, Puerto Princesa, and Tandag; and 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.

The analysis and characterization of waste found significant variations across the ten surveyed areas, with Timor-Leste exhibiting relatively high waste generation rates (WGR). The combined household and non-household sources generate about 2,701 kg/day to 48,268 kg/day, where 654 kg/day to 8,903 kg/day are plastic waste. These results in WGRs ranging from 0.17 kg/cap/day to 0.57 kg/cap/day, and plastic WGRs of 0.05 kg/cap/day to 0.18 kg/cap/day. When compared to national-level estimates from global and local studies, the Philippines sites generally show a lower WGR, while Timor-Leste sites exceed the recorded and estimated WGRs, which may reflect the economic conditions and characteristics of the surveyed area. Households account for a significant portion of the generated waste, accounting for about 71% to 95% of the total waste. The Philippines and Timor-Leste record a national household WGR of 0.29 kg/cap/day and 0.38 kg/cap/day, respectively. While waste generation rates vary, the most common plastic waste in both countries are diapers and napkins, polyethylene terephthalate (PET) items, and polypropylene (PP) items.

The KAP survey highlighted key insights into community practices, awareness of local policies, and perceptions regarding environmental changes. All project sites frequently purchase plastic products, with common items packaged in flexible plastic packaging such as laminated sachets, and single-film wrappers. Buying water in PET bottles is frequently practiced in Timor-Leste. In the Philippines, most households follow waste segregation practices under the "no segregation, no collection" policy, but full compliance is hindered by waste collectors mixing waste and a lack of segregated bins. In Timor-Leste, the absence of a local policy on waste segregation leads to households not adopting the practice. In both countries, infrequent waste collection poses a challenge, leading most households to resort to improper disposal methods such as burning, burying, and open dumping. While most respondents in the Philippines are aware of local policies, some lack knowledge. Moreover, the absence of a local policy in Timor-Leste contributes to ongoing unsustainable waste management practices.

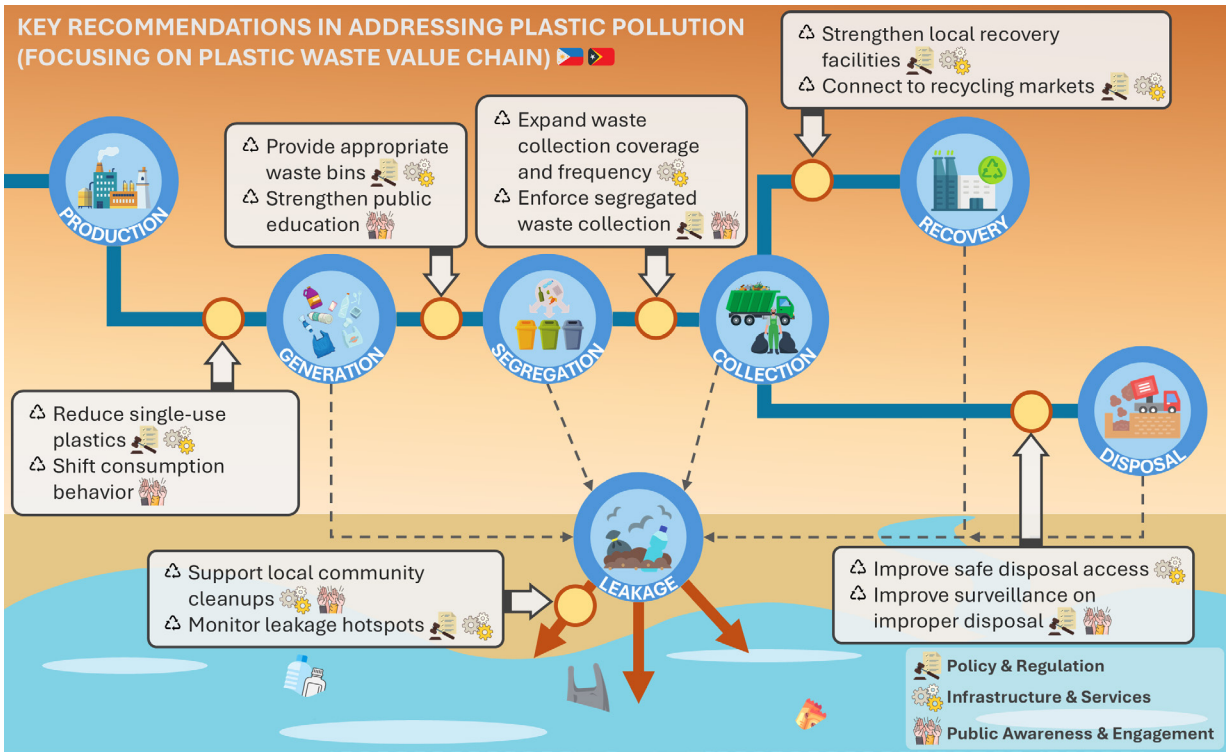
The regional synthesis identified persistent challenges across the plastic waste value chain, including high plastic waste generation, weak segregation, limited collection coverage, low recovery performance, inadequate disposal systems, and continued plastic leakage. Addressing these issues requires targeted interventions across all stages of the solid waste management system. Key recommendations focus on reducing single-use plastics through local policy and behavior change, improving segregation by providing bins and strengthening implementation, and expanding collection through additional vehicles and better route planning. Recovery must be enhanced by upgrading facilities and linking communities to recycling markets, while safe disposal options should be developed or improved to reduce open dumping and burning. Across all sites, leakage must be addressed by pairing cleanup efforts with systemic improvements and monitoring to prevent plastic waste from entering the environment. These actions are guided by three interconnected areas — policy and regulation, infrastructure and services, and public awareness and engagement — that work together to build an effective and locally appropriate response to plastic pollution.



Plastic Waste Value Chain for the Philippines and Timor-Leste Sites

Key Challenges Identified in the Philippines and Timor-Leste Sites

Component	Applicable Site	Key Challenges
Generation	Philippines and Timor-Leste sites	• High reliance on plastics, including disposable and pre-packaged products due to affordability, convenience, limited alternatives, and geographic isolation • Limited implementation or enforcement of policies discouraging plastic use and promoting reduction at source • Weak public awareness in adopting waste reduction practices
Segregation	Philippines and Timor-Leste sites	• Poor infrastructure such as limited number of segregating bins or lack of space for the installation of waste bins
	Philippines sites	• Lax implementation of segregation policy leads to low compliance with the practice, thus, continuous collection and disposal of mixed waste
	Timor-Leste sites	• Absence of local policy on segregation results in continuous disposal of mixed waste
Collection	Philippines and Timor-Leste sites	• Low collection coverage due to limited number of collection trucks and inaccessible roads • Infrequent collection schedule, which results in improper waste disposal • No separate collection leading to continuous disposal of mixed waste
Recovery	Philippines and Timor-Leste sites	• Preference of informal waste collectors and small recovery facilities on materials considered high value like metal further limits plastic recovery
	Philippines sites	• Recovery facilities designed for storing and processing recyclables are used as temporary storage areas without significant recycling activities
	Timor-Leste sites	• Lack of recycling facilities accepting and processing recyclable plastics and residual plastics
Disposal	Philippines and Timor-Leste sites	• Due to inefficiencies in the waste management system, communities often resort to improper waste disposal such as burning, burying in the ground, and open dumping
	Philippines sites	• Overcapacity of sanitary landfill due to continuous dumping of unsegregated waste • Some local government units utilize residual containment areas as disposal facilities, which may lack the essential protective measures like that of sanitary landfills, increasing risk of waste leakage
	Timor-Leste sites	• Dependence on uncontrolled facilities as disposal sites



Key Recommendations in Addressing Plastic Pollution at the Philippines and Timor-Leste Sites

The regional synthesis of baseline assessment examines the overall solid waste management system in selected coastal areas in the Philippines and Timor-Leste to better understand how gaps and challenges contribute to marine plastic pollution. The findings support targeted, data-driven solutions that strengthen local governance and promote coordinated action across all levels to address marine plastic pollution in the region.

Coastal Clean up in San Pedro Creek,
Brgy. Poblacion, Daanbantayan, Cebu.

1 Introduction

Plastic pollution in the ocean and rivers poses a significant threat to marine life, human health, and the environment. With the rapid increase in the production and consumption of plastic products, effective management of plastic waste remains a challenge, especially for developing countries, due to limited facilities and resources. Globally, around 8 to 10 million metric tons of plastic waste end up in oceans annually, contributing to 80% of the overall marine pollution. Only about 10% of the total plastic produced is recycled, while the remaining percentage is either incinerated or improperly disposed of. Mismanaged plastic waste entering water systems eventually form microplastics, further contributing to the adverse effects of plastic pollution due to its increased potential to enter the food chain (UNESCO, 2022).

Southeast Asia, with its rapid urbanization, growing economy, and generally underdeveloped waste management infrastructure, faces severe challenges in terms of plastic pollution. In 2021, it was reported that six out of the ten highest ocean plastic polluters are countries from Southeast Asia, contributing to about 577,000 metric tons of plastic waste leaked into oceans annually. This key finding emphasizes the need to address the pressing issue of plastic waste in the region (Meijer, Emmerik, Van Der Ent, Schmidt, & Lebreton, 2021).

Marine plastic pollution is a serious issue in the Philippines, with approximately 356,371 metric tons of plastic waste entering water systems annually (Meijer, Emmerik, Van Der Ent, Schmidt, & Lebreton, 2021). Each year, about 2.15 million metric tons of plastics are consumed in the country. Of this number, only 9% is recycled while 35% is improperly disposed of, eventually leaking into the open environment (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020).

Similarly, in Timor-Leste, plastics account for 13% of the country's total waste stream. About 20.7 metric tons of plastic waste was reported leaking into marine systems in 2010, with a projected increase to 64.2 metric tons by the year 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 cities and municipalities—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.

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

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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. As part of Component 1, the Plastic Analysis and Characterization Study (PACS) will provide essential data to guide project decisions and establish 10-year marine plastic management strategies and action plans, which will be developed, adopted, and implemented by local governments and stakeholders.

This baseline assessment on marine plastics includes the results of Plastic Analysis and Characterization Studies (PACS) and Knowledge, Attitude, and Practice (KAP) Surveys, specifically conducted on key coastal areas in the six cities and municipalities in the Philippines: Bulan, Calbayog, Daanbantayan, Dipolog, Puerto Princesa, and Tandag (**Figure 1**); and four municipalities in Timor-Leste: Atauro, Dili, Liquiçá, and Manatuto (**Figure 2**). These components are designed to understand the specific dynamics of plastic waste generation and local community behaviors towards waste management.

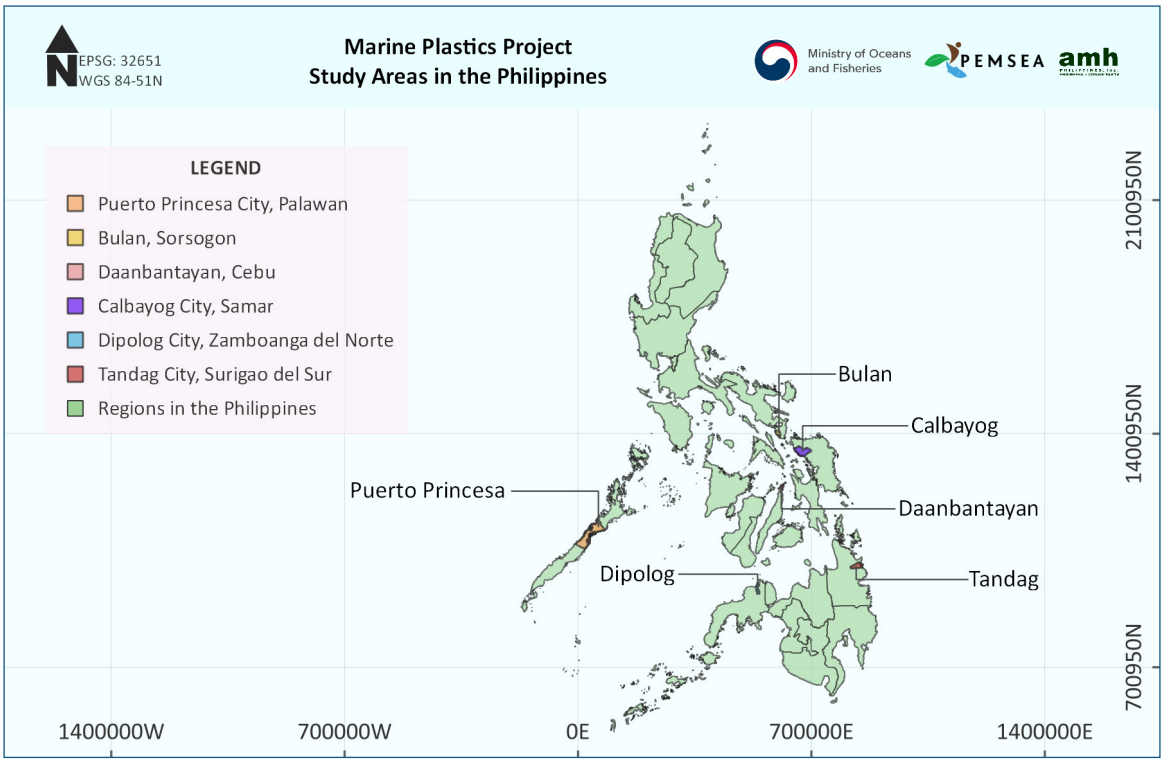

Figure 1. Study Areas in the Philippines for Reducing Marine Plastics in the East Asian Seas Region Project

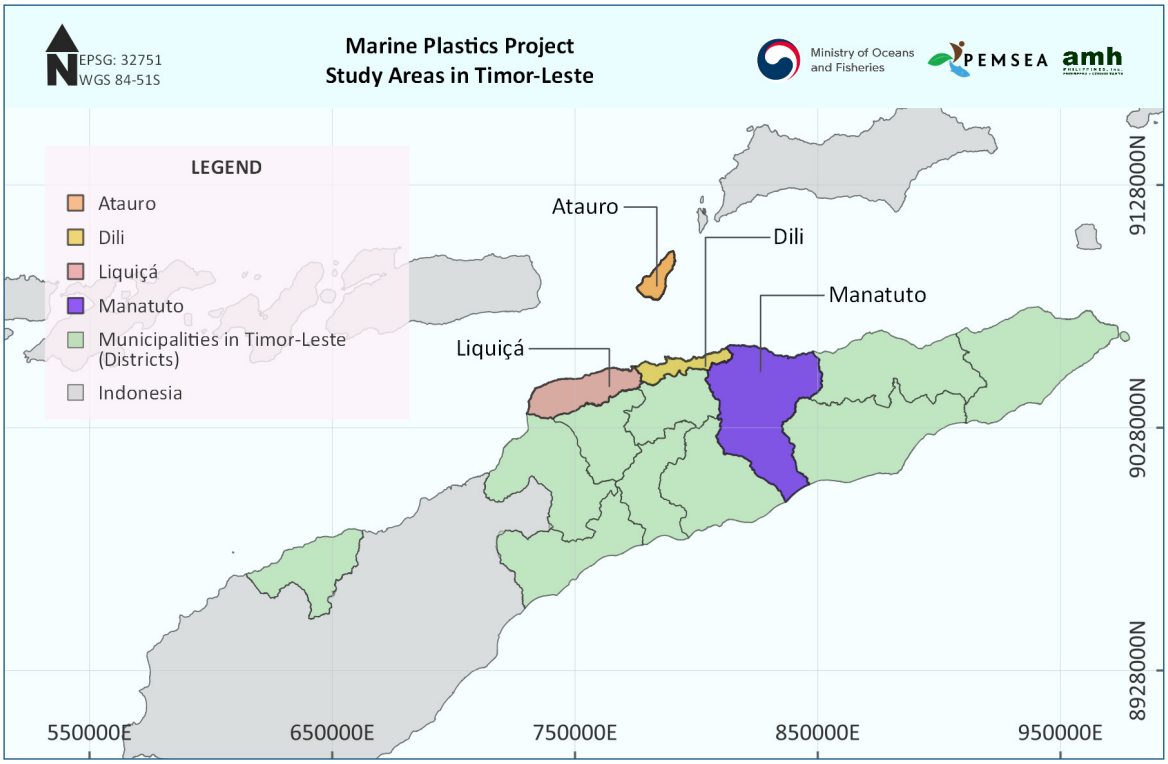

Figure 2. Study Areas in Timor-Leste for Reducing Marine Plastics in the East Asian Seas Region Project

The regional 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 and comparison of solid waste management across the Philippine and 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 regional 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 barangays (in the case of the Philippines) or sucos (in the case of Timor Leste) 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 waste value chain and the possible leakage points in the study area;
- Conduct Knowledge, Attitude, and Practice survey on household solid waste management; and
- Synthesize and compare the findings from national and local baseline assessments of the Philippines and Timor-Leste to establish the regional baseline assessment on marine plastics.

Regional Profile 2

The Philippines and Timor-Leste are two Southeast Asian nations in the Asia-Pacific Region, both characterized by extensive coastlines and economies that rely heavily on maritime resources. While the Philippines is a large archipelagic country, Timor-Leste is a smaller island nation situated on the eastern half of the Timor Island. Their geographical characteristics and reliance on coastal industries make them particularly vulnerable to marine plastic pollution, threatening their marine biodiversity, coastal livelihoods, and ecosystems.

The extent of coastal dependence is reflected in the geographical composition and settlement patterns of each country. The Philippines, which lies approximately 1,424,150 Northing and 366,968 Easting based on World Geodetic System 1984 Universal Transverse Mercator Zone 51N, consists of 7,641 islands grouped into three main island groups—Luzon, Visayas, and Mindanao. There are 1,642 cities and municipalities in the country (DILG, 2024), of which almost 900 are located along the coast.

Timor-Leste, on the other hand, is positioned at about 9,017,954 Northing and 800,002 Easting. 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. Philippines

1. Demographic Profile

The Philippines had a population of 109,035,343[1] in 2020, with an average annual population growth rate of about 1.67% from the census period of 2015 to 2020 (Philippine Statistics Authority, 2021). The nation's population density averages around 363 persons/km2, calculated over a total land area of about 300,000 km^2 (Philippine Statistics Authority, 2021).

Considering the population growth rate of the country, the population of the Philippines in 2023 was projected at approximately 114,589,748, in which about 51% or 58 million people are estimated residing in coastal cities and municipalities.[2]

[1] Including 2,098 Filipinos in Philippine embassies, consulates, and missions abroad.

[2] Population estimation is based on the definition that a coastal city or 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. Economic Profile

As a developing country, the Philippines exhibited a gross domestic product (GDP) of Php 24,289,426 million based on 2023 current prices (Philippine Statistics Authority, 2024). The GDP is primarily divided among the three major sectors, which include agriculture, forestry, and fishing; industry; and services. The services sector contributes about 62.3% to the GDP, indicating the role of the sector in driving economic growth (**Figure 3**). The leading contributors to the country's GDP are wholesale and retail trade at 18.3%, manufacturing industry at 16.1%, and financial and insurance activities at 10.6%. In addition, the country, classified as a lower-middle-income country, recorded a per capita gross national income (GNI) of US$ 3,950, positioning itself for a gradual recovery and reform efforts aimed at transitioning to an upper-middle-income status (World Bank Group, 2024).

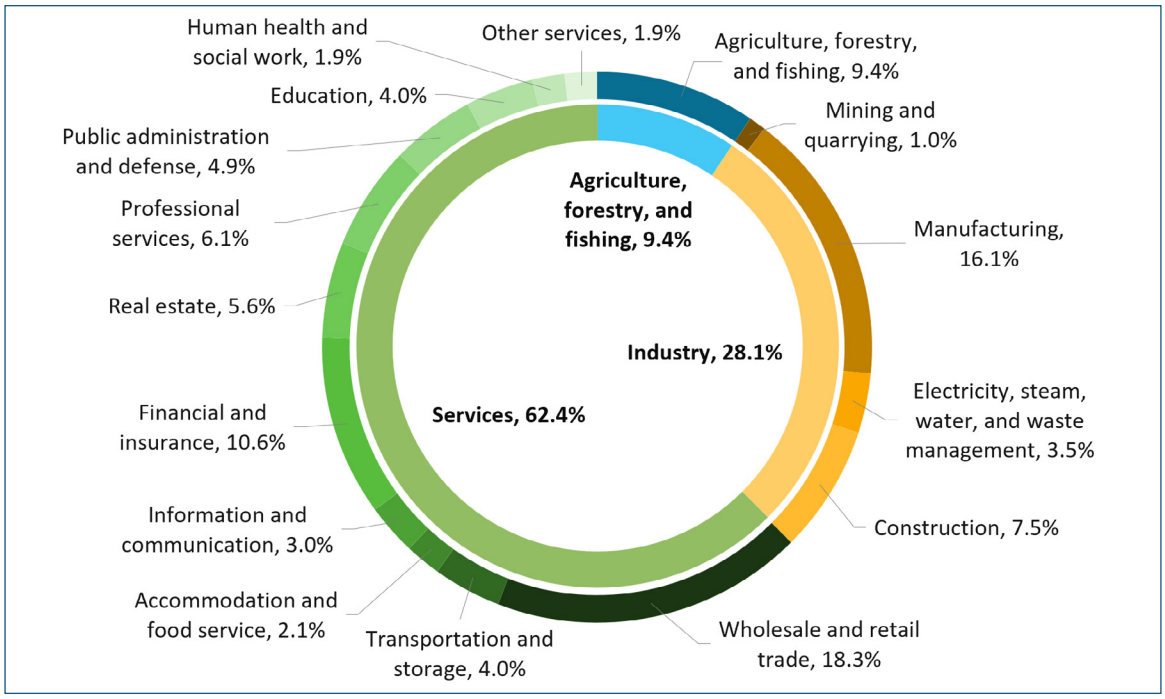

Figure 3. Philippine GDP Share by Sector in 2023 (Philippine Statistics Authority, 2024)

Urbanization has played a crucial role in shaping economic trends. In 2020, 58.93 million or 54% of the total recorded population resided in urban barangays, marking a rise from 51.2% in 2015 (Philippine Statistics Authority, 2022). Aside from the National Capital Region (NCR), which is classified as entirely urban, four other regions posted a level of urbanization higher than the national level, including Region IV-A – CALABARZON, Region XI – Davao, Region III – Central Luzon, and Region XII – SOCCSKSARGEN (**Table 1**).

Table 1. Level of Urbanization by Region in the Philippines (Philippine Statistics Authority, 2022)

Region	Total Population	Urban Population	Level of Urbanization[a] (%)
NCR	13,484,462	13,484,462	100.0
CAR	1,797,660	598.688	33.3
I - Ilocos	5,301,139	1,351,205	25.5
II – Cagayan Valley	3,685,744	717,788	19.5
III - Central Luzon	12,422,172	8,230,254	66.3
IV-A - CALABARZON	16,195,042	11,415742	70.5
IV-B - MIMAROPA	3,228,558	1,138,021	35.2
V – Bicol	6,082,165	1,447,370	23.8
VI - Western Visayas	7,954,723	3,353,205	42.2
VII - Central Visayas	8,081,988	4,196,639	51.9
VIII - Eastern Visayas	4,547,150	666,473	14.7
IX - Zamboanga Peninsula	3,875,576	1,489,443	38.4
X - Northern Mindanao	5,022,768	2,528,239	50.3
XI - Davao	5,243,536	3,504,533	66.8
XII - SOCCSKSARGEN	4,360,974	2,418,843	55.5
XIII - Caraga	2,804,800	1,027,223	36.6
BARMM	4,944,800	1,362,601	27.6
Philippines	**109,033,245**	**58,930,729**	**54.0**

[a] Defined as the proportion of the total population living in barangays classified as urban, calculated by dividing the urban population with the total population and multiplying the quotient by 100.

Out of more than 42,000 barangays in the Philippines, 18.9% were classified as urban, meeting at least one of the following criteria: having a population size of 5,000 or more, hosting at least one establishment with a minimum of 100 employees, or having five or more establishments with 10 to 99 employees and at least five facilities within the two-kilometer radius from the barangay hall (Philippine Statistics Authority, 2022). The urbanization trend is expected to continue, with projections indicating that the Philippine urbanization rate will increase to 61.5% by 2050 (UN DESA, 2018).

The country's trade activity has also seen notable growth. As of January 2025, the merchandise imports grew by 10.8% or USD 11,453,000,000, contributing to a total trade value of USD 17,817,000,000 (Department of Trade and Industry, 2025). The leading import categories included capital goods, raw materials and intermediate goods, and consumer goods. Electronic products, primarily classified under capital and consumer goods, are the top imports with a significant share, reflecting the country's growing demand for technology and industrial components. The Philippines primarily sources imports from China, Japan, Indonesia, South Korea, and the United States.

Tourism has demonstrated a strong recovery, contributing approximately 8.6% to the GDP in

2023, equivalent to Php 2.09 trillion (Philippine Statistics Authority, 2024). Key growth areas within the sector include accommodation services, food and beverage serving activities, transport services, travel agencies and other reservation services, entertainment and recreation services, and shopping. Visitor arrivals for 2024 reached 5.95 million, with foreign tourists comprising 5.44 million or 91.42% of these arrivals and overseas Filipinos[3] accounting for the remaining 8.58% (Department of Tourism, 2025). The resurgence of international travel underscores the sector's potential for revitalizing economic activity, particularly in regions reliant on tourism revenues.

Household consumption is also a key driver of economic activity in the Philippines, significantly influenced by income, employment, consumer confidence, and remittances from overseas. In the fourth quarter of 2024, the Household Final Consumption Expenditure (HFCE)[4] recorded a 4.7% year-on-year growth rate, indicating an expanding but moderated consumer spending compared to 5.3% in 2023 (Philippine Statistics Authority, 2024). The major contributors to this growth were health expenditures at 11.5%, transport at 10.9%, miscellaneous goods and services at 7.7%, restaurant and hotels at 5.3%, and food and non-alcoholic beverages at 1.3%.

In terms of family finances, the 2021 Annual Family Income and Expenditure Survey (FIES) reported that the annual income of Filipino families is about Php 307,190, with annual expenditures averaging about Php 238,640. The primary source of income for the majority of families is wages and salaries, which constitute about 52.7% of total family income, highlighting the role of employment in the economic well-being of the people (Philippine Statistics Authority, 2022).

Income disparity remains a concern, with the country recording a Gini coefficient of 0.4119 in 2021, indicating a moderate level of income inequality. Regionally, the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) showed the lowest income disparity with a Gini coefficient of 0.2764, while Region VIII or the Eastern Visayas exhibited the highest with a coefficient of 0.4531 (Philippine Statistics Authority, 2022). The poverty threshold of the country in 2023 is at Php 13,873 per month for a family of five. The poverty incidence among families is at 10.9%, with Region IX or Zamboanga Peninsula having the highest regional poverty incidence at 24.2% (Philippine Statistics Authority, 2024). These figures suggest the uneven economic conditions across different areas of the country, which may influence policy direction towards more equitable growth.

3. Coastal Areas and Waterways

The Philippines has an extensive coastline stretching about 36,289 km (The World Factbook, 2024), which is the fifth longest coastline in the world. Its coastal waters are part of its exclusive economic zone (EEZ) as set by the United Nations Convention on the Law of the Sea (UNCLOS), covering more than 2 million km^2. This zone is rich in marine biodiversity and plays an important role in the nation's economy, particularly through fishing and tourism industries. About 12% of

[3] Philippine Passport holders who are permanently residing abroad (Department of Tourism, 2025).

[4] HFCE consists of expenditures made by households for their own final consumption on goods and services, regardless of where it occurred. It also includes purchases of consumer goods, estimated value of barter transactions, own account production, and consumption of goods or services (Philippine Statistics Authority, 2024).

this sea area consists of productive continental shelves hosting coral reef, mangrove, and algal ecosystems, which form the habitats of various species supporting coastal marine fisheries (The Fisheries Centre, 2014).

The country is positioned at the apex of the Coral Triangle, which is the world's richest marine eco-region (Department of Environment and Natural Resources, 2016). This location contributes to the high biodiversity of the Philippines, making it a priority area for marine conservation. Additionally, the country has designated marine protected areas (MPAs) covering about 32,010 km^2 (UNEP-WCMC, 2024), to safeguard its marine resources and to ensure the sustainability of the marine ecosystems and the communities that depend on them.

In addition to its rich marine ecosystems, the Philippines is home to an extensive network of waterways as part of its over 1,000 water bodies, including both freshwater and marine environments (Environmental Management Bureau, 2019). The country features 18 major river basins, covering a total area of about 108,678 km^2. The largest among these is the Cagayan River Basin in Luzon, which is approximately 27,500 km^2 (River Basin Control Office, 2019). This basin is centered around the Cagayan River, the country's longest river at about 505 km, which flows into the Philippine Sea (Too, 2019). With over 900 rivers, these waterways are vital for agriculture, transport, and as sources of freshwater for communities which highlights their importance in supporting both biodiversity and human livelihoods.

B. Timor-Leste

1. 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 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.[5]

2. Economic Profile

In 2022, the total GDP of Timor-Leste was $3.205 billion based on current prices, where $1.533 billion is from oil-related GDP,[6] 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 4**). 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.[7]

[5] 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.

[6] 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).

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

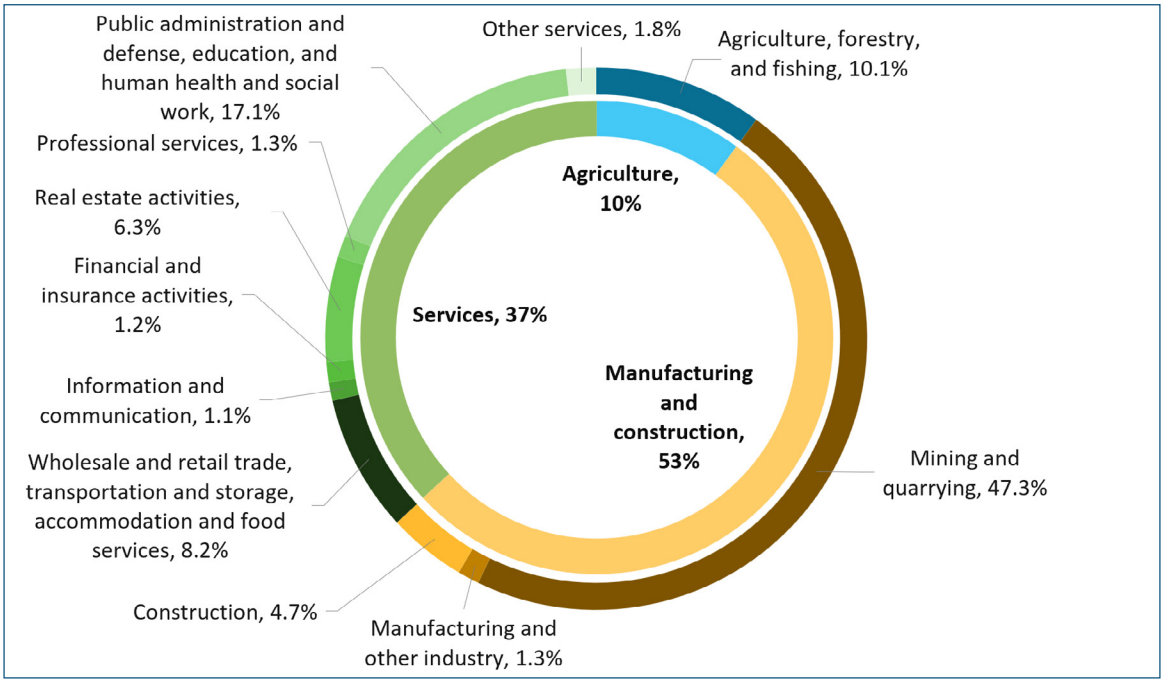

Figure 4. Timor-Leste's Non-Oil-Related GDP Share by Sector in 2022 (INETL, 2023)

Urbanization trends in Timor-Leste show that in 2022, approximately 383,737 or 28.6% of the population resided in urban areas, marking a slight decrease from 29.5% in 2015 (INETL, 2023).

The decrease is primarily due to a higher rural population growth rate of 2% annually compared to 1.3% in urban areas, shifting overall distribution toward rural settlements. Among the 13 municipalities, Dili recorded the highest level of urbanization at 82.4% (**Table 2**), reflecting its role as the capital and economic center of the country. In contrast, Atauro, an island municipality, is classified as entirely rural. Urban areas are classified based on a set of criteria, including a minimum population of 5,000 for each suco, and access to essential services such as education, healthcare, markets, water supply, sanitation, electricity, radio and television, and public administration (INETL, 2023).

Table 2. Level of Urbanization by Municipality in Timor-Leste (INETL, 2023)

Municipality	Level of Urbanization[a] (%)
Aileu	5.4
Ainaro	11.7
Atauro	0.0
Baucau	14.2
Bobonaro	12.3
Covalima	14.4
Dili	82.4
Ermera	9.1
Lautem	18.3
Liquica	5.5
Manatuto	9.2
Manufahi	11.9
Oecusse	18.9
Viqueque	5.5
Timor-Leste	**28.6**

[a] Defined as the proportion of the total population living in sucos classified as urban, calculated by dividing the urban population with the total population and multiplying the quotient by 100.

Trade data for 2022 highlights strong growth in both exports and imports. Exports of goods and services rose to 30.3%, while imports increased to 22.8% (INETL, 2023). Measured at constant prices, the total value of imports reached approximately US$ 894 million. The rise in imports was driven by the 29% increase in goods and the 13.2% growth in services. Key contributors to the surge in goods imports included food products, mineral products, and machinery and electrical goods. On the other hand, the expansion in service imports was largely influenced by a substantial rise in public investments.

Tourism, a sector that had seen steady growth in previous years, was severely impacted by the COVID-19 pandemic. Total international tourist arrivals peaked at 80,800 in 2019 before plummeting to 5,500 in 2021 due to global travel restrictions (UN Tourism, 2022).

The majority of the tourists in 2021 came from East Asia and the Pacific, accounting for approximately 2,700 visitors, followed by Europe, with 1,000 arrivals. Despite the decline in arrivals, the total expenditure of tourists reached approximately US$ 12 million, demonstrating continued economic contribution even amid reduced numbers.

Household income and expenditure trends provide further insight into the country's economic landscape. In 2011, the Household Income and Expenditure Survey (HIES) revealed that the average monthly household income in Timor-Leste is US$ 377.73, while monthly household expenditure averaged US$ 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).

Consumption patterns indicate that the Final Consumption Expenditure (FCE)[8] increased to 7% in 2022, reaching approximately US$ 2,425,000,000 (INETL, 2023). Household consumption accounted for 52.7% of the total FCE, rebounding significantly from a -3.3% decline in 2021 to a 14.6% increase in 2022. The growth was closely linked to the private income provided by the government through cash and in-kind transfers. The expansion in consumption coincided with a 19% increase in domestic rice production and a substantial 31.3% rise in imports of consumption goods.

3. 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

[8] Final consumption expenditure is the current expenditure by general government bodies on services to the community such as defense, education, and public order and safety less than any explicit charges for these services.

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 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 face pollution from 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).

C. Profile of the Project Sites

A summary of the profiles of the project sites is summarized in **Table 3**. All sucos in Atauro are coastal, while coastal barangays in Puerto Princesa and Daanbantayan constitute about 77% and 75% of the total number of barangays, indicating extensive exposure to marine areas. As urban centers, Puerto Princesa and Dili had the largest overall population. Apart from Atauro, the highest coastal village populations are found in Puerto Princesa, Daanbantayan, and Liquiçá.

Major economic activities for most of the local sites primarily involve agriculture and fishing. As coastal areas, some of the cities and municipalities also thrive in tourism. Dili, as an urban center, mostly thrives in services, finance, trade, and tourism. All project sites are surrounded by essential marine environments, providing resources to sustain major livelihoods such as agriculture and fishing. Among the locations, Puerto Princesa has the longest coastline at 416 km, while Dipolog has the shortest, at approximately 15 km.

These site profiles provide valuable insights into waste generation trends, particularly the prevalence of plastic waste along coastal areas. Understanding these patterns can help guide targeted interventions to mitigate marine plastic pollution and promote sustainable waste management.

Table 3. Summary Profile of Philippine and Timor-Leste Project Sites

City / Municipality	Total Number of Villages	Total Number of Coastal Villages[a]	Total Population[b]	Total Population in Coastal Villages[b]	Major Economic Activities	Nearby Waterbodies	Length of Coastline[c]
Bulan	63	20 (32%)	108,065	45,648 (42%)	agriculture, fisheries	Ticao Pass	~33 km
Calbayog	157	38 (24%)	208,092	102,101 (49%)	agriculture, fisheries, trading	Samar Sea	~54 km
Daanbantayan	20	15 (75%)	99,721	84,296 (85%)	agriculture, fisheries, tourism	Camotes Sea, Visayan Sea	~55 km
Dipolog	21	8 (38%)	143,008	71,391 (50%)	agriculture, fisheries	Sulu Sea	~ 15 km
Puerto Princesa	66	51 (77%)	345,223	328,775 (95%)	agriculture, fisheries, commerce, tourism	Sulu Sea, West Philippine Sea	~416 km
Tandag	21	12 (57%)	67,013	53,890 (80%)	forestry	Philippine Sea	~24 km
Atauro	5	5 (100%)	10,607	10,607 (100%)	agriculture, fishing, tourism	Banda Sea	~62 km
Dili	31	13 (42%)	342,510	162,168 (47%)	government services, finance, trade, tourism	Banda Sea (Ombai-Wetar Strait)	~51 km
Liquiçá	23	11 (48%)	87,378	54,275 (62%)	agriculture, fishing, livestock	Banda Sea (Ombai Strait)	~61 km
Manatuto	31	9 (29%)	52,089	20,618 (40%)	agriculture, fishing, livestock	Banda Sea (Wetar Strait), Timor Sea	~53 km

[a] coastal village is defined as a village where its boundaries, or a portion of its boundaries, include coastlines. In this report, the classification of barangays and sucos as coastal villages is determined using geographic information system (GIS) data.

[b] The reported population in the Philippines is based on 2020 census projected to 2023, while population data for Timor-Leste is based on 2022 census projected to 2024.

[c] The length of coastline is estimated using GIS.

Sabang Port, Barangay Cabayugan,
Puerto Princesa City, Palawan.

3 Regional and National Context of Solid Waste Management

A. Regional Policies and Regulations

Increased solid waste due to rapid urbanization, population growth, and economic development, has become a critical environmental issue globally. In Southeast Asia, many countries have developed national policies for solid waste management, such as the Ecological Solid Waste Management Act of 2000 in the Philippines and the Basic Law on the Environment and Statute of Municipal Administrations in Timor-Leste. However, the effectiveness of these efforts is often hindered by insufficient resources, outdated technology, and limited public awareness and involvement (Aziz & Ariffin, 2024). This lack of effective solid waste management results in increased environmental pollution, including marine plastic pollution, which has become a rising global concern.

It is reported that about 80% of marine litter in the ocean consists of plastics. A study in 2015 identified Southeast Asia as a primary source of marine plastic pollution (Asian Development Bank, 2024). Globally, international conventions that tackle marine plastic litter have been adopted to prevent accidental or intentional release of plastic litter into the oceans including the Stockholm Convention on Persistent Organic Pollutions (Stockholm Convention), United Nations Convention on the Law of the Sea (UNCLOS), Convention on the Prevention of Marine Pollution by Dumping Wastes and other Matter (London Convention), International Convention for the Prevention of Pollution from Ships (MARPOL), Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention). These conventions aim to strengthen global efforts in reducing marine plastic pollution and promoting sustainable ocean management. The Philippines is a signatory to all these conventions, while Timor-Leste is a party only to UNCLOS (**Table 4**).

Table 4. International Conventions on Marine Plastic Litter and Status of the Philippines and Timor-Leste (Asian Development Bank, 2024; Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023)

International Convention	Description	Agreement to Convention[a]	
		Philippines	Timor-Leste
Convention on the Prevention of Marine Pollution by Dumping Wastes and other Matter 1972 (London Convention)	• Aims to control all sources of marine pollution • Legally binding guidelines for compensation for damages from dumping of hazardous waste in the sea	**2012 Ascension[b]**	
United Nations Convention on the Law of the Sea 1982 (UNCLOS)	• Establishes responsibilities of nations on the use of oceans and management of marine natural resources	**1984 Ratification[c]**	**2013 Ratification**
International Convention for the Prevention of Pollution from Ships Annex V 1988 (MARPOL)	• Addresses plastic pollution from vessels and ships • Annex V prohibits the discharge of waste into the sea and requires reception facilities in ports where waste can be delivered and managed	**1980 Acceptance[d]**	
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1992 (Basel Convention)	• Addresses generation, management, and transboundary movement of hazardous waste, aiming to prevent transfer of waste from developed to less developed nations • Amendment in 2019 specifies categories of plastic waste subject to control for transboundary movements	**1993 Ratification**	
Stockholm Convention on Persistent Organic Pollutions 2004 (Stockholm Convention)	• Strives to protect human health and the environment from toxic substances that remain in the environment for extended periods	**2004 Ratification**	

[a] Green highlight indicates agreement to the convention, while gray highlight shows non-participation
[b] Ascension refers to the acceptance of a state of the opportunity to become a party to the treaty or convention that has already been created and holds same legal effect as ratification (Asian Development Bank, 2024)
[c] Ratification is when a state agrees to be bound to a treaty, allowing it sufficient time for approval at the national level and to implement necessary legislations (Asian Development Bank, 2024)
[d] Acceptance holds the same meaning as ratification but is used in some states where ratification of treaties is not required by constitutional law (Asian Development Bank, 2024)

Regional frameworks have also been developed to tackle the escalating issue of marine plastic litter in the area. The Association of Southeast Asian Nations (ASEAN), an intergovernmental organization of ten Southeast Asian countries, including the Philippines, spearheads the ASEAN Regional Action Plan for Combating Marine Debris in ASEAN Member States for the period 2021-2025. This initiative was developed between 2019 and 2020 following the ASEAN Conference on Reducing Marine Debris held in Thailand in November 2017, which

highlighted the need for a regional action plan addressing marine plastic litter. The regional action plan is built on the four frameworks of action introduced during the 34th ASEAN Summit in 2019, which are policy support and planning, research, innovation, and capacity-building, public awareness, education, and outreach, and private sector engagement. The framework further identifies 14 specific action plans including, creating guiding principles for phasing out select single-use plastics (SUPs), developing a guidebook for harmonized methodologies to assess and monitor marine litter, and organizing regional training on plastic waste management (**Figure 5**). As of November 2022, ASEAN leaders agreed in principle to admit Timor-Leste as the 11th member state, granting it observer status and allowing its participation in all ASEAN meetings.

Additionally, regional partnerships addressing marine plastic litter have been formed (Table 5). PEMSEA, with 11 country partners in the East Asian Seas including the Philippines and Timor-Leste, promotes sustainable development of coastal areas in the East Asian Seas region through the implementation of a regional policy framework, the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA) and strategic action plans such as the Integrated Coastal Management solutions, which aim to generate positive outcomes for communities through programs on plastic waste prevention and management (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023). Besides PEMSEA, the Coordinating Body on the Seas of East Asia (COBSEA), an intergovernmental mechanism under the United Nations Environment Programme (UNEP), adopted

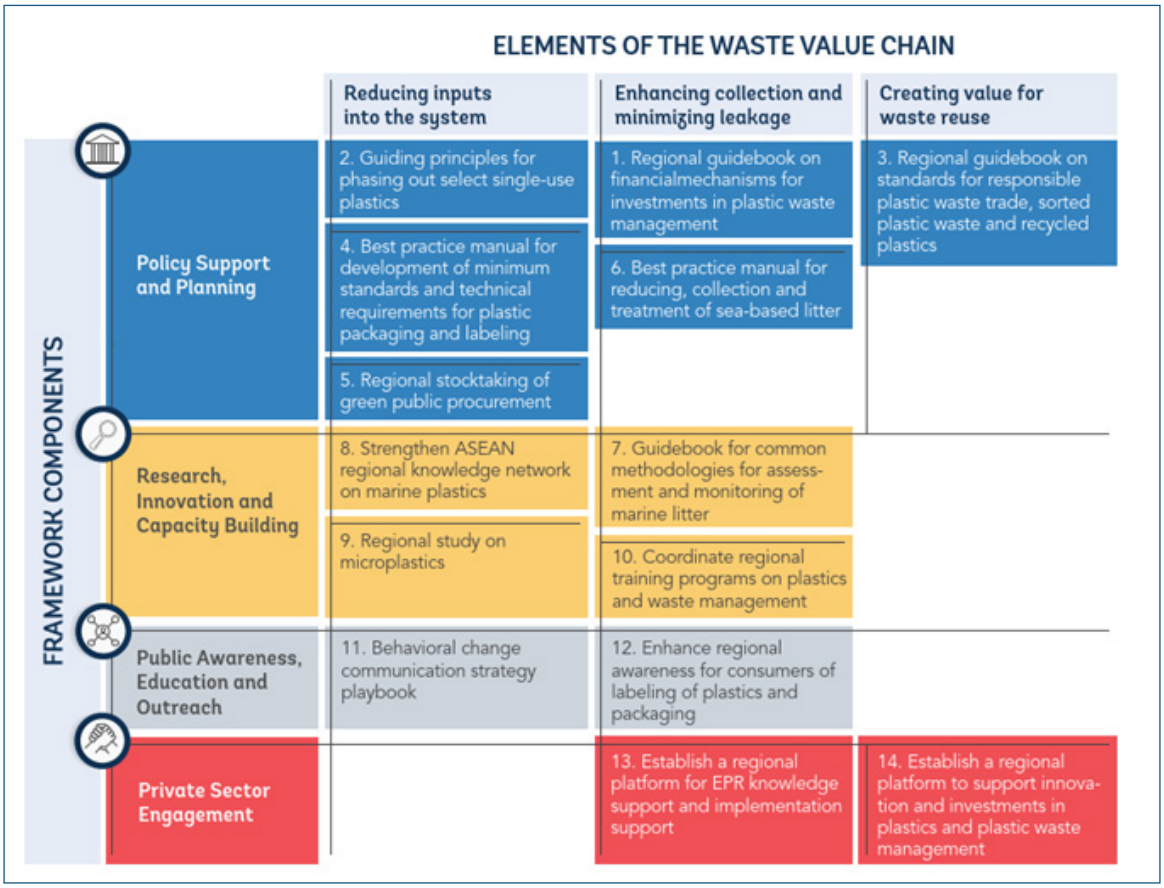

Figure 5. Framework Components of the ASEAN Regional Action Plan (ASEAN, 2021)

the Regional Action Plan on Marine Litter (RAP MALI) in June 2019. This plan primarily focuses on preventing and reducing marine litter from both land-based and sea-based sources, enhancing marine litter assessment and monitoring, and creating favorable conditions for action, including knowledge sharing through the East Asian Seas Node of the Global Digital Platform on Marine Litter (Asian Development Bank, 2024). While Timor-Leste is not a COBSEA member, it collaborates with COBSEA through PEMSEA (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023).

Table 5. Regional Associations and Programs and Status of the Philippines and Timor-Leste (Asian Development Bank, 2024; Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023)

Regional Associations	Description	Status	
		Philippines	Timor-Leste
Association of Southeast Asian Nations (ASEAN)	• Developed the Regional Action Plan for Combating Marine Debris in ASEAN Member States, establishing four major actions including policy support and planning, research and capacity building, public awareness, education, and outreach, and private sector engagement • Launched the Southeast Asia Regional Program on Combating Marine Plastics (SEA-MaP) Regional Project in 2022, with funding from the World Bank (WB), and is expected to run until 2027 to support the member states in the implementation of the regional action plan	ASEAN Member State	Observer Status
Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)	• Promotes sustainable development of coasts and oceans through strategic action programs included in the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA) • The PEMSEA Resource Facility serves as a technical advisory organization to the SEA-MaP project	PEMSEA Partner Country	PEMSEA Partner Country
Coordinating Body on the Seas of East Asia (COBSEA)	• Aims to coordinate, consolidate, and facilitate cooperations for the development and implementation of coherent environmental policies for sustainable and integrated management of marine litter in East Asian Seas • Adopted the RAP MALI in 2019 to prevent marine litter from land and sea-based sources, strengthen marine litter assessment and monitoring, and facilitate regional coordinated actions	COBSEA Participating Country	Participating country through PEMSEA

B. National Policies and Regulations

1. Philippines

Republic Act 9003 (RA 9003), also referred to as the Ecological Solid Waste Management Act of 2000, is the Philippines' most comprehensive law regarding solid waste management. The law establishes a systematic approach in addressing problems on solid waste management through formulation of best environmental practices in waste segregation, collection, transport, treatment, and disposal. Local government units (LGUs) serve as the primary implementing bodies of the mandates contained in the act and the main monitoring units of programs and policies related to solid waste management within their respective jurisdictions.

The technical guidelines of RA 9003 are specified in the Department of Environment and Natural Resources (DENR) Administrative Order (DAO) 2001-34 which requires each LGU to form a solid waste management board and develop the 10-year solid waste management plan (SWMP). The National Solid Waste Management Commission (NSWMC) oversees the implementation of the Act, formulates the national framework, reviews and approves the 10-year SWMPs of LGUs, and prepares the national status reports. The law also mandates the establishment of a materials recovery facility (MRF) in every barangay or cluster of barangays, the closure of open dumpsites within three years of the Act taking effect, and at least a 25% diversion of the LGU's solid waste five years within the effectivity of the Act. DAO 2006-09 contains the guidelines for the proper closure and rehabilitation of open dumpsites. DAO 2006-10 under the same series refers to the classification of final disposal sites based on net residual waste generation and upon consideration of the amount of waste diverted.

As of March 2025, the total number of approved SWMPs is 916 out of 1,592 targeted LGUs, or about 89% (National Solid Waste Management Commission, 2024). The Commission on Audit (COA) office continuously conducts audit reviews and assessments on the number of open dumpsites, operating landfills, and functional barangay MRFs to ensure compliance with the law.

Other complementary policies to RA 9003 are summarized in **Table 6**.

Table 6. Complementary Policies to RA 9003 (Manejar & Domingo, 2021; NSWMC & JICA, 2010)

Policy	Description
RA 6969: Toxic Substances and Hazardous and Nuclear Waste Act of 1990	Regulates the importation, manufacturing, sale, distribution, usage, and disposal of substances that are assessed to pose environmental and health threats
RA 8749: Clean Air Act of 1999	Provides a framework for air pollution management, which includes the prohibition of the use of incinerators on municipal, medical, and hazardous wastes
RA 9275: Philippine Clean Water Act of 2004	Establishes a system to address pollution from land-based sources entering the water environments, and outlines water quality standards and regulations
RA 9512: Environmental Awareness and Education Act of 2008	Promotes education on environmental awareness, which are incorporated in public and private school curricula at all levels of education

Table 6. Complementary Policies to RA 9003 (Manejar & Domingo, 2021; NSWMC & JICA, 2010) (cont.)

Policy	Description
RA 9513: Renewable Energy Act of 2008	Formulates programs and initiatives to promote the development, utilization, and commercialization of renewable energy
RA 9729: Climate Change Act of 2009	Adopts the goals of the United Nations Framework Convention on Climate Change (UNFFC), which includes the stabilization of greenhouse gas concentrations in the atmosphere at levels assessed to be acceptable for the environment and human health
PD 856: Code of Sanitation of the Philippines	Contains guidelines in the management of waste in commercial establishments, and preservation of sanitary operations for commercial establishments and facilities with potable water, sewage treatment, and septic tanks
PD 1586: Environmental Impact Assessment Law	Establishes an environmental impact statement system for projects assessed to be environmentally critical or situated in critical areas, to maintain balance between economic growth and environmental protection

In addition to general solid waste management efforts, recent policies in the Philippines have specifically focused on reducing plastic waste and preventing pollution. The Extended Producer Responsibility (EPR) Act of 2022, otherwise known as Republic Act 11898 (RA 11898), amends RA 9003 by mandating large companies with assets of over Php 100 million to implement EPR programs focused on plastic packaging. The act specifically addresses various types of plastic packaging such as flexible plastics, rigid plastics, plastic bags, and polystyrene, while setting a gradual increase in recovery targets from 20% of plastic product footprint of the preceding year by the end of 2023 to 80% by the end of 2028 (Republic of the Philippines, 2022). EPR programs may be in the form of reduction of non-environment friendly packaging products or recovery programs aimed at effectively preventing waste from leaking to the environment (DENR, 2023).

Despite local ordinances regulating or banning SUPs in 168 cities and municipalities, with about 46% of these enforcing a complete ban based on United Nations Development Programme (UNDP) report in 2020 (Senate Economic Planning Office, 2023), no comprehensive national law has yet been enacted regarding the matter. However, the NSWMC, released Resolution No. 1363 of 2020, mandating a ban on the use of unnecessary SUPs, including plastic cups, drinking straws, coffee stirrers, cutlery, and plastic bags, across all national and local government offices (NSWMC, 2020). This resolution has been adopted by the Philippine Ports Authority (PPA), through PPA Memorandum Circular No. 11-2021, impacting all port-related facilities under PPA as ports serve as gateway to the sea (PPA, 2021).

On a broader scale, the National Plan of Action on Marine Litter (NPOA-ML) was established by the Department of Environment and Natural Resources in 2021, aiming for zero waste in Philippine waters by 2040. The plan highlights the need for unified stakeholder action through its ten strategies (Department of Environment and Natural Resources, 2021), with cities including Legazpi, Cagayan de Oro, Calapan, Davao, Manila, and Ormoc developing and implementing local action plans to complement national efforts (UN-Habitat, 2022). Strategies in the plan are organized into a programmatic cluster and an enabling or cross-cutting cluster of actions (**Figure 6**).

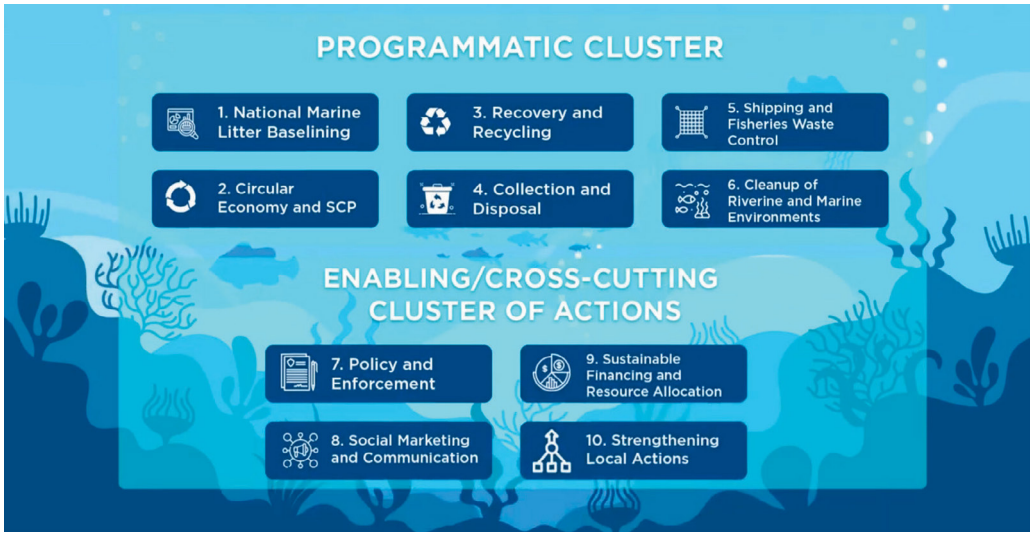

Figure 6. Ten Strategies of the NPOA-ML of the Philippines (UN-Habitat, 2023)

In response to the challenges of growing plastic waste, DENR has introduced a comprehensive roadmap as part of the country's efforts to address plastic pollution. The "Roadmap for the Management of Plastic Waste and Reduction of Non-recyclable Single-use Plastics in the Philippines," prepared in collaboration with the World Bank, outlines the strategies to achieve zero plastic waste pollution by 2040 (World Bank, 2024). The roadmap delineates a phased approach which aims to close plastic leakage pathways, enable plastic recycling, and manage plastic demand (**Figure 7**).

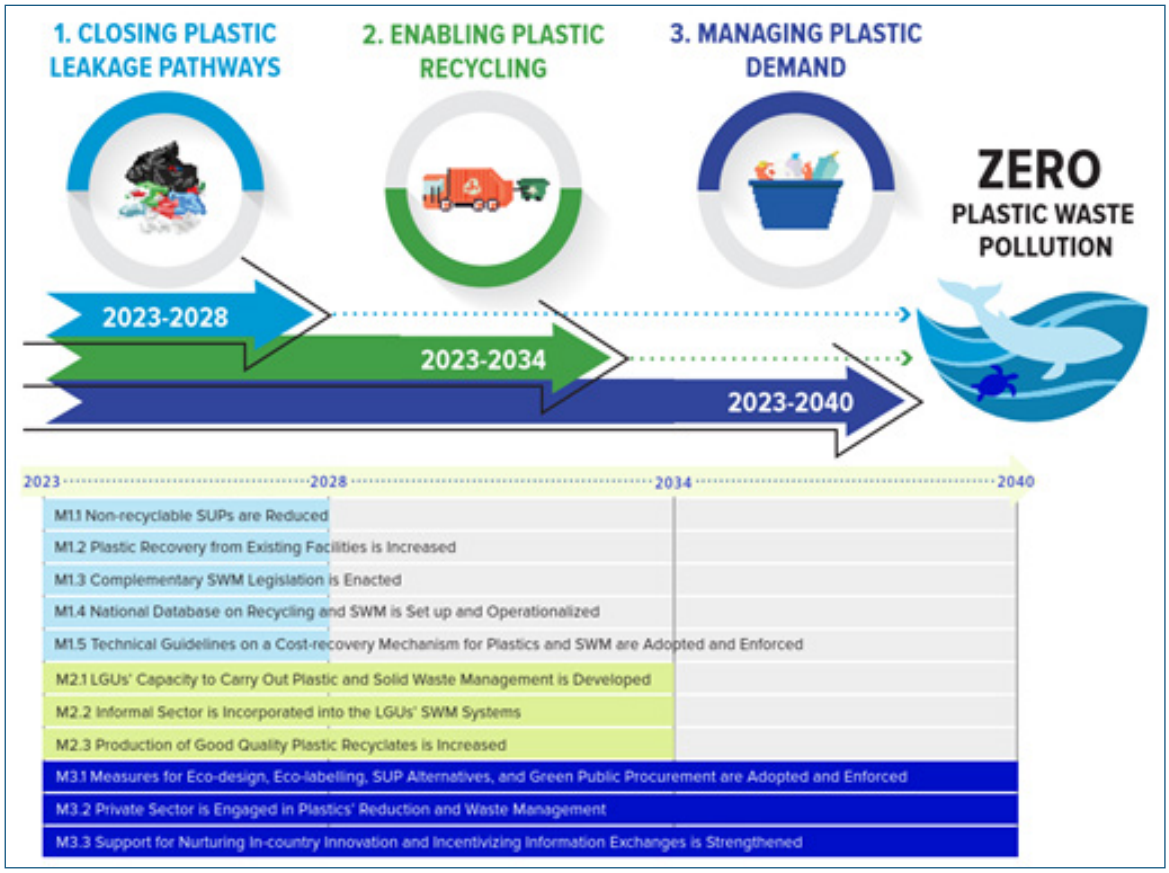

Figure 7. Outcomes and Milestones of the Philippine Plastic Waste Management Roadmap (World Bank, 2024)

2. Timor-Leste

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 legislations 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 capital city 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. 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 US$ 50 to US$ 115 apply for violations like improper disposal or interference with collection (SPREP, 2020).

Other complementary decree-laws in Timor-Leste are summarized in **Table 7**.

Table 7. 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

Table 7. Complementary Decree-Laws Governing Solid Waste Management in Timor-Leste (SPREP, 2020) (cont.)

Legislation	Brief Description
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

Building on general solid waste regulations, Timor-Leste has also implemented a policy specific to addressing plastic waste. The Decree Law 37/2020 for the Disposal, Import and Production of Bags, Packaging and other Plastics covers the vital components of plastic manufacturing, importation, and disposal in the country (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023). Some salient features of the document include prohibiting the use and distribution to the public of SUPs 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 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 tax and fee are imposed on importers and purchases of the specified SUPs operating within Timor-Leste. The fee applies to SUPs and packaging, whether primary or secondary packaging, that are imported or purchased within the country. The environmental tax is applied to SUPs 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 EPR and must be responsible for the subsequent waste management of the returned plastic products (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023).

The significance of recycling activities and energy recovery are also tackled in this decree-law. Article 7 underscores that plastic products should be designed such that they can be reused, with or without the aid of supporting materials, for the same or different function, while Article 8 emphasizes that these materials should be transformed into raw materials for new products. In addition, plastic materials that cannot be recycled or reused should be used in other forms such as in producing energy (Food and Agriculture Organization, 2020; Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023).

Key articles in the decree-law that are crucial in plastic waste management are summarized in **Table 8**.

Table 8. Articles in Decree-Law 37/2020 (Food and Agriculture Organization, 2020)

Article No.	Brief Description
Article 4	Ban on SUPs 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 SUP materials and articles
Article 20	Specific requirements in the substances used in the production of plastic layer in SUP 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 US$ 100 to US$ 1,000 for offenses related to Articles 4, 9, 10, 19, and 21. Violations of Articles 13, 27, and 28 carry fines between US$ 500 and US$ 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 also introduced, 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 the plastic recycling industry. Geared towards this goal, the Government of Timor-Leste signed a Memorandum of Understanding (MoU) with Mura Technology in 2019 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). Additionally, Plastic Solutions Alliance (PSA) spearheaded the creation of a value-chain to reduce SUPs 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).

C. Functional Elements

1. Generation

In the Philippines, data from 2008 to 2013 shows that municipal solid waste is predominantly composed of biodegradable waste at 52.31%, recyclables at 27.78%, residual waste at 17.98%, and special waste at 1.93% (**Figure 8**). Notable sources include households at 56.7%, commercial establishments at 27.1%, and institutions and industries at 12.1% and 4.1%, respectively (DENR-EMB, 2018). As of 2024, the solid waste generation rate is approximately 0.53 kg/cap/day, reflecting an increase from the national weighted average of 0.40 kg/cap/day from base year 2010.

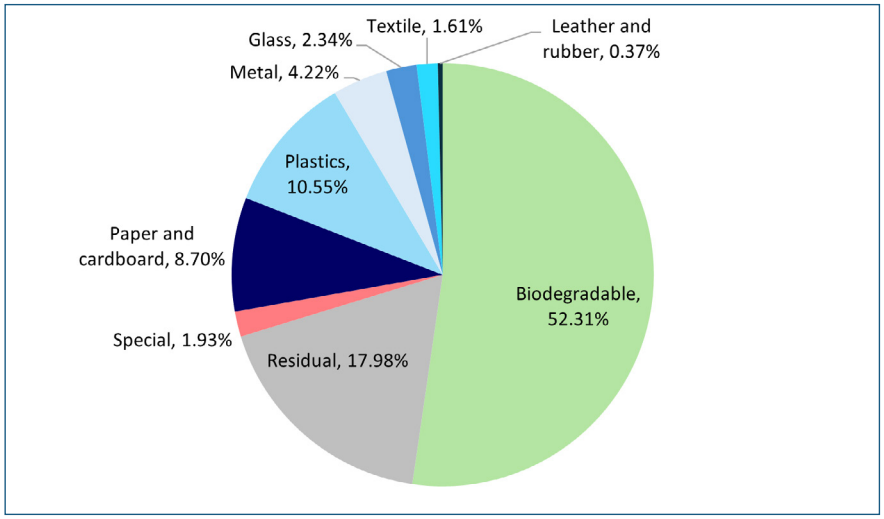

Figure 8. Municipal Solid Waste Composition in the Philippines (DENR-EMB, 2018)

In Timor-Leste, available data is limited, making it difficult to conduct cross-country comparisons. A waste audit in 2021 of the municipalities of Baucau and Covalima reported a national average of 0.47 kg/cap/day. Household waste composition is primarily organic waste at 57.77% **(Figure 9**).

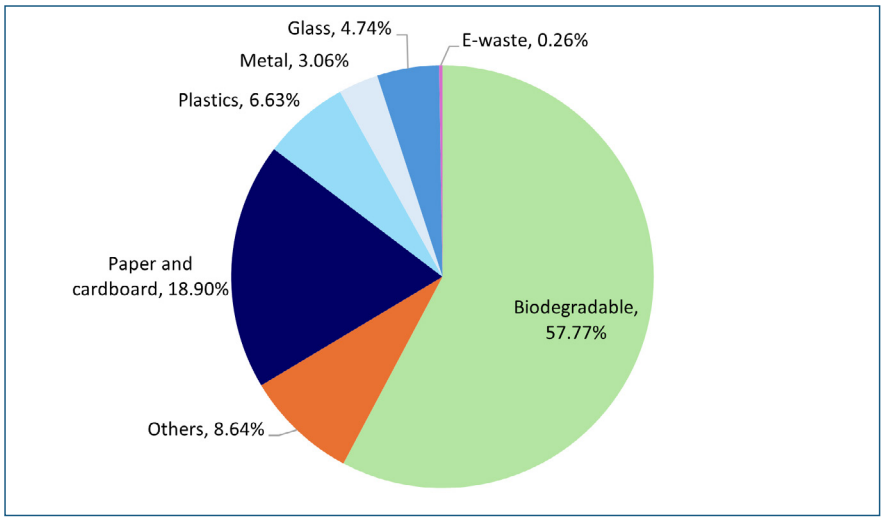

Figure 9. Household Waste Composition in Timor-Leste (SPREP, 2023)

2. Segregation

In the Philippines, waste segregation at the source is outlined in RA 9003, where biodegradable and recyclable wastes are collected by the barangay government, while residual and special wastes are managed by the city or municipal government. At the local level, several cities and municipalities have adopted the "no segregation, no collection" policy to strengthen the practice. However, some local governments continue to practice mixed waste collection. In a data survey in 2022, about 88% of interviewed local government participants have ordinance on segregation, while 12% have not mandated the practice in their respective areas (Commission on Audit, 2023). In addition, compliance with waste segregation and segregated collection remains a major challenge. Data from 128 pilot local governments of the Environmental Natural Resources Management Project (ENRMP) of DENR, compliance with at-source segregation ranges from 53% to 100%, while segregated collection is found at 43% to 100% (DENR-EMB, 2018). To intensify waste segregation, RA 9003 mandates the establishment of an MRF in each barangay or cluster of barangays. These MRFs are designed to receive, store, and process recyclables for effective waste diversion (DENR-EMB, 2018). Other supporting facilities include the segregated waste bins, typically found in commercial establishments, schools, and offices to further promote segregation practices.

There is no available national data on waste segregation practices nor specific guidelines on waste segregation in the national laws in Timor-Leste. Waste studies in 2018 in four administrative posts in Dili reports a segregation participation of 46% among 431 surveyed households, with organic waste and cans as materials that are commonly

segregated (Da Costa & De Jesus, 2018). A waste audit in 2021 in Baucau and Covalima reveals that households in urban areas focus on separating organic waste for composting or reused as animal feed, while those in rural areas are focused on segregating key recyclables (SPREP, 2021). Waste is temporarily disposed of in bak sampah, which are brick-and-mortar waste containers that serve as common collection points (**Figure 10**). As there is no segregation policy in the country, mixed waste continues to be disposed of in these waste bins.

Figure 10. Brick-and-mortar Common Collection Points in Dili

3. Collection

Waste collection is a critical component of solid waste management. In the Philippines, waste collection techniques include door-to-door collection, where waste is left outside households, and from common collection points, which are typically the MRFs in the covered area. The reported collection coverage in the LGUs is reported to be between 30% to 99%. In most LGUs, collection is focused on urban areas, receiving higher frequencies than in rural areas (DENR-EMB, 2018). Coastal cities and municipalities face major challenges in receiving waste collection service due to geographical conditions, making access difficult. In many island or remote areas, communities rely on improper forms of disposal such as burning or burying them in the ground.

A similar collection system, as well as challenges encountered, exists in Timor-Leste. Waste is gathered from communal collection points or directly from outside households. Low collection coverage is an existing problem due to the inadequate number of collection vehicles or lack of resources. Unreached communities often resort to backyard burning and open burning of waste.

4. Recovery

Waste recovery and recycling remains a critical issue in both countries. In the Philippines, solid waste diversion remains low, at 54%, in 2021 (NEDA, 2023). MRFs play a significant role in increasing waste diversion rates at a community level. These facilities must be provided with sufficient space to receive and store recyclables, along with the appropriate machinery to process compostable materials. Data in 2023 shows that there are 11,823 MRFs servicing 18,450 barangays over the country, which represents 47% compliance with the mandate of RA 9003 (Environmental Management Bureau, 2024). However, most of these MRFs primarily function as temporary storage without significant recycling activities taking place. In addition to MRFs, the latest data in 2023 show that there are approximately 1,800 junk shops operating in the country, around 1,000 of which are in the National Capital Region, along with at least 90 recycling facilities (NSWMC, 2024). These facilities support the recovery industry by connecting local waste collectors to higher-level recycling facilities. Despite these recovery efforts, the country's recycling rate remains low. A 2019 report indicated a 28% collection-for-recycling rate

for key resins such as polyethylene terephthalate (PET) packaging, high-density polyethylene (HDPE), low-density polyethylene (LDPE), and polypropylene (PP) (World Bank Group, 2021), while another report revealed that only 9% of plastic is recycled (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020), with the majority ultimately ending up in disposal facilities.

Timor-Leste faces similar challenges with limited data available on recovery rates. With no government-operated recovery and recycling facility, waste recovery efforts are primarily driven by private companies and small recovery establishments. While some small businesses accept and repurpose plastic waste into accessories and bags (JICA, 2024), plastic recycling in the country is largely handled by Caltech, which also processes glass waste and paper waste, transforming these materials into pavers and landscape boards. Local waste collectors primarily focus on recovering metals and aluminum cans, which are considered high-value materials. In addition to private sector initiatives, national efforts have been launched to tackle plastic waste. The "Zero Plastic Timor Leste" campaign, launched in 2018, aimed to eliminate plastics from the environment by 2023 through strategic action plans such as bag bans, awareness campaigns, and the development of a plastic recycling industry (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023). Moreover, community and school programs promoting environmental education and recycling awareness are being implemented to further encourage recycling. Despite these various waste recovery efforts, the current recycling system in Timor-Leste may not adequately address the growing needs for plastic waste recovery. Additionally, the lack of data on recovery rates and information regarding informal waste workers and recovery centers makes it difficult to accurately quantify the country's recovery efforts.

5. Disposal

Pursuant to the mandates of RA 9003, which prohibits the use of open dumpsites as disposal facilities, local governments are working to close all existing open dumpsites and replace them with sanitary landfills (SLFs). As of March 2025, the country has only 362 operational sanitary landfills, which serve about 40% or 665 out of 1,642[9] cities and municipalities (NSWMC, 2024). This finding highlights the insufficiency of active SLFs in the nation. To address delays in constructing SLFs, local governments have turned to using residual containment areas (RCA) as temporary disposal facilities while they await the approval or operationalization of their respective SLFs. However, challenges persist in establishing SLFs, particularly in finding suitable locations due to land characteristics and environmental limitations, especially in island communities. Consequently, many of these remote communities resort to improper waste disposal methods such as open burning and dumping waste into the environment, significantly contributing to marine plastic litter.

Similarly, communities in Timor-Leste rely heavily on uncontrolled facilities for waste disposal such as the Tibar dumpsite, the only formal disposal facility in the country (SPREP, 2023). Open burning of waste and dumping in public spaces have become primary alternatives to landfilling due to challenges in waste collection, posing serious threats to public health and the environment.

[9] There has been an increase in number of cities and municipalities in the Philippines following the administrative divisions and creation of new localities made in recent years.

4 Overview of the Solid Waste Management of the Local Sites

A. Policies and Regulations

In many countries, particularly in Southeast Asia, regional and national policies have been enforced to address the pressing issue of solid waste management. However, to achieve these broader goals, action must start with the local communities. Establishing a site-specific framework for waste management at the local level is thus imperative to carry out sustainable practices and effectively manage systems, facilities, and resources.

At the local sites in the Philippines, municipal ordinances regarding general and plastic waste management are enforced (**Table 9**). As mandated in RA 9003, all local government units must implement their respective municipal ordinances concerning general solid waste management. These ordinances outline the primary framework for implementing and monitoring activities, programs, and policies related to municipal solid waste management. A central provision of these ordinances is the establishment of a solid waste management board at the city or municipal level, responsible for overseeing and ensuring the effective implementation of relevant policies and programs. In addition to the Ecological Solid Waste Management Act, other complementary policies are also implemented to improve the management of municipal solid waste including coastal cleanups, rehabilitation of waterbodies, and protection of tourism sites in the area.

In terms of plastic waste management in the Philippine local sites, most of the local policies focus on the prohibition or regulation of SUPs and the promotion of alternative and reusable materials such as eco-bags and reusable utensils and containers. No specific ordinances regarding plastic waste are enforced in Tandag City and Calbayog City. Instead, provisions on plastic waste management in the aforementioned cities are incorporated in their respective city ordinances on general waste management.

Table 9. Municipal Ordinances Regarding Solid Waste Management in the Philippine Sites

City/Municipal Ordinance/s on Solid Waste Management	Main Provision
Ecological Solid Waste Management	
Municipality Ordinance 008-2005 (Bulan)	• Establishes or reconstitutes the organization of offices responsible for solid waste management such as the City/Municipal Solid Waste Management Board • Establishes the creation of the City Solid Waste Management Office responsible for management of solid waste and to answer the need to prevent health hazards to human lives and mitigating environmental degradation • Restructures the organization of the City Solid Waste Management Board and delineation its duties and functions • Authorizes the City Mayor to enter intoMOA to five barangays for the collection and transportation of residual waste to the SLF and recyclables to Pilot MRF improve solid waste management and foster inter-barangay cooperation on SWM • Presents the regulations and prohibited acts related to the general management of solid waste • Emphasizes the implementation of the "No Segregation, No Collection" policy • Prohibits the use of single-use plastic packaging and encourages usage of alternatives such as reusable containers and bags in Tandag and Calbayog City • Authorizes Tandag City Mayor to sign a Memorandum of Agreement (MoA) with the 21 barangay local government units (BLGU) for the implementation of the SWM System under the Republic Act No. 9003 at the barangay level
City Ordinance No. 97-42-3682 (1997) (Calbayog)	
Executive Order No. 006, Series of 2024 (Calbayog)	
Resolution No. 2025-17-469 (2025) (Calbayog)	
City Ordinance No. 2011-33-064 (2011) (Calbayog)	
Municipality Ordinance No. 18-2020 (Daanbantayan)	
Municipality Ordinance No. 18-2020 (Daanbantayan)	
Executive Order No. 22 (2002) Reconstituting the Dipolog City Solid Waste Management Board (Dipolog)	
City Ordinance No. 396 (2008) Environmental Code (Puerto Princesa)	
City Ordinance No.11 (2017), as amended in City Ordinance No.01 (2020) and Resolution No. 130 (Series of 2021) (Tandag)	

Table 9. Municipal Ordinances Regarding Solid Waste Management in the Philippine Sites (cont.)

City/Municipal Ordinance/s on Solid Waste Management	Main Provision
Environmental Protection	
Municipality Ordinance No. 12-97: Protection of Sandy Beaches (Daanbantayan)	• Prohibits activities that could harm the environmental conditions of the sandy beaches, such as littering
City Ordinance No. 396 (2008): Environmental Code (Puerto Princesa)	• Presents the code of conduct for the conservation, protection, and restoration of land, air, and water resources
City Ordinance No. 2007-10-057 (2007) (Calbayog)	• Prohibits the construction of toilets and pig pens along river banks of Calbayog River, Jibatang River and Hamonini River and Oquendo River System, thereby instituting protection programs
Cleanliness and Sanitation	
City Ordinance No. 123 (1998): Establishing a System of Garbage Collection, Health Protection and Sanitation, as amended in City Ordinance No. 22-321 (Dipolog)	• Provides the rules and regulations regarding the city's sanitation and cleanliness • Mandates the city to follow "No Segregation, No Collection" policy • Declares the tourism sites in the city as "Clean-As-You-Go" zones • Includes the provision of segregating bins to ensure that proper waste disposal is practiced by tourists
Resolution No. 2024-08-054 (2024) (Calbayog)	• Urges the Barangay Council of 21 Barangays to construct one heavy duty trash bin and install in their respective pick-up points to keep their respective barangays clean and safe
City Ordinance No. 2006-36-106 (2006) (Calbayog)	• Regulates the hanging and display of streamers over the city streets
City Ordinance No. 2011-33-064 (2011) (Calbayog)	• Requires segregation of waste at source • Require segregated collection and transport of solid waste • Strict implementation of "No Collection, No Segregation" Policy
Ordinances on Disposal Practices	
Municipality Ordinance 037-1996: Requiring Receptacles in Public Utility Vehicles (Bulan)	• Requires owners and operators of public utility vehicles (PUVs) to provide receptacles inside their vehicles for waste disposal of commuting public
Municipality Ordinance 024-2012: Prohibiting Open Burning of Trash (Bulan)	• Prohibits open burning of trash and other refuse material in the municipality
City Ordinance No. 2011-33-064 (2011) (Calbayog)	• Prohibits open burning of solid waste

Table 9. Municipal Ordinances Regarding Solid Waste Management in the Philippine Sites (cont.)

City/Municipal Ordinance/s on Solid Waste Management	Main Provision
Anti-Littering Ordinances	
City Ordinance No. 2002-19-032 (2002) Anti-Littering Ordinance (Calbayog)	• Prohibits the littering, throwing, dumping of garbage, other waste objects and materials on any street, sidewalk, canal, river, plaza and other public places in the city
City Ordinance No. 2011-33-064 (2011) (Calbayog)	• Prohibits the littering, scattering, throwing and dumping of waste in public places, such as roads, rivers, esteros, parks, coastlines, seas, etc. • Prohibits littering from vehicles
City Ordinance No.163-91 (1991): Anti-Littering Ordinance (Puerto Princesa)	• Prohibits illegal dumping of waste • Posting of Anti-Littering Ordinance in all tourism establishments
City Ordinance No. 640 (2015): Posting of City Ordinance No. 163-91 in Tourism Related Establishments (Puerto Princesa)	
Ordinances Banning the Use of Single-use Plastics and Styrofoam	
Municipal Ordinance No. 06-2015: Regulation Concerning the Use of Plastics and Polystyrene/Styrofoam (Daanbantayan)	• Prohibits the use of plastic bags and expanded polystyrene (EPS) or Styrofoam food service containers across all establishments
Municipality Ordinance 020-2012: Anti-Plastic Ordinance (Bulan)	
Municipality Ordinance 013-2012: Ordinance Mandating All Business Establishments Using Plastic Bags in their Transaction to Display Conspicuously in their Stores the Notice "Zero Wastes – Zero Plastics, Bring your Own Recyclable/ Reusable Bags" (Bulan)	• Mandates all business establishments to display a notice encouraging the community to bring reusable bags
City Ordinance No. 2011-33-064 (2011) (Calbayog)	• Bans the use of non-biodegradable plastic bags, and styrofoams as food containers • Strictly prohibits the use of plastics, such as cellophanes, styrofoams/ Styropor, plastic straws, plastic drinking cups, spoons, forks, in the operation of business establishments, such as restaurants, carenderias, fast food chains, "turon-turo", etc. • Prohibits the use of transparent plastic film or colored cellophane materials for packaging of any meat, fish products, etc.

Table 9. Municipal Ordinances Regarding Solid Waste Management in the Philippine Sites (cont.)

City/Municipal Ordinance/s on Solid Waste Management	Main Provision
Ordinances Regulating the Use of Single-use Plastics and Styrofoam	
City Ordinance No. 13 -245: An Ordinance Regulating the Sale, Distribution or Use of Non-compostable Plastic Bag such as Thin Film, Single-Use, Carry Out, Plastic Bags, and Polystyrene Foam Products (Dipolog)	• Regulates the sale, distribution, or use of polystyrene foam products and plastic products such as plastic bags, straws, disposable cups, plastic utensils, and other single-use plastics in all establishments
City Ordinance No. 993: Single-Use-Plastic and Styrofoam Regulation (Puerto Princesa)	

Among the penalties imposed for violators of these ordinances are fines ranging from Php 100.00 to Php 5,000.00, community service for 8 hours to 40 hours, and imprisonment of 1 day to 6 months, depending on the severity and frequency of violation. For non-household establishments, non-compliance with these ordinances will be used as basis for non-renewal of business permits.

Meanwhile, in Timor-Leste, there is a lack of standardized waste management policies at the local level, particularly when it comes to general and plastic waste. Decree-Law 2/2017 and Decree-Law 37/2020, however, serve as bases for the development of local policies to effectively manage each municipality's general and plastic waste, respectively (Section III.B). Particularly in Dili, the necessary investments and policies for the enhancement of waste collection services in the municipality are outlined in the Investment Strategy for the Management of Solid Urban Waste (SPREP, 2020). Moreover, the "Zero Plastic Timor-Leste" campaign is carried out to address the issue of improper plastic waste disposal in the country, which often leads to clogged drains and marine litter. This policy aims to reduce plastic consumption through the prohibition of SUPs such as straws and plastics for packaging through plastic bag bans, holding activities for strengthened public awareness, and the development of a plastic recycling facility (Steenhagen, Fuller, Farrelly, Borrelle, & Rengal-Goncalves, 2023).

Generally, non-households are identified to be the primary contributors to plastic waste generation, hence, policies and ordinances specific to these businesses and establishments are implemented, regulating or banning the use of plastics as containers or packaging, and promoting the use of alternative sustainable materials instead.

B. Institutional Framework

1. Institutional Arrangement

In the Philippines, each city or municipality has its own solid waste management board, responsible for the development of its respective 10-Year Solid Waste Management Plans and the implementation of SWM policies and programs. Solid waste management committees are designated in each barangay, which serve as primary enforcers of proper solid waste management within its respective areas.

The Environment and Natural Resources Office (ENRO) is tasked to organize environmental initiatives such as cleanup drives and to strengthen public awareness on proper management of solid waste through information, education, and communication (IEC) strategies. In some cities and municipalities, the City/ Municipality ENRO operates under the City/ Municipality Solid Waste Management Board, while in others, it reports directly to the Office of the City/Municipality Mayor. Additionally, the City/ Municipality ENRO in certain local government units also has a Solid Waste Management Office working under it. In Dipolog City, the City ENRO is responsible for the maintenance and operation of the landfill and barangay MRFs. Meanwhile, the Municipality ENRO of Daanbantayan manages the municipality's waste collection. Other supporting offices generally include the City/ Municipality Engineering Office for structural and engineering-related components of local solid waste management, media partners for efficient information dissemination to the community, and the local police to assist in the enforcement of city ordinances (**Figure 11**).

In Calbayog City, the City Solid Waste Management Office is an independent Office, and distinct from CENRO. It was created pursuant to City Ordinance No. 97-42-3682 to answer the needs to prevent health hazards to human lives and mitigate environmental degradation and to take charge of solid waste management. The Office spearheads in maintaining cleanliness of the city, overseeing and providing assistance to the barangays to fulfill their roles on solid waste management as mandated under R.A. 9003. The CSWMO provides street sweeping services to maintain the cleanliness and orderliness at the parks, city streets, city hall grounds, coastal areas and other public areas. It is also tasked with the collection of waste along with their respective routes with five teams assigned in day shift, and three teams ply at night shift, each team headed by an Environmental Management Officer. The Office is also tasked to operate and maintain the SLF in accord with R.A. 9003 with 34 personnel under this Division including the heavy equipment operators. The Office also maintains the Central, Market and Pilot MRFs, tasked with composting of biodegradable waste and recycling of recyclable waste mostly plastics utilizing only manual operation which limits their outputs, but not their quality and their aesthetic value. The Office also manages the River Care-Update which maintains the cleanliness of Calbayog River and advocates for its preservation and protection. Eventually, RCU will expand to cover other rivers of the city. It has an Advocacy Section tasked to spearhead the roll out of the value of cleanliness, protection of the environment and preservation of water bodies among barangays, institutions, establishments, schools, etc. It has an Enforcement and Monitoring Team tasked to oversee the implementation of its programs, and apprehend violators. The Office spearheads in raising public awareness on proper solid waste management and in organizing environmental enhancement activities through regular barangay clean-ups, coastal and river clean-up drives.

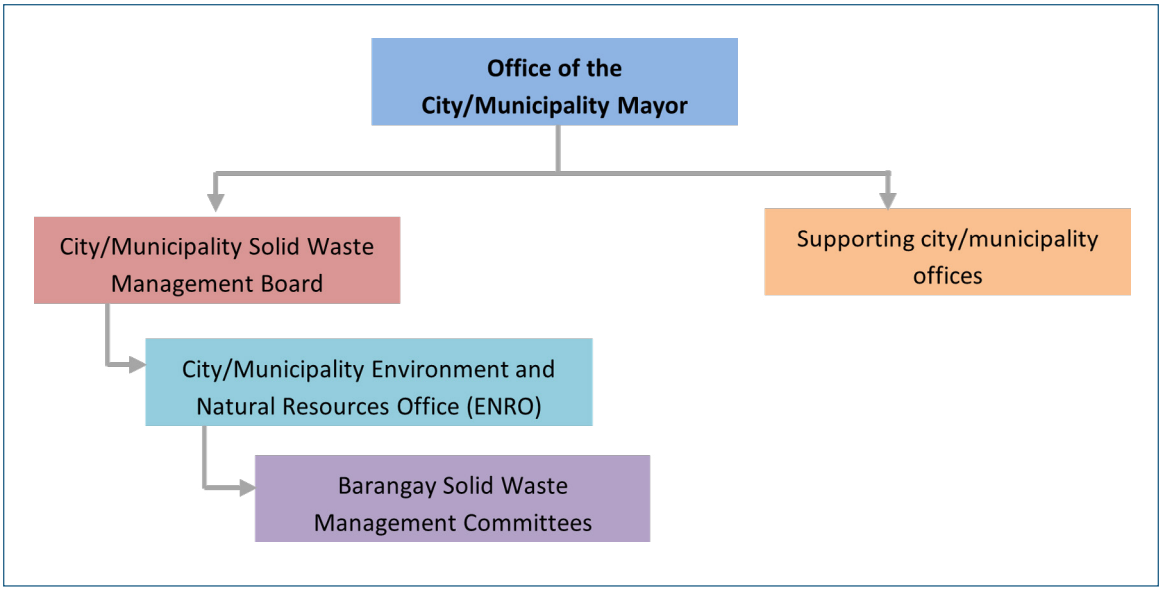

Figure 11. General Institutional Arrangement in Philippine Sites

In Timor-Leste, the Ministry of State Administration (MSA) is responsible for overseeing solid waste management in the country, which includes the formulation of policies and development of infrastructure plans, and the provision of technical and financial assistance for SWM programs enforced by municipal authorities at the local level. The Municipal Services for Water, Sanitation, and the Environment (SMASA) is responsible for waste management 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. Other offices relevant to the solid waste management in the country are listed below (**Table 10**).

Table 10. List of Relevant Offices Related to Solid Waste Management in Timor-Leste (SPREP, 2021; JICA, 2024)

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 wastes • Regulates private and commercial sector usage of sanitation services, goods, and installations
Ministry of Education	• Ensures that hygiene and sanitation are included in school curriculum • Develops and maintains hygiene and sanitation systems in schools
Ministry of Tourism and Environment	• Monitors hygiene and sanitation systems in tourist destination, commercial establishments, and industrial areas

Table 10. List of Relevant Offices Related to Solid Waste Management in Timor-Leste (SPREP, 2021; JICA, 2024) (cont.)

Responsible Office	Role and Function
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

All local sites in the Philippines and Timor-Leste are equipped with facilities and resources to manage solid waste and carry out related activities (**Table 11**). Typical utilities used for waste collection in both the Philippines and Timor-Leste sites include dump trucks and compactors.

Majority of the barangays in the Philippine sites have its respective MRFs, established in accordance with the provisions in RA 9003. Other municipality-managed recovery facilities such as central MRFs, composters, and shredders are utilized as well. Meanwhile, in Timor-Leste sites, there are no documented recovery facilities managed by the local government unit.

RCAs and SLFs serve as disposal sites for municipal solid waste generated in the Philippine sites, while open dumpsites are utilized for this purpose in Timor-Leste sites.

An equally important aspect of solid waste management is the human resources involved in various roles and offices, as they are crucial to the efficient management and operation of these facilities. Personnel with permanent positions and job order contracts make up the solid waste management team of each local site.

Barangay Material Recovery Facility in Barangay Poblacion, Daanbantayan, Cebu.

Table 11. Collection and Recovery Facilities and Resources in Philippine and Timor-Leste Sites

City/ Municipality	Collection [a,b,c]	Recovery[a]
Philippine Sites		
Bulan	• 1 Bulldozer • 1 Backhoe • 1 Grader • 1 -Loader • 1 10 m^3-Garbage Dump Truck • 5 Compactor Trucks with various capacities (from small to large) • 1 Trailer • 1 Boom Truck • 23 Modified Tricycles (22 for garbage collection; 1 for multi-purpose use, needs repair)	• 57 (out of 63) Barangays with MRFs • 2 Central MRF (1 public, 1 private) • 1 Vermi- composting Facility • 1 Pavilion for Training • 1 Septic Vault for Hazardous Waste • 5 Shredders for Biodegradable Waste • 1 Set of Plastic Recycling Equipment • 2 Rotary Drum Composter • 3 Push Carts • 1 Satellite MRF • 1 Septic Vault • 1 Generator Set • 1 Mobile Speaker • 1 Amplifier • Cleaning Tools (Shovel, Rake, Safety Shoes / Field Shoes, Bolo) • At least 10 units of rice hull carbonizers
Calbayog	• 2 Garbage Dump Trucks with capacities 15 tons • 2 Garbage Dump Trucks with capacities 12-13 tons • 3 Garbage Dump Trucks with capacities 8 tons • 1 Toyota Pick-up Hi-lux • 1 Wheel Loader with capacity of 17 tons • 2 Excavators (Wheel Type and Trackpad) • 1 Bulldozer • 1 Road Roller	• 147 (out of 157) Barangays with MRFs • 1 Pilot MRF • 1 Market MRF • 1 Central MRF • 1 Multi-Purpose Reduction Machine • 1 Multi-Purpose Shredder • 1 Bottle and Glass Crusher • 1 Maxi-Saver Fertilizer Machine • 2 Shredding Machines • 4 Waste Composters • 1 Glass Pulverizer • 1 Heavy Duty Sewing Machine • 1 Set Sewing Tools • 1 Set Planting Tools (Shovels, Bolos, Brooms, Dustpans, Sprinkling Cans)
Daanbantayan	• 3 6 m^3-Garbage Compactors (1 is non-serviceable) • 1 1 m^3-Eco-Police Multicab	• 1 Central MRF • 20 (out of 20) Barangays with MRFs • 2 Biodegradable Shredders • 2 Non-biodegradable Shredders • 5 Sewing Machines
Dipolog	• 7 6-wheeler truck with capacity of 5 tons • 1 10-wheeler truck with capacity of 8 tons	• 21 (out of 21) Barangays with MRFs • 1 City MRF • 2 Shredders • 1 Rotary Composter • 1 Plastic Recycling Oven • 1 Plastic Shredder • 1 Charcoal Briquetting Machine

Table 11. Collection and Recovery Facilities and Resources in Philippine and Timor-Leste Sites (cont.)

City/ Municipality	Collection [a,b,c]	Recovery[a]
Puerto Princesa	• 7 Compactors with 36.61 m^3 capacity • 13 Dump Trucks (1 is under repair; 3 6-wheelers: 69.30 m^3; 7 6-wheeler: 32.50 m^3, 85.05 m^3; 2 6-wheeler: 20.27 m^3; 1 10-wheeler) • 1 Excavator • 1 Man-lift Truck/Modified to Stake Truck • 1 Mini Dump Truck	• 49 (out of 66) Barangays with MRFs • 1 City MRF
Tandag	• 1 Garbage Truck with capacity of 3 tons • 6 Garbage Compactor Trucks	• 17 (out of 21) Barangays with MRFs • 1 Centralized MRF
Timor-Leste Sites		
Atauro	• 1 Collection Truck	• No documented municipality-managed recovery facility or storage for recyclables
Dili	• 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
Liquiçá	• No available data on facilities and equipment	• No documented municipality-managed recovery facility or storage for recyclables
Manatuto	• 1 Dump Truck (6 m^3)	• No documented municipality-managed recovery facility or storage for recyclables

[a] Data for Philippine sites as of September 2024
[b] Data for Timor-Leste sites as of January 2025
[c] 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 of both Philippine and Timor-Leste sites are shown in **Table 12**. For the Philippines sites, this allocation primarily accounts for cleanups, facility repair and maintenance, and the expenses for the construction and operation of recovery and disposal facilities. For Timor-Leste sites, the allocated budget followed an increasing trend from 2024 to 2025 and is mainly for the purchase or rental of waste collection trucks, particularly in the municipalities of Manatuto, Atauro, and Dili. For the Municipality of Liquiçá, it is primarily intended for the acquisition of waste bins and hiring of additional waste management personnel. Also included in Dili's financial allocation is the establishment of a Project Management Unit (PMU), responsible for the collection and transportation of waste, and the construction and maintenance of relevant facilities.

Table 12. Latest Available Budget Allocation for Solid Waste Management and Calculated Budget per Capita in Philippine and Timor-Leste Sites

City/ Municipality	Projected Population in Study Year[a]	Latest Available Budget Allocation	Calculated Budget per Capita[b] (US$/cap)
Philippine Sites			
Bulan	108,065 (2023 population)	Php 15,100,000 (2019 budget)	3.27
Calbayog	208,092 (2023 population)	Php 49,909,867 (2025 budget)	4.27
Daanbantayan	99,721 (2023 population)	Php 7,973,535 (2023 budget)	1.44
Dipolog	143,008 (2023 population)	Php 81,865,479 (2019 budget)	13.42
Puerto Princesa	345,223 (2023 population)	Php 80,311,040 (2024 budget)	3.80
Tandag	67,013 (2023 population)	Php 6,000,390 (2024 budget)	1.51
Timor-Leste Sites			
Atauro	10,607 (2024 population)	US$ 10,000 (2025 budget)	0.93
Dili	342,510 (2024 population)	US$ 4,229,898 (2025 budget)	12.03
Liquiçá	87,378 (2024 population)	US$ 30,938 (2025 budget)	0.35
Manatuto	52,089 (2024 population)	US$ 13,040 (2025 budget)	0.25

[a] Population data is forecasted based on available recent census data.
[b] Presented data is based on the equivalent value of US$ as of January 2025. Units in Philippine Peso were converted to US Dollar using historical data on foreign exchange from Bangko Sentral ng Pilipinas (BSP). Inflation was accounted for using the consumer price index (CPI) from the US Bureau of Labor Statistics.

The per capita budget allocation for each local site was determined by dividing the projected 2025 budget by the population for the corresponding study year. For consistency, all amounts were converted to the value of US Dollars as of January 2025, using the consumer price index to account for inflation. Among all sites, Dipolog City in the Philippines and Dili Municipality in Timor-Leste registered the highest per capita allocations. For Dipolog City, the 2019 budget included significant expenditures such as the safe closure and rehabilitation of the city's open dumpsite, as well as the construction of a sanitary landfill, resulting in an elevated per capita value. When considering only the regular solid waste management services, such as waste collection, and the maintenance of MRFs, the adjusted per capita budget in Dipolog City amounts to US$ 2.55/cap, which aligns more closely with the other Philippine sites.

In the case of Dili, aside from its higher level of urbanization among other Timor-Leste sites, its high per capita budget can be attributed

mainly to its responsibility in managing the Tibar Dumpsite, which is the country's main disposal facility. Meanwhile, the higher budget per capita in Atauro than Liquiçá and Manatuto may be attributed to the island being a tourism destination, which drives increased demand for waste management services to meet both community needs and maintain environmental cleanliness for visitors.

3. Stakeholder Participation

Effective management of municipal solid waste is achieved through the collaboration of various stakeholders. The roles of these stakeholders are crucial from policy development to community involvement. Private sectors, academic institutions, and various non-governmental organizations (NGOs) and community-based organizations (CBOs) significantly contribute to the solid waste management system at the Philippine local sites through their active participation in planning and community initiatives.

Among the NGOs in Bulan involved in organizing community service projects are the Rotary Club – Bulan West Coast, Bulan Eagle's Club, and Bulan Lion's Club. The Association of Bulan Brokerage and Fisherfolks targets to address issues in coastal ecosystems and promote sustainable fishing practices. In Calbayog, NGOs such as the Calbayog SAVE ME Movement, Calbayog Eagles Club, Tau Gamma Phi, Christ the King College (CKC), Northwest Samar State University (NwSSU), Puno ng Buhay are engaged in SWM planning and creation of task forces and committee groups to effectively manage solid waste in the city. The People and the Sea Marine Conservation Foundation in Daanbantayan has conducted projects focusing on marine science education, economic resilience, fisheries, and solid waste management. Lastly, the Motherly Association for River Initiatives Towards Environmental Sustainability (MARITES), a CBO in Tandag motivates the local community to engage in plastic waste-related initiatives and programs such as the River Care Program (RCP), Basuralympics, and Urban Hanging Garden using Plastics.

When it comes to waste recovery, the City Solid Waste Management Office and the Barangay Solid Waste Management Committees in Calbayog are responsible for the management of barangay MRFs and other recovery facilities in the City. The City Solid Waste Management Board oversees the implementation of the city's SWM program. Besides this, the Calbayog Junk Shop Dealers Association is also involved in the implementation of recovery-related policies and programs. In Puerto Princesa City, junk shops play a significant role in waste diversion by accepting various types of recyclable materials. Despite the abundance of registered junk shops in the city, challenges persist in selected areas. The recovery industry in Dipolog City, primarily involving junk shops, faces a challenge in containing large amounts of recyclable waste and in their profitability due to the lack of market for certain recyclables.

In Timor-Leste sites, particularly in Dili, the local government, in collaboration with the municipality's NGOs and CBOs, is responsible for the development and implementation of solid waste management programs and initiatives. Academic institutions such as Universidade Nacional Timor Lorosa'e (UNTL) and Oriental University of Timor Leste (UNITAL) also play a significant role in exploring sustainable methods and technologies for the enhancement of the municipality's solid waste management systems.

Recycling facilities, mostly managed by private entities, support the recovery and diversion of recyclable waste materials.

Meanwhile, due to the limitations in accessibility in the municipalities of Atauro, Liquiçá, and Manatuto, the involvement of stakeholders is relatively less than Dili, as logistical constraints and financial limitations impede developments in the solid waste management system.

C. Functional Elements

The existing waste management in the study areas in the two countries reveals major challenges and opportunities for improvement. The lack of available data in Timor-Leste sites results in difficulties to compare management systems across the two countries.

Waste generation rates in the Philippine sites from the conducted waste audits in different years show values between 0.32 kg/cap/day in Bulan and Daanbantayan to 0.70 kg/cap/day in Puerto Princesa (**Figure 12**). Biodegradable waste makes up the majority of the waste stream in all Philippine sites. Residual waste is a major contributor to the waste generation in Bulan, Dipolog, and Tandag, while recyclables are found to be the next predominant waste type in Calbayog, Daanbantayan, and Puerto Princesa.

In Timor-Leste, there is no available data on waste generation and waste composition at a municipal level for the study areas. A waste survey in 2024 reveals that households in urban areas in Dili reported a WGR of 0.71 kg/cap/day, while in rural areas, a household WGR is found at 0.57 kg/cap/day. Household waste composition is majorly composed of soil and dirt at 22%, food waste at 16%, and garden waste at 8%. Household recyclable plastics are found at about 8% (JICA, 2024).

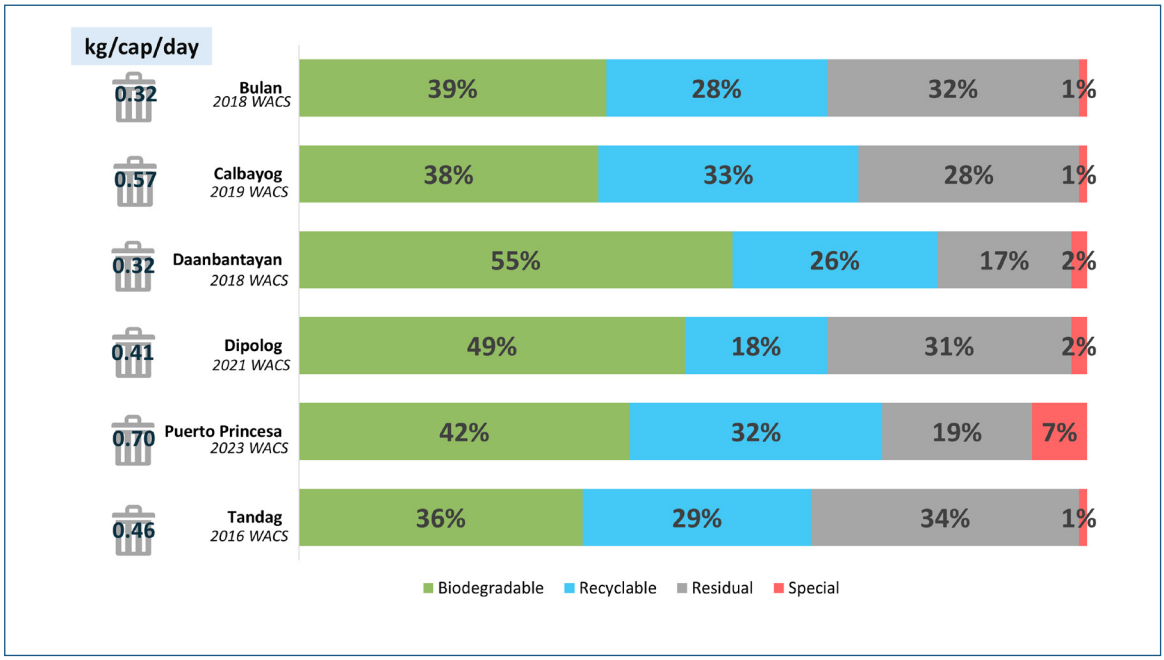

Figure 12. Reported Waste Generation Rates and Waste Composition in Philippine Sites

All local sites in the Philippines implement the "no segregation, no collection" policy. However, compliance with household segregation remains to be a challenge, reporting compliance rates from 71% in Calbayog to 85% in Bulan. There is no reported number for Tandag City. Similarly, there is no available data for local sites in Timor-Leste, as no local segregation policy has been implemented.

Waste collection is a crucial component of solid waste management, yet many areas across the study sites still lack access to proper collection services (**Figure 13**). In the Philippine sites, collection coverage rates generally exceed 90%. Daanbantayan, Dipolog, and Tandag report full coverage, while Bulan and Puerto Princesa achieve 97%. The low collection coverage of Calbayog City, at 75%, is attributed to the shortage of waste collection vehicles, which struggle to cover all 157 barangays in the city.

Similarly, study areas in Timor-Leste face challenges in providing waste collection across all sucos within their municipalities. Dili reports a 77% coverage rate, while Atauro covers 63% of its 19 sub-villages. In Liquiçá and Manatuto, waste collection remains a major issue, with only 22% and 13% of sucos covered, respectively.

Notably, separate collection is observed in most of the local sites in the Philippines in accordance with local segregation policy. However, regular waste collection is not consistently implemented even in areas where collection services are available. The inconsistent frequency is attributed to several factors including limited number of collection vehicles, and inaccessible roads. Moreover, collection efforts are concentrated in urban areas, leaving rural and remote communities to manage their waste independently, often resorting to improper disposal methods (**Figure 14**).

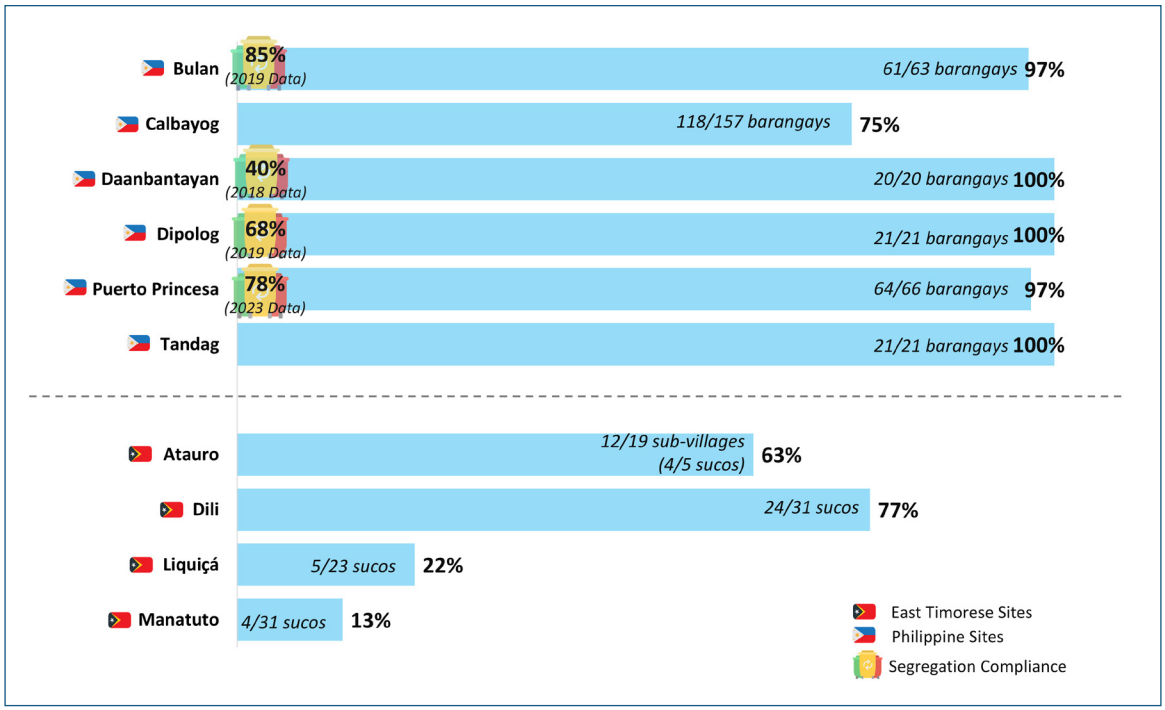

Figure 13. Reported Segregation Compliance and Collection Coverage in the Philippine Sites and Timor-Leste Sites

City/ Municipality	Weekday	Weekday	Weekday	Weekday	Weekday	Weekend	Weekend
PHILIPPINE SITES							
Bulan	Two times a week collection in poblacion barangays						
		Biodegradable		Non-biodegradable			
	Once a month collection in remote areas						
				Collection			
Calbayog	Daily collection in city proper						
	Residuals *(Special Wastes)**	Residuals	Residuals *(Special Wastes)**	Residuals	Residuals	Residuals	Residuals *(Special Wastes)**
	Two to three times a week collection in covered rural barangays						
	Residuals *(Special Wastes)**		Residuals *(Special Wastes)**			Residuals *(Special Wastes)**	
Daanbantayan	Six times a week collection in mainland barangays and in Barangay Carnaza						
	Biodegradable	Residuals	Recyclables	Biodegradable	Residuals	Special Waste	
	Four times a week collection in Barangay Logon						
	Biodegradable	Residuals	Recyclables		Residuals		
Dipolog	Daily collection in urban and rural barangays						
	Biodegradable	Residuals	Biodegradable	Residuals	Biodegradable	Residuals	
Puerto Princesa	Daily collection in urban barangay						
	Collection	*Collection*	*Collection*	*Collection*	*Collection*	*Collection*	*Collection*
	Once a month in rural barangays						
	Collection						
	Two times a month in Northwestern Barangays						
	Collection		*Collection*				
Tandag	Daily collection in urban barangays						
	Wet Biodegradable	Residuals	Special Waste	Dry Biodegradable	Residuals	Glass, Tin Cans, Bulky Items	Glass, Tin Cans, Bulky Items
	Three times a week collection in rural barangays						
		Residuals	Special Waste		Residuals		
EAST TIMORESE SITES							
Atauro	*Collection*	*Collection*	*Collection*	*Collection*	*Collection*	*Collection*	*Collection*
Dili	*Collection*	*Collection*	*Collection*	*Collection*	*Collection*	*Collection*	*Collection*
Liquiçá	*Collection*		*Collection*				
Manatuto	*Collection*		*Collection*		*Collection*		

Days of the week are for visualization of the frequency only

Figure 14. Reported Collection Schedule in the Philippine Sites and Timor-Leste Sites

In accordance with RA 9003, all local sites in the Philippines have established barangay MRFs, covering most of their respective barangays (**Table 11**). While these MRFs are intended for storing and processing compostable and recyclable materials, they primarily function as temporary storage facilities with minimal recycling activities. City/municipal MRFs support barangay MRFs by processing most of the recovered materials. Commonly accepted and processed materials include biodegradable waste, which is converted into soil compost, and plastic residual waste and recyclable glass, which are used to produce hollow blocks and pavers. While these are commendable efforts, improving recycling rates requires investment

in appropriate and well-maintained equipment and sustainable operations to ensure the effective transformation of recyclables into usable products. Additionally, junk shops and the informal waste sector play a crucial role in supporting the waste recovery system by linking recovered materials to higher-level recycling facilities.

In contrast, there are no municipality-managed recovery facilities or storage areas in the study sites in Timor-Leste (**Table 11**). Waste recovery efforts are primarily led by private recycling facilities and small businesses, which may be insufficient to address the plastic waste management needs of the municipalities. A shared challenge between the two countries is the preference on recovering general metal and aluminum cans, which are considered as materials of substantial value, resulting in limited recovery of plastic materials.

The current disposal facilities in the Philippine sites are RCAs and SLFs, with four of the study areas utilizing SLFs, and two using RCAs. In Timor-Leste, open dumpsites primarily serve as the disposal facilities in all study areas, which lack essential environmental safeguards and protective measures, significantly contributing to waste leakage into the surrounding areas (**Figure 15**).

Inefficiencies in the entire waste management of all study sites, from low segregation compliance, inconsistent collection, and poor recovery and recycling rates, results in the majority of the generated waste ending up in designated disposal facilities. In the Philippines, the nearing overcapacity of SLFs is a pressing concern that requires immediate action. Exploring alternative disposal methods, such as converting plastics into other materials, could reduce waste sent to the landfills.

In Timor-Leste, the use of uncontrolled disposal sites increases the risk of waste leakage. Recognizing the urgent need for safer waste management solutions, efforts are underway to develop sanitary landfills. The Tibar dumpsite, which is currently serving Dili and Liquiçá, is currently under construction into a sanitary landfill, while a proposed landfill in Baucau aims to accommodate waste from Manatuto.

City/ Municipality	Sanitary Landfill	Residual Containment Area (RCA)	Uncontrolled Facility (Open Dumpsite)
Philippine Sites			
Bulan	■	✓	
Calbayog	✓		
Daanbantayan	■	✓	
Dipolog	✓		
Puerto Princesa	✓		
Tandag	✓	✓	
Timor-Leste Sites			
Atauro	■		✓
Dili	v		✓
Liquiçá	v		✓
Manatuto	■		✓

✓ The facility is currently in use
v The facility is currently under construction
■ The facility is included in the city/ municipality plan

Figure 15. Current Disposal Facilities in Philippine and Timor-Leste Sites

5 Methodology

A regional synthesis was developed based on the 10 local baseline assessment reports from the Philippines and Timor-Leste. These reports were informed by three core activities conducted in all project sites, including Plastic Analysis and Characterization Study (PACS), Knowledge, Attitude, and Practice (KAP) survey, and field observations and review of secondary data. These activities generated both quantitative and qualitative data used to understand and map the plastic waste value chain in the coastal areas of the project sites (**Figure 16**).

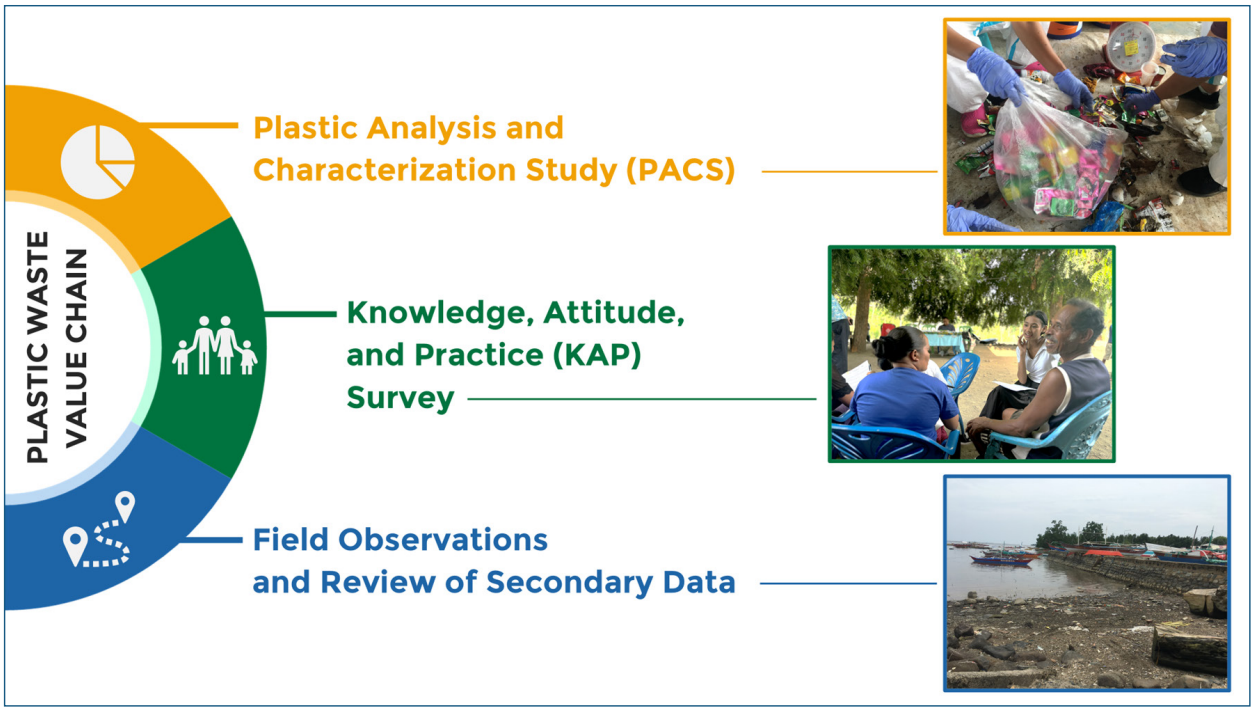

Figure 16. General Methodology

A. Plastics Analysis and Characterization Study (PACS)

The Plastic Analysis and Characterization Study was developed under the project to standardize the waste audit methodology, mainly adopting the methods of the Waste Analysis and Characterization Study (WACS) guidelines from the National Solid Waste Management Commission (NSWMC) of the Philippines and the Waste Wise Cities Tool (WaCT) by the United Nations Human Settlements Programme (UN-Habitat), with a focus on plastics. The approach was applied across all project sites to ensure consistency and comparability of results, including Timor-Leste where no national waste audit methodology is currently available.

Three coastal villages[10]—barangays in the Philippines and sucos in Timor-Leste—were selected in each site considering project resource availability. In the Philippines, survey areas were identified based on population size, tourism and fishing activities, and the status of waste collection and recovery systems. In Timor-Leste, selection was guided by consultations with municipal governments, focusing on areas with significant plastic pollution, limited waste services, and practical accessibility for fieldwork activities.

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[11]
e = 10% margin of error for Highly Urbanized Cities (HUCs), 1st to 6th class municipalities[11]

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

To ensure sufficient statistical coverage, an additional 10% contingency was added to the calculated number of household samples to account for potential inconsistent participation during the PACS period. For each project site, the final target sample size, including the contingency, was calculated at 67 households, which is distributed across the three identified coastal areas.

For non-households, there must be at least one representative from each of the most dominant subcategories listed within the WaCT guidelines (UN-Habitat, 2021). The recommended number of non-household samples for each subcategory are summarized considering the available resources for the project (**Table 13**). While fishing activities are prevalent in coastal communities, fish ports and dock areas are not typically included from the recommended sampling categories for non-households within the WaCT guidelines. To address this, the WACS guidelines were used, as they provide the recommended sampling unit for industries based on area (NSWMC, 2020).

[10] A coastal village is defined as a village where its boundaries, or a portion of its boundaries, include coastlines. In this report, the classification of a village as a coastal village is determined using Geographic Information System (GIS).
[11] 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 in Timor-Leste context.

Table 13. Sample Size for Non-Households

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

Preparations were undertaken to ensure resources were properly organized prior to the conduct of PACS activities. These included the identification of a sorting area and the procurement of essential materials such as weighing equipment, sorting tools, personal protective equipment, and health and sanitation kits. A local PACS team was also formed on each site, composed of a team leader, safety officer, logistics-in-charge, sorters, collection-in-charge, recorders, interviewers, and documenters. A national training session was initially conducted to equip relevant stakeholders with the necessary knowledge and skills for implementing PACS, followed by local training sessions on each site to strengthen the readiness of the local teams. Orientation sessions were also held with household and non-household PACS cooperators to explain their roles and distribute orientation materials, including color-coded plastic bags for the waste samples.

The PACS activity was conducted over three consecutive days, including a one-day trial or dry run, to save 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 received color-coded plastic bags for each day to separate their waste into the different waste categories

throughout the 4-day PACS. The plastic bags were collected every morning on the day after the waste was generated. In the sorting area, the collected waste samples were organized by source, sorted and characterized into specific waste categories, and placed in respective containers. The sorted waste was disposed of according to the agreed disposal plan.

Processing and analysis of data gathered during the PACS sampling include the calculation of the household waste generation rate (WGR), which represents the amount of waste that the average resident of a locality generates in a day (**Equation 2**). 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, meanwhile, is computed using the amount of collected plastic items from the sample (**Equation 3**).

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

Equation 2. Formula for Computing Household Waste Generation Rate (NSWMC, 2020)

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

Equation 3. 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 weight of the collected samples by the number of units and sampling days (**Equation 4** and **Equation 5**).

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

Equation 4. 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 5. 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 6**) 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 or information needed for the different non-household sources (**Equation 7**).

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

Equation 6. Formula for Daily Household Waste Generation

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

Equation 7. 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 8**).

The total daily waste generation of the survey areas is the sum of the total household and non-household waste generation (**Figure 17**). 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.

$$Plastic\ Waste\ Generation\ [kg/day] = Daily\ Waste\ Generation\ (kg/day) \times Plastic\ Composition\ (\%)$$

Equation 8. Formula for Daily Household and Non-Household Plastic Waste Generation

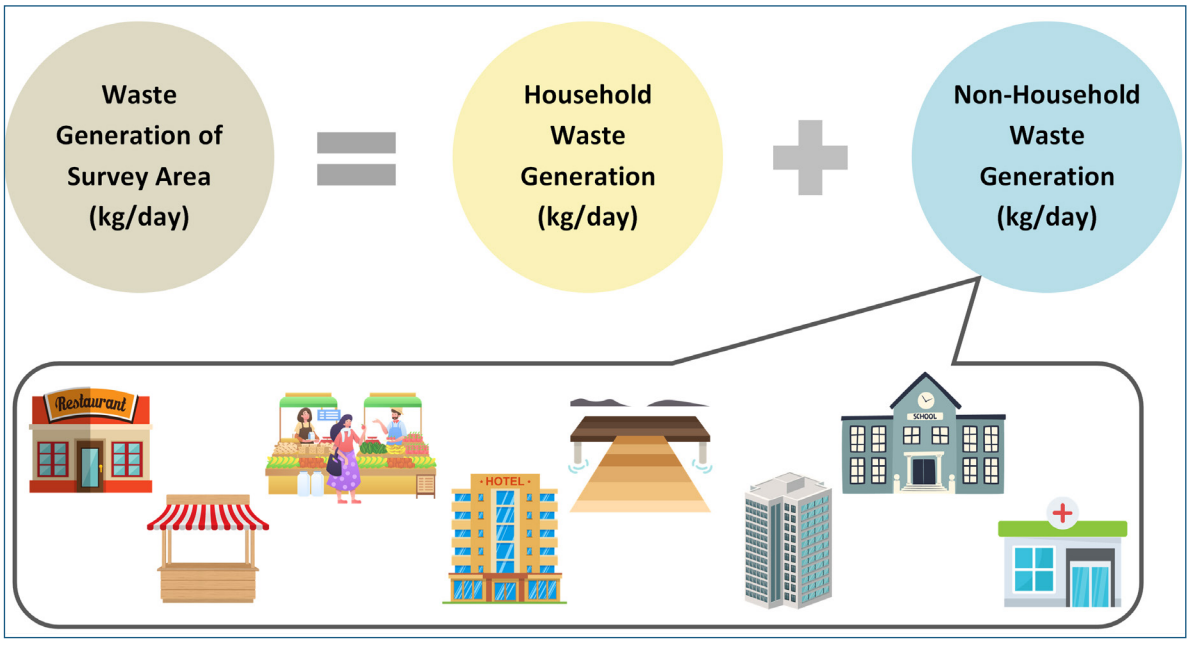

Figure 17. Calculation of the Total Daily Solid Waste Generation of a Survey Area

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 areas.

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 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. Reported national averages were based on population-weighted data from the surveyed coastal areas.

C. Field Observations and Review of Secondary Data

Field observations and review of secondary data were carried out to support and contextualize the results of PACS and KAP surveys, and to develop a more complete picture of the plastic waste value chain. These covered the overall solid waste management system, including waste generation, collection, recovery, disposal, and leakage in each project site. Each stage of the waste management system was observed directly, capturing on-the-ground practices, conditions, and infrastructure. This was complemented by a review of relevant secondary data, including local and national government policies and reports, published studies, project documents, and other available datasets. These sources provided additional insights to fill data gaps, validate field findings, and strengthen the overall analysis.

D. Assumptions and Limitations

The PACS method used in this study is primarily based on WACS guidelines of the Philippines, as there are no existing national guidelines in Timor-Leste. In addition, while WACS guidelines recommend a seven-day sampling period for highly urbanized cities (i.e., Puerto Princesa City), the study applied a standardized

approach of three consecutive sampling days, preceded by a one-day dry run, across all sites. These approaches were adopted to ensure consistency in implementation and allow comparability of results across the ten project sites.

The identified coastal villages surveyed were considered representative of the local coastal context in each city or municipality. The selection of household and non-household participants was supported by the respective local governments, based on the availability of resources, accessibility, and operational feasibility in each survey area.

While the study aimed to meet the recommended number of non-household samples, some establishments were either not operational in the selected survey area or declined to participate in the study, particularly in Timor-Leste. In such cases, data from other municipalities or sites with similar economic and geographic conditions were used to reflect the dominant non-household subcategories of the corresponding project site. Projections for non-household units were estimated using information from local consultants, available GIS data, and secondary sources when precise data for the survey areas were not available.

Some local-specific data and information, such as GDP, were not readily available at the municipal or village level. When necessary, estimates were derived from published studies and regional or national sources to fill gaps and support the analysis. The shapefiles used in mapping administrative boundaries were sourced from the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) dataset. These were primarily used for visualization, and while useful for spatial context, the boundaries may not be fully updated or completely accurate.

Collection of segregated wastes from non-household facility in Barangay Cabayugan, Puerto Princesa, Palawan.

PACS sorting and weighing of collected waste in Atauro.

Key Results of Plastic Analysis and Characterization Study (PACS) and Knowledge, Attitude, and Practice (KAP) Survey

6

A. Plastic Analysis and Characterization Study (PACS)

The Philippines and Timor-Leste exhibit distinct waste generation patterns while sharing similarities as developing nations in Southeast Asia. The Philippines, with its growing economy and large population, generates a significant amount of waste; however, its per capita waste generation rate is generally lower than that of Timor-Leste. Across both countries, the combined household and non-household waste generation rate ranges from 0.17 kg/cap/day to 0.57 kg/cap/day, with Timor-Leste consistently showing higher WGR across surveyed sites. When compared to national-level estimates from global and local studies, Philippine sites generally show a lower WGR, while Timor-Leste sites exceeded the recorded and estimated WGRs, which may reflect the economic conditions and characteristics of the surveyed area. Despite differences in generation rates, the two countries share similar dominant general waste categories, consisting mainly of recyclables, biodegradable waste, and residual waste with potential for recycling.

The trend extends to plastic waste, where combined household and non-household generation rates vary from 0.05 kg/cap/day to as high as 0.18 kg/cap/day. Both countries have similar prevalent plastic waste categories, specifically diapers and napkins, PET items, and PP items.

To fully contextualize waste generation in the Philippines and Timor-Leste, multiple influencing patterns must be considered. While the economy plays a significant role in waste generation, other factors such as geographic environment, urbanization, tourism, consumption patterns, and demographic characteristics also contribute to the variations in waste trends and their broader implications for waste management.

1. Household Waste Generation and Composition

The average household waste generation across the ten coastal sites in the Philippines and Timor-Leste range from 0.16 kg/cap/day to 0.50 kg/cap/day (**Figure 18**).

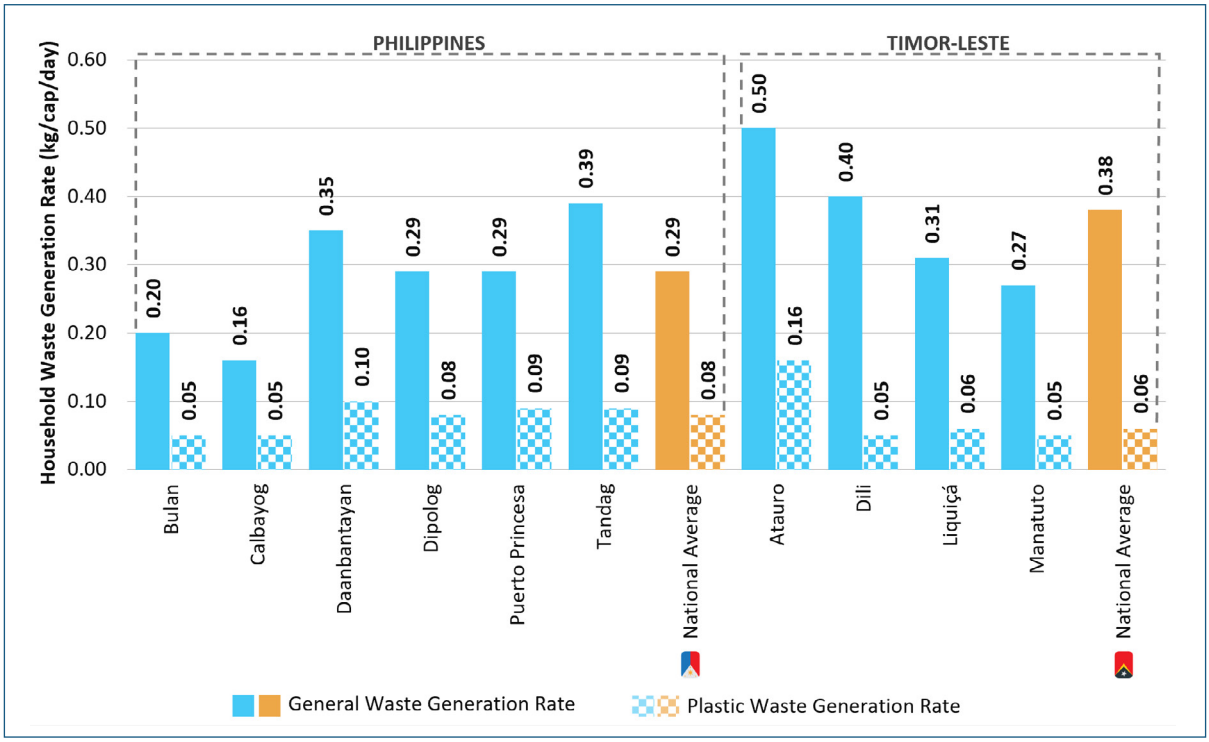

Figure 18. Household General and Plastic Waste Generation Rates (kg/cap/day) of Surveyed Coastal Areas in Philippine and Timor-Leste Sites

Among these areas, Atauro in Timor-Leste exhibits the highest WGR, while Calbayog City in the Philippines records the lowest. Urban centers, such as Dili and Puerto Princesa, show a relatively higher WGR with 0.40 kg/cap/day and 0.29 kg/cap/day, respectively. The national average for household general waste generation was 0.29 kg/cap/day for the Philippines, showing greater variations across the six locations, and 0.38 kg/cap/day for Timor-Leste, with consistently high WGR across the four surveyed sites.

Plastic waste generation rate follows a different trend, with Philippines recording a higher national average of 0.08 kg/cap/day compared to the 0.06 kg/cap/day of Timor-Leste. Notably, despite the higher general WGR of Timor-Leste, plastic waste remains a smaller fraction of the total waste stream due to the high proportion of biodegradable waste. The highest plastic WGR was observed in Atauro at 0.16 kg/cap/day, while the lowest was observed in various sites across the two countries, specifically Bulan, Calbayog City, Dili, and Manatuto, at 0.05 kg/cap/day.

In general, island-based sites such as Atauro, Daanbantayan, and Puerto Princesa present a higher plastic WGR, influenced by factors such as tourism, reliance on plastic products due to geographical constraints, and the prevalence of commercial establishments.

The average daily waste generation of households within the sampled coastal sites can be projected to represent the waste patterns of households in other coastal areas within the corresponding city or 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 or barangays of a city or municipality considering the inherent variability across different non-household categories and areas.

The total household daily general waste and plastic waste in the surveyed coastal barangays in the Philippines (**Figure 19**) and sucos in Timor-Leste (**Figure 20**) were estimated using the corresponding waste generation and projected population for each site. Household general waste in these areas ranges from 5,342 kg/day to 95,345 kg/day, while plastic waste varies from 1,031 kg/day to 29,590 kg/day. Urban centers such as Dili and Puerto Princesa record the highest general and plastic waste generation, reflecting greater consumption levels and economic activity. In contrast, Bulan and Manatuto have the lowest general and plastic waste generation, corresponding to their relatively smaller populations.

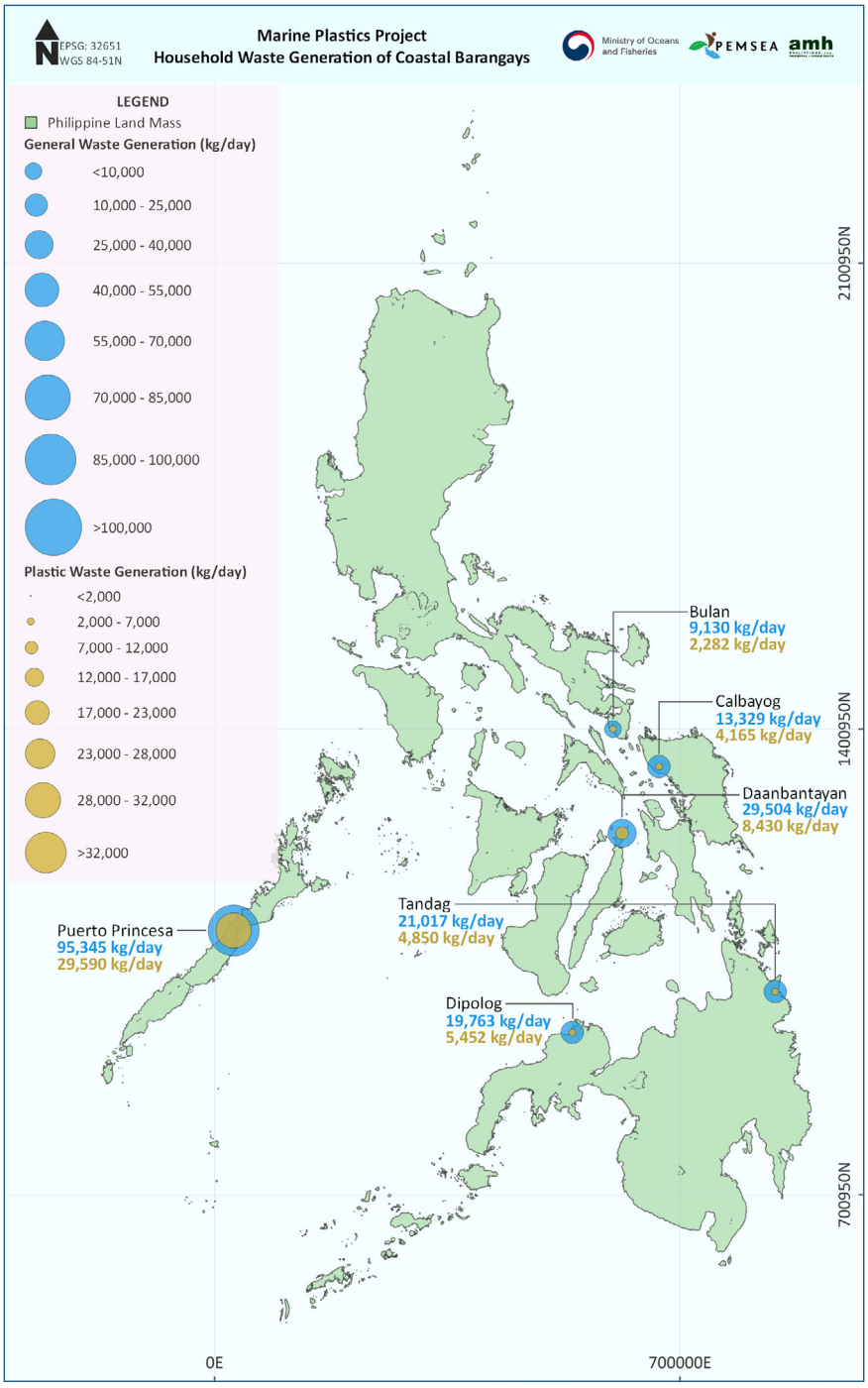

Figure 19. Household Waste Generation of Coastal Barangays in Philippine Sites

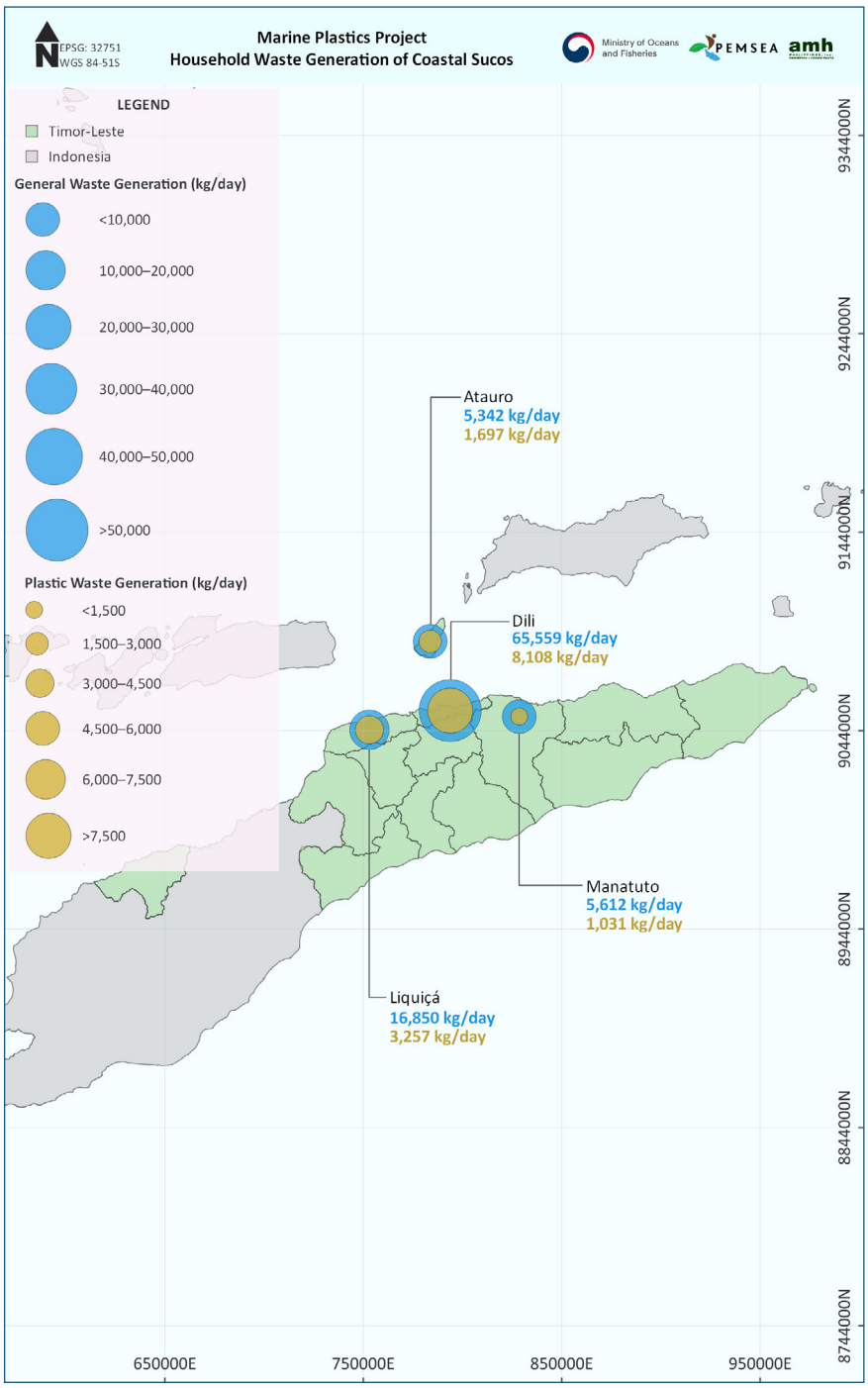

Figure 20. Household Waste Generation of Coastal Sucos in Timor-Leste Sites

The general household waste composition across the ten surveyed sites shows distinct patterns for each country (**Figure 21**). In the Philippines, recyclable waste is the predominant category in most locations, except for Bulan. As a result, the national average shows a higher proportion of recyclables at 42% compared to 23% for biodegradable waste. Conversely, biodegradable waste is the most prevalent in the surveyed sites in Timor-Leste, except for Liquiçá. The national average for Timor-Leste reflects this trend, with biodegradable waste making up 55% of household waste, while recyclable waste accounts for 26%.

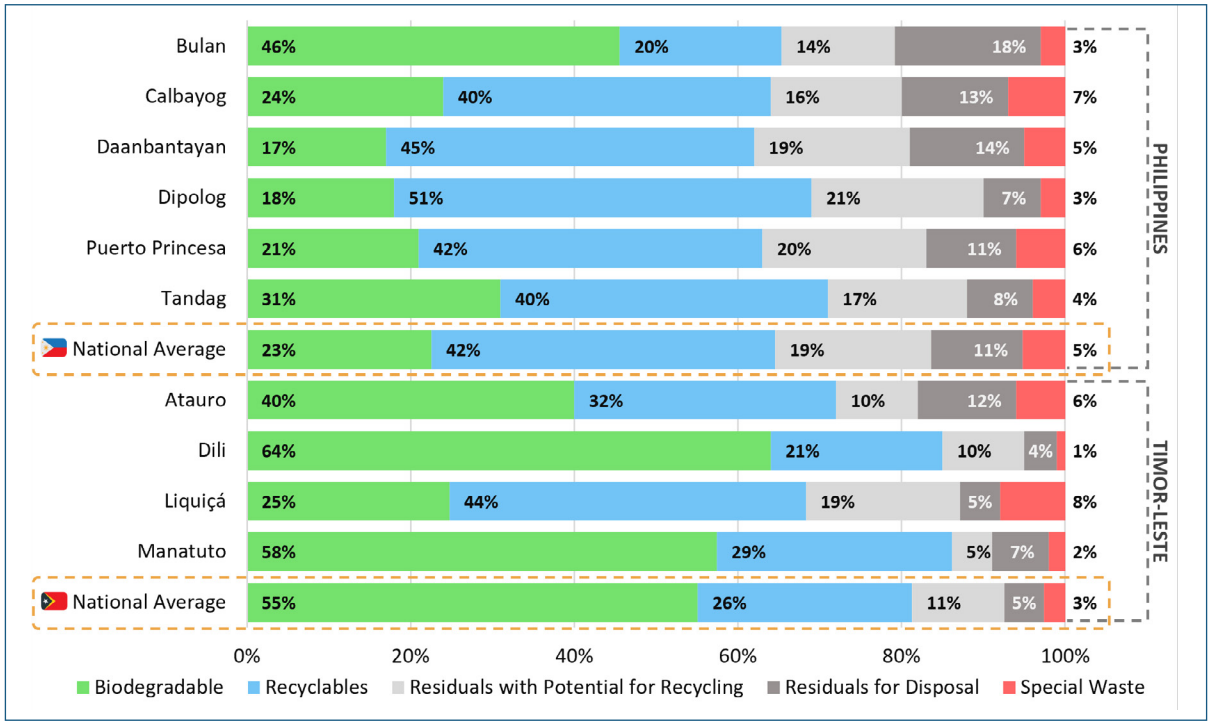

Figure 21. General Waste Composition of Household Waste in Philippine and Timor-Leste Sites

Across the surveyed sites, plastic waste constitutes a smaller share of household waste compared to non-plastic materials in both countries, with the Philippines having a larger proportion of plastic waste at 28%, compared to 15% in Timor-Leste (**Figure 22**).

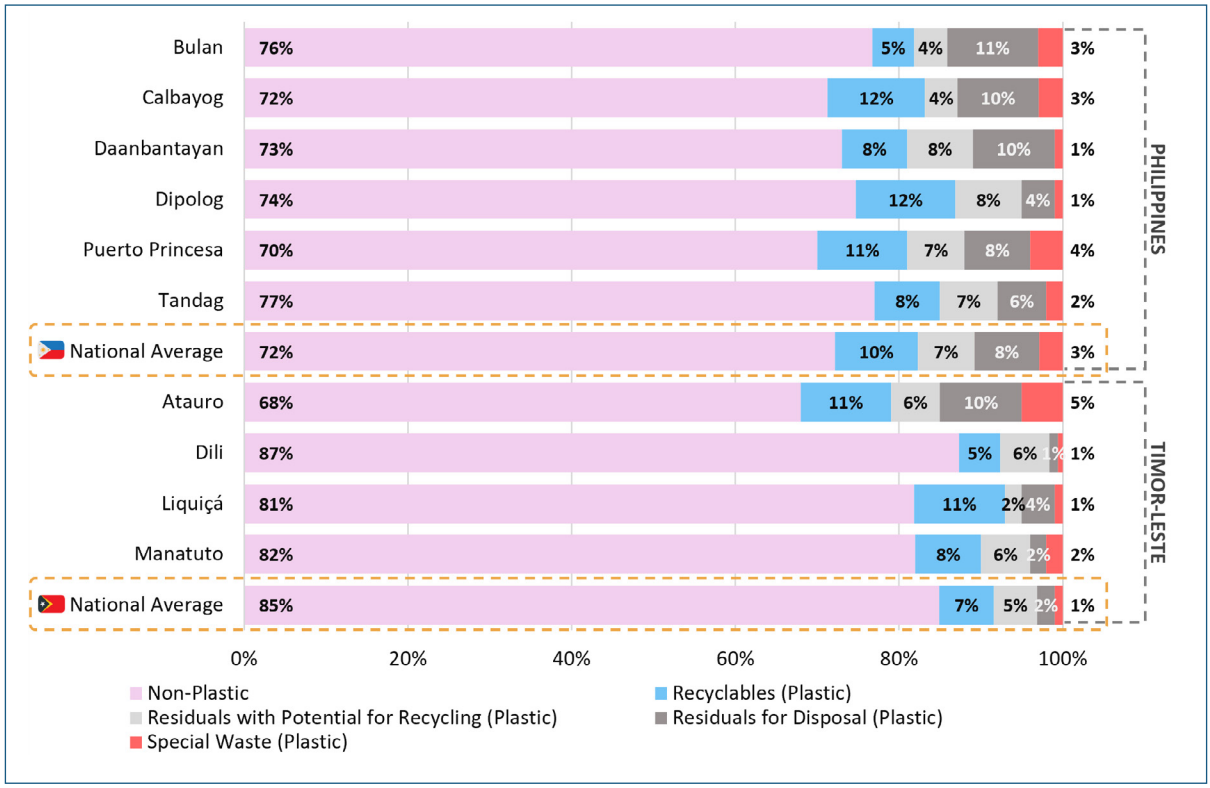

Figure 22. Plastic Waste Composition of Household Waste in Philippine and Timor-Leste Sites

Notably, Atauro in Timor-Leste records the highest plastic waste composition at 32%, followed by Puerto Princesa City at 30%. Recyclable plastics are the dominant category plastic waste category in most sites, including Calbayog City, Dipolog City, Puerto Princesa City, Tandag, Atauro, Liquiçá, and Manatuto. Residual plastics for disposal make up the largest proportion of plastic waste in Bulan and Daanbantayan, while in Dili, residual plastics with potential for recycling are the most prominent. On a national average, recyclable plastics is the most prevalent type of plastic waste in both countries, making up 10% of total waste in surveyed sites in the Philippines and 7% in Timor-Leste.

2. Non-Household Waste Generation and Composition

Non-household waste generation rates vary significantly across the surveyed coastal sites, influenced by local consumption patterns, waste management practices, and establishment types (**Table 14**). Markets exhibit the highest unit waste generation, ranging from 0.029 kg/stall/day in Calbayog to as high as 7.52 kg/stall/day in Puerto Princesa City. In contrast, fish ports consistently generate the least waste, with rates as low as 0.0001 kg/m²/day in Daanbantayan and Dipolog City and a peak of 0.008 kg/m²/day in Puerto Princesa City. Among the project sites, Puerto Princesa City and Dili record the highest general WGR in multiple non-household establishments, which may be attributed to their level of urbanization and role as the national center, respectively.

Plastic waste generation, on the other hand, varies across locations, with Bulan, Puerto Princesa, Tandag, Dili, and Manatuto presenting the highest rates in multiple types of non-household (**Table 15**). Puerto Princesa leads in food establishments at 0.237 kg/seat/day, markets at 0.202 kg/stall/day, and fish ports at 0.004 kg/m²/day, likely due to its active commercial activity as a highly urbanized city. Dili has the highest plastic WGR in hotels with 0.770 kg/bed/day, schools with 0.011 kg/student/day, and health facilities with 0.471 kg/bed/day, reflecting its role as Timor-Leste's capital, where major institutions, businesses, and services are concentrated. Tandag records the highest plastic WGR in general stores at 0.018 kg/m²/day and offices at 0.119 kg/employee/day. Manatuto exhibits the highest plastic WGR for schools with 0.011 kg/student/day, while Bulan records the highest for general stores at 0.249 kg/stall/day.

Table 14. Non-Household General Waste Generation Rates of Surveyed Coastal Areas in Philippine and Timor-Leste Sites

Type of Non-Household	Philippine Sites						Timor-Leste Sites			
	Bulan	Calbayog	Daanbantayan	Dipolog	Puerto Princesa	Tandag	Atauro	Dili	Liquiçá	Manatuto
Food Establishment (kg/seat/day)	0.552	0.099	0.120	0.033	**1.25**	0.162	0.175[c]	0.664	0.107	0.175
General Store (kg/stall/day)	**1.63**	0.441	0.026[b]	0.046[b]	**0.070[b]**	0.056[b]	0.590	0.590[e]	0.287[c]	0.287
Market (kg/stall/day)	0.126	0.029	0.233	4.09	**7.52**	3.26	1.460[c]	1.460[c]	1.460[c]	1.460
Hotel/ Accommodation (kg/bed/day)	0.307	0.071	0.231	0.297	0.660	0.476	0.210	**1.180**	0.210[e]	0.210[e]
Fish Port/Dock Area (kg/m²/day)	0.003	0.003	0.0001	0.0001	**0.008**	N/A	0.002	0.002[e]	0.002[e]	0.002[e]
Office (kg/employee/day)	0.012	0.011	0.040	0.013	0.011	0.298	0.300	**0.311**	0.163	0.163[d]
School (kg/student/day)	0.002	0.004	0.006	0.027	0.015	0.028	0.026[d]	**0.053[c]**	0.026	**0.053**
Health-Related (kg/bed/day)	0.003[a]	0.168	0.076	0.658	0.156	0.750	0.286[d]	**1.298**	0.984	0.286

[a] Unit is in kg/chair/day due to lack of beds for patients in the health-related facilities from the surveyed coastal areas
[b] Unit is in kg/m²/day based on available data obtained by the local consultant
[c] Data is based on the conducted PACS in the Municipality of Manatuto due to lack of participating establishment
[d] Data is based on the conducted PACS in the Municipality of Liquiçá due to lack of participating establishment
[e] Data is based on the conducted PACS in the Municipality of Atauro due to lack of participating establishment
* Values in red font color represent the highest waste generation rates among the project sites. General stores have two highest rates considering the difference in units[b].

Table 15. Non-Household Plastic Waste Generation Rates of Surveyed Coastal Areas in Philippine and Timor-Leste Sites

Type of Non-Household	Philippine Sites						Timor-Leste Sites			
	Bulan	Calbayog	Daanbantayan	Dipolog	Puerto Princesa	Tandag	Atauro	Dili	Liquiçá	Manatuto
Food Establishment (kg/seat/day)	0.102	0.004	0.048	0.005	**0.237**	0.040	0.023 [c]	0.086	0.021	0.023
General Store (kg/stall/day)	**0.249**	0.022	0.007[b]	0.011[b]	0.006[b]	**0.018[b]**	0.203	0.203[e]	0.044[c]	0.044
Market (kg/stall/day)	0.023	0.009	0.090	0.099	**0.202**	0.018	0.152 [c]	0.152[c]	0.152[c]	0.152
Hotel/ Accommodation (kg/bed/day)	0.040	0.009	0.027	0.067	0.351	0.038	0.137	**0.770**	0.137[e]	0.137[e]
Fish Port/Dock Area (kg/m²/day)	0.001	0.001	0.00001	<0.00001	**0.004**	N/A	0.0004	0.001	0.0004[e]	0.0004[e]
Office (kg/employee/day)	0.001	0.003	0.010	0.004	0.004	**0.119**	0.040	0.068	0.090	0.090[d]
School (kg/student/day)	0.0003	0.002	0.002	0.005	0.005	0.002	0.009[d]	**0.011[c]**	0.009	**0.011**
Health-Related (kg/bed/day)	0.002[a]	0.056	0.032	0.155	0.115	0.196	0.088[d]	**0.471**	0.025	0.088

[a] Unit is in kg/chair/day due to lack of beds for patients in the health-related facilities from the surveyed coastal areas
[b] Unit is in kg/m²/day based on available data obtained by the local consultant
[c] Data is based on the conducted PACS in the Municipality of Manatuto due to lack of participating establishment
[d] Data is based on the conducted PACS in the Municipality of Liquiçá due to lack of participating establishment
[e] Data is based on the conducted PACS in the Municipality of Atauro due to lack of participating establishment
* Values in red font color represent the highest waste generation rates among the project sites. General stores have two highest rates considering the difference in units[b].

In the surveyed coastal areas across the ten project sites, non-household waste generation varies significantly, ranging from 158 kg/day in Calbayog City, Philippines to as high as 13,960 kg/day in Dili, Timor-Leste (**Figure 23**). This variation in waste generation can largely be attributed to differences in the type and number of non-households. The selected barangay or suco for sampling might have fewer non-households as compared with other areas. The variability in non-household categories and differing levels of urbanization among cities and municipalities preclude accurate projections of non-household waste generation at the city-level or municipal-level, thereby making it impractical to calculate a national average from the data gathered at these sites.

Non-household plastic waste generation in the surveyed coastal sites ranges from 21 kg/day in Calbayog City to 4,432 kg/day in Dili.

Commercial establishments are the primary contributors of plastic waste in the majority of the surveyed sites, except for Calbayog City, Liquiçá, and Manatuto, where institutions account for the majority of non-household plastic waste.

The composition of non-household general waste varies across the ten surveyed sites, with biodegradable and recyclable waste being the dominant components (**Figure 24**). Biodegradable waste is the prevalent category in most of the surveyed sites, including Bulan, Dipolog City, Puerto Princesa City, and Tandag City in the Philippines, as well as Atauro, Liquiçá, and Manatuto in Timor-Leste. On the other hand, recyclable waste accounts for the highest share in Calbayog City, Daanbantayan, and Dili. The proportion of biodegradable waste varies from 21% to 57%, and recyclables range from 23% to 50% of non-household waste.

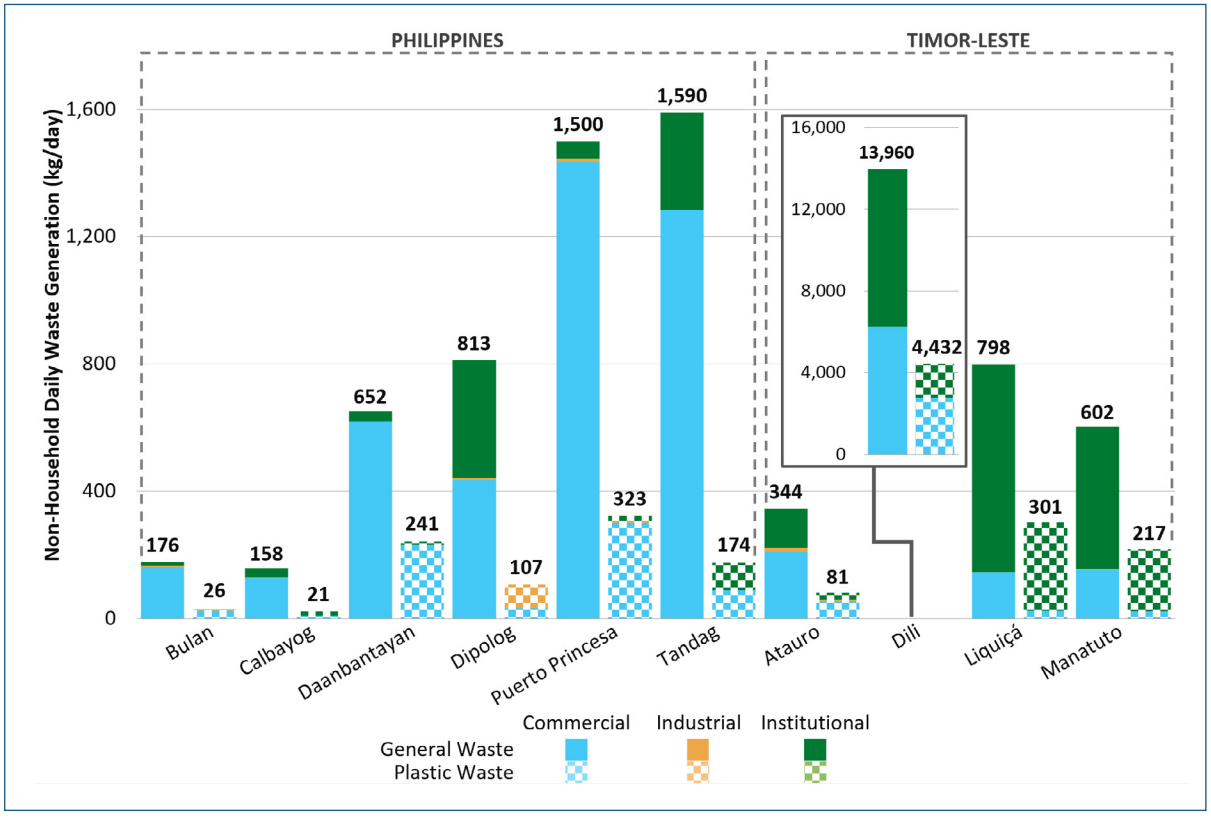

Figure 23. Non-Household Daily General and Plastic Waste Generation (kg/day) of Surveyed Coastal Areas in Philippine and Timor-Leste Sites

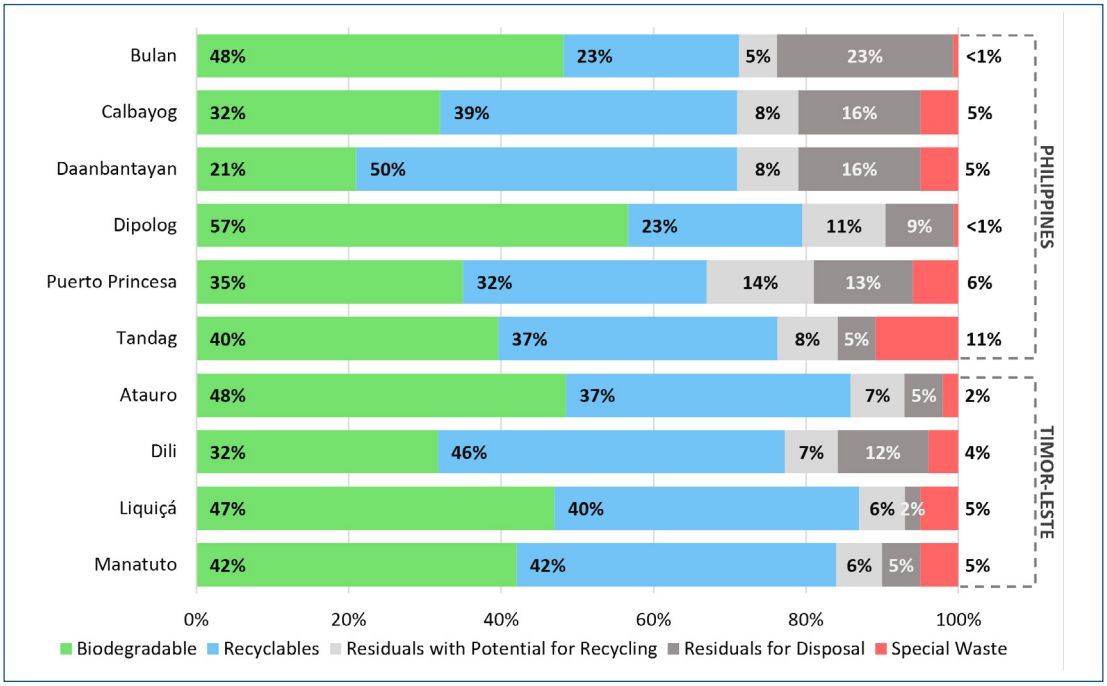

Figure 24. General Waste Composition of Non-Household Waste in Philippine and Timor-Leste Sites

The composition of plastic waste in non-household sources across the ten project sites in the Philippines and Timor-Leste varies significantly (**Figure 25**). Plastic waste constitutes about 17% to 32% of the total non-household waste. Among this, recyclable plastic waste, ranging from 5% to 13%, is the most substantial category in all the surveyed coastal areas. Residual plastics with potential for recycling range from 3% to 12%, representing the next largest portion of plastic waste for most of the sites. Residual plastics for disposal account for 1% to 13% of non-household waste.

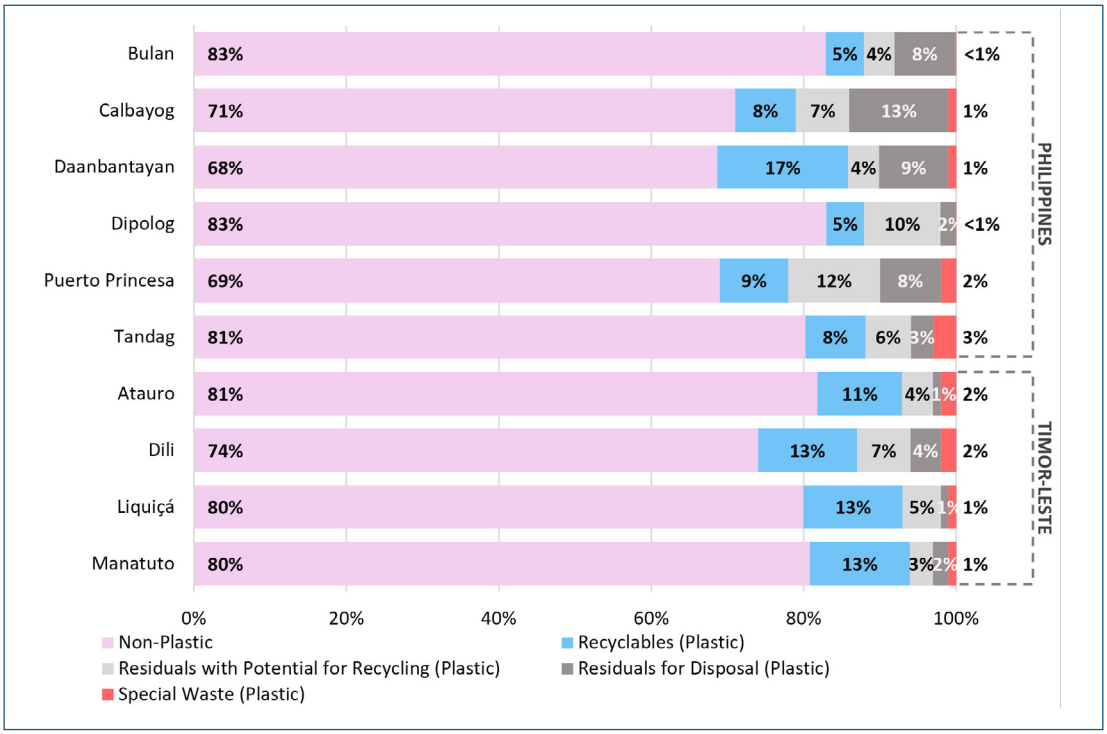

Figure 25. Plastic Waste Composition of Non-Household Waste in Philippine and Timor-Leste Sites

3. Combined Household and Non-Household Waste Generation and Composition

The total combined household and non-household general waste generation across the ten project sites exhibits significant variations, primarily influenced by factors such as population size, and the size and type of non-household entities operating within the area. Daily waste generation ranges from 2,701 kg/day in Bulan, Philippines to as high as 48,268 kg/day in Dili, Timor Leste (**Figure 26**). Notably, household waste contributes to the majority of the total waste in all the surveyed coastal areas, accounting for about 71% to 95% of the total waste.

A similar pattern is observed in plastic waste generation, with household sources consistently contributing the largest share. Dili records the highest plastic waste generation at 8,903 kg/day, while Bulan has the lowest at 654 kg/day. Other high-generating sites include Dipolog City at 3,538 kg/day and Daanbantayan at 3,001 kg/day, while lower plastic waste generation is observed in Manatuto with 717 kg/day and Calbayog City with 812 kg/day.

In terms of combined household and non-household waste, Timor-Leste sites, specifically Dili and Atauro, record the highest combined general WGR at 0.57 kg/cap/day and 0.56 kg/cap/day, respectively (**Figure 27**). In contrast, surveyed areas in the Philippines exhibit the lowest rates with Calbayog City at 0.17 kg/cap/day and Bulan at 0.21 kg/cap/day. Across the ten project sites, WGR varies from 0.17 kg/cap/day to 0.57 kg/cap/day.

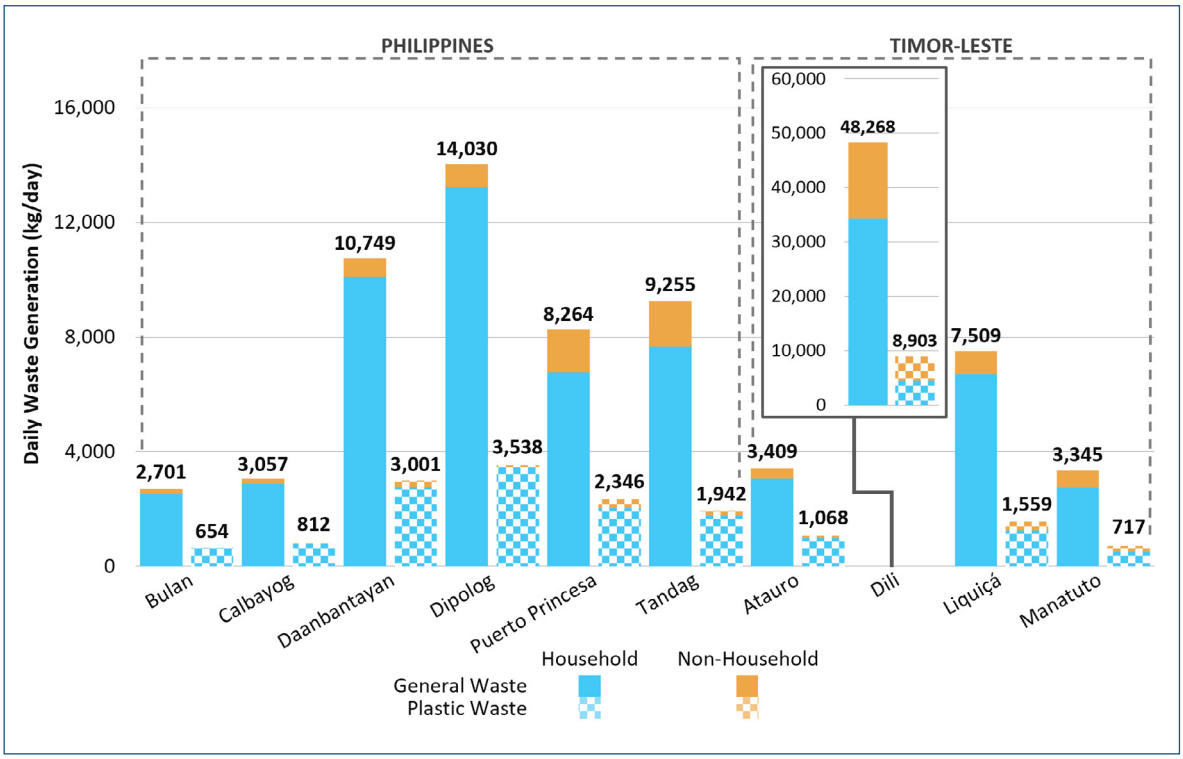

Figure 26. Combined Household and Non-Household Daily General and Plastic Waste Generation (kg/day) of Surveyed Coastal Areas in Philippine and Timor-Leste Sites

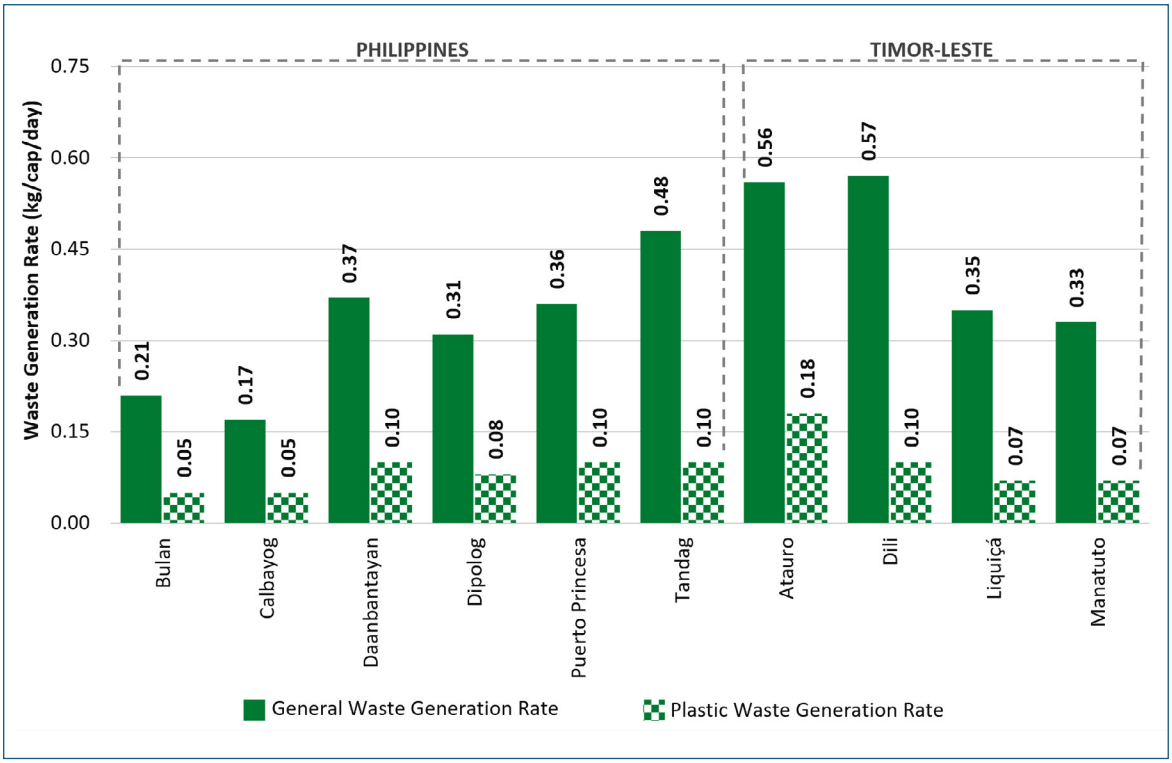

Figure 27. Combined Household and Non-Household General and Plastic Waste Generation Rates (kg/cap/day) of Surveyed Coastal Areas in Philippine and Timor-Leste Sites

The combined household and non-household plastic waste generation reflects the overall trend in total waste generation, with Timor-Leste sites recording the highest combined plastic WGR. Atauro has the highest rate with 0.18 kg/cap/day, suggesting significant plastic consumption driven by the reliance of the island on packaged items. Dili also presents a relatively higher plastic WGR with 0.10 kg/cap/day, reflecting its role as the capital and economic center of the country. Bulan and Calbayog City consistently report low plastic WGR with 0.05 kg/cap/day.

The general composition of total combined household and non-household waste in the surveyed coastal areas across the two countries presents variation in waste types (**Figure 28**). In the Philippines, recyclable waste is the predominant category in most locations, except for Bulan and Tandag City, where biodegradable waste accounts for the largest share. In contrast, biodegradable waste is the most prevalent in the surveyed sites in Timor-Leste, except for Liquiçá, where recyclables make up the majority of the total waste samples.

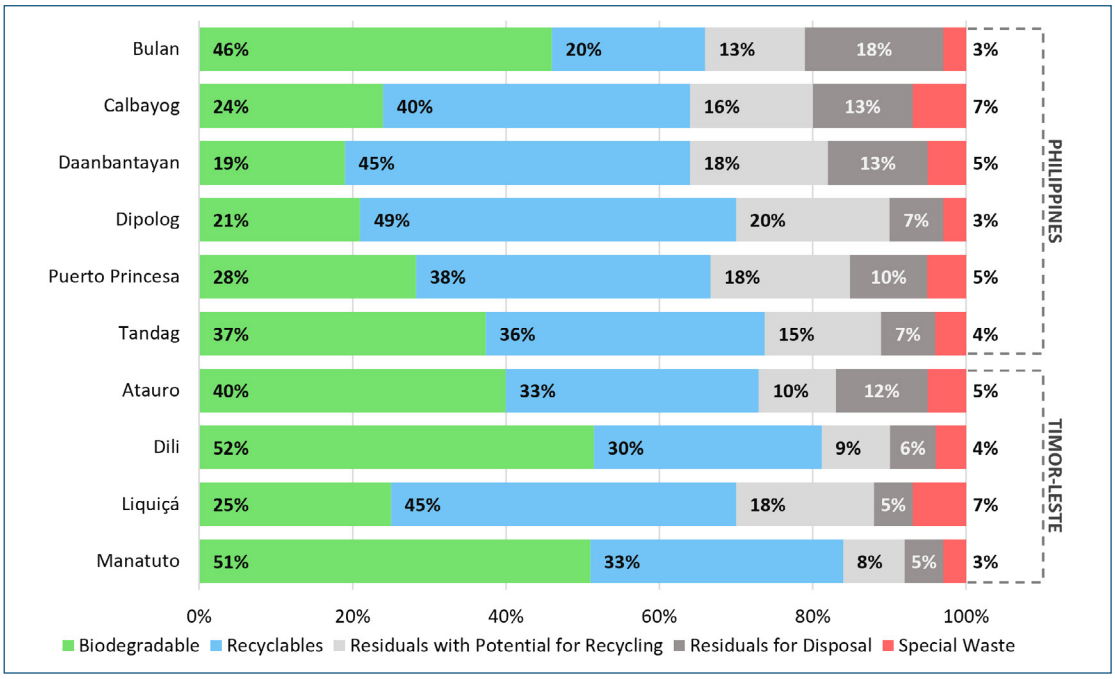

Figure 28. General Waste Composition of Combined Household and Non-Household Waste in Surveyed Coastal Areas in Philippine and Timor-Leste Sites

Plastic waste generated from the combined household and non-household sources across the surveyed coastal areas ranges from 18% in Dili to as high as 32% in Atauro (**Figure 29**). Recyclable plastics, making up 5% to 12%, constitute the largest portion of plastic waste in all project sites. Meanwhile, residual plastics with potential for recycling account for 3% to 8%, suggesting untapped opportunities for increased recovery and waste diversion. Residual plastics for disposal contribute 1% to 11% to the total combined waste for each site.

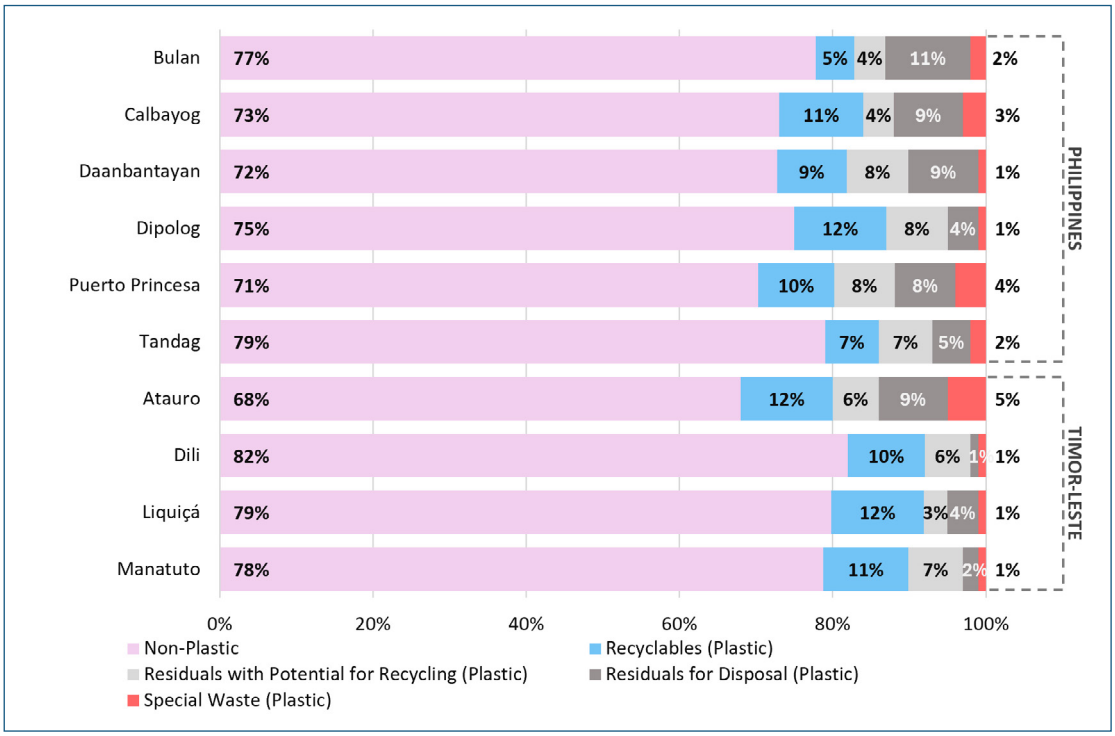

Figure 29. Plastic Waste Composition of Combined Household and Non-Household Waste in Surveyed Coastal Areas in Philippine and Timor-Leste Sites

Across both countries, waste generation rates observed in the project sites reveal significant similarities and differences when compared to national-level estimates from global and local studies. In the Philippines, WGRs in the surveyed coastal barangays are generally lower than the national averages reported in existing studies. Except for Tandag, all sites recorded WGRs below the World Bank estimate of 0.39 kg/cap/day (The World Bank, 2018). Compared to recent national projections–0.53 kg/cap/day[12] (NSWMC, 2024) and 0.70 kg/cap/day (Cottom, Cook, & Velis, 2024)–the coastal WGRs observed in this study range from about one-fourth to half of these national averages. These lower rates may be explained by the characteristics of the surveyed areas, focusing on coastal communities which may vary in economic conditions, urban activities, and cultural practices. The national datasets also cover inland areas, accounting for about 50% of the cities and municipalities in the country, which may have different waste generation conditions.

In Timor-Leste, all project sites recorded WGRs higher than the World Bank estimate of 0.14 kg/cap/day (The World Bank, 2018). Atauro and Dili exceeded more recent national averages of 0.471 kg/cap/day (SPREP, 2023) and 0.53 kg/cap/day (Cottom, Cook, & Velis, 2024). These higher rates reflect common local conditions, such as high composition of biodegradable waste and greater use of imported packaged goods. Given that most municipalities in the country are coastal and share similar conditions, the WGR observed in the project sites are likely around the latest available national averages.

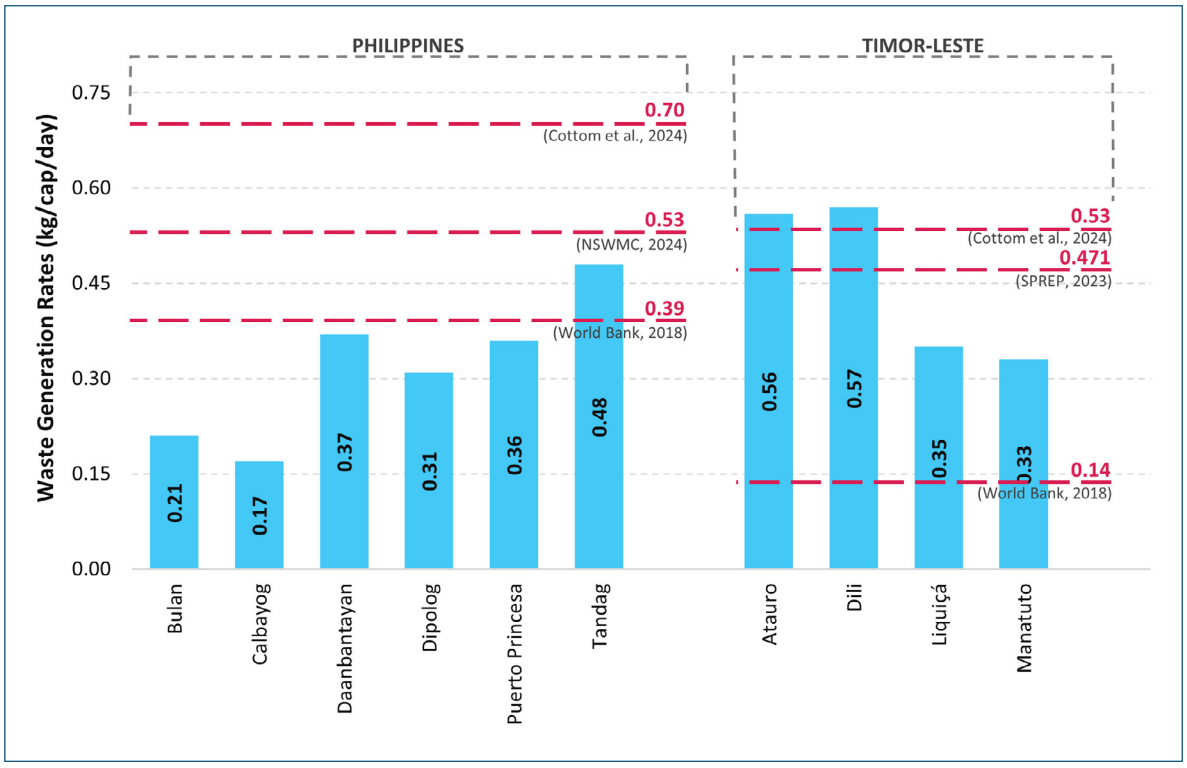

Figure 30. Comparison of Waste Generation Rates of Project Sites with National Data

[12] The waste generation rate of about 0.53 kg/cap/day was obtained using the estimated annual generation of about 22.1 million metric tons (NSWMC, 2024) and the projected population of 114,589,748 in the Philippines in 2023 based on 2020 national census (Philippine Statistics Authority, 2021).

4. Contextualizing Waste Generation Rates

Waste generation rates across the ten project sites generally reflect the commonly observed relationship between income levels and waste generation (The World Bank, 2018), where higher GDP per capita is associated with higher per capita waste generation (**Figure 31**). Sites such as Dili, Puerto Princesa, and Daanbantayan, which have relatively higher GDP/capita,[13] also reported higher general and plastic WGRs. Puerto Princesa, as a highly urbanized city,[14] and Dili, which houses the capital of Timor-Leste, are expected to generate more waste due to greater economic activity, consumption, and service accessibility. Although Daanbantayan is a 1st income class municipality,[15] its higher GDP/capita may be attributed to its relatively low population and the presence of local industries such as tourism and aquaculture, which may increase GDP/capita without corresponding increase in urban scale. Tandag, while positioned in the mid-range of GDP/capita of the project sites, shows a relatively high WGRs compared to other sites. This may be influenced by its role as a provincial capital with concentrated economic activities, which can drive higher consumption patterns and waste generation.

At the lower end of the GDP/capita scale, sites such as Bulan, Manatuto, and Liquiçá–with GDP/capita below US$ 2,000–report relatively lower general and plastic WGRs, consistent with expected patterns in lower-income communities. Atauro, however, presents a notable finding. Despite having one of the lowest GDP/capita among the project sites, it recorded the second highest general WGR and the highest plastic WGR. This may be attributed to the municipality's geographic condition as an island municipality with limited access to goods and services, resulting in a high dependency on packaged items, particularly bottled water, due to the absence of a reliable drinking water supply. Conversely, Calbayog, a 1st income class city,[16] shows the lowest WGR despite having a mid-range GDP/capita among the project sites, possibly influenced by its less commercialized urban landscape in which majority of the city's land area is utilized for agricultural crop production (Calbayog City Solid Waste Management Office, 2020).

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[13] All municipal-level GDP/capita estimates presented in this report are based on a published study (Rossi-Hansberg & Zhang, 2025), which used a random forest model trained on global data to estimate local GDP shares. The model considers predictors such as population, nighttime lights, land use, carbon dioxide emissions, and vegetation. Due to the lack of official municipal-level data, the 2021 GDP/capita based on constant 2017 USD of each project site was extracted from the grid cell at 0.25° resolution covering most of its parts and nearest to the survey areas. While cells may not perfectly align with the administrative boundaries, this method provides a reasonable approximation of local economic conditions.

[14] A highly urbanized city is a city with at least 200,000 residents, as certified by the Philippine Statistics Authority, and has an annual income of at least Php 50,000,000 based on 1991 constant prices, as certified by the city treasurer (Republic of the Philippines, 1991).

[15] A first income class municipality is defined as having a four-year average annual income of at least Php 55 million based on Department of Finance Department Order No. 23-08 (DOF, 2008). Under the "Automatic Income Classification of Local Government Units Act" (Republic Act 11964) in October 2023, the threshold was updated to a three-year average of over Php 200,000,000 (Republic of the Philippines, 2023). Daanbantayan remains classified as a first income class municipality after the reclassification.

[16] A first income class city is defined as having a four-year average annual income of at least Php 400 million based on Department of Finance Department Order No. 23-08 (DOF, 2008). Under the "Automatic Income Classification of Local Government Units Act" (Republic Act 11964) in October 2023, the threshold was updated to a three-year average of over Php 1,300,000,000 (Republic of the Philippines, 2023). Tandag remains classified as a first income class city after the reclassification.

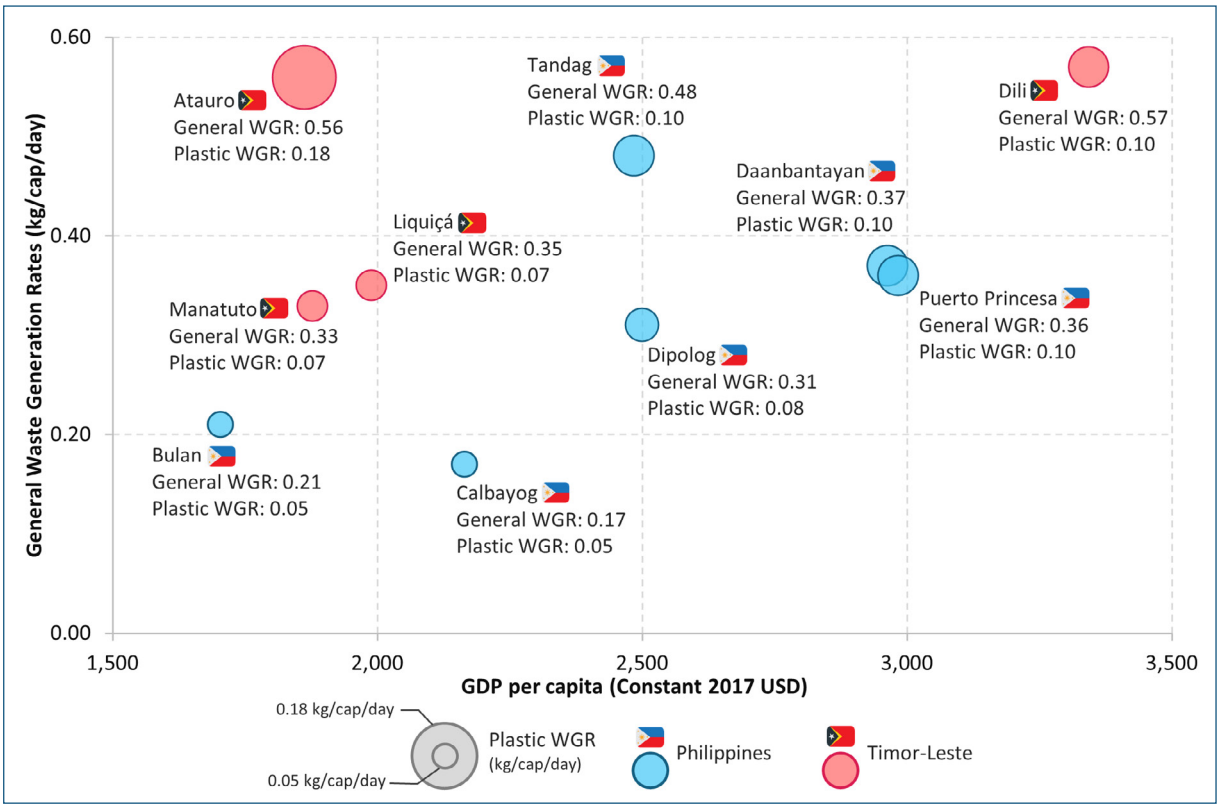


Figure 31. General and Plastic Waste Generation Rates (kg/cap/day) and Gross Domestic Product (Constant 2017 USD/capita) of Philippine and Timor-Leste Sites

Biodegradable waste, which comprises a significant portion of the total waste stream, showed varying generation rates across the project sites (**Figure 32**). Dili, Atauro, and Tandag have the highest values, ranging from 0.18 to 0.29 kg/cap/day, with 37% to 52% of their general waste stream composed of biodegradable waste. Higher rates in these sites may be attributed to their reliance on fresh produce. In contrast, Calbayog, Dipolog, and Daanbantayan recorded relatively lower biodegradable WGR from 0.04 to 0.07 kg/cap/day, with corresponding shares of about 19% to 24% of the general waste. Bulan and Manatuto, despite having relatively low biodegradable WGRs, had notably high proportions of biodegradable waste in their overall waste composition, suggesting smaller amounts of generated waste, but a significant share coming from organic sources.

Non-food biodegradable waste, which includes garden waste, agricultural waste, livestock waste, human waste, and small wood, is a major contributor to the relatively high waste generation rates observed, particularly in project sites in Timor-Leste (**Figure 32**). The municipalities of Timor-Leste recorded consistently higher non-food biodegradable WGRs (0.07 to 0.17 kg/cap/day) compared to the Philippine sites (<0.01 to 0.06 kg/cap/day), with Atauro having the highest rate. This may reflect the lower urban density of Timor-Leste surveyed coastal areas, where gardens, open spaces, and agricultural plots remain common features in their communities. While Calbayog has a significant land area for agricultural use, the surveyed coastal areas may not reflect this land use which are commonly located in non-coastal areas, resulting in the lowest non-food biodegradable waste generation among the project sites.

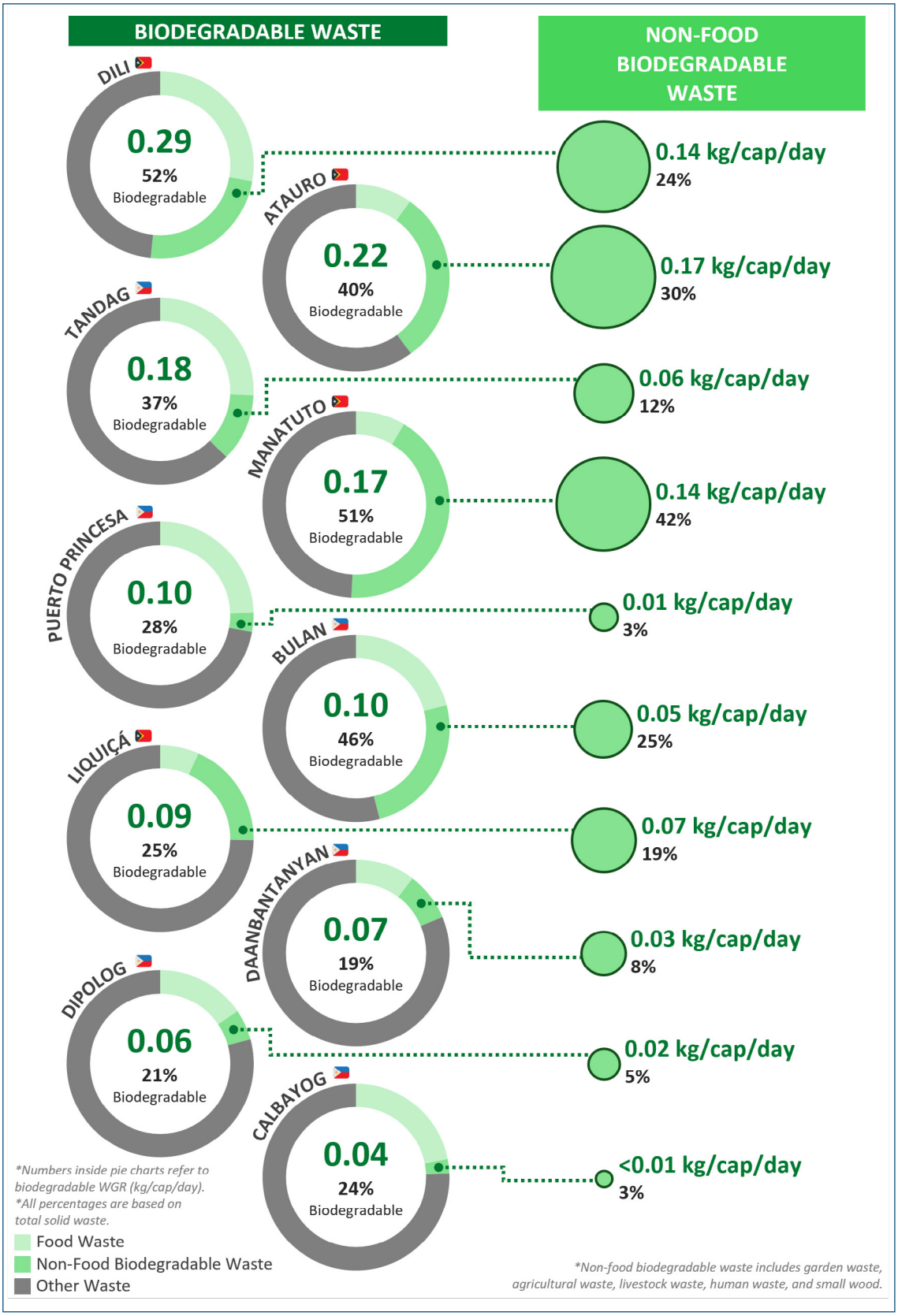


Figure 32. Biodegradable Waste and Non-Food Biodegradable Waste Generation Rates of Philippine and Timor-Leste Sites

SUP[17] waste generation rates of the project sites were observed to increase with rising GDP/capita, reflecting a shift toward greater consumption of pre-packaged and convenience goods (**Figure 33**). This trend, however, is also strongly influenced by geography, particularly in coastal and island areas. Atauro, Daanbantayan, and Puerto Princesa—all located on or associated with smaller islands from the mainland—record some of the highest SUP WGRs, ranging from 0.08 to 0.14 kg/cap/day. These areas also have the highest SUP waste composition, accounting for 23% to 26% of the total waste stream in their respective coastal areas surveyed. Limited access to bulk goods often leads to greater reliance on items packaged in smaller retail such as bottled water, sachets, and other disposable plastics. The presence of tourism in these locations may also contribute to higher demand for ready-to-use and single-use products. In such contexts, SUPs become the most practical and accessible option for households, small businesses, and tourists.

Dili and Tandag also reported relatively high SUP WGRs, despite not being part of smaller islands than the mainland. Dili's urban economy and Tandag's role as a provincial capital may contribute to the increased access and use of plastic packaged goods. The rising trend in SUP waste generation reflects how both economic status and geographical conditions of the cities and municipalities influence consumption patterns, particularly in areas where limited infrastructure and supply restrict access to more sustainable alternatives.

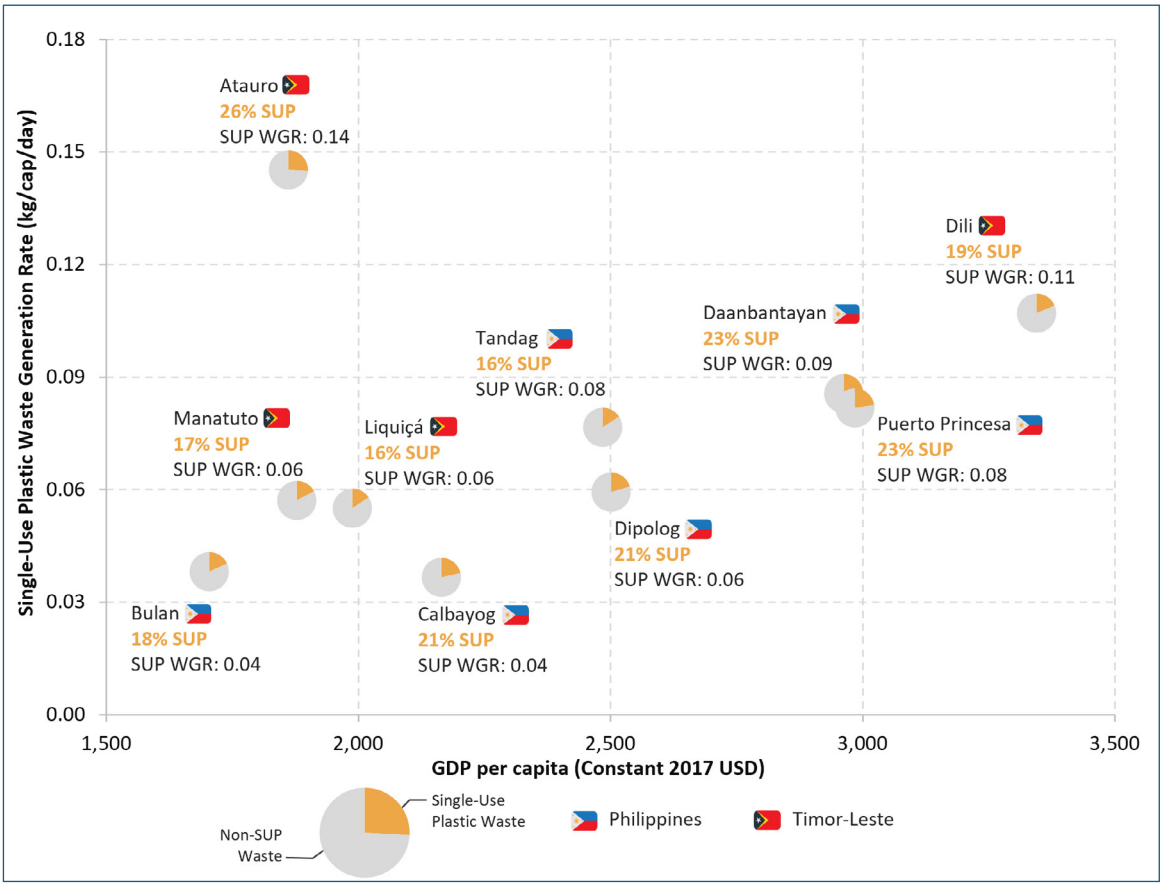


Figure 33. Single-Use Plastic Waste Generation Rate (kg/cap/day), SUP Composition, and GDP (Constant 2017 USD/capita) of Philippine and Timor-Leste Sites

[17] Single-use plastics considered in the analysis include PET bottles, food packaging and containers, cutlery, drinking straws, sachets, personal care containers, plastic bags, bubble wrap, cigarette butts, diapers, napkins, and other residual plastics

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

The KAP survey results offered valuable insights into community practices and perceptions regarding environmental changes. All project sites purchase plastic products either daily or more than once a week. Common plastic items include those packaged in flexible plastics, such as laminated sachets and single-layer films. In Timor-Leste sites, buying drinking water in PET bottles is a frequent practice.

Most of the households surveyed in the Philippine sites practice waste segregation following the "no segregation, no collection" policy in their communities. However, full compliance is not achieved due to waste collectors mixing waste and a lack of segregated bins. In contrast, in Timor-Leste sites, non-compliance with segregation is largely due to the absence of a local policy. A major challenge in the Philippines is infrequent waste collection, as observed by the majority of surveyed households. While most respondents in Timor-Leste report daily collection, observations and interviews with local teams suggest it occurs less frequently. Improper disposal methods, such as burning, burying, and open dumping, are common in Timor-Leste sites.

While majority of the respondents in the Philippine sites are aware of existing local policies, there are still some who are unfamiliar with these regulations. Additionally, in Timor-Leste sites, the absence of a local policy will likely result in the continuation of unsustainable waste management practices.

1. Demographic Profile

Majority of the respondents from the study areas are female, except in Puerto Princesa City where male respondents exceeded female participants by 10% (**Table 16**). Most of the surveyed households in all local sites lived within the study areas between 26 years to 50 years except in Manatuto, where most of the households have resided in the priority areas for 10 years to 25 years. A substantial duration of residence in a location reflects a strong familiarity with the environment and a deeper understanding of policy changes.

Table 16. Gender Composition of Respondents in Philippine and Timor-Leste Sites

Country	City / Municipality	Male Respondents	Female Respondents
Philippines	Bulan	19%	81%
	Calbayog	15%	85%
	Daanbantayan	24%	76%
	Dipolog	36%	64%
	Puerto Princesa	55%	45%
	Tandag	9%	91%
Timor-Leste	Atauro	17%	83%
	Dili	41%	59%
	Liquiçá	46%	54%
	Manatuto	42%	58%

The size of households is important to gain insights into the amount and type of waste generated. The majority of the interviewed participants in the cities of Dipolog and Puerto Princesa have an average size of less than 5 members. In the other study areas, the majority have 5 members to 10 members.

Household monthly income in the Philippines sites vary, with most of the households claiming that they receive Php 1,000 to 25,000 every month. In Timor-Leste sites, majority of the households receive less than US$ 1,000. This income distribution among the study areas highly influences the waste consumption of the households and the type of waste generated. Employment and fishing are the primary sources of income for the respondents in the Philippine sites. In Timor-Leste sites, most participants are engaged in fishing, employment, and livestock.

Regarding the frequency of purchasing plastic products, the majority of the households buy plastic items once a week, more than once a week, or on a daily basis (**Figure 34**). Buying food, beverage, and seasoning in flexible plastic packaging such as laminated sachet and single-film wrappers is observed in both countries. In Timor-Leste sites, purchasing of drinking water in PET bottles is highly observed.

2. Waste Management

Besides respondents from Puerto Princesa, majority of the households practice waste segregation in the Philippine sites. In contrast, most of the participants do not engage in segregation practices in Timor-Leste sites (**Table 17**).

A "no segregation, no collection" policy is implemented in all local sites in the Philippines, primarily driving the households to practice segregation at the source. In contrast, the lack of segregation policy in Timor-Leste reflects in the continuous disposal of mixed wastes. Common reasons for not engaging in the practice include no separate collection for each waste type and limited segregation bins, highlighting issues with the waste management infrastructure in both countries.

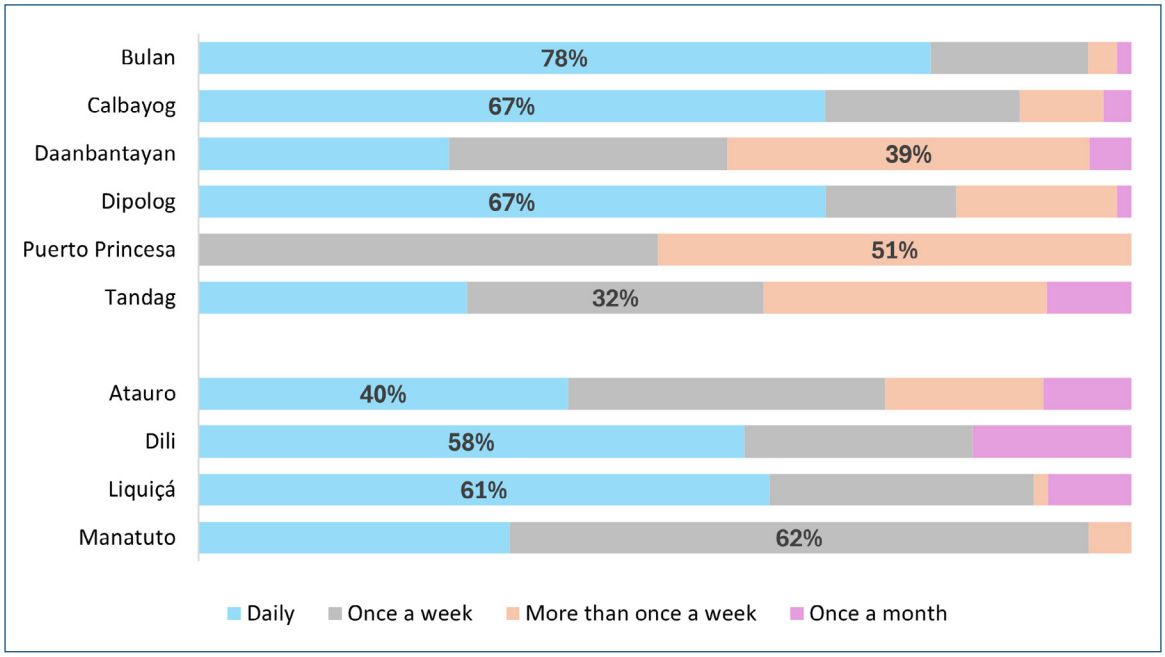


Figure 34. Frequency of Purchasing Plastic Products in Philippine and Timor-Leste Sites

Table 17. Waste Segregation Practices in the Philippine Sites and Timor-Leste Sites

Country	City / Municipality	Practicing segregation	Trying to adopt the practice	Not practicing segregation
Philippines	Bulan	65%	26%	9%
	Calbayog	73%	11%	16%
	Daanbantayan	70%	18%	12%
	Dipolog	79%	6%	15%
	Puerto Princesa	0%	33%	67%
	Tandag	94%	0%	6%
Timor-Leste	Atauro	17%	4%	79%
	Dili	30%	24%	46%
	Liquiçá	6%	3%	91%
	Manatuto	27%	17%	56%

Majority of the respondents in the Philippine sites claim to receive waste collection services more than once a week, while surveyed households in Timor-Leste sites indicate that waste is collected daily in their areas (**Figure 35**). In all local sites, inadequate collection service coverage remains a significant issue, leading to improper waste disposal.

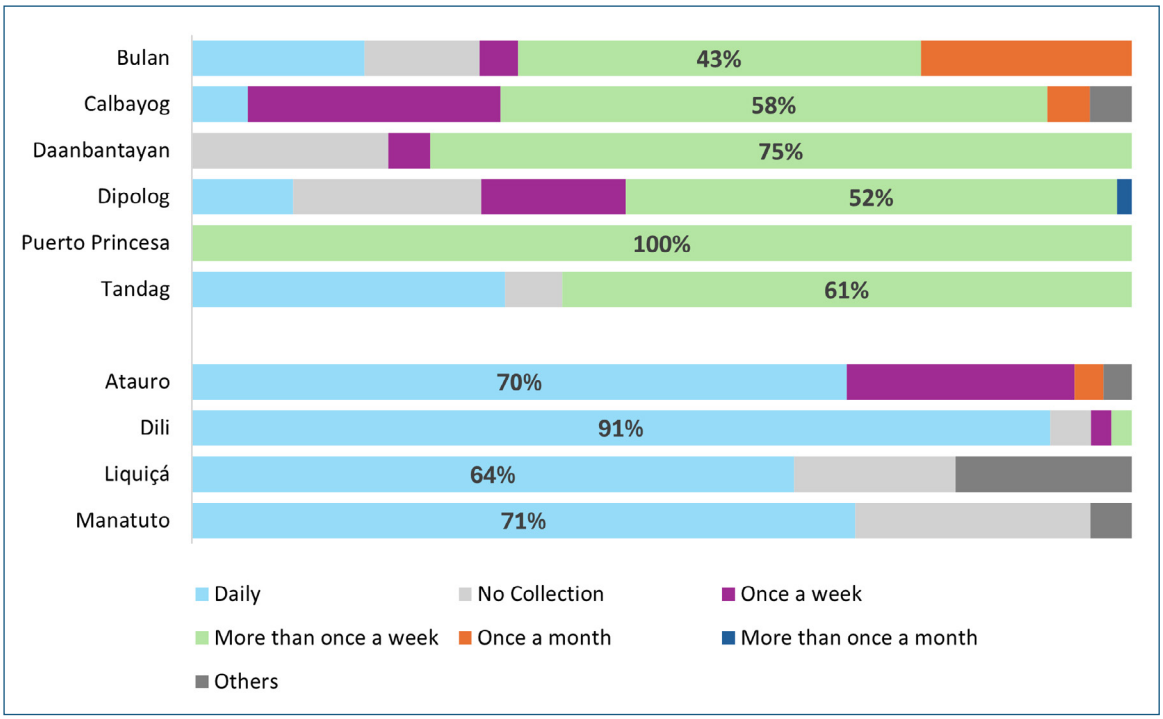
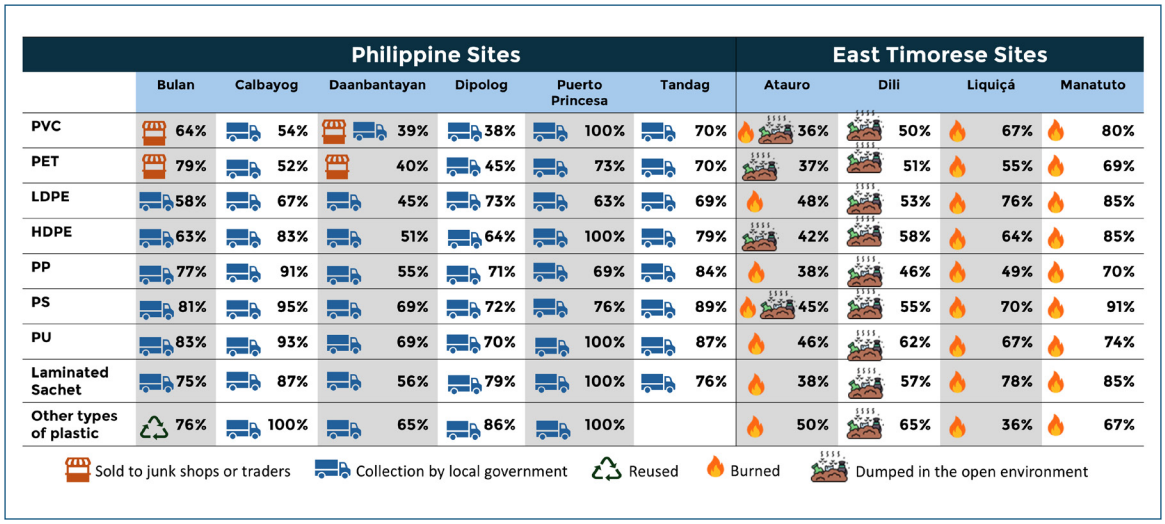


Figure 35. Frequency of Waste Collection in the Philippine Sites and Timor-Leste Sites

The predominant forms of waste disposal vary between the Philippine sites and Timor-Leste sites (**Figure 36** and **Figure 37**). In the Philippine sites, collection by the local government is the predominant form of disposal for most types of both plastic and general waste. Collected waste is then delivered to designated disposal facilities, such as SLFs or RCAs. Certain recyclable materials, including PET, PVC, glass bottles, and cans, are commonly sold to junk shops or traders. Respondents from Bulan, Dipolog, Puerto Princesa report on practicing open dumping of waste and burning.

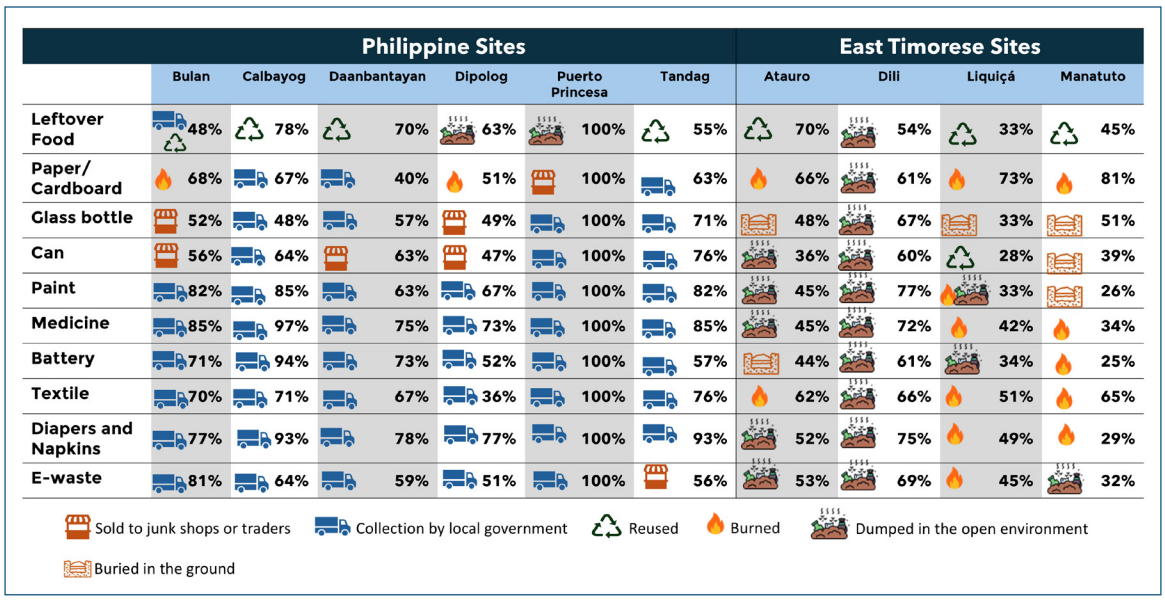
Burning, open dumping, and burying in the ground are the common forms of disposal in Timor-Leste sites. Although the majority of the households report on having daily waste collection, site observations and interviews with local surveyor team suggests lower frequency, leading to increased reliance on improper disposal practices.



	Philippine Sites						East Timorese Sites			
	Bulan	Calbayog	Daanbantayan	Dipolog	Puerto Princesa	Tandag	Atauro	Dili	Liquiçá	Manatuto
PVC	64%	54%	39%	38%	100%	70%	36%	50%	67%	80%
PET	79%	52%	40%	45%	73%	70%	37%	51%	55%	69%
LDPE	58%	67%	45%	73%	63%	69%	48%	53%	76%	85%
HDPE	63%	83%	51%	64%	100%	79%	42%	58%	64%	85%
PP	77%	91%	55%	71%	69%	84%	38%	46%	49%	70%
PS	81%	95%	69%	72%	76%	89%	45%	55%	70%	91%
PU	83%	93%	69%	70%	100%	87%	46%	62%	67%	74%
Laminated Sachet	75%	87%	56%	79%	100%	76%	38%	57%	78%	85%
Other types of plastic	76%	100%	65%	86%	100%		50%	65%	36%	67%

Sold to junk shops or traders; Collection by local government; Reused; Burned; Dumped in the open environment

Figure 36. Plastic Waste Disposal in the Philippine Sites and Timor-Leste Sites



	Philippine Sites						East Timorese Sites			
	Bulan	Calbayog	Daanbantayan	Dipolog	Puerto Princesa	Tandag	Atauro	Dili	Liquiçá	Manatuto
Leftover Food	48%	78%	70%	63%	100%	55%	70%	54%	33%	45%
Paper/ Cardboard	68%	67%	40%	51%	100%	63%	66%	61%	73%	81%
Glass bottle	52%	48%	57%	49%	100%	71%	48%	67%	33%	51%
Can	56%	64%	63%	47%	100%	76%	36%	60%	28%	39%
Paint	82%	85%	63%	67%	100%	82%	45%	77%	33%	26%
Medicine	85%	97%	75%	73%	100%	85%	45%	72%	42%	34%
Battery	71%	94%	73%	52%	100%	57%	44%	61%	34%	25%
Textile	70%	71%	67%	36%	100%	76%	62%	66%	51%	65%
Diapers and Napkins	77%	93%	78%	77%	100%	93%	52%	75%	49%	29%
E-waste	81%	64%	59%	51%	100%	56%	53%	69%	45%	32%

Sold to junk shops or traders; Collection by local government; Reused; Burned; Dumped in the open environment; Buried in the ground

Figure 37. General Waste Disposal in the Philippine Sites and Timor-Leste Sites

3. Environmental Status, Awareness, and Care

The KAP survey reveals that most respondents in the Philippine sites perceive little to no changes in their environment over time. In contrast, responses from Timor-Leste sites collectively indicate varying degrees of environmental change, ranging from slight to significant (**Figure 38**).

Majority of the surveyed households in the Philippine sites and Timor-Leste sites are aware of the income opportunities from solid waste, except for participants in Liquiçá, where most of the respondents lack knowledge on these opportunities (**Figure 39**). In Timor-Leste, there is the clear preference on recovering general metal and aluminum cans, while in the Philippines, recovered materials include PET bottles and hard plastics.

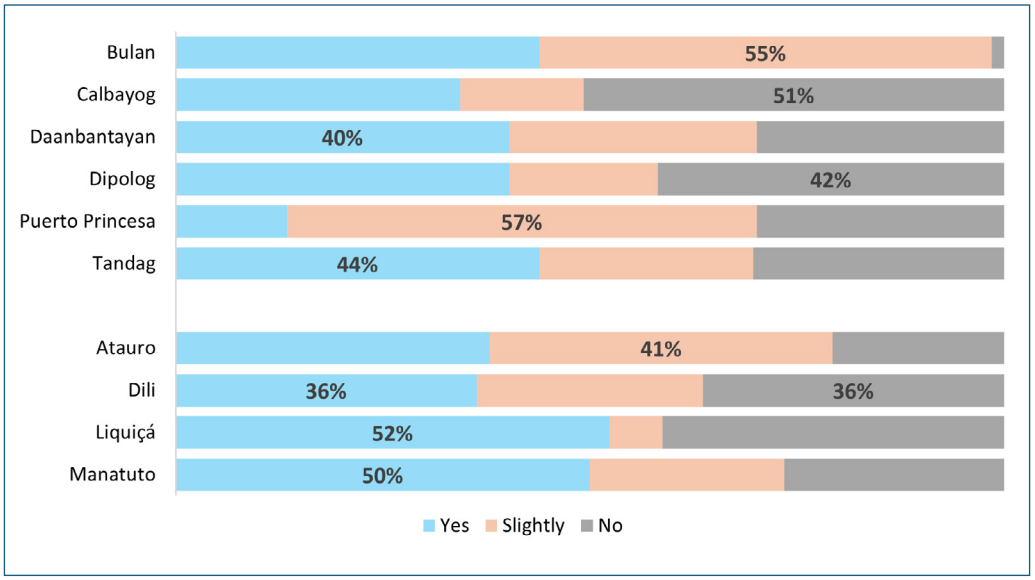


Figure 38. Perception on Environmental Pollution Increase Over Time

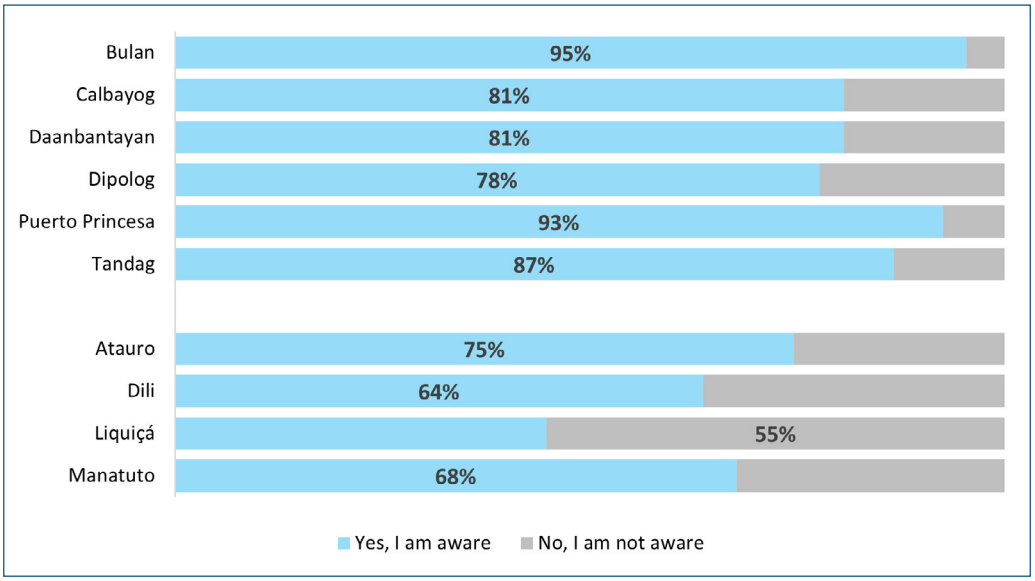


Figure 39. Awareness of Income Opportunities from Solid Waste

In the Philippine sites, majority of the households are aware of their respective local ordinances except for participants in Puerto Princesa. In Timor-Leste sites, most of the surveyed households are unfamiliar of their local policies, primarily because such policies do not exist (**Figure 40**).

Collective answers in all sites in both countries lean towards observing the presence of waste in waterbodies except in Liquiçá, where majority of the households report to not seeing waste in surrounding waterbodies (**Figure 41**). Observed waste includes flexible plastic packaging such as laminated sachet and single-film wrappers. PET bottles are also predominantly observed particularly in Timor-Leste sites.

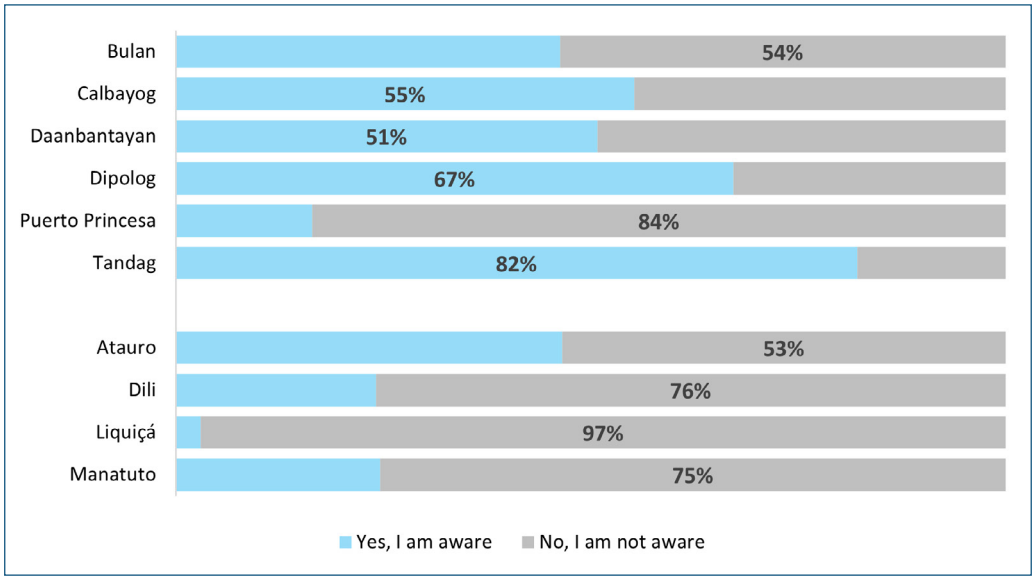


Figure 40. Awareness of Plastic-Related Ordinances

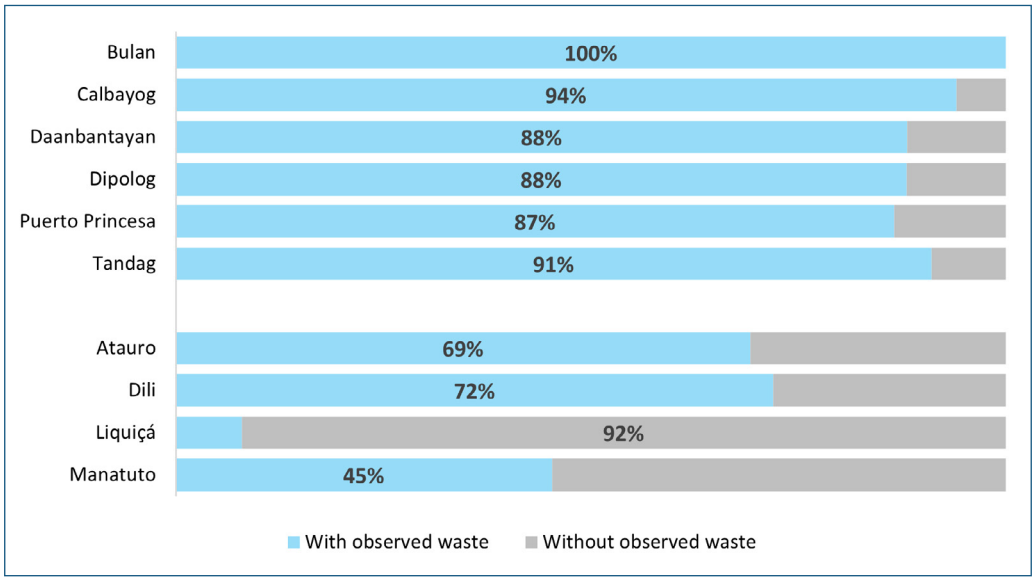


Figure 41. Observance of Waste in Waterbodies

In relation to the observed waste in waterbodies, the majority of the respondents in the study areas affirmed the conduct of coastal cleanup activities (**Figure 42**).

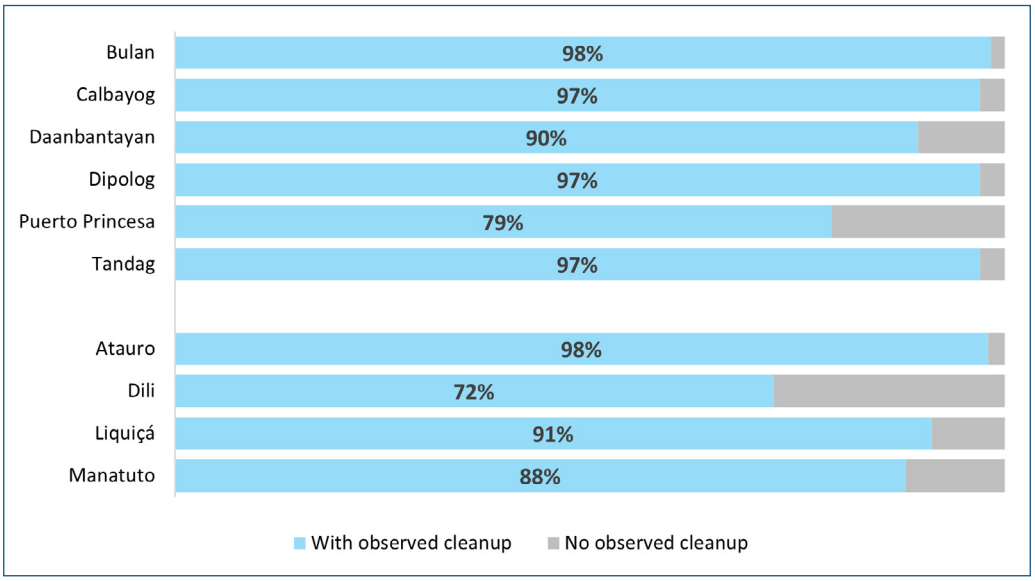


Figure 42. Observance of Cleanup Activities

Waste disposal of all collected waste from PACS in Liquica.

Waste analysis during the PACS in Tandag City, Surigao del Sur.

Plastic Waste Value Chain Analysis 7

The plastic waste value chain across the project sites in the Philippines and Timor-Leste highlights persistent challenges in managing plastic waste from generation to final disposal (**Figure 43**). Daily household plastic waste generation rate ranges from 0.05 to 0.16 kg/cap/day. Plastic waste accounted for 13% to 32% of the household waste stream; however, only 10% to 20% of household waste in Philippine sites, and 12% to 18% in Timor-Leste sites, are plastics that can be recovered or diverted. When household and non-household sources are combined, plastic WGR ranges from 0.05 to 0.18 kg/cap/day, with surveyed coastal areas generating a total of 654 kg/day to 8,903 kg/day.

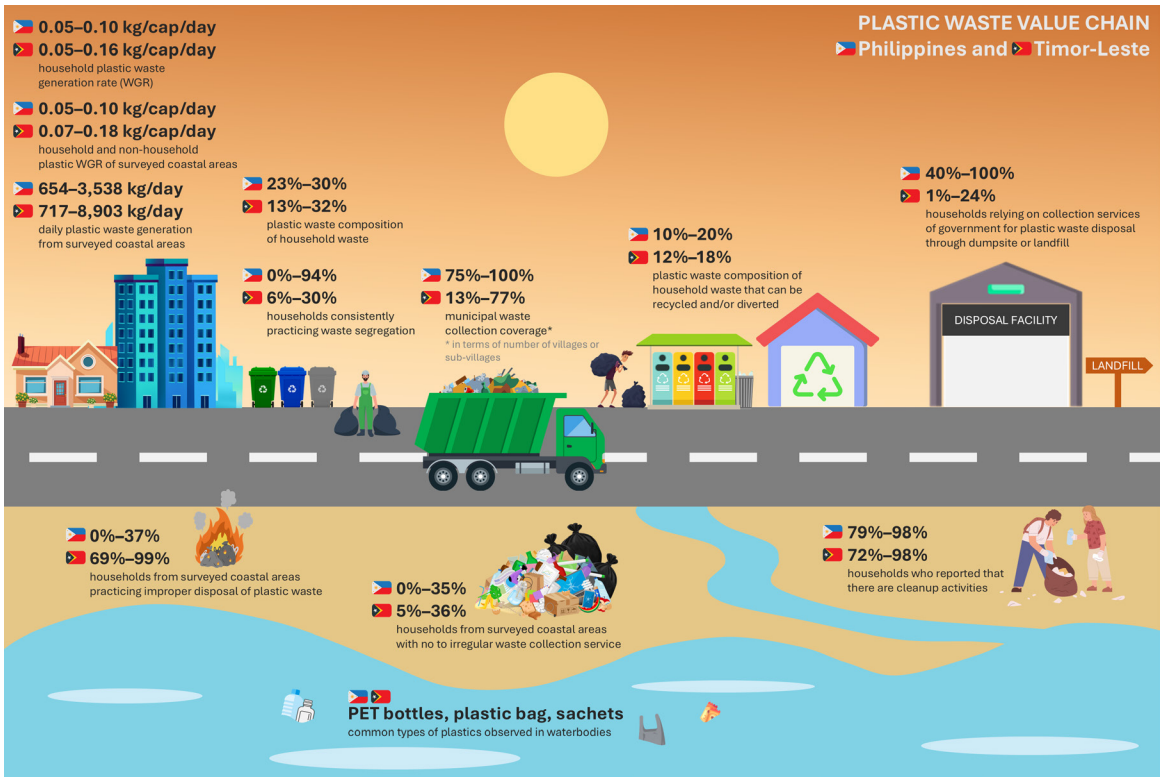


Figure 43. Plastic Waste Value Chain for Philippine and Timor-Leste Sites

Waste segregation remains highly inconsistent. In the Philippines, consistent household compliance with waste segregation ranged from 0% to 94%, often limited by the mixing of waste during collection, lack of bins for segregation, absence of regular separate collection for specific waste types, inefficient use of time, and limited public understanding of its purpose. Project sites in Timor-Leste, meanwhile, recorded relatively lower rates between 6% and 30%, primarily due to lack of national policy mandating waste segregation at source. Collection coverage also varies. The Philippine sites reported 75% to 100% barangay-level coverage, while Timor-Leste sites have lower collection coverage, ranging from 13% to 77% of the sucos. Access to regular collection services is also a challenge, with up to 35% of surveyed households in the Philippines and 36% in Timor-Leste experiencing no or irregular waste collection. These gaps in segregation and collection systems contribute to inefficiency in waste recovery and disposal, particularly in Timor-Leste where 69% to 99% of surveyed households were practicing improper disposal of plastic waste, compared to 0% to 37% in Philippine sites.

Recovery and disposal also present key bottlenecks in both countries. In Philippines sites, 40% to 100% of households rely on local government services for waste collection, but most of the collected waste—such as in Puerto Princesa—is directly disposed of in a residual containment area or a sanitary landfill with minimal plastic recovery, especially if waste is mixed and is not segregated at source. In Timor-Leste, only 1% to 24% of households rely on government collection services due to limited infrastructure and the absence of proper recovery and final disposal facilities, especially in Atauro and Manatuto. Even when collection occurs, waste is often burned or dumped in an open dumpsite. Similarly, while cleanup activities are observed across both countries, sustained waste diversion remains limited.

Plastic leakage remains a visible consequence of gaps across the plastic waste value chain (**Figure 44**). Results from the quarterly beach monitoring in 2024 show that collected plastic litter in Philippine sites ranged from 7,706 to 45,233 grams (**Figure 45**), while in Timor-Leste, collected plastics ranged from 8,663 to 109,130 grams (**Figure 46**). The wide variation reflects the differing conditions and characteristics of the monitoring sites, where some are located in remote coastal areas with lower population, while others may be known plastic accumulation hotspots influenced by ocean currents, human activities, and poor waste management coverage. These findings provide direct evidence of the extent of plastic leakage in the region and reinforce the need to address upstream and downstream issues across the waste value chain.

Figure 44. Observed Plastic Waste Along the Coastline of Atauro, Timor-Leste (November 27, 2024)

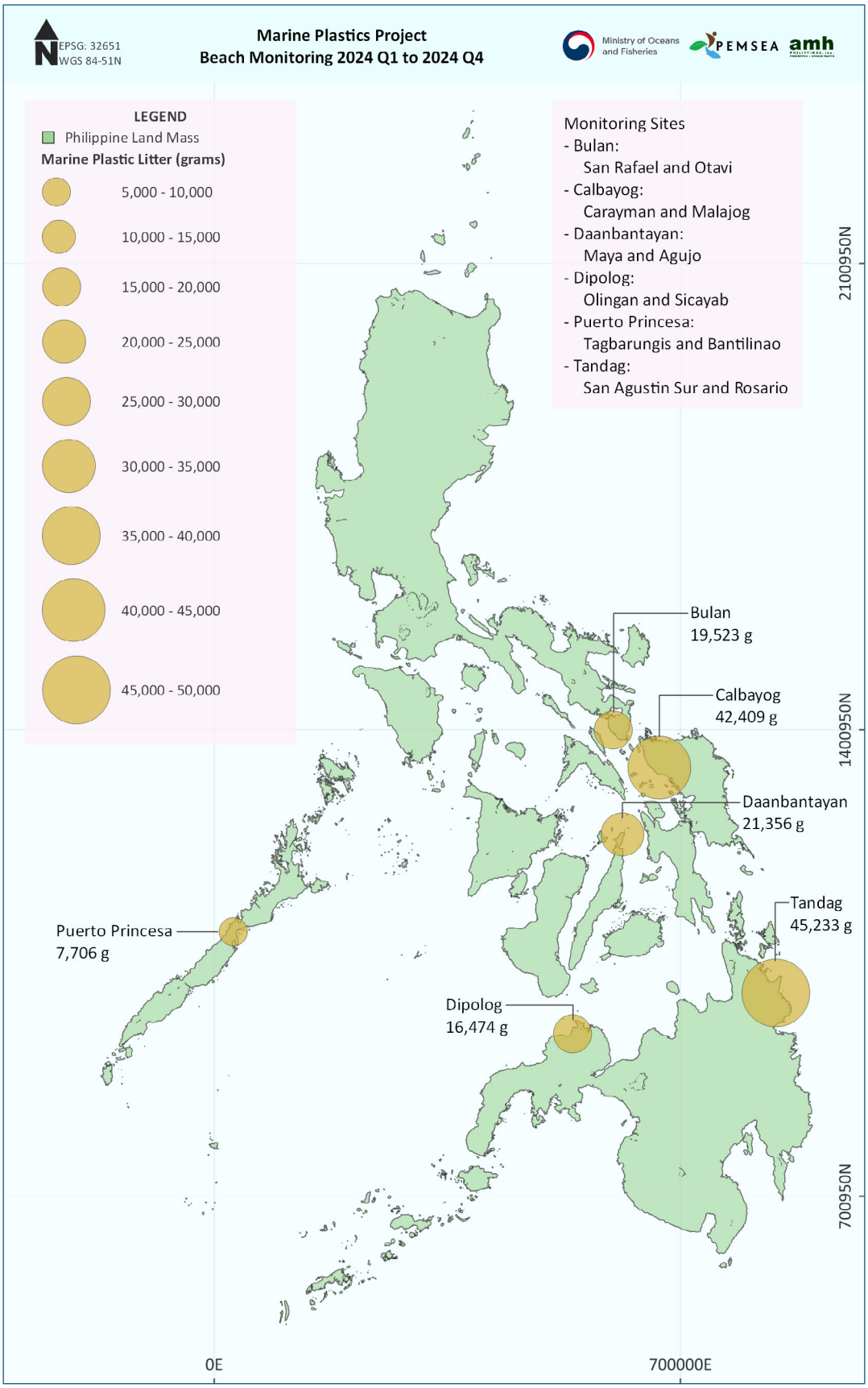


Figure 45. Marine Plastic Litter Recorded during Beach Monitoring from Q1 to Q4 of 2024 in Philippine Sites (PEMSEA, 2025)

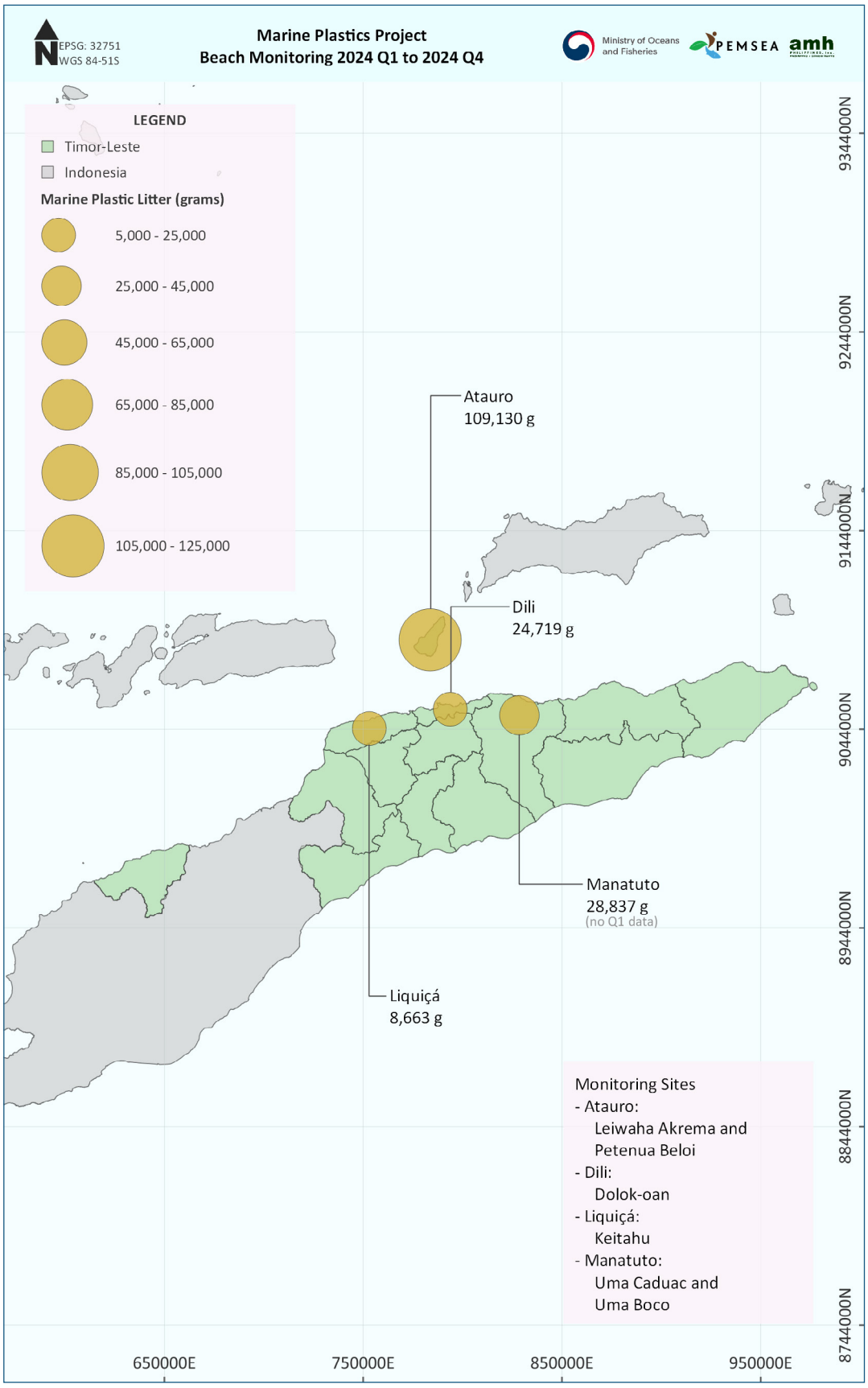


Figure 46. Marine Plastic Litter Recorded during Beach Monitoring from Q1 to Q4 of 2024 in Timor-Leste Sites (PEMSEA, 2025)

Overall, the value chain analysis illustrates how each functional stage contributes cumulatively to plastic leakage in coastal environments (**Table 18**). The results point to the need to encourage plastic waste reduction, improve waste segregation at source, expand and regularize collection services, strengthen recovery systems, ensure proper disposal, and reinforce local policy implementation.

Table 18. Key Challenges Identified in Philippine and Timor-Leste Sites

Component	Applicable Site	Key Challenges
Generation	Philippines and Timor-Leste sites	• High reliance on plastics, including disposable and pre-packaged products due to affordability, convenience, limited alternatives, and geographic isolation • Limited implementation or enforcement of policies discouraging plastic use and promoting reduction at source • Weak public awareness in adopting waste reduction practices
Segregation	Philippines and Timor-Leste sites	• Poor infrastructure such as limited number of segregating bins or lack of space for the installation of waste bins
	Philippines sites	• Lax implementation of segregation policy leads to low compliance with the practice, thus, continuous collection and disposal of mixed waste
	Timor-Leste sites	• Absence of local policy on segregation results in continuous disposal of mixed waste
Collection	Philippines and Timor-Leste sites	• Low collection coverage due to limited number of collection trucks and inaccessible roads • Infrequent collection schedule, which results in improper waste disposal • No separate collection leading to continuous disposal of mixed waste
Recovery	Philippines and Timor-Leste sites	• Preference of informal waste collectors and small recovery facilities on materials considered high value like metal further limits plastic recovery
	Philippines sites	• Recovery facilities designed for storing and processing recyclables are used as temporary storage areas without significant recycling activities
	Timor-Leste sites	• Lack of recycling facilities accepting and processing recyclable plastics and residual plastics

Table 18. Key Challenges Identified in Philippine and Timor-Leste Sites (cont.)

Component	Applicable Site	Key Challenges
Disposal	Philippines and Timor-Leste sites	• Due to inefficiencies in the waste management system, communities often resort to improper waste disposal such as burning, burying in the ground, and open dumping
	Philippines sites	• Overcapacity of sanitary landfill due to continuous dumping of unsegregated waste • Some local government units utilize residual containment areas as disposal facilities, which may lack the essential protective measures like that of sanitary landfills, increasing risk of waste leakage
	Timor-Leste sites	• Dependence on uncontrolled facilities as disposal sites

Key Recommendations 8

Based on the findings from the regional synthesis of the local baseline assessment on marine plastics, a summary of key challenges and corresponding strategic recommendations is presented (**Figure 47**). To effectively address plastic pollution, it is essential to examine and strengthen each stage of the solid waste management system—waste generation, segregation, collection, recovery, and disposal. These recommendations are framed around three key areas: policy and regulation, infrastructure and services, and public awareness and engagement. Together, these areas provide a coordinated and practical approach. Policy and regulation guide planning and implementation of local policies. Infrastructure and services ensure the availability of essential systems to enable proper waste management including basic access to adequate waste bins, regular and efficient collection services, and accessible recovery and disposal facilities. Public awareness and engagement promote long-term behavior change, community participation, and better waste management practices. This integrated framework aims to respond to priority issues identified in the assessment and to improve plastic waste management system across both Philippine and Timor-Leste sites.

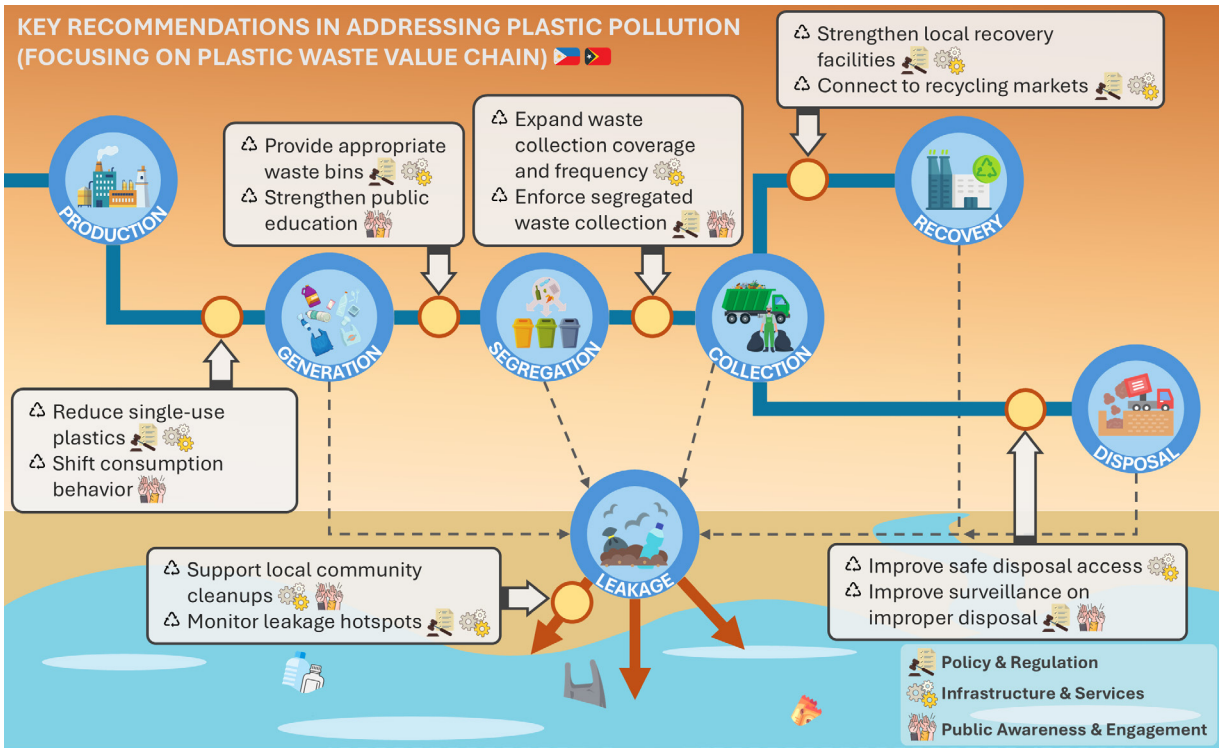


Figure 47. Key Recommendations in Addressing Plastic Pollution at the Philippine and Timor-Leste Sites

Plastic waste generation remains a concern across several sites, driven by the widespread use of SUPs and limited access to alternatives. To reduce plastic waste at source, recommendations focus on strengthening local policies and ordinances to regulate or discourage SUPs, alongside promoting reuse and refill systems. These must be supported by socio-behavioral change communication (SBCC) campaigns that build awareness and shift daily consumption habits. These actions are particularly relevant in Dili and Dipolog, which recorded the highest daily plastic waste generation among the surveyed coastal areas, and in Atauro, which has the highest per capita plastic waste generation across all sites.

Waste segregation is generally weak across both countries. In Timor-Leste, there is currently no national or local policy requiring waste segregation at source. In the Philippines, while segregation is mandated, its enforcement remains inconsistent at the local level. To address this, recommendations include strengthening implementation mechanisms, providing standardized and adequate bins, and investing in community-based education campaigns. These interventions are most needed in Timor-Leste sites, as well as in Bulan, Daanbantayan, and Puerto Princesa, where limited awareness, lack of materials enabling segregation, and weak or absent enforcement continue to hinder proper waste segregation at the source.

Waste collection systems remain underdeveloped in several sites, affecting coverage, frequency, and efficiency. Recommendations focus on expanding service coverage, procuring additional or smaller vehicles for remote or narrow areas, and improving route planning through time-motion studies. Several sites require these interventions, including all Timor-Leste sites and in Calbayog, Dipolog, and Puerto Princesa, where unserved areas are still prevalent, and waste often ends up improperly disposed.

Recovery systems are generally inefficient due to lack of accessible facilities, limited equipment, and lack of market connections. In the Philippines, local materials recovery facilities typically operate as storage areas rather than processing facilities. To improve recovery, local government units should invest in equipment, integrate livelihood opportunities in recycling, and develop partnerships with industries and recycling markets. Aside from Timor-Leste sites which has significantly limited facilities for processing plastic waste, these strategies are crucial for Bulan, Calbayog, Daanbantayan as well, where recovery performance can further be improved.

Disposal challenges are pronounced in areas lacking engineered landfill facilities, resulting in continued improper disposal practices such as burying, dumping, and burning. In some cases, such as in Puerto Princesa, existing disposal sites have reached or are nearing capacity, which adds pressure to the overall waste management system and may reduce the efficiency of waste collection operations. Recommendations include improving access to safe disposal facilities, developing containment measures, and expediting planned sanitary landfill projects. These actions are especially needed in Bulan, Daanbantayan, Puerto Princesa, Atauro, and Manatuto, where current disposal conditions may present environmental risks.

Across all sites, plastic leakage into the environment remains a persistent concern. Recommendations emphasize supporting cleanup efforts and establishing monitoring systems to identify and address leakage hotspots. While supporting local cleanup efforts helps manage visible pollution, these are short-term solutions and must be paired with improvements across the entire solid waste management system to address the root causes of leakage. Recommendations also include establishing monitoring systems to identify and manage leakage hotspots more effectively.

9 Conclusion

The regional baseline assessment on marine plastics provides a comprehensive understanding of plastic waste generation, waste management practices, and plastics leakage pathways across the selected coastal areas in the Philippines and Timor-Leste. As part of the project's component on strengthening local governance for marine plastics management, this synthesis brings together critical baseline data, value chain analysis, and community insights to inform targeted and locally relevant solutions, recognizing both the shared challenges and distinct contexts across the sites. The findings highlight persistent challenges throughout the solid waste management system but also point to practical opportunities for intervention at each stage. Addressing marine plastic pollution requires coordination action—from national government agencies to local governments and communities—anchored in sound policies, effective infrastructure, and sustained public engagement. The findings reinforce the importance of localized, data-driven strategies as a foundation for broader cooperation in tackling plastic pollution in the region.

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