Ministry of Oceans and Fisheries

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MOF/PEMSEA ODA Project

Reducing Marine Plastics in the East Asian Seas Region

Baseline Assessment Report on Marine Plastics in the Six ODA Project Sites in the PHILIPPINES

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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.

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

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List of Abbreviations and Acronyms

AMH	-	AMH Philippines, Inc.
BARMM	-	Bangsamoro Autonomous Region in Muslim Mindanao
BSWMC	-	Barangay Solid Waste Management Committee
CBO	-	Community-Based Organization
CENRO	-	City Environment and Natural Resources Office
CMCI	-	Cities and Municipalities Competitive Index
CMRF	-	Central Materials Recovery Facility
DAO	-	Department Administrative Order
DENR	-	Department of Environment and Natural Resources
DOST	-	Department of Science and Technology
EEZ	-	Exclusive Economic Zone
EMB	-	Environmental Management Bureau
ENRMP	-	Environmental Natural Resources Management Project
ENRO	-	Environment and Natural Resources Office
EPR	-	Extended Producer Responsibility
EPS	-	Expanded Polystyrene
ESWMC	-	Ecological Solid Waste Management Committee
FIES	-	Family Income and Expenditure Survey
GDP	-	Gross Domestic Product
GNI	-	Gross National Income
HDPE	-	High-Density Polyethylene
HUC	-	Highly Urbanized City
IRR	-	Implementing Rules and Regulations
KAP	-	Knowledge, Attitude, and Practice
kg	-	Kilogram
km	-	Kilometer
km^2	-	Square Kilometer
LDPE	-	Low-Density Polyethylene
LGU	-	Local Government Unit
m	-	Meter
m^2	-	Square Meter
m^3	-	Cubic Meter
MARITES	-	Motherly Association for River Initiatives Towards Environmental Sustainability
MENRO	-	Municipal Environment and Natural Resources Office
MSWMB	-	Municipal Ecological Solid Waste Management Board
MO	-	Municipal Ordinance

MOF	-	Ministry of Fisheries
MPA	-	Marine Protected Area
MRF	-	Materials Recovery Facility
MT	-	Tonne/Metric Ton
NEDA	-	National Economic and Development Authority
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
PDP	-	Philippine Development Plan
PEMSEA	-	Partnerships in Environmental Management for the Seas of East Asia
PET	-	Polyethylene Terephthalate
PhP	-	Philippine Peso
PP	-	Polypropylene
PPA	-	Philippine Ports Authority
PPE	-	Personal Protective Equipment
PS	-	Polystyrene
PSA	-	Philippine Statistics Authority
PU	-	Polyurethane
PVC	-	Polyvinyl Chloride
RA	-	Republic Act
RCA	-	Residual Containment Area
RDF	-	Refuse-Derived Fuel
SBCC	-	Socio-Behavioral Change Communication
SUP	-	Single-Use Plastic
SWM	-	Solid Waste Management
SWMP	-	Solid Waste Management Plan
UNCLOS	-	United Nations Convention on the Law of the Sea
UNDP	-	United Nations Development Programme
UNEP	-	United Nations Environment Programme
WACS	-	Waste Analysis and Characterization Study
WaCT	-	Waste Wise Cities Tool
WGR	-	Waste Generation Rate

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

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

AMH Philippines, Inc.

- Dr. Maria Antonia Tanchuling
- Mr. Ezra Osorio
- Mr. Aerol Cedrick Treyes
- Ms. Kayla Macadangdang
- Ms. Darlene Joy Desacada
- Ms. Stefani Bernice Baysa
- Ms. Ma. Brida Lea Diola

Local Consultants

- Mr. Aran Escote, Bulan
- Ms. Shian Moralles, Calbayog City
- Ms. Daff Binobo, Daanbantayan
- Ms. Editha Bernad, Dipolog City
- Mr. Alonzo Peralta, Puerto Princesa City
- Mr. Radigundo Rivas, Tandag City

Local government units (LGUs):

- Municipal Government of Bulan
  - Ms. Kelly Chua Tan
  - Mr. Mikhail Paolo Rosil
- City Government of Calbayog
  - Ms. Jannett Cabujat
  - Mr. Michael Roa
- Municipal Government of Daanbantayan
  - Mr. Mamerto Rodrigo
  - Ms. Jonette Mendel Conejos
- City Government of Dipolog
  - Atty. Gratian Paul Tidor
  - Ms. Chonita Velasco
- City Government of Puerto Princesa
  - Atty. Carlo Gomez
  - Mr. Cardelar Stevie Madriñan
- City Government of Tandag
  - Mr. Edwin Ajos
  - Ms. Kizeljene Alimpago

Executive Summary

Plastic pollution in oceans and rivers poses a significant threat to marine life and human health. This issue is especially severe in the Philippines, which is a major source of plastic waste entering the ocean, emitting approximately 356,371 metric tons each year (Meijer, Emmerik, Van Der Ent, Schmidt, & Lebreton, 2021). The country consumes about 2.15 million metric tons of plastics annually, but only 9% is recycled, while 35% is discarded improperly, ending up in the open environment (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020).

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 towns and cities—six in the Philippines and four in Timor-Leste. The project aims to protect and improve the health and well-being of people and marine ecosystems by tackling the root causes of plastic pollution through coordinated actions and innovative solutions among key stakeholders, including governments, industry, civil society, and individuals.

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

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

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

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

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

The baseline assessment includes both the PACS and a Knowledge, Attitude, and Practice (KAP) Survey, specifically targeting key coastal areas in six Philippine sites: the municipalities of Bulan and Daanbantayan, and the cities of Calbayog, Dipolog, Puerto Princesa, and Tandag. These assessments aim to uncover the specific dynamics of plastic waste generation and local community behaviors toward waste management, supporting the development of data-driven interventions to address marine plastic pollution effectively.

The analysis and characterization of waste from the surveyed coastal barangays of each site found that household and non-household sources generate about 2,701 kg/day to 14,030 kg/day, of which 654 kg/day to 3,538 kg/day are plastic waste. These results in general waste generation rates (WGRs) ranging from 0.17 kg/cap/day to 0.48 kg/cap/day, and plastic WGRs of 0.04 kg/cap/day to 0.10 kg/cap/day. Households contribute a significant portion of the generated waste in the surveyed coastal barangays, accounting for about 82% to 95% of the total waste, with a national household general WGR of 0.30 kg/cap/day and national household plastic WGR of 0.08 kg/cap/day. When projected to all the coastal barangays of the respective cities and municipalities, the household plastic waste generation scales up to 2,282 kg/day to 29,590 kg/day. Common household plastic waste includes diapers and napkins, polyethylene terephthalate (PET) items, polypropylene (PP) items, and single-layer sachets.

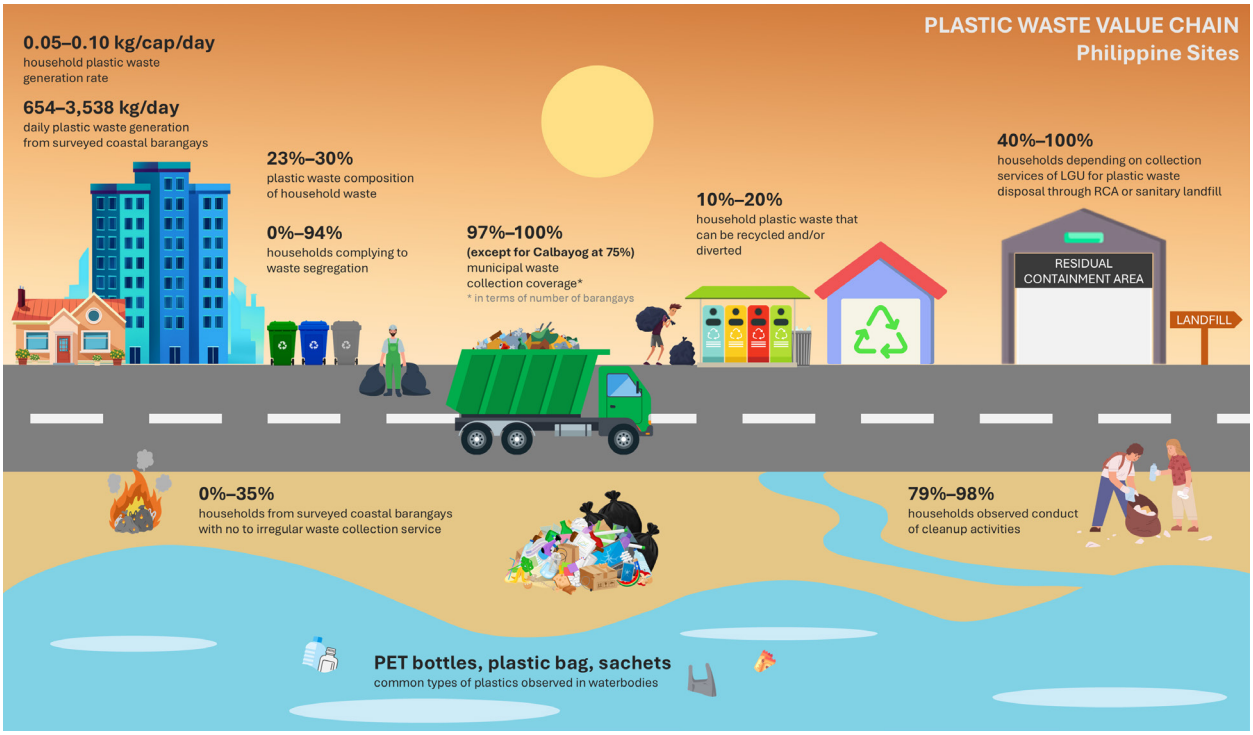
Key results of the KAP survey highlight the habit of the community members in purchasing items in small quantities and packaged in plastic items, such as plastic bags and single-layer films, for their daily convenience and basic needs. This practice significantly contributes to the generation of plastic waste that ends up in landfills and along the coast. Although majority of the survey respondents comply with waste segregation, limitations on the coverage of areas for waste collection, vehicle breakdowns, and the lack of a comprehensive understanding on solid waste management are crucial concerns that contribute to improper waste disposal. The passage of ordinances focusing on the management of plastic wastes is generally recognized, however, nonconformity to these policies persists due to a combination of poor community engagement and laxed implementation of policies. These findings further underscore the crucial need to strengthen social and behavioral change communication campaigns on proper solid waste management and enhance productive collaboration between relevant stakeholders.

The plastic waste value chain analysis across the Philippine sites reveals systemic challenges and opportunities in managing plastic waste from generation to disposal, which presents the need for integrated strategies to mitigate plastic pollution. About 23% to 30%, with a national average of 27%, of household waste comprises plastics, with 10% to 20% being recyclable and residual plastics with potential for recycling, highlighting opportunities for waste diversion. While there are local ordinances which regulate single-use plastics such as plastic bags and polystyrene containers, a significant amount of such plastics continues to be generated, suggesting a challenge in policy implementation.

The lack of consistent waste segregation practices among households further complicates waste management.

Additionally, maintaining a regular waste collection schedule and coverage remains a challenge, in which up to 35% of households, based on KAP survey, experience either no waste collection or less frequent waste collection services. This inconsistency may influence residents towards improper disposal methods. Efforts to divert waste through junk shops and materials recovery facilities (MRFs) face technological and market demand limitations. Hence, the majority of the waste across all sites is still being disposed of in residual containment areas (RCAs) and sanitary landfills. Ongoing efforts to mitigate the impact of plastic pollution include strengthening waste diversion efforts and coastal cleanup activities through community involvement.

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



Plastic Waste Value Chain for Philippine Sites

Priority Issues and Key Recommendations for Philippine Sites

BULAN

Priority Issue 1

Recovery

- Barangay MRFs function as mere collection points, without basic processing of recyclables
- CMRF cum RCA has limited equipment needed to effectively process waste, particularly plastics, into usable materials
- Limited partnerships and market access for recyclables restrict waste recovery efforts

Key Recommendations

- Enhance MRF capabilities by investing in additional processing equipment to increase waste diversion rate, particularly for residual plastics with potential for recycling
- Support and scale up upcycling and advanced recycling initiatives by allocating appropriate funds and engaging communities to optimize material recovery and reduce landfill-bound waste
- Establish stable, long-term partnerships with local, provincial, and regional industries and businesses to ensure a sustainable market for recovered materials and products from the CMRF

Priority Issue 2

Disposal

- Lacks a local final disposal site, forcing waste to be transported to another province, increasing costs, inefficiencies, and environmental risks

Key Recommendations

- Expand waste treatment options by increasing RDF capacity through public-private partnerships.
- Develop a long-term local disposal solution by either constructing a sanitary landfill or establishing a shared provincial landfill through municipal partnerships to reduce transport costs

CALBAYOG

Priority Issue 1

Collection

- The waste collection service of the city only covers 118 out of 157 barangays, leaving the remaining areas prone to improper disposal methods, such as burning and dumping of waste into the open roads and end up in waterways, drifts in Calbayog River and eventually floats into the sea
- Daily waste collection is concentrated in urban areas, with only 47 barangays, thrice to once a week only in rural barangays
- Uncollected waste in narrow roads which cannot be accessed by the dump trucks of the city

Key Recommendations

- Explore localized collection systems to reduce dependence on centralized collection of the city government
- Enhance waste collection efficiency by procuring trash traps to be installed in identified portions of Calbayog River, additional flat boats to collect ensnare trash in trash traps and smaller eco-vehicles to collect trash especially plastics in areas that are inaccessible by standard garbage trucks

Priority Issue 2

Recovery

- Barangay MRFs mostly serve as storage areas for recyclables, lacking the necessary facilities for recycling
- Despite MRF operations which employ plastic recovery schemes, collection by LGU still remains to be the most preferred form of disposal for all plastic waste among the households surveyed
- Low recycling rate due to inadequate plastic recycling machines. The City operates the Pilot, Central and Market MRFs, which are engaged in recycling/ upcycling activities that produce eco-bags, tarpacks, wallets, back backs, gowns, dresses, key chains, decorative items, frames, Christmas parols (special and ordinary) from recovered plastic waste but do them manually or "*mano-mano*". Due to limited production, excess plastic materials end up at the SLF

Key Recommendations

- Develop shared MRFs for clusters of nearby barangays, ensuring efficient waste recovery while addressing logistical challenges through coordinated collection efforts
- Establish MRFs as part of local livelihood programs with recycling facilities for on-site processing or designated areas for selling recyclable materials
- Upgrade the current operations in the central MRF by procuring additional plastic recycling machines like baling, hydraulic press brick and paver machines to produce new recycled products like eco- bricks, thus completing the plastic cycle and promoting a circular economy
- Strengthen public participation by introducing incentive-based programs alongside MRF operations

DAANBANTAYAN

Priority Issue 1

Segregation

- Despite the existing ordinance, waste segregation showed low community participation, driven by misconceptions about its purpose and the perception that it is a waste of time
- Although local policies impose penalties for non-compliance, enforcement has been inconsistent due to the lack of awareness and resources such as separate bins for segregated waste

Key Recommendations

- Implement a balanced system of incentives and penalties by recognizing compliant households and businesses through rewards while enforcing stricter and progressively increasing fines for repeated violations
- Improve the enforcement of waste segregation policies by providing barangays with adequate resources, such as separate bins for different waste types
- Expand information, education, and communication (IEC) campaigns by addressing misconceptions about waste segregation, emphasizing its benefits, and integrating interactive community activities to encourage participation.

Priority Issue 2

Recovery

- The municipality relies on distant facilities due to limited local processing capacity, adding logistical difficulties to waste management

Key Recommendations

- Enhance waste processing capabilities by investing in additional recycling equipment to reduce reliance on distant sites, minimizing transportation costs and logistical challenges while improving overall recovery efficiency
- Strengthen partnerships with manufacturers to implement EPR program, ensuring plastic waste is collected and processed efficiently

DIPOLOG

Priority Issue 1

Generation

- Household sources are significant contributors to waste generation in the city, with 0.29 kg/cap/day of general WGR and 0.08 kg/cap/day of plastic WGR
- Without an effective solid waste management system, the large volume of plastic waste generated will inevitably end up in waterbodies, worsening plastic leakage into marine environments
- Residents along the rivers are observed dumping waste directly into water bodies, exacerbating the plastic pollution

Key Recommendations

- Enforce a stringent implementation of City Ordinance No. 13 – 245 to minimize usage of single-use plastics through:
  - conduct of regular inspections to verify compliance
  - provision of incentives (e.g. tax incentives, business permits discount) to establishments that adopt alternative materials for single-use plastics such as reusable containers
- Offer incentives to local establishments and households that voluntarily adopt waste reduction practices such as discount programs for using reusable containers or community recognition programs for sustainable practice

Priority Issue 2

Collection

- About 22% of the surveyed households surveyed do not receive regular waste collection services, leading to improper waste disposal
- Due to accessibility, urban barangays are prioritized while rural or remote areas receive minimal to no collection services, further worsening the practice of improper waste disposal
- The observed mixing of wastes discourages some households from practicing proper waste segregation

Key Recommendations

- Assess the optimal collection routes and schedule by conducting time and motion study to improve waste collection coverage and travel time
- Conduct regular inspections of existing collection trucks to maintain optimal conditions and prevent unexpected breakdowns, ensuring that all barangays receive fair collection distribution
- Implement a stringent enforcement of segregated waste collection through capacity-building activities for waste workers on handling unsegregated wastes, and the conduct of inspections to verify compliance with segregated collection

PUERTO PRINCESA

Priority Issue 1

Collection

- High volume of uncollected waste, with about 16,000 MT/year or 18% of municipal solid waste remaining unmanaged
- Lower waste collection frequency than the expected or scheduled frequency
- Lack of separate compartments in collection vehicles or segregated waste collection schedules results in mixing of waste, limiting waste diversion efforts

Key Recommendations

- Increase collection efficiency by procuring additional collection vehicles, including smaller units for narrow streets, to improve frequency and coverage
- Strengthen and capacitate barangay-led collection systems to manage biodegradable waste and recyclables, in compliance with RA 9003
- Implement waste collection compartments in vehicles or establish a separate collection schedule for different waste types to maximize recovery

Priority Issue 2

Disposal

- The sanitary landfill in Barangay Sta. Lourdes has exceeded its capacity, which can affect waste collection efficiency, leading some residents to resort to improper open dumping and burning

Key Recommendations

- Expedite the identification and development of a new landfill site to relieve the current system's burden
- Accelerate plans for sustainable waste processing facility through public-private partnerships to reduce landfill dependency
- Integrate advanced waste treatment and recovery technologies into the new disposal facility to enhance waste diversion efforts

TANDAG

Priority Issue 1

Generation

- Household sources are the primary contributors to waste generation in the city, with 0.39 kg/cap/day of general WGR and 0.09 kg/cap/day of plastic WGR
- Household plastic recyclables and residual wastes with a potential for recycling are found at about 8% and 7%, respectively, with diapers and napkins, laminated sachets, and PET bottles as the most dominant plastic materials

Key Recommendations

- Intensify the implementation of City Ordinance No. 01 Series of 2020 to minimize usage of single-use plastics through:
  - conduct of regular inspections to ensure compliance
  - Offering incentives (e.g. tax incentives, business permits discount) to establishments that adopt alternative materials for single-use plastics like reusable containers
- Introduce incentives to local establishments and households that voluntarily adopt waste reduction practices such as discount programs for using reusable containers or community recognition programs for sustainable practice

Priority Issue 2

Recovery

- Low plastic recycling rate due to no end-use application or destination caused by inadequate plastic recycling equipment in the EWSM park, which only employs manual sorting and shredding of plastic residual wastes
- Only 7 of the 17 barangay MRFs are maintained, which primarily function as storage areas without any recycling activities

Key Recommendations

- Upgrade the current operations in the centralized MRF in the ESWM, incorporating additional recycling equipment like extruders and molders to further process and produce new recycled products such as chairs, and eco-bricks, completing the plastic loop and promoting a circular economy
- Explore markets for recyclables, particularly for recycled plastic products, to sustain operations of plastic recycling facility

Shooting trash bins dedicated for plastic bottles and cups in Daanbantayan, Cebu.

1 Introduction

Plastic pollution in oceans and rivers poses a significant threat to marine life and human health. This issue is especially severe in the Philippines, which is a major source of plastic waste entering the ocean, emitting approximately 356,371 metric tons each year (Meijer, Emmerik, Van Der Ent, Schmidt, & Lebreton, 2021). The country consumes about 2.15 million metric tons of plastics annually, but only 9% is recycled, while 35% is discarded improperly, ending up in the open environment (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020).

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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 data will inform tailored policies

and activities for reducing the impacts of marine plastic pollution in each area. Under the first component, the project has initiated the development of a baseline assessment on marine plastics in the Philippines, which includes the conduct of Plastic Analysis and Characterization Study (PACS) and survey on Knowledge, Attitude, and Practice (KAP) at six coastal cities and municipalities (**Figure 1**).

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

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

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

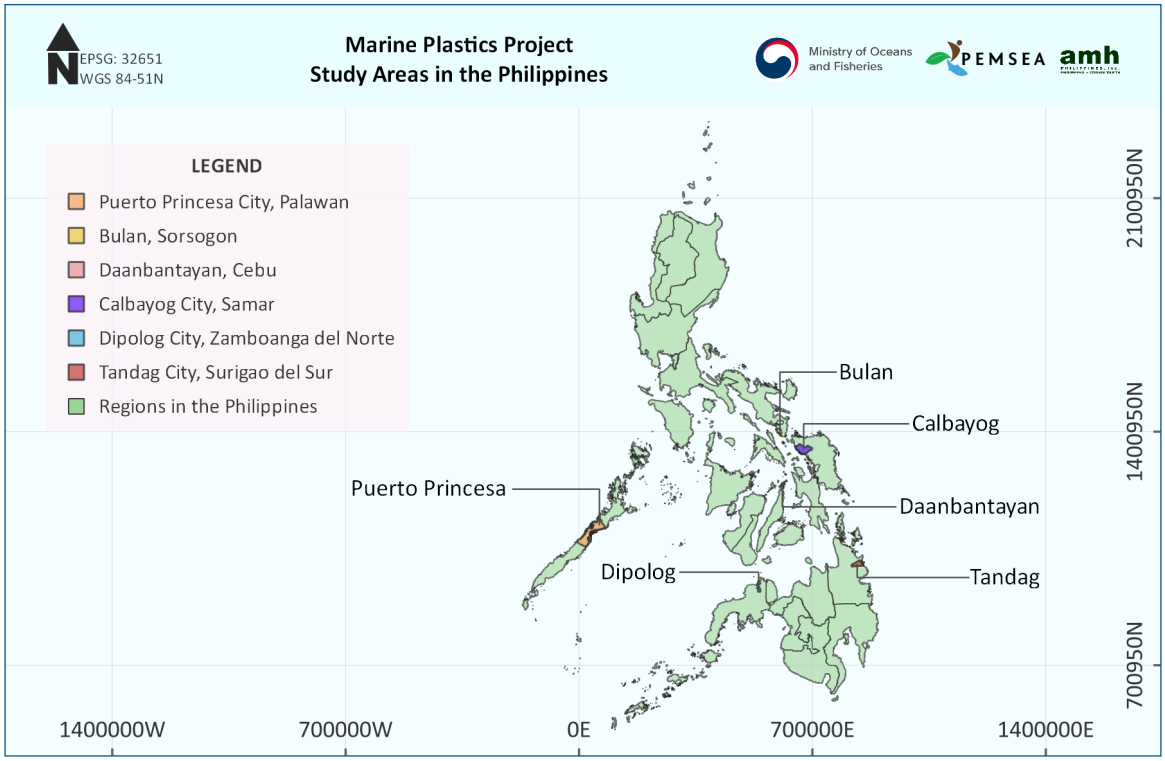

Figure 1. Study Areas in the Philippines for Reducing Marine Plastics in the East Asian Seas Region Project

National Profile 2

The Philippines is an archipelagic country situated in the Southeast Asian Region, surrounded by vast bodies of water, making it particularly vulnerable to marine plastic pollution. Geographically, the country lies approximately 1,424,150 Northing and 366,968 Easting based on World Geodetic System 1984 Universal Transverse Mercator Zone 51N. The country is composed of 7,641 islands grouped into three main island groups—Luzon, Visayas, and Mindanao. There are 1,642 cities and municipalities in the country, of which almost 900 are located along the coast.

A. 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/km^2, calculated over a total land area of about 300,000 km^2 (Philippine Statistics Authority, 2021).

Considering the population and 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]

B. 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 predominantly contributes about 62.3% to the GDP, indicating the role of the sector in driving economic growth (**Figure 2**). 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 to a gradual recovery and reform efforts aimed at transitioning to an upper-middle-income status (World Bank Group, 2024).

[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.

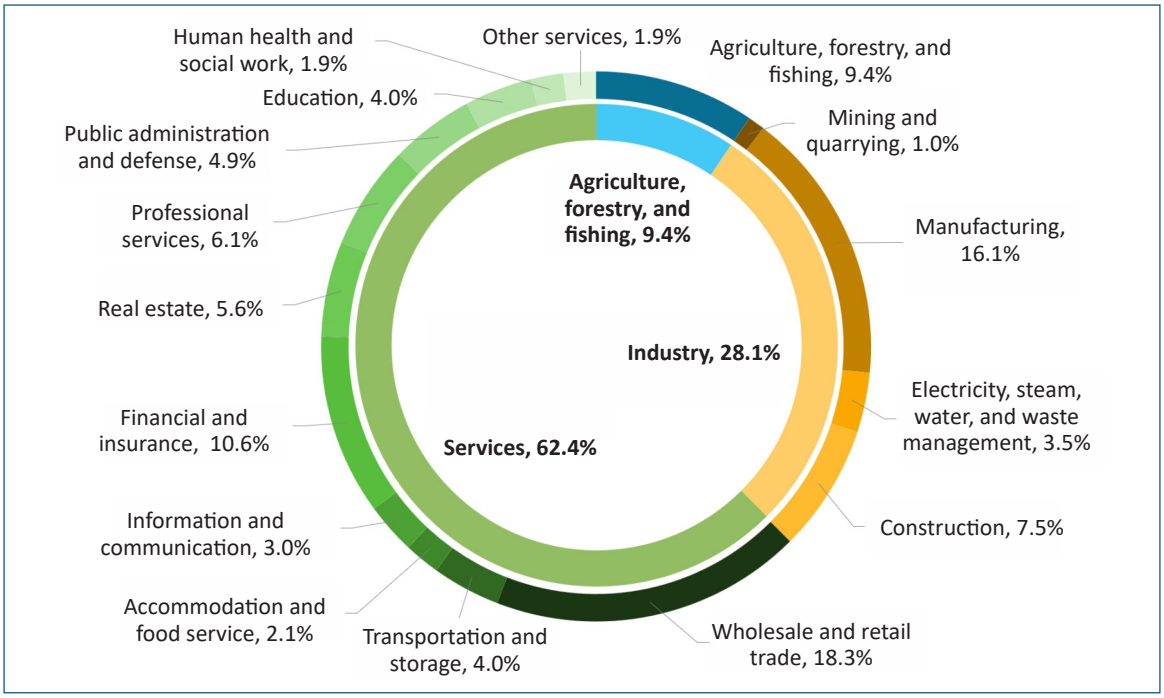

Figure 2. Philippine Gross Domestic Product Share by Sector in 2023 (Philippine Statistics Authority, 2024)

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.

C. 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 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 waterbodies, 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.

D. Profile of the Local Sites

An overview of the key demographic, economic, and geographic characteristics of the six project sites is summarized (**Table 1**). Calbayog has 24% of its barangays classified as coastal, but it has 157 barangays with a population at 208,092, while Puerto Princesa City, situated in an island province, has 77%, indicating extensive exposure to marine areas. Puerto Princesa City also has the largest population at 345,223, while Tandag City has the smallest at 67,013. Notably, 95% of the population of Puerto Princesa resides in coastal barangays, compared to 42% in Bulan. The high proportion of coastal populations could indicate increased contributions to marine litter due to proximity to coastal and marine environments.

All project sites are engaged in agriculture and forestry, with fisheries as one of the major economic activities in Bulan, Daanbantayan, Dipolog City, Puerto Princesa City and Calbayog City. In the 2023 Cities and Municipalities Competitive Index (CMCI) rankings for economic dynamism, Puerto Princesa ranks 16th among 33 HUCs. Among the 114 component cities, Dipolog ranks 47th, followed by Tandag at 88th, and Calbayog at 96th. Meanwhile, among the 511 first-income and second-income municipalities, Daanbantayan ranks 115th and Bulan is at 212th.

The project sites are surrounded by various significant waterbodies, which contribute to their marine and coastal characteristics. In Bulan, major rivers such as Banuang Daan River, Sabang River, Fabrica River, Butag River, Managa-nga River, and the Ticao Pass support the municipality's agriculture and fisheries sector, with approximately 33 kilometers of coastline serving coastal barangays. Calbayog in Eastern Visayas, a city surrounded by the Jibatang River, Calbayog River, Hamonini River and the Samar Sea, has a 54-kilometer coastline and a mix of agricultural, fishing and trading activities. In Central Visayas, Daanbantayan boasts access to the San Pedro River, Visayan Sea, and Camotes Sea, with a 55-kilometer coastline that supports its economy centered around agriculture, fisheries, and tourism.

Dipolog, in the Zamboanga Peninsula, is bordered by the Dipolog River and the Sulu Sea along a 15-kilometer coastline, which is vital for agriculture and fisheries. Meanwhile, Puerto Princesa in Southwestern Tagalog has extensive coastal areas along the Babuyan River, West Philippine Sea, and Sulu Sea; its 416-kilometer coastline underpins a robust economy that includes tourism, agriculture, fisheries, and commerce. Lastly, Tandag in the Caraga Region, with the Tandag River and the Philippine Sea along its 24-kilometer coastline, relies heavily on forestry, providing essential resources to local industries and supporting the livelihoods of its coastal residents.

Table 1. Summary Profile of Project Sites

Profile	Bulan	Calbayog	Daanbantayan	Dipolog	Puerto Princesa	Tandag
Region	Bicol Region (Region V)	Eastern Visayas Region (Region VIII)	Central Visayas Region (Region VII)	Zamboanga Peninsula (Region IX)	Southwestern Tagalog (Region IV-B)	Caraga Region (Region XIII)
Total Number of Barangays	63	157	20	21	66	21
Total Number of Coastal Barangays[a]	20 (32%)	38 (24%)	15 (75%)	8 (38%)	51 (77%)	12 (57%)
Total Population (2023)	108,065	208,092	99,721	143,008	345,223	67,013
Population in Coastal Barangays (2023)	45,648 (42%)	83,305 (48%)	84,296 (85%)	71,391 (50%)	328,775 (95%)	53,890 (80%)
Income Class	First-class income municipality	First-class income city	First-class income municipality	Third-class income city	First-class income city and a highly urbanized city	Fifth-class income city
Major Economic Activities	Agriculture and Fisheries	Agriculture, Fisheries and Trading	Agriculture, Fisheries, and Tourism	Agriculture and Fisheries	Tourism, Agriculture, Fisheries, and Commerce	Forestry
Cities and Municipalities Competitive Index Rank on Economic Dynamism Pillar (2023)[b]	212th among 511 first-income and second-income municipalities (3.3977/20)	96th among 114 component cities (2.6205/20)	115th among 511 first-income and second-income municipalities (3.8761/20)	47th among 114 component cities (3.7882/20)	16th among 33 highly urbanized cities (4.6238/20)	88th among 114 component cities (2.8616/20)
Major Waterbodies	Sabang River, Banuang Daan River, Fabrica River, Butag River, Managanaga River, Ticao Pass	Jibatang River, Calbayog River, Hamonini River, Samar Sea	San Pedro River, Visayan Sea, Camotes Sea	Dipolog River, Sulu Sea	Babuyan River, West Philippine Sea, Sulu Sea	Tandag River, Philippine Sea
Coastline	~33 km	~54 km	~55 km	~15 km	~416 km	~24 km

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

[b] Higher scores in economic dynamism reflect better capacity of a locality to support business growth, job creation, and economic productivity through its local resources.

National Context and Background of Solid Waste Management

3

A. Policies and Regulations

1. General Waste

The 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. Adopting a holistic, and systematic approach in addressing problems on solid waste management, this law establishes necessary framework and guidelines for solid waste avoidance and reduction through formulation of best environmental practices in waste segregation, collection, transport, treatment, and disposal. The policy also highlights the crucial role of the local government units (LGUs) 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 DENR Administrative Order (DAO) 2001-34. This law mandates the formation of a solid waste management board in each LGU to develop the 10-year solid waste management plan (SWMP) instituting an effective solid waste management structure, and sustainable action plans to better manage solid waste in respective cities and municipalities. 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.

Other salient features of this Act include the establishment of a materials recovery facility (MRF) in every barangay or cluster of barangays, the closure of open dumpsites and the conversion of these to controlled or sanitary landfills within 3 years of the Act taking effect, and the mandatory diversion of at least 25% of the LGU's solid wastes 5 years within the effectivity of this Act, through recycling, and composting activities. Several administrative orders provide specific instructions concerning these components of solid waste management. 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 wastes diverted.

As of July 2024, the total number of approved SWMPs is 1,378 out of 1,592 targeted LGUs, or about 87% (National Solid Waste Management Commission, 2024). Conversely, audit reviews and assessments on the number of open dumpsites, operating landfills, and functional barangay MRFs are continuously conducted by the Commission on Audit (CoA) office.

Other complementary policies to RA 9003 are summarized in the table below (**Table 2**).

2. Plastic Waste

The Extended Producer Responsibility Act of 2022, otherwise known as Republic Act 11898 (RA 11898), introduces a structured extended producer responsibility (EPR) system focusing on plastic packaging, amending RA 9003. This legislation requires companies with assets over Php 100 million to develop EPR programs that meet specific diversion goals, that are subject to audits and comply with the implementing rules and regulations.

Table 2. 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
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 wastes 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 environmental critical or situated in critical areas, to maintain balance between economic growth and environmental protection

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 various local ordinances that regulate or ban the use of single-use plastics 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.

The National Solid Waste Management Commission (NSWMC), meanwhile, released Resolution No. 1363 of 2020, mandating a ban on the use of unnecessary single-use plastics, 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. The NPOA-ML, aiming for zero waste to Philippine waters by 2040, highlights the need for unified stakeholder efforts in addressing marine litter through its ten strategies (Department of Environment and Natural Resources, 2021). Notably, cities including Legazpi, Cagayan de Oro, Calapan, Davao, Manila, and Ormoc are developing and implementing local action plans to complement national efforts in addressing marine litter through localized strategies (UN-Habitat, 2022). Strategies in the plan are organized into a programmatic cluster and an enabling or cross-cutting cluster of actions (**Figure 3**).

Figure 3. Ten Strategies of NPOA-ML (UN-Habitat, 2023)

In response to the growing plastic waste challenge, 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 4**).

B. Functional Elements

1. Generation

The Philippines has observed a significant increase in waste generation over the years, reflecting the growing demand of its developing economy. In 2023, the country produces approximately 60,639.86 metric tons of waste daily, amounting to an annual generation of 22.1 million metric tons, with the average per capita waste generation rate at about 0.53 kg/cap/day[3] (NSWMC, 2024).

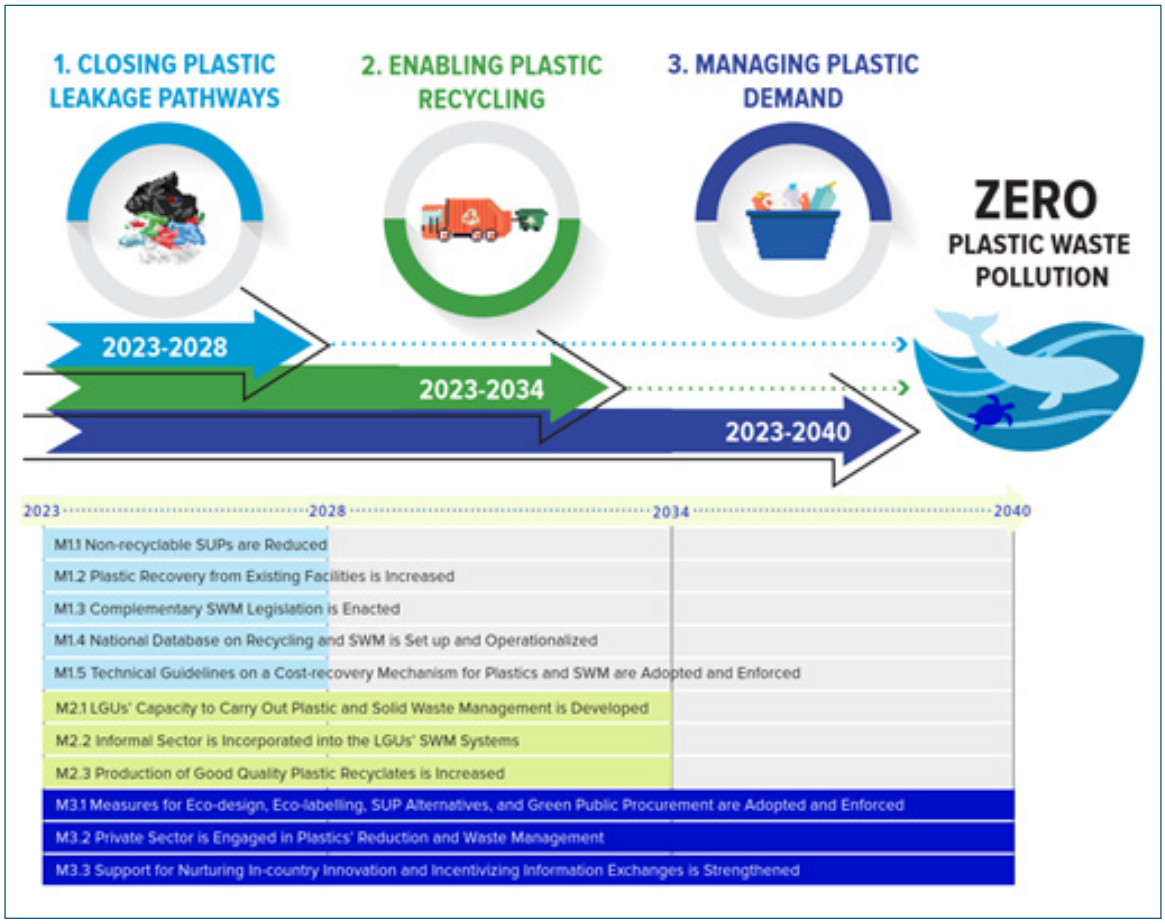

Figure 4. Outcomes and Milestones of the Philippine Plastic Waste Management Roadmap (World Bank, 2024)

[3] 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).

This marks a substantial increase from the 2010 base year in which the per capita waste generation rate of the country ranges from 0.10 to 1.00 kg/cap/day, with a weighted average of 0.40 kg/cap/day (DENR-EMB, 2018). Based on the data from the submitted solid waste management plans to the Environmental Management Bureau (EMB) from 2008 to 2013, the primary sources of municipal waste include residential sources, contributing about 57%, followed by commercial sources at 27% (**Figure 5**). The waste composition predominantly features biodegradable materials, which constitute 52% of the municipal solid waste in terms of weight (**Figure 6**). Plastics account for about 11%; however, it should be noted that this value pertains only to recyclable plastics and does not include single-use plastics that are classified as residual waste.

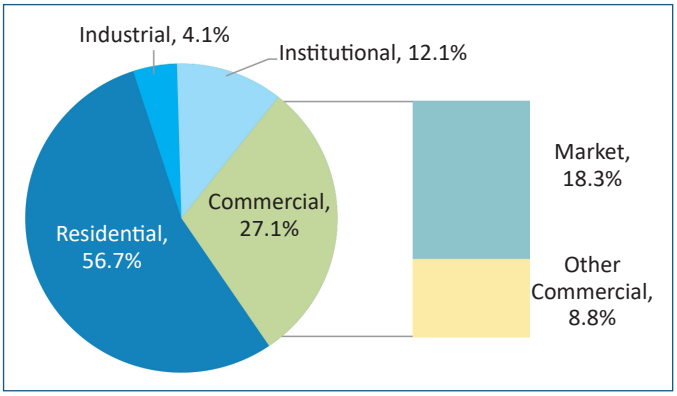

Figure 5. Sources of Municipal Solid Waste based on 2008-2013 Data (DENR-EMB, 2018)

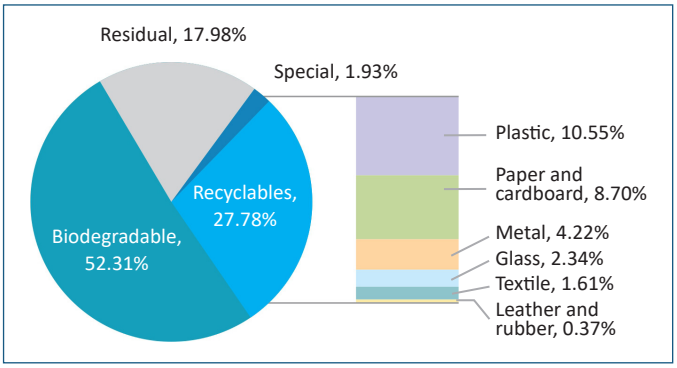

Figure 6. Composition of Municipal Solid Waste based on 2008-2013 Data (DENR-EMB, 2018)

During pre-COVID-19 pandemic in 2019, the Philippines has an estimated annual plastic consumption of 2.15 million metric tons which translates to about 20 kg/cap/year or 0.05 kg/cap/day (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020). Recent estimates from DENR-EMB, meanwhile, indicate that 12% to 24% of solid waste constitutes plastic waste (Department of Environment and Natural Resources, 2023), yielding to about 0.06 kg/cap/day to 0.13 kg/cap/day of the estimated municipal solid waste generation of 0.53 kg/cap/day.

2. Segregation

RA 9003 mandates waste segregation at the source, where biodegradable and recyclable wastes are collected by the barangay government, while residual and special wastes are managed by the city or municipal government. Despite the mandate, adherence varies significantly across different areas. A growing number of cities and municipalities have adopted "no segregation, no collection" policies; however, many LGUs continue to practice mixed waste collection which undermine the effectiveness of the law. According to data from 128 pilot LGUs of the Environmental Natural Resources Management Project (ENRMP) of DENR, compliance with waste segregation at the source ranges from 53% to 100%, while segregated collection is between 43% to 100% (DENR-EMB, 2018). It should be noted that the pilot LGUs were selected for their initiatives and regular monitoring of compliance.

3. Collection

In the Philippines, waste collection is a critical component of municipal solid waste management as heavily influenced by

geographic and socio-economic factors. Urban centers, such as cities in Metro Manila, typically have structured waste collection systems which ensure a high collection rate which may reach more than 90% of the population. Rural and remote areas, meanwhile, experience less frequent collection due to logistical challenges and limited resources, leading to lower coverage rates of as low as 30%. Overall, the national waste collection rate is at about 40% (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020). Collection methods vary widely from door-to-door services in densely populated urban areas to communal collection points in less accessible regions. These services are either provided by the LGU or by a waste collection service provider contracted by the LGU (DENR-EMB, 2018).

Coastal and island communities face distinctive challenges in waste management, particularly with the lack or absence of centralized waste collection services. In many smaller islands and remote coastal barangays, communities must manage their own waste, often resorting to improper disposal practices such as burying, open burning, or discarding waste directly into waterbodies, which contribute to marine litter (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020). Efforts to improve waste management in these areas include promotion of community-based segregation, conduct of diversion initiatives, and adoption of residual containment areas.

4. Recovery

Waste recovery and recycling efforts face significant challenges in meeting national targets. As of 2021, the national waste diversion rate is at 54%, falling short of the 80% target set by the National Economic Development Authority (NEDA) under the Philippine Development Plan 2017-2022 (NEDA, 2021). The subsequent PDP 2023-2028, however, does not specify a new waste diversion target. Instead, the plan aims to enhance waste management infrastructure by increasing the proportion of barangays served by materials recovery facilities (MRFs) from 41% in 2021 to 53% by 2028 (NEDA, 2023).

MRFs play a significant role in the national strategy to improve waste recovery as they should serve as facilities that initiate recovery at the community level, where ideally, segregated waste from households is brought. As of 2023, there are 11,823 MRFs servicing 18,450 barangays over the country, which represents 47% compliance with the mandate of RA 9003, requiring an MRF in each barangay (Environmental Management Bureau, 2024). Many of these MRFs, however, function primarily as temporary storage locations for waste, waiting for scheduled collections by local governments, rather than processing centers. Strategies to boost the effectiveness of MRFs include providing technical assistance, converting existing junk shops into MRFs through a memorandum of agreement, and promoting the clustering of barangays for shared MRF.

In addition to the MRFs, there are also over 1,800 junk shops and at least 90 recycling facilities in the country,[4] in which more than 1,000 of these junk shops are located in the National Capital Region (NCR) as of December 2023 (NSWMC, 2024). These facilities provide an avenue for processing recyclables such as plastic bottles, metals, cardboards, paper, cans, and glass bottles. The presence of these facilities helps bridge the gap between local waste collection efforts and the higher levels of the recycling value chain.

[4] The junk shops and recycling facilities in Central Luzon (Region III), Zamboanga Peninsula (Region IX), and Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) are not yet included in the count due to unavailability of data.

Despite these efforts, the recycling capacity within the country remains limited. According to a World Bank report, in 2019, only 28% of key plastic resins such as PET packaging, PP, HDPE, and LDPE were recycled in the Philippines (**Figure 7**). This is attributed to inadequate technology and investment in recycling infrastructure (World Bank Group, 2021). In another report, only 9% of plastic materials are recycled, with 5% being exported primarily to China and other Asian countries, and 2% recovered as refuse-derived fuel (RDF). About 525 thousand metric tons of plastic waste are consolidated, recycled, recovered, and exported, with 35% of these are recycled locally (**Figure 8**), while 33% of the materials collected for diversion were eventually disposed of as residual waste (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020).

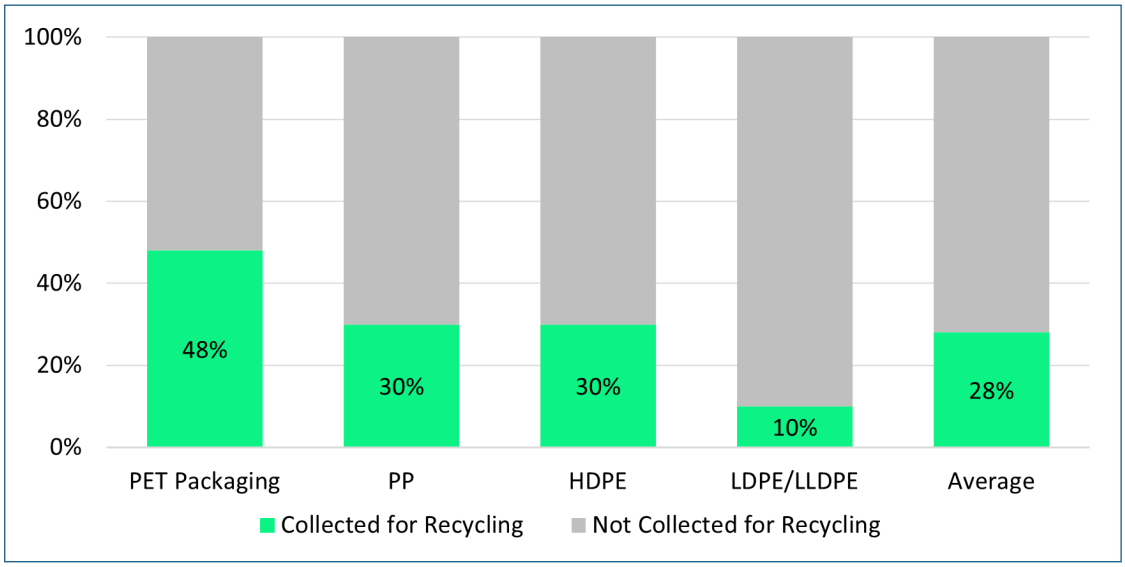

Figure 7. Estimated Collection for Recycling Rates for Each Key Plastic Resin in the Philippines (World Bank Group, 2021)

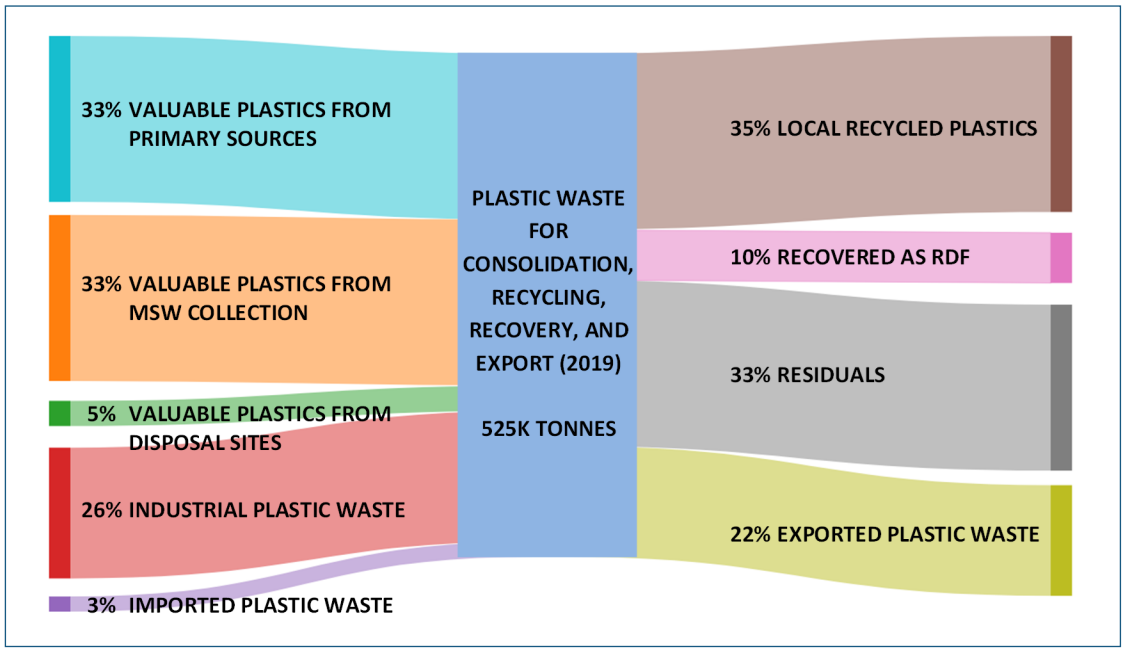

Figure 8. Philippine Plastic Recycling and Recovery Streams in 2019 (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020)

5. Disposal

A significant amount of waste, including 33% of plastic waste generated (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020), is disposed of in landfills. As of August 2024, about 19,595 metric tons are being disposed of across various regions, with Region IV-A receiving the most significant portion, accounting for 10,027 metric tons per day (NSWMC, 2024).

The strategic expansion of sanitary landfill access to cities and municipalities has been a key objective in recent national plans. Under the PDP 2017-2022, the goal was set to have about 29% or 479 out of 1,634 cities and municipalities have access to sanitary landfills by the end of 2022 (NEDA, 2021). Progress was evident by 2021, with 32% of cities and municipalities securing access to sanitary landfills. Building on this, the subsequent PDP 2023-2028 has set the target to increase the proportion of cities and municipalities with sanitary landfill access to 50% by the end of 2028 (NEDA, 2023). As of August 2024, the country has 317 operational sanitary landfills, which serve about 43% or 701 out of 1,642[5] cities and municipalities. The majority of these facilities, at about 93%, are operated by LGUs, while about 7% are managed by private entities (NSWMC, 2024). The archipelagic nature of the country, however, poses significant geographical challenges that complicate access to sanitary landfills, particularly for remote and island communities.

Enacted in 2000, the RA 9003 played an important role in reshaping the landscape of waste disposal in the country by prohibiting open dumps and mandating their conversion into controlled dumpsites within three years, with no controlled dumps allowed five years after the effectivity of the law (Republic of the Philippines, 2021). More than 20 years later, as of March 2021, 125 open dumps were still operating (Teves, 2021), but were eventually closed by May 2021, as reported by DENR following the Safe Closure and Rehabilitation Plan for each site (Department of Environment and Natural Resources, 2021). In response to the closure of dumpsites, LGUs have increasingly turned to using residual containment areas (RCAs) as temporary waste storage solutions while they negotiate agreements for sanitary landfill use or await the operationalization of their own sanitary landfill. This situation has encouraged LGUs to enhance waste reduction initiatives and increase waste diversion efforts to manage their residual waste effectively in these spatially limited areas.

[5] 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.

Overview of Solid Waste Management of the Local Sites 4

A. Policies and Regulations

1. General Waste

Pursuant to the mandates within RA 9003, each local site has implemented its own city or municipal ordinances (MO) regarding general waste management. All local sites have their respective ecological solid waste management ordinances, which contain the primary guidelines on the implementation and monitoring of activities, programs, and policies related to solid waste management within their jurisdictions (**Table 3**). Key provisions of these ordinances include the establishment of a city or municipality solid waste management board to oversee and ensure the effective implementation of related policies and programs.

Table 3. City and Municipal Ordinances Regarding General Waste Management per Local Site

City/ Municipality	City/Municipal Ordinance/s on General Waste	Main Provision
BULAN	Municipality Ordinance 037-1996: Requiring Receptacles in public utility vehicles	• Requires owners and operators of public utility vehicles (PUVs) to provide receptacles inside their vehicles for waste disposal of commuting public
	Municipality Ordinance 008-2005: Comprehensive Ecological Solid Waste Management	• Emphasized the "no segregation, no collection" policy • Established the Municipal Solid Waste Management Board (MSWMB)
	Municipality Ordinance 024-2012: Prohibiting Open Burning of Trash	• Prohibits open burning of trash and other refuse material in the municipality

Table 3. City and Municipal Ordinances Regarding General Waste Management per Local Site (cont.)

City/ Municipality	City/Municipal Ordinance/s on General Waste	Main Provision
CALBAYOG	City Ordinance No. 2011-33-064 (2011): Calbayog City Ecological Solid Waste Management Act of 2011	• Presents the regulations and prohibited acts related to the general management of solid waste • Requires segregation of waste at source by generators • Requires segregated collection and transport of solid waste • Strict implementation of the "No Collection, No Segregation" policy • Prohibits littering, scattering, throwing and dumping of waste in public places, such as roads, rivers, esteros, gutters, manholes, parks, public playground, coastlines, seas and creeks • Prohibits littering from vehicles • Prohibits the open burning of solid waste • Fines for violators include payment of Php 300.00 to Php 5,000.00, and imprisonment of 1 day to 6 months
	City Ordinance No. 97-42-3682	• Establishes the creation of the City Solid Waste Management Office to answer the needs to prevent health hazards to human lives and mitigating environmental degradation and to take charge of solid waste management
	City Ordinance No. 2007-10-057	• Prohibits the construction of toilets and pig pens along river banks of Jibatang River, Calbayog River, Hamonini River, Oquendo River System, and institutes protection programs
	City Ordinance No. 2006-36-106	• Regulates the hanging and display of streamers over the city streets
	Resolution No. 2024-08-054	• Urges the Barangay Council of 21 Barangays to construct one heavy duty trash bin to be placed in every designated pick-up point of the respective barangay to their respective area clean and safe
	Resolution No. 2025-17-469	• Authorized the City Mayor, Hon. Raymund C. Uy to enter into a MOA with Five Baragays for the collection and transportation of waste to enhance solid waste management and foster inter-barangay cooperation

Table 3. City and Municipal Ordinances Regarding General Waste Management per Local Site (cont.)

City/Municipality	City/Municipal Ordinance/s on General Waste	Main Provision
DAANBANTAYAN	Municipality Ordinance No. 12-97: Protection of Sandy Beaches	• Prohibit activities that could harm the environmental conditions of the sandy beaches, such as littering
	Municipality Ordinance No. 18-2020: Ecological Solid Waste Management Ordinance	• Establishes or reconstitutes the organization of offices responsible for solid waste management • Presents the regulations and prohibited acts related to solid waste management • Fines and penalties for violations include payment of Php 500.00, Php 1,500.00, and Php 2,500.00 for the 1st to 3rd offenses. Additionally, community service of 8 hours to 40 hours may be imposed. 4th offenses are subject to imprisonment of 1 month but not more than 6 months.
DIPOLOG	City Ordinance No. 123 (1998): Establishing a System of Garbage Collection, Health Protection and Sanitation	• City's main law on sanitation and cleanliness • Mandates the city to follow "No Segregation, No Collection" policy • Fines for violations include payment ranging from Php 200.00 to Php 1,000.00 and/or conduct of community service
	City Ordinance No. 22-321: Amendment of Ordinance No. 123	• Declares the tourism sites in Dipolog City as "Clean-As-You-Go" zones • Provision of segregating bins to ensure that proper waste disposal is practiced by tourists • Fines and penalties for violations include payment of Php 200.00 for 1st offense, Php 500.00 for 2nd offense, Php 1,000.00 for 3rd offense, and Php 2,000.00 for the succeeding offenses
PUERTO PRINCESA	City Ordinance No.163-91 (1991): Anti-Littering Ordinance	• Prohibits illegal dumping of waste • Fines and penalties for violations include payment ranging between Php 200.00 to Php 1,000.00 and/or imprisonment for more than one to two months
	City Ordinance No. 396 (2008): Environmental Code	• Presents the code of conduct for the conservation, protection, and restoration of land, air, and water resources • Establishes the City Ecological Solid Waste Management Board
	City Ordinance No. 640 (2015): Posting of City Ordinance No. 163-91 in Tourism Related Establishments	• Posting of Anti-Littering Ordinance in all tourism establishments

Table 3. City and Municipal Ordinances Regarding General Waste Management per Local Site (cont.)

City/Municipality	City/Municipal Ordinance/s on General Waste	Main Provision
TANDAG	City Ordinance No.11 (2017): Ecological Solid Waste Management Code of Tandag City	• Tandag City's main law on solid waste management, addressing essential components of solid waste management such as the development of 10-year ecological solid waste management plan, mandatory waste segregation, construction and maintenance of materials recovery facilities (MRFs), management of disposal facilities • Fines and penalties for violations (i.e., littering in public spaces, open burning of wastes, mixing of wastes) range between Php 500.00 to Php 500,000.00 or imprisonment of two years
	City Ordinance No.01 (2020): Amended City Ordinance No.11	
	Resolution No. 130 (Series of 2021): Implementation of the Solid Waste Management System under the Republic Act No. 9003	• Authorizes 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

Besides the ecological solid waste management act, complementary policies are also enforced to better manage municipal solid waste such as coastal cleanups, the rehabilitation of waterbodies, and protection of tourism sites in the city or municipality.

2. Plastic Waste

The majority of local policies concerning the use of plastics involve banning the use of plastic products or single-use plastics (SUPs) and encouraging the community to opt for reusable materials such as reusable utensils, and eco-bags (**Table 4**).

Table 4. City and Municipal Ordinances Regarding Plastic Waste Management per Local Site

City/Municipality	City/Municipal Ordinance/s on General Waste	Main Provision
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"	• Mandates all business establishments to display a notice encouraging the community to bring reusable bags
	Municipality Ordinance 020-2012: Anti-Plastic Ordinance	• Prohibits the use of "Styrophor" and polystyrene containers for food and drink purposes

Table 4. City and Municipal Ordinances Regarding Plastic Waste Management per Local Site (cont.)

City/Municipality	City/Municipal Ordinance/s on General Waste	Main Provision
CALBAYOG	Policies on plastic waste are covered under City Ordinance No. 2011-33-064 (2011): Calbayog City Ecological Solid Waste Management Act of 2011	• Bans on the use of non-biodegradable plastic bags and styrofoam as food containers • Prohibits the use of plastics, such as cellophanes, styrofoams/ styrophor, plastic straws, plastic drinking cups, plastic spoons and forks in the operation of business, such as restaurants, carenderia, fast food chain, "*turo-turo*", etc. • Prohibits the use of transparent plastic film or colored cellophane materials for packaging of any meat, fish products, etc.
DAANBANTAYAN	Municipal Ordinance No. 06-2015: Regulation Concerning the Use of Plastics and Polystyrene / Styrofoam	• Prohibits the use of plastic bags and expanded polystyrene (EPS) or Styrofoam food service containers across all establishments • Violations will be used as basis for non-renewal of business permits
DIPOLOG	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	• Regulates the sale, distribution, or use of non-compostable plastic Bags such as thin films, single-use plastics, and polystyrene foam products • Fines for violations include payment of Php 100.00 to Php 500.00 and/ or imprisonment of not more than 6 months for households, and payment of Php 1,000.00 to Php 5,000.00 for non-household sources, along with the imprisonment of the operator of said establishment of not more than 6 months
PUERTO PRINCESA	City Ordinance No. 993: Single-Use-Plastic and Styrofoam Regulation	• Restricts the use of plastic products such as plastic bags, straws, disposable cups, and plastic utensils in all establishments • Fines for violations include payment of Php 1,000.00, Php 3,000, and Php 5,000.00 for 1st, 2nd, and 3rd offenses, respectively. Imprisonment from 7 days to 30 days also serves as a penalty.
TANDAG	Policies on plastic waste are covered under City Ordinance No. 2017	• Prohibits the use of single-use plastic packaging and encourages usage of alternatives such as reusable bags and containers • Fines for violations include payment of Php 1,000.00

For site like Tandag City, there are no specific ordinances on plastic waste; rather, policies are incorporated in city ordinances relating to general waste. There are specific provisions on plastic waste in Calbayog City, only they are incorporated in City Ordinance No. 2011-33-064.

Non-household establishments are recognized to be significant contributors to plastic waste, hence, tailored policies such as prohibiting and restricting the use of plastics as food and beverage containers and putting up displays encouraging individuals to use reusable bags and items are enforced specifically for these businesses.

B. Institutional Framework

1. Institutional Arrangement

Each city or municipality has established its own city or municipality solid waste management board to prepare and develop their respective 10-year SWMPs, and ensure the smooth implementation of programs and policies concerning solid waste. Moreover, designated solid waste management committees are formed in each barangay of cities and municipalities to act as primary enforcers of proper solid waste management within their respective areas.

The Environmental and Natural Resources Office (ENRO) for each city or municipality proves to be a key player in strengthening public awareness on proper solid waste management and organizing environmental activities such as coastal cleanups. In Dipolog City, the city ENRO is responsible for maintaining the operations of the landfill and the barangay MRFs. The municipality ENRO of Daanbantayan, on the other hand, maintains the condition of the collection equipment and the conduct of proper and timely waste collection. Other supporting offices generally include the City Engineering Office to aid in structural and engineering components of solid waste management in the city or municipality, media partners for timely and effective information dissemination to the public, and the local police to assist in the enforcement of city ordinances (**Figure 9**).

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 Environmental Management Officer. The Office is also tasked to operate and maintain the SLF in accord with R.A. 9003 with 34 personnel 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

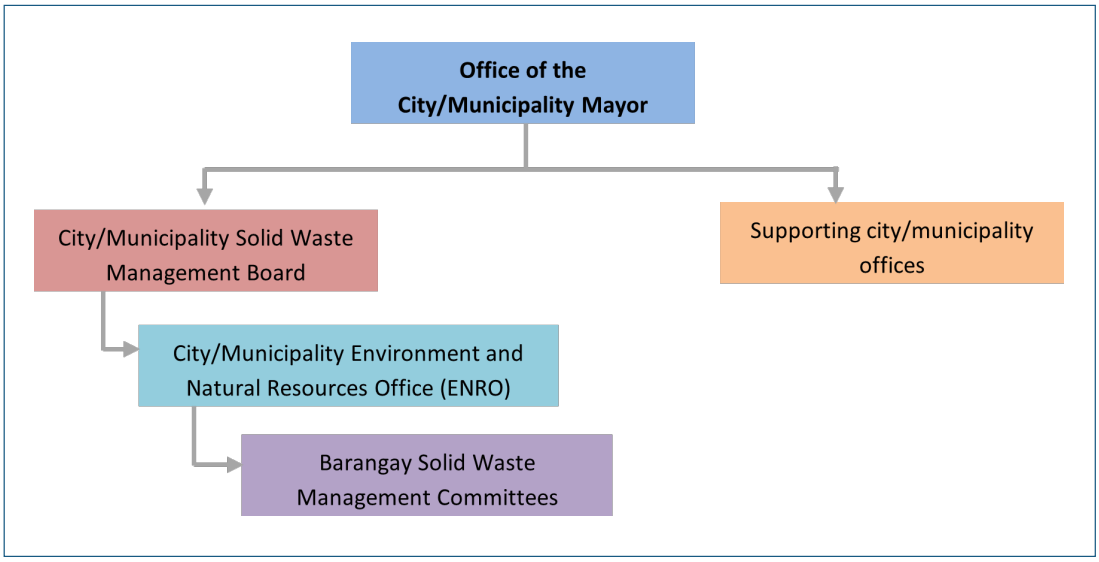

Figure 9. General Institutional Arrangement in Philippine Sites

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.

2. Facilities and Resources

All cities and municipalities are equipped with facilities and personnel to manage solid waste and carry out effective programs on solid waste management (Table 5). Utilities for collection typically include dump trucks and garbage trucks. Other types of supporting collection equipment are also available such as garbage compactor trucks, bulldozers, and backhoes.

Pursuant to the mandates in RA 9003, barangay MRFs are established in all studied cities and municipalities. Additional MRF structures such as the central MRF are established to contain recycling equipment and perform processing of biodegradable waste and recyclable materials. Disposal facilities for the study sites include sanitary landfills and residual containment areas (RCA).

Personnel in various roles and offices ensure that operations concerning management of solid wastes are implemented efficiently. The cities and municipalities utilize individuals in permanent roles and job order contracts to perform tasks related to solid waste management.

Table 5. Facilities and Resources in Solid Waste Management in Philippine Sites

City/Municipality	Component of Solid Waste Management			Total Personnel in Various Roles and Offices[b]
	Collection[a]	Recovery[a]	Disposal[a]	
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	• 1 Residual Containment Area / Dumpsite	• 38 permanent positions • 79 job order contracts
		• 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	• 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	• 1 Sanitary Landfill	• 246 Personnel • 20 Permanent Positions • 236 Job Order Contracts

Table 5. Facilities and Resources in Solid Waste Management in Philippine Sites (cont.)

City/Municipality	Component of Solid Waste Management			Total Personnel in Various Roles and Offices[b]
	Collection[a]	Recovery[a]	Disposal[a]	
CALBAYOG	• 2 Excavators (Wheel Type and Trackpad) • 1 Bulldozer • 1 Road Roller	• 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	• 1 RCA	• 34 personnel
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	• 1 Sanitary Landfill	• 78 personnel
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 m3, 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	• 1 Sanitary Landfill • 1 Controlled Dump	• 2 permanent/ coterminous positions • 264 job order contracts

Table 5. Facilities and Resources in Solid Waste Management in Philippine Sites (cont.)

City/Municipality	Component of Solid Waste Management			Total Personnel in Various Roles and Offices[b]
	Collection[a]	Recovery[a]	Disposal[a]	
TANDAG	• 1 Garbage Truck with capacity of 3 tons • 6 Garbage Compactor Trucks	• 17 (out of 21) Barangays with MRFs • 1 Centralized MRF	• 1 Ecological Solid Waste Management (ESWM) Ecopark	• 8 permanent/ coterminous positions • 35 job order contracts

[a] As of September 2024

[b] Data for each site was recorded on the following years: Bulan in 2024, Calbayog in 2020, Daanbantayan in 2023, Dipolog in 2019, Puerto Princesa in 2021, and Tandag in 2024

Financial allocation for solid waste management for each site primarily accounts for the implementation of waste management-related activities such as cleanups, maintenance and repair of facilities, and construction and operational expenses of MRFs and landfills (**Table 6**).

3. Stakeholder Participation

The role of stakeholders is vital in maintaining sustainable and effective waste management practices. All cities and municipalities greatly benefit from the support of a diverse range of stakeholders with various specializations including from the business and private sector, material recovery industry, academic and research institutions, community groups, and the general public (**Table 7**).

Table 6. Latest Budget Allocation for Solid Waste Management in Philippine Sites

City/Municipality	Latest Budget Allocation (Php)
Bulan	15,100,000 (2019 budget)
Calbayog	49,909,867 (2025 budget)
Daanbantayan	7,973,535 (2023 budget)
Dipolog	81,865,479 (2019 budget)
Puerto Princesa	80,311,040 (2024 budget)
Tandag	6,000,390 (2024 budget)

Table 7. Involvement of Stakeholders in Philippine Sites

Stakeholder Group	Involvement
Local Government	• Implement and enforce waste management policies and regulations • Coordinate and manage waste collection, recycling programs, and public education initiatives
Local Businesses and Establishments	• Comply with local waste management regulations and participate in recycling initiatives • Implement waste reduction strategies and promote the use of sustainable products (e.g., reusable items)
Private Sector Partners	• Support the government in efforts to improve waste collection, treatment, and disposal services
Waste Management Operators	• Manage the collection, processing, and sale of recyclable materials for recycling • Caters waste from LGU for final disposal
Community-based Organizations (CBOs) and Non-governmental Organizations (NGOs)	• Educate the public about proper waste management and promote recycling and waste reduction • Organize local cleanup events in coordination with the local government
Academic and Research Institutions	• Partner with local government to conduct studies on waste management to develop policies, programs, and technologies
General Public	• Participate in waste management programs of the municipal government

The active participation of certain stakeholders is more pronounced and evident in some cities and municipalities.

In Calbayog City, the City Solid Waste Management Office and Barangay Solid Waste Management Committees spearhead the implementation of related policies on waste management and strengthen waste recovery by monitoring and maintaining the operations of BMRFs, Central, Market and Pilot MRFs. Additionally, institutions from the private sector, academe, and non-governmental organizations (NGO) actively participate in SWM planning, forums, task forces, and committee groups. These notable entities include the Calbayog SAVE ME Movement, Calbayog Eagles Club, Tau Gamma Phi, Christ the King College (CKC), and Northwest Samar State University (NwSSU), Puno ng Buhay, among others. They also organize clean-up drive activities in coordination with CSWMO. The Calbayog Junk Shop Dealers Association in Calbayog City, on the other hand, is involved throughout all stages of the implementation of related programs and policies, from planning to execution.

The local government of Tandag City receives immense support from CBOs and NGOs, and academic institutions. One of the notable CBOs in the city is the Motherly Association for River Initiatives Towards Environmental Sustainability (MARITES). MARITES significantly helps in motivating the public to join activities and programs related to plastic waste management, particularly the River Care Program (RCP) of the city. As a representation of community volunteerism, MARITES further empowers the involvement and role of women in solid waste management. MARITES is

recognized as the local partner in Tandag City of PEMSEA for its Marine Environment Protector (MEP) program, one of the components of the marine plastics project. The launched initiatives include *Basuralympics* and Urban Hanging Garden using Plastics, which are community-focused information drives aimed at tackling proper solid waste segregation, collection of recyclable plastics, and promotion of plastic upcycling (PEMSEA, 2024). The active engagement of MARITES further paves the way to strengthen collaboration among community members and local government offices.

In Daanbantayan, the People and the Sea Marine Conservation Foundation has been an active NGO for about 8 years now. Implemented projects are mostly focused on marine science education, economic resilience, fisheries, and solid waste management. The NGO is recognized for its organization of its waste collection and education programs, their immense support on cleanup drives, and well-managed record-keeping of essential information on the municipality's waste situation.

A similar observation can be made for the municipality of Bulan, where several NGOs mostly organize community service projects, such as the Rotary Club – Bulan West Coast, Bulan Eagle's Club, Magic 5 Organization, Alpha Kappa Rho Fraternity and Sorority, Alpha Sigma Fraternity and Sorority, and Bulan Lion's Club. The Association of Bulan Brokerage and Fisherfolks addresses problems in coastal ecosystems and leads activities tackling sustainable fishing practices. The notable waste generation of public establishments such as the public market, fish port, bus and jeep terminals, as well as the commercial businesses contribute to the environmental impacts in the municipality and must ensure that proper waste management is practiced in these sectors.

The junk shops play a crucial role in the environmental sustainability of Puerto Princesa City. 20 registered junk shops in the city accept recyclable materials including plastics, metals, glass bottles, cartons, and batteries, which significantly helps in waste diversion. However, challenges persist in some areas. In Dipolog City, the recovery industry, which includes the junk shops, sees the recycling industry as unprofitable due to difficulties in maintaining a large storage space and the unappealing market prices for some recyclables.

C. Functional Elements

1. Generation

Available data from conducted waste analysis and characterization study (WACS), performed in different years, shows a WGR value ranging from 0.32 to 0.70 kg/cap/day in the studied cities and municipalities (**Table 8**).

Table 8. Reported WGR in Philippine Sites

City/Municipality	General Waste Generation Rate (kg/cap/day)	Daily Waste Generation (kg/day)
Bulan *(2016 WACS)*	0.213	22,008
Calbayog *(2019 WACS)*	0.57	19,765
Daanbantayan *(2018 WACS)*	0.32	29,000
Dipolog *(2021 WACS)*	0.41	56,981
Puerto Princesa *(2023 WACS)*	0.70	240,851
Tandag *(2016 WACS)*	0.46	26,744

Biodegradable wastes make up the majority of waste composition for all cities and municipalities. In certain cities and municipalities such as Bulan, Dipolog, and Tandag, residual wastes follow biodegradable wastes as primary contributors to overall waste. In Calbayog, Daanbantayan, and Puerto Princesa, recyclable wastes are the next dominating category of waste (**Figure 10**). These findings further highlight the need to develop recovery initiatives to address the large amount of generated recyclable and residual waste with potential for recycling.

2. Segregation

Following the four general waste classification outlined in RA 9003, segregation in certain study areas, such as Daanbantayan, typically categorizes the generated wastes into biodegradable waste, residual waste, recyclable, and special wastes. Other cities and municipalities follow a simpler categorization including Dipolog City, where wastes are separated according to only three classifications of biodegradable wastes, non-biodegradable wastes, and recyclable wastes. In Tandag City, biodegradable wastes are further separated into wet and dry wastes. Wet biodegradable wastes include kitchen waste, eggshells, dung, and tissue paper soiled with food residue, while garden wastes and laminated food containers are considered as dry biodegradable waste. Moreover, plastic recyclables like plastic bottles and single-layer films are considered as residual waste.

All cities and municipalities are implementing the "no segregation, no collection" policy within their respective areas. However, compliance to household segregation-at-source remains to be a major obstacle. An interview of 240 respondents in 2023 show 78% compliance to waste segregation in Puerto Princesa City. The city and municipality reports compliance rates of 85%, 40%, and 68% for Bulan, Daanbantayan, and Dipolog City, respectively (**Figure 11**). There are no reported numbers for Calbayog City and Tandag City.

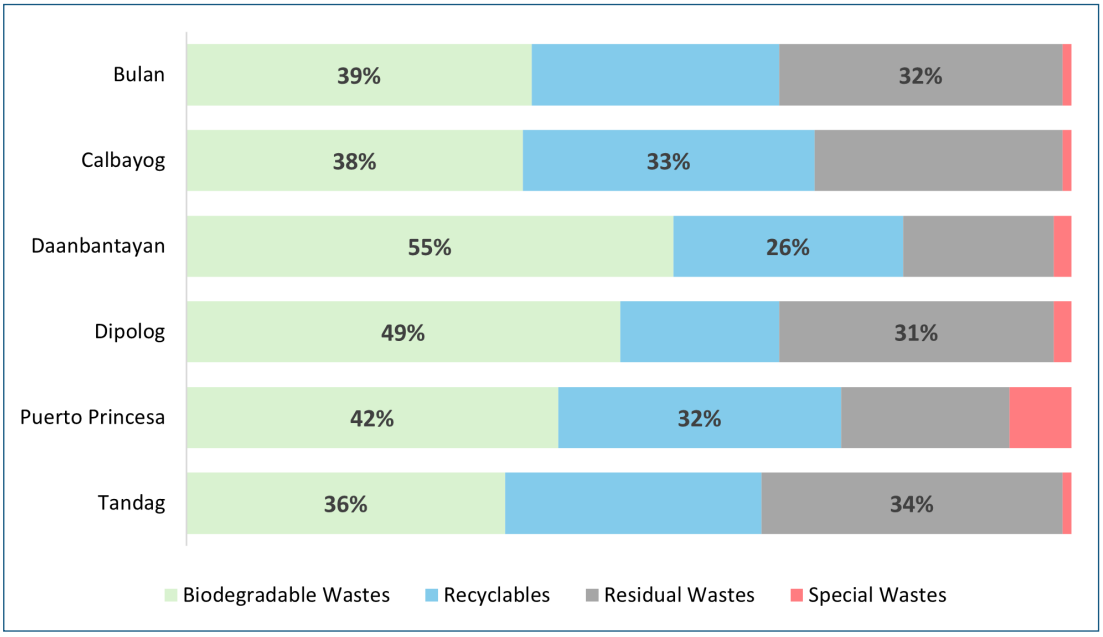

Figure 10. Waste Composition in Philippine Sites

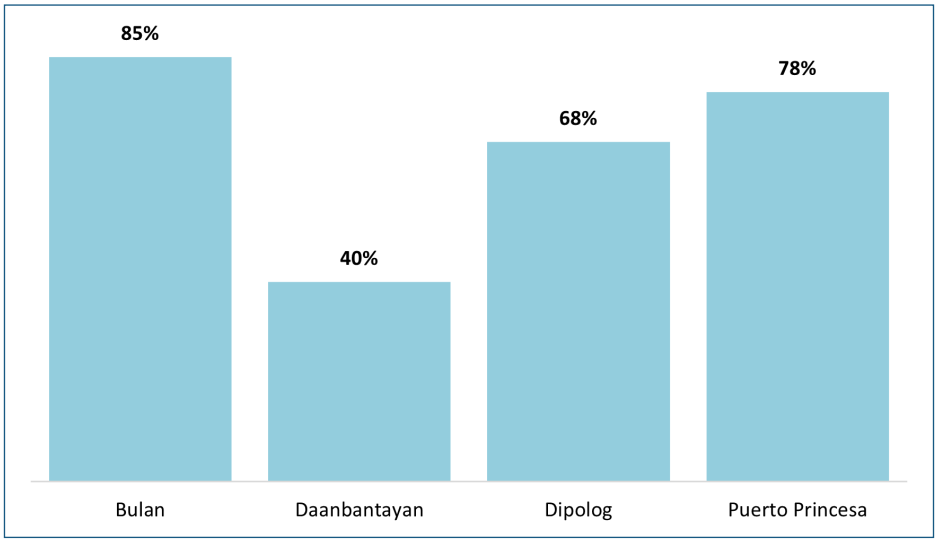

Figure 11. Reported Compliance Rates to Waste Segregation in Philippine Sites

A common observation among the households is the mixing of wastes by garbage collectors during waste collection, indicating the lax implementation of the segregation policy. The limited segregating bins and occurrences of missed areas during waste collection are also cited as primary reasons for not engaging in this practice. These findings further highlight the need to improve waste management infrastructure and ensure a reliable waste collection service is essential to encourage widespread participation in waste segregation.

3. Collection

Of the 6 local sites, Daanbantayan, Dipolog City, and Tandag City reported that all barangays are covered for collection, while Bulan and Puerto Princesa City exceed 90% collection coverage.[6] 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 (**Figure 12**).

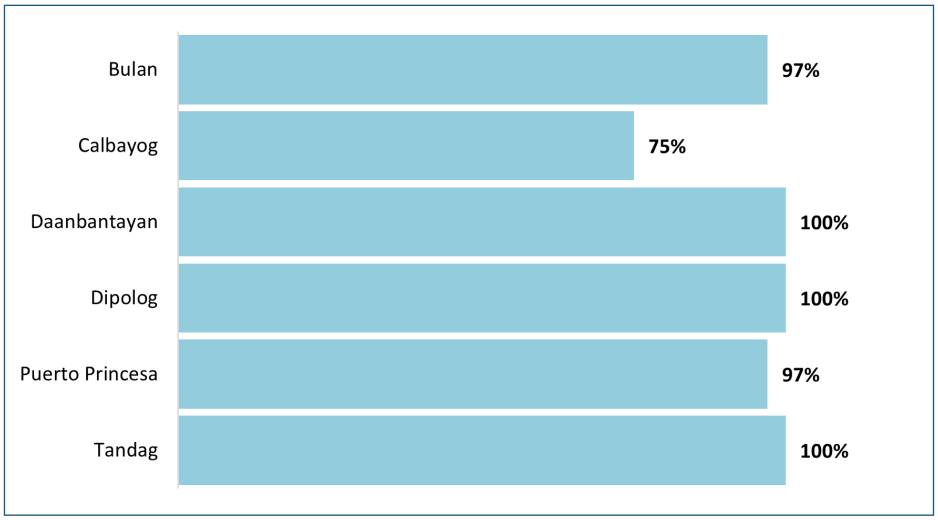

Figure 12. Reported Collection Coverage in Philippine Sites

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

For strict compliance with the "no segregation, no collection" policy, specific types of wastes are only collected on designated days, further encouraging the households to effectively sort their wastes. Special collection of healthcare wastes is done in certain hospitals in select urban and rural barangays in Calbayog City (**Figure 13**).

City/ Municipality	Weekday	Weekday	Weekday	Weekday	Weekday	Weekend	Weekend
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		

Figure 13. Waste Collection Schedule in Philippine Sites

While the majority of the barangays in the local sites are covered for waste collection, instances of missed collection arise due to several factors. Collection vehicle maintenance or unexpected breakdown often leads to limited collection areas since less vehicles will be available for usage.

Although collection coverage is high in Puerto Princesa city, the narrow streets prevent some of the collection trucks from accessing certain areas. This problem is prevalent in the city, resulting in about 16,000 metric tons of uncollected waste.

In most cities and municipalities, urban barangays are prioritized for waste collection, while only certain wastes are collected from rural barangays, making the collection less frequent in these areas. The lack of intuitive and functional segregating bins further discourages residents from practicing waste segregation. These circumstances ultimately lead to the illegal dumping of garbage into the open environment, which eventually contaminates the city or municipal waterbodies.

4. Recovery

All cities and municipalities have established their barangay MRFs in compliance with RA 9003 mandating the operation of an MRF in each barangay at the LGU level. In Daanbantayan and Dipolog City, all barangays have their individual MRFs. Meanwhile, about 94% and 90% compliance rates are reported in Calbayog City, and Bulan, respectively. Puerto Princesa City has 74% of its barangays equipped with MRFs, while Tandag City has 17 of 21 barangays, or 81%, with MRF (**Figure 14**). Most of these barangay MRFs primarily function as temporary storage areas and main pick-up points during waste collection. There is no additional processing such as cleaning, crushing, or washing of the delivered or collected recyclables in these facilities. The presented compliance does not differentiate whether the barangay MRFs are fully operational or not.

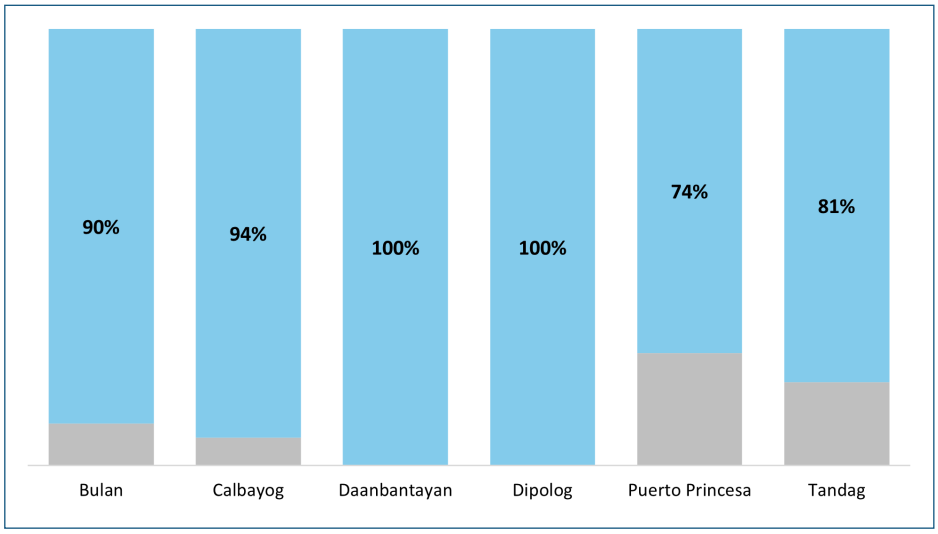

Figure 14. Reported Compliance to the Establishment of Barangay MRFs in Philippine Sites

Difficulties in maintaining the operations of Material Recovery Facilities (MRFs) persist at local sites. In Calbayog City, 136 out of 147 barangay MRFs are functional, while in Dipolog City, only 5 out of 21 barangay MRFs are maintained. The local government of Tandag City faces similar issues, with only 7 out of 17 barangay MRFs operational. Challenges in maintaining these MRFs include land acquisition, securing budget allocations for compensating personnel responsible for collecting and managing recyclables, low market demand for recyclables, and insufficient funding for maintenance.

Most processing of waste is done in each respective city or central MRFs (**Table 9**). These facilities house several equipment such as shredders and composters to process biodegradable waste and convert these into soil fertilizer. Plastic residual wastes such as single-use plastics and plastic bags are processed into pillows and bean bags in Daanbantayan, and plastic paver blocks in Dipolog City. Recyclables are further sorted and are sold to nearby junk shops. Calbayog City employs plastic processing by manual labor or "*mano-mano*" in the manufacture of eco-bags, tarpacks, backpacks, wallets, key chains, frames, gowns, dresses, display items, Christmas Parols (special and ordinary), etc., but the quantity is low that said efforts hardly make a dent on the quantity of plastic waste generated by the city.

Table 9. Waste Processing at Supporting MRFs

City/ Municipality	Supporting MRF Structure	Accepted Materials	Products and Other Activities
Bulan	Central MRF or CMRF *(cum RCA)*	• Biodegradable wastes • Plastic wastes	• Compost
Calbayog	• Pilot MRF • Market MRF • Central MRF *(beside SLF)*	• Biodegradable wastes (backyard and food waste) • Recyclable Plastic Wastes • Other recyclable wastes like, papers, tin cans, woods, rubber	• Soil conditioner/ • Fertilizer • Bags, Tarpacks • Backpacks, wallets • Gowns, Dresses • Frames • Christmas Parols (special and ordinary) • Throw Pillows • Training center
Daanbantayan	Central MRF *(beside SLF)*	• Biodegradable wastes • Recyclable Residual wastes with a potential for recycling	• Compost • Pillows and bean bags
Dipolog	City MRF	• Biodegradable wastes • Recyclables	• Soil conditioner • Hollow blocks (from crushed glass) • Plastic paver blocks
Puerto Princesa	City MRF *(in SLF complex)*	The City MRF does not function as an ideal MRF. Instead, it serves as a waiting area for visitors of the SLF complex.	
Tandag	Centralized MRF *(in ESWM Ecopark)*	• Biodegradable wastes • Recyclables	• Compost • Hollow blocks (from glass) • Floating docks • Eco-bricks

The role of junk shops and the informal waste members play a significant role in waste diversion (**Table 10**). Rigid plastics such as high-density polypropylene (HDPE) items, and other recyclable materials including glass, metals, and paper are commonly accepted in these facilities. Particularly in the cities of Dipolog and Tandag, polyethylene terephthalate (PET) bottles are often rejected due to low selling prices and the required large storage area.

In the municipalities of Bulan and Daanbantayan, junk shops buy PET bottles for Php 4.00/kg to 6.00/kg, while rigid HDPE items are priced between Php 5.00/kg to 8.00/kg. The high-value recyclable items include metals and e-waste, priced between Php 8.00/kg to 20.00/kg, and Php 10.00/kg, respectively.

5. Disposal

The local governments of Calbayog, Dipolog, and Puerto Princesa operate and maintain a sanitary landfill as the final disposal site for the waste generated in their city. Conversely, a Residual Containment Area (RCA) is utilized in Tandag City, Daanbantayan, and Bulan as the destination for their wastes (**Figure 15**). Particularly in Bulan, the Greenways Waste Venture Services supports the LGU in managing their CMRF that also serves as RCA, where processable waste is converted into refuse-derived fuel (RDF), with approximately 396 metric tons of plastic waste utilized annually. Unprocessed waste, meanwhile, is stored in the RCA before being transported to the sanitary landfill operated by IWA BESU Corporation in Albay.

While RCAs are equipped with necessary facilities to safely store residual and special wastes, RA 9003 mandates that a sanitary landfill be used as the ultimate disposal facility, prompting the local governments of Tandag City, Daanbantayan, and Bulan to construct their own RCAs. As of latest reports, Daanbantayan is collaborating with the Environmental Management Bureau (EMB) Region VII in building a Category 4 sanitary landfill while Tandag City is currently on the 3rd phase of the construction of its sanitary landfill. On July 19, 2024, cell number 1 of the constructed sanitary landfill had been turned over to Tandag City local government. Bulan, on the other hand has already acquired an ECC for the establishment of a Category II Sanitary Landfill.

Meanwhile, the local government of Dipolog City signed a partnership with Geocycle of Holcim, a cement manufacturing facility with co-processing, in August 2023, for the disposal of the city's residual waste, aiming to reduce the volume of waste that is sent to the city's landfill (Fumero, 2023).

Table 10. Number of Registered Junk Shops in Philippine Sites

City/Municipality	Number of Registered Junk Shops[a]
Bulan	6
Calbayog	13
Daanbantayan	2
Dipolog	9
Puerto Princesa	21
Tandag	5

[a] Data for each site was recorded on the following years: Bulan in 2019, Calbayog in 2024, Daanbantayan in 2023, Dipolog in 2024, Puerto Princesa in 2022, and Tandag in 2024

City/ Municipality	Sanitary Landfill	Residual Containment Area (RCA)
Bulan	■	✓
Calbayog	✓	
Daanbantayan	■	✓
Dipolog	✓	
Puerto Princesa	✓	
Tandag	✓	✓

✓ The facility is currently in use
■ The facility is included in the city plan or is currently under construction

Figure 15. Current Disposal Facilities in Philippine Sites

Methodology 5

A. Plastic Analysis and Characterization Study (PACS)

The Plastic Analysis and Characterization Study adopted the methods of the Waste Analysis and Characterization Study (WACS) guidelines from the National Solid Waste Management Commission (NSWMC) of the Philippines (NSWMC, 2020) and the Waste Wise Cities Tool (WaCT) by the United Nations Human Settlements Programme (UN-Habitat) with focus on plastics.

The most appropriate survey areas or the top three plastic pollution hotspots in the city were selected based on several key factors such as areas with a larger population share, active tourism, and fishing activities, limited to no municipal solid waste (MSW) collection service, and the absence of operational MRF or junk shops.

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**).

The number of household samples for the three selected barangays is calculated using ratio and proportion (**Equation 2**). An additional 10% contingency was accounted in case some of the cooperators were not able to consistently provide their waste during the 3-day PACS period.

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

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

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

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

Equation 2. Computing for the Sample Size per Barangay

For non-households, there must be at least one representative of the most dominant sub-categories. The recommended number of non-household samples for each category are summarized (**Table 11**) as adopted from the methods of WaCT to maximize the resources of the project (UN-Habitat, 2021). Fishing activities are prevalent in coastal communities; however, fish ports are not typically considered from the recommended sample size for non-households within the WaCT guidelines. The WACS guidelines were used to address this, as it provides the recommended unit for industries based on area (NSWMC, 2020).

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

A training session on PACS was held on August 31, 2023, to equip relevant LGUs, national government agencies, and local consultants from the partner sites with the necessary knowledge and skills for the implementation of PACS. The session aimed to orient participants with a comprehensive understanding of PACS procedures, protocols, and their respective roles.

Table 11. Sample Size for Non-Households

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

Following the national training, a local training session for the local PACS team was held a day before the start of the PACS activities. This training further honed their readiness and competence to enable them to contribute effectively to the execution of PACS.

An orientation with the PACS household and non-household cooperators who agreed to participate in the study was also held on the same day as the local training. The aim of the orientation is to inform the cooperators about their responsibilities and the important instructions to remember. After the orientation, color-coded plastic bags were distributed to the cooperators. Additionally, the cooperators who failed to attend the event due to conflict on schedule were visited to provide them with their orientation materials and plastic bags for PACS.

The activity proper was conducted over three consecutive days, including a one-day trial or dry run prior to the actual PACS, to save on resources while still covering recommended variations in days such as a market day, a weekend, and an ordinary day or weekday (NSWMC, 2020). Each participating household and establishment were given a total of 20 color-coded plastic bags wherein five plastic bags were used each day to represent the different waste categories for the 4-day PACS. The plastic bags were collected every morning on the day after the waste has been generated. In the sorting area, the set of trash bags were sorted per source into categories and placed in respective containers. The sorted waste was disposed of accordingly based on the agreed disposal plan.

Processing and analysis of data gathered during the 4-day PACS includes 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 3**). This WGR is used to estimate the total waste generation rate of the study area and the projected future waste generation amounts.

The plastic WGR for each household is computed using the amount of collected plastic items from the sample (**Equation 4**).

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

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

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

Equation 4. Formula for Computing Household Plastic Waste Generation Rate

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

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

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

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

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

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

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

Equation 7. Formula for Daily Household Waste Generation

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

Equation 8. Formula for Daily Non-Household Waste Generation

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

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

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

The total daily waste generation of the survey areas is the sum of the total household and non-household waste generation (**Figure 16**). It should be noted, however, that the non-household waste generation is limited to a number of establishments considered in this study (**Table 11**), which may not reflect other types of non-household sources that may be operating in a survey area.

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

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

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

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

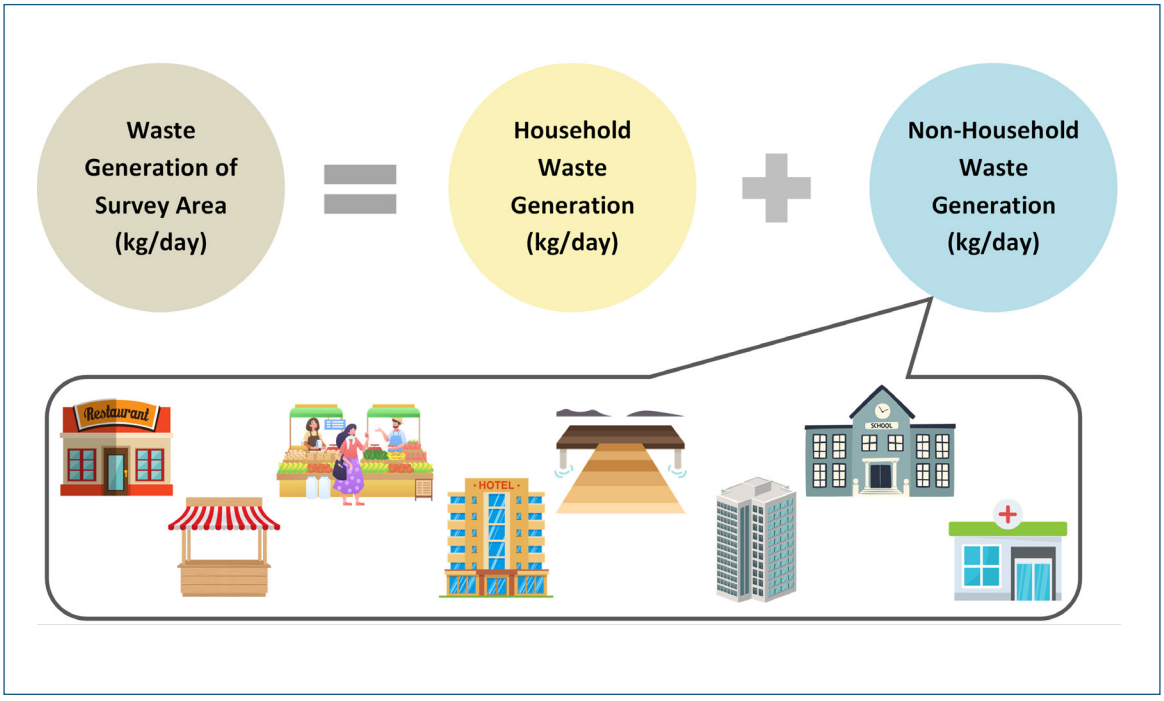

Figure 16. Calculation of the Total Daily Solid Waste Generation of a Survey Area

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

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

Plastics Analysis and Characterization Study orientation in Brgy. Tapilon, Daanbantayan, Cebu.

Plastic Analysis and Characterization Study (PACS) Results

6

The analysis and characterization of waste in the three surveyed coastal barangays at each site revealed that the combined household and non-household WGR ranges from 0.17 kg/cap/day to 0.48 kg/cap/day. The primary categories of general waste include recyclables, biodegradable waste, and residuals with potential for recycling.

Specifically for plastic waste, the combined household and non-household plastic WGR in the surveyed barangays is reported to be between 0.05 kg/cap/day and 0.10 kg/cap/day. The plastic waste is mostly comprised of diapers and napkins, PET items, and PP items.

The general weather conditions during the conduct of the study are clear and sunny skies, with no observed precipitation throughout the waste sample collection and sorting periods.

A. Household Waste Generation and Composition

A total of 377 households consisting of 2,112 individuals were successfully sampled from the six Philippine sites.

1. Generation

The average household waste generation rates across the surveyed coastal cities and municipalities in the Philippines ranges from 0.16 kg/cap/day to 0.39 kg/cap/day (**Figure 17**). Among the sites, Calbayog City exhibits the lowest WGR, while Tandag City records the highest. The national average for household general waste generation, based on a weighted average from the six coastal cities and municipalities, is calculated at about 0.29 kg/cap/day.

In a similar way, the plastic WGRs among the households show variation, ranging from as low as 0.05 kg/cap/day in Bulan and Calbayog City to as high as 0.10 kg/cap/day in Daanbantayan. The national average based on the six sites is about 0.08 kg/cap/day.

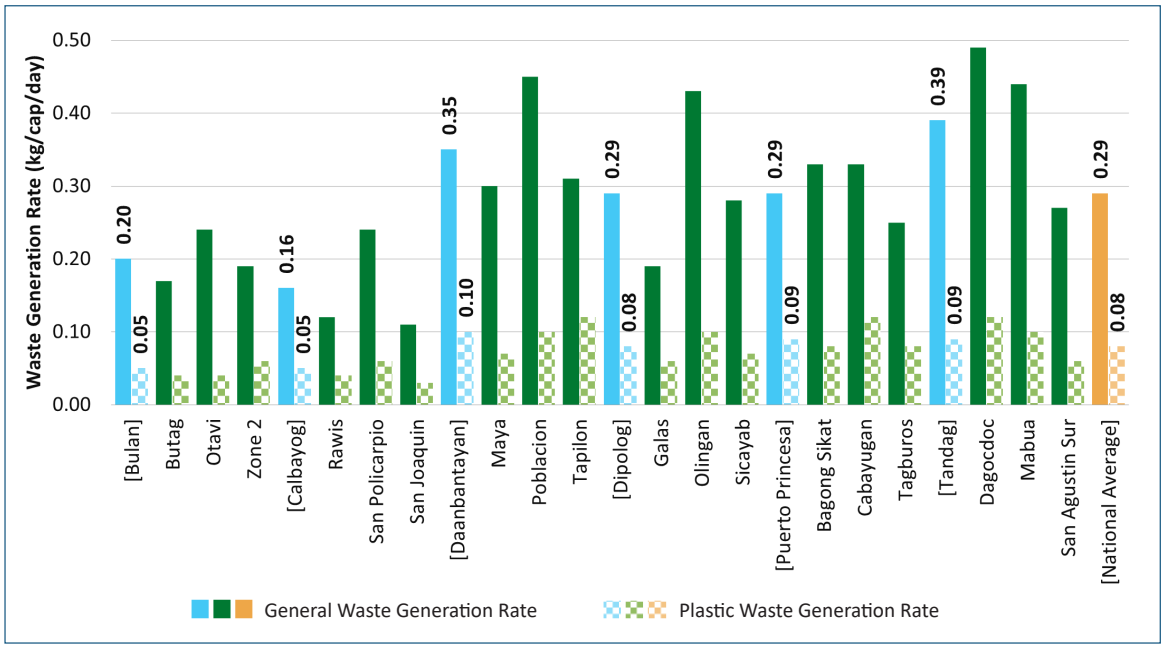

Figure 17. Household General and Plastic Waste Generation Rates (kg/cap/day) of Surveyed Coastal Barangays in Philippine Sites

2. Composition

The general household waste composition across surveyed Philippine sites shows that recyclables are the dominant category in all locations except in Bulan, where biodegradable waste is the most prevalent (**Figure 18**). Among the sites, Dipolog has the highest proportion of recyclables at 51%. Biodegradable waste constitutes between 17% and 46% of household waste, while recyclables account for 20% to 51%. The weighted average based on these six sites indicates that recyclables make up about 42% of household waste, followed by biodegradable waste at 23%, and residuals with potential for recycling at 19%. This household waste composition highlights a substantial opportunity for recovery and diversion of waste, particularly in enhancing recycling processes.

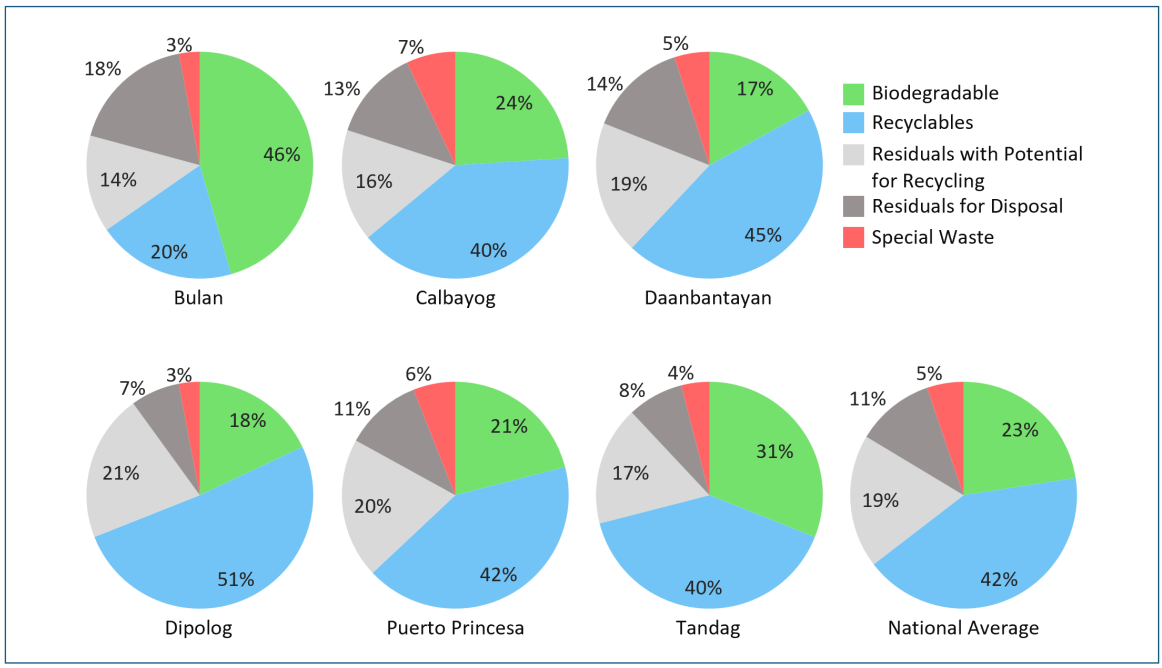

Figure 18. General Waste Composition of Household Waste in Philippine Sites

The composition of plastic waste in household waste across surveyed sites varies, with plastic waste comprising 23% to 30% of the total household waste (**Figure 19**). Puerto Princesa City has the highest plastic waste composition at 30%. In Calbayog City, Dipolog City, Puerto Princesa City, and Tandag, recyclable plastics form the predominant category, while in Bulan and Daanbantayan, residual plastics for disposal are the most prominent. Nationally, the average composition of plastic waste is at about 28% of household waste, with recyclable plastics such as PET and PP, making up 10%. This is followed by residual plastics for disposal, including diapers and napkins, accounting for 8% of the household waste.

Fishermen commonly reside along coastal areas, where they usually bring home their tools for fishing. Household-generated fishing-related waste, such as fish nets, fishing gear, and other fishing tools, varies across surveyed coastal areas, ranging from 0.001% in Tandag City to 0.33% in Bulan. Household fishing-related waste, meanwhile, is at 0.13% in Puerto Princesa City, 0.03% in Dipolog City, and 0.01% in Daanbantayan. Notably, PACS results in Calbayog City indicate that households do not generate any fishing-related waste. On a national level, the average contribution of waste from fishing activities is about 0.10% of household waste generation from coastal barangays.

B. Non-Household Waste Generation and Composition

A total of 71 non-households, which include 37 commercial establishments, six industries, and 28 institutions representing the surveyed coastal barangays from each city and municipality, were sampled.

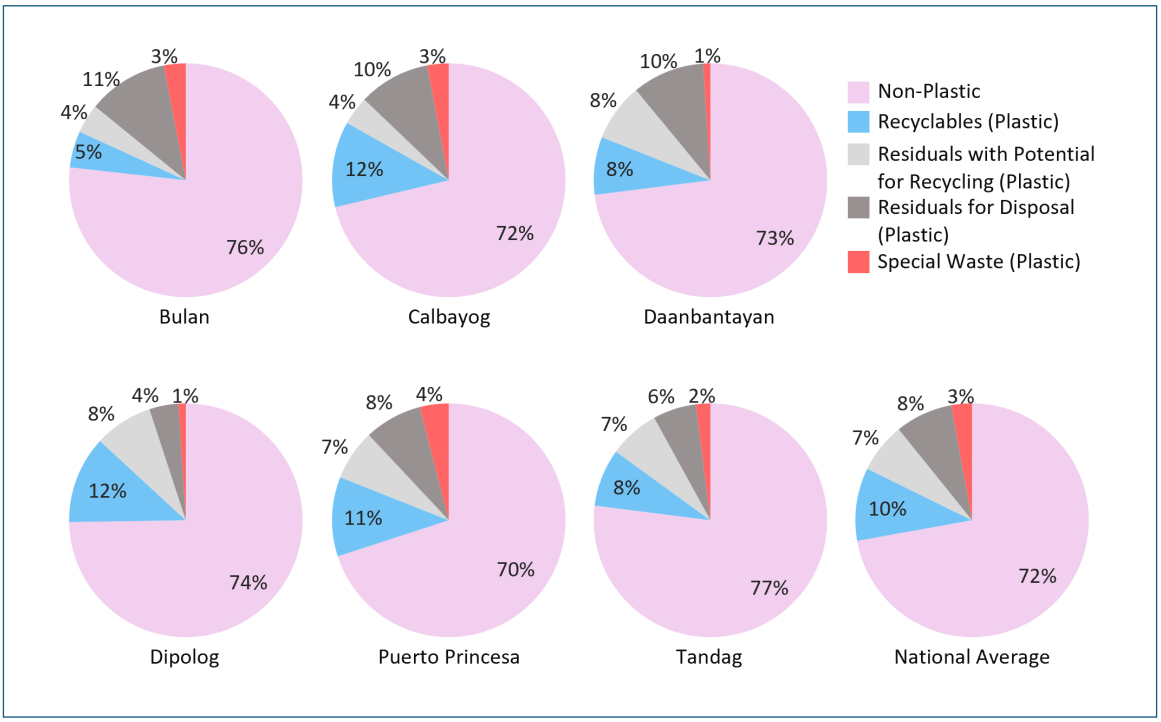

Figure 19. Plastic Waste Composition of Household Waste in Philippine Sites

1. Generation

In the surveyed coastal barangays across the various sites, non-household waste generation varies significantly, ranging from 158 kg/day in Calbayog City to 1,590 kg/day in Tandag City (**Figure 20**). This variation in waste generation can largely be attributed to differences in the type and number of non-households. The selected barangays for sampling might have fewer non-households as compared with other barangays. 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.

Regarding plastic waste, non-households from surveyed coastal barangays generate between 21 kg/day and 323 kg/day. Puerto Princesa City generates the highest plastic waste from non-households among the sites. Commercial establishments are the primary contributors of plastic waste in all sites, except in Calbayog and Dipolog, where institutions and industries produce the largest share, respectively.

2. Composition

The composition of non-household waste in surveyed coastal barangays across various Philippine sites shows a diverse range of waste types (**Figure 21**). Biodegradable waste is the predominant waste category from non-households in Bulan, Dipolog City, Puerto Princesa City, and Tandag City, while recyclables are the most prominent category in Calbayog City and Daanbantayan. The proportion of biodegradable waste varies from 21% to 57%, and recyclables range from 23% to 50% of non-household waste.

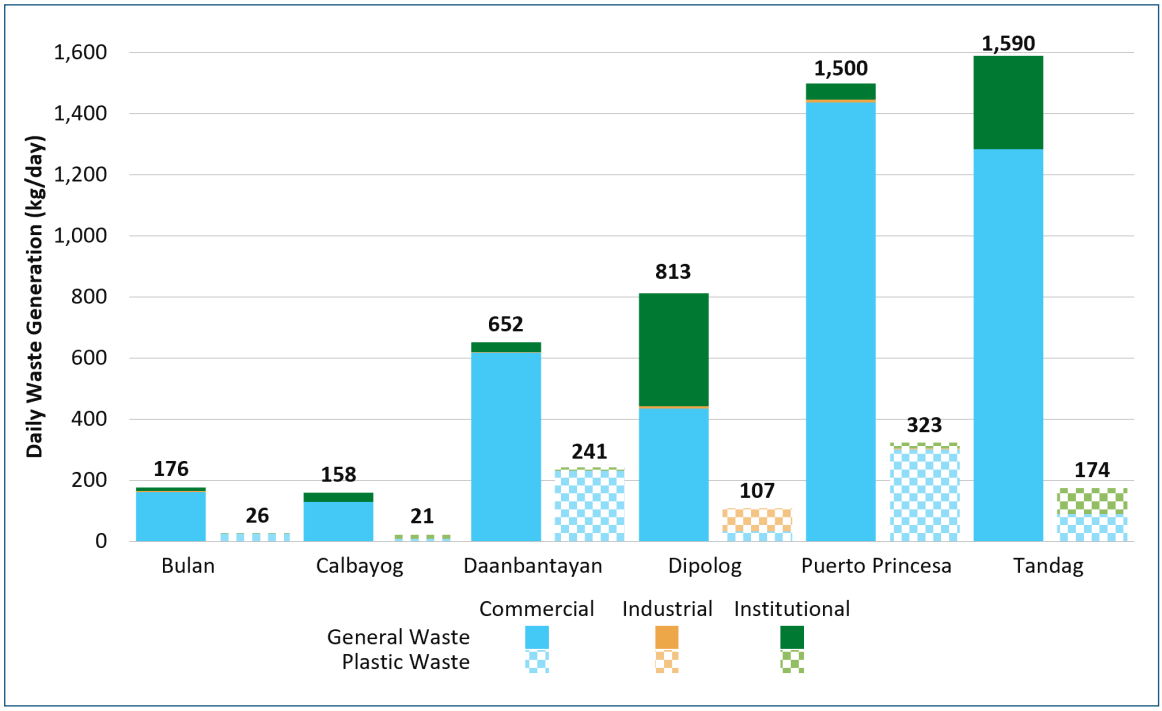

Figure 20. Non-Household Daily General and Plastic Waste Generation (kg/day) of Surveyed Coastal Barangays in Philippine Sites

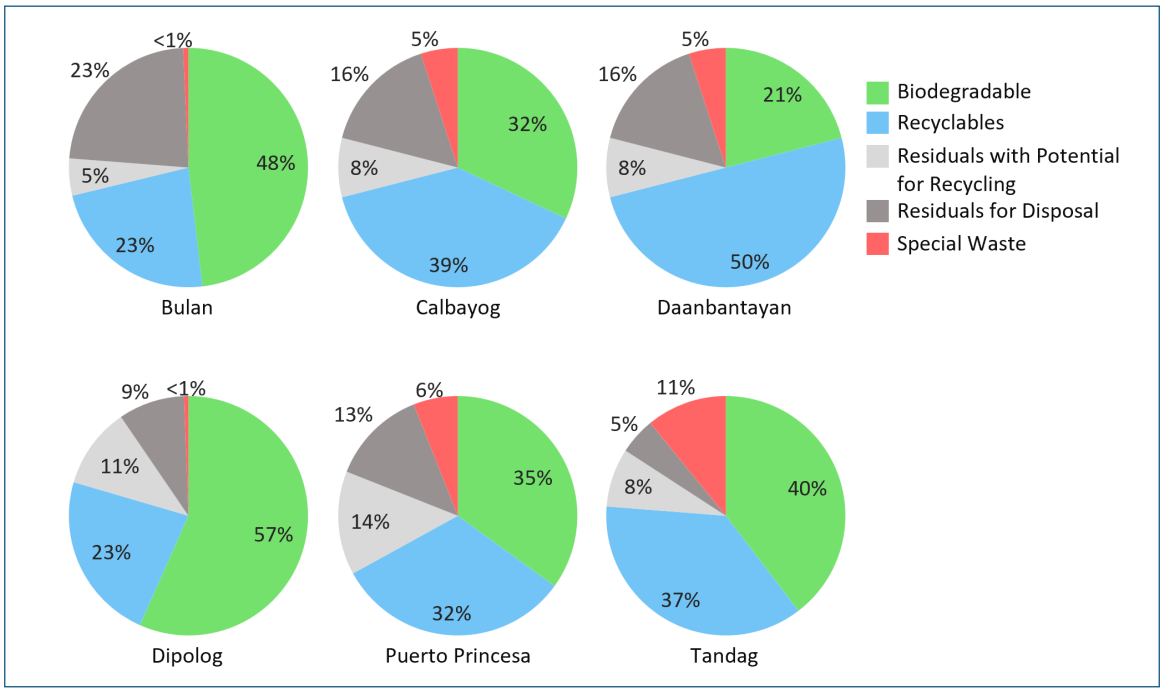

Figure 21. General Waste Composition of Non-Household Waste in Surveyed Barangays in Philippine Sites

The composition of plastic waste in non-household sources across the surveyed coastal barangays in the Philippines varies significantly (Figure 22). Plastic waste constitutes about 17% to 32% of the total non-household waste. Among this, recyclable plastic waste, ranging from 5% to 17%, is the most substantial category in Daanbantayan and Tandag City. Residual plastics for disposal range from 2% to 13%, showing the largest portion of plastic waste in Bulan and Calbayog City. Residual plastics with potential for recycling, meanwhile, account for 4% to 12% of non-household waste, which is the most significant in Dipolog City and Puerto Princesa City.

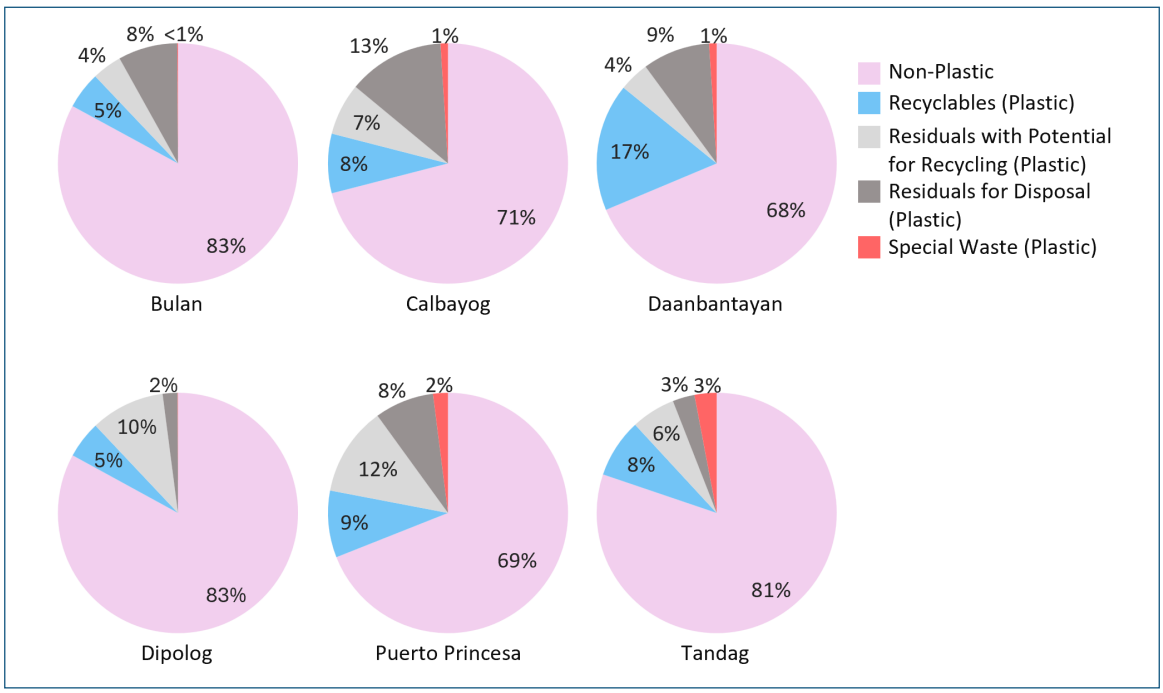

Figure 22. Plastic Waste Composition of Non-Household Waste in Surveyed Barangays in Philippine Sites

C. Combined Waste Generation and Composition of Surveyed Coastal Barangays

1. Generation

In the surveyed coastal barangays in the Philippine sites, the total combined daily general waste from both households and non-households varies significantly, ranging from 2,701 kg/day in Bulan to 14,030 kg/day in Dipolog (**Figure 23**). This wide range in waste generation is primarily influenced by the population and the size and type of non-household entities operating within these barangays. Notably, household waste comprises a substantial majority of the total municipal solid waste from the surveyed barangays of each site, accounting for about 82% to 95%. Additionally, the combined general WGR across the sites varies from as low as 0.17 kg/cap/day in Calbayog City to as high as 0.48 kg/cap/day in Tandag City.

In terms of plastic waste, the combined generation from the surveyed coastal barangays of the Philippine sites range from 654 kg/day in Bulan to 3,538 kg/day in Dipolog City. Additionally, the plastic WGR among these barangays varies from 0.05 kg/cap/day to 0.10 kg/cap/day. Notably, the highest plastic WGRs are observed in the surveyed coastal barangays of Daanbantayan, Puerto Princesa City, and Tandag City, each significantly contributing to the plastic waste generation in their respective areas.

2. Composition

The general waste composition of combined household and non-household waste in surveyed coastal barangays across various Philippine sites presents variation in waste types (**Figure 24**). Biodegradable waste, which ranges from 19% to 46% of the total waste composition, is the most dominant category in Bulan and Tandag City. Recyclables, meanwhile, comprise between 20% and 49% of the total waste, forming the largest portion in the surveyed barangays of the rest of the sites.

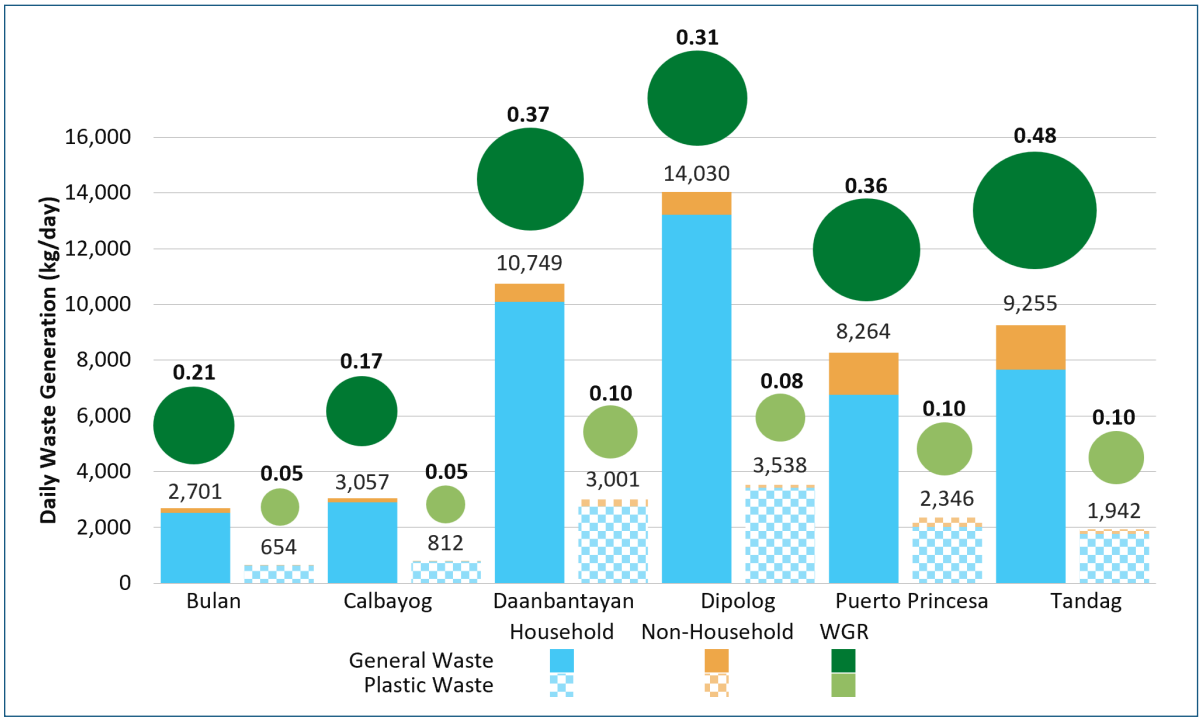

Figure 23. Combined Household and Non-Household Daily General and Plastic Waste Generation (kg/day) and Waste Generation Rates (kg/cap/day) of Surveyed Coastal Barangays in Philippine Sites

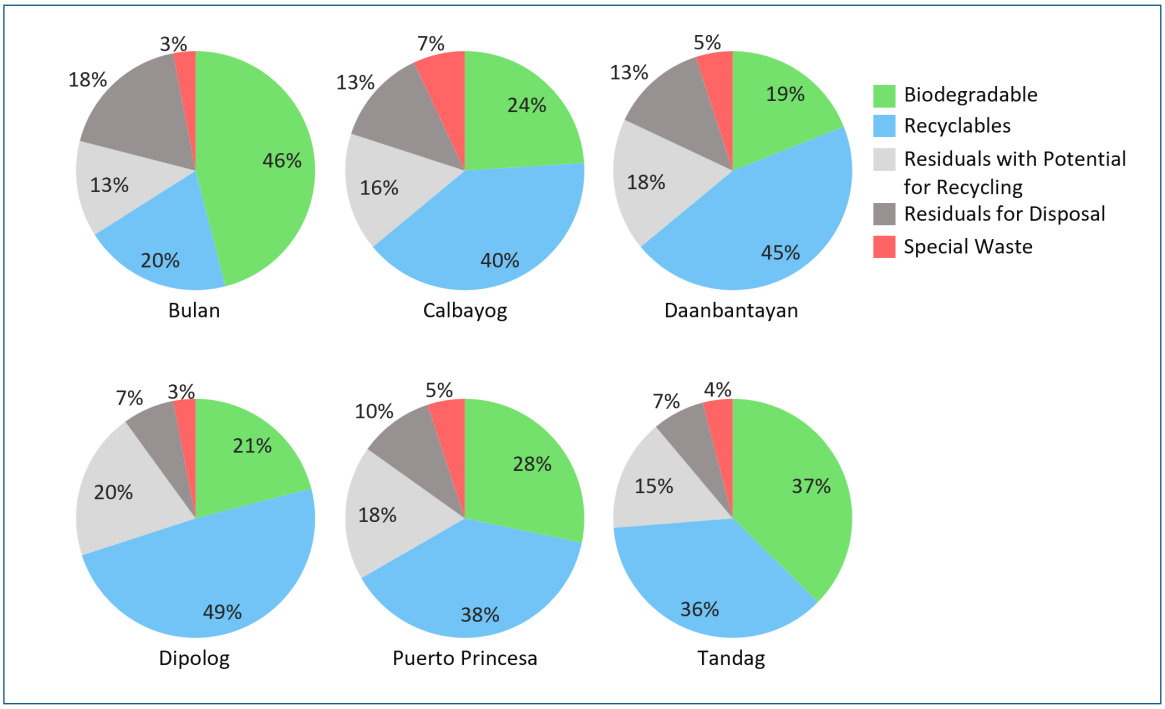

Figure 24. General Waste Composition of Combined Household and Non-Household Waste in Surveyed Barangays in Philippine Sites

Plastic waste generated from the combined household and non-household sources across the surveyed coastal barangays varies at about 21% to 29% of the total waste (**Figure 25**). Recyclable plastics, which range from 5% to 12%, are the predominant type of plastic waste in all sites, except in Bulan, where residual plastics for disposal are the most prominent. Residual plastics with potential for recycling make up between 4% and 8%, while residual plastics for disposal range from 4% to 11% of the total waste. Special waste containing plastic components is relatively low, accounting for 1% to 4%.

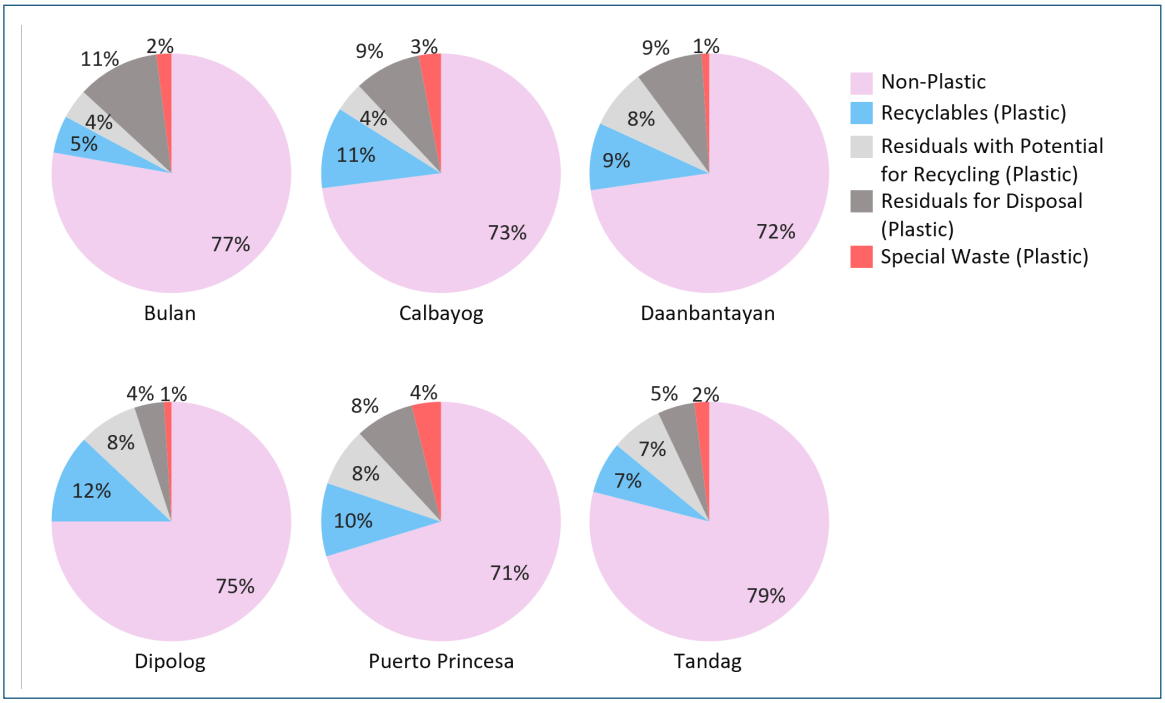

Figure 25. Plastic Waste Composition of Combined Household and Non-Household Waste in Surveyed Barangays in Philippines Sites

D. Projected Household Waste Generation of Coastal Barangays

The average daily waste generation of households within the sampled coastal barangays 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 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 are obtained based on the corresponding WGRs (Section VI.A.1) and the projected population of coastal barangays of each site (Table 12 and Figure 26). The general waste generated by the households from these sites ranges from 9,130 kg/day to 95,345 kg/day. The plastic waste generated, meanwhile, varies from 2,282 kg/day to 29,590 kg/day. Puerto Princesa City has the highest general and plastic waste generation, which is attributed to the majority of its barangays classified as coastal due to its location in an island province.

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

Table 12. Daily Household Waste Generation of Coastal Barangays of Philippine Sites

City/Municipality	2023 Population of Coastal Barangays	General Waste		Plastic Waste	
		WGR (kg/cap/day)	Daily Generation (kg/day)	WGR (kg/cap/day)	Daily Generation (kg/day)
Bulan	45,648	0.20	9,130	0.05	2,282
Calbayog	208,092	0.16	33,295	0.05	10,405
Daanbantayan	84,296	0.35	29,504	0.10	8,430
Dipolog	71,391	0.29	20,703	0.08	5,711
Puerto Princesa	328,775	0.29	95,345	0.09	29,590
Tandag	53,890	0.39	21,017	0.09	4,850

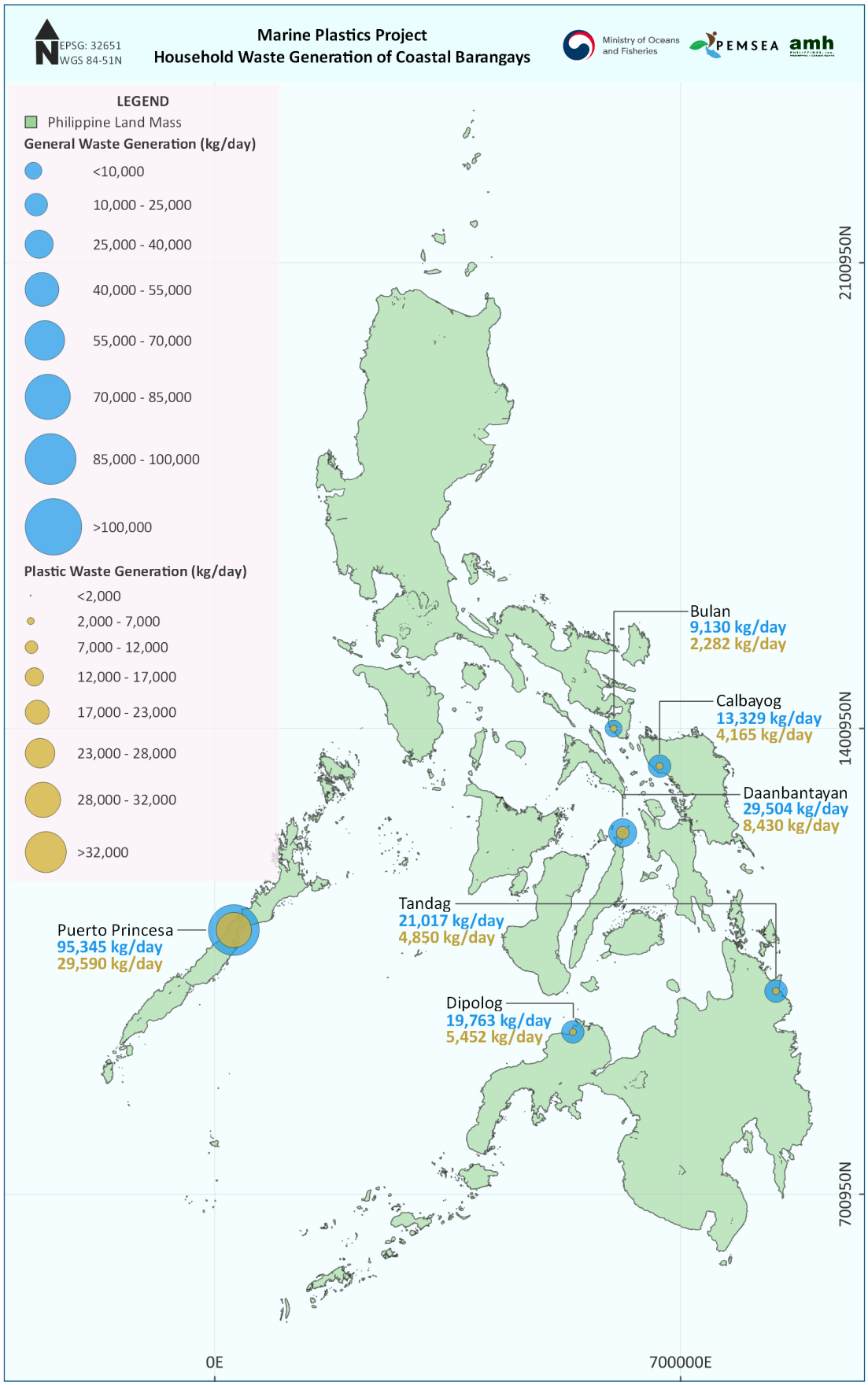

Figure 26. Household Waste Generation of Coastal Barangays in Philippine Sites


Bulan Municipality, Sorsogon


Daanbantayan Municipality, Cebu


Puerto Princesa City, Palawan


Dipolog City, Zamboanga Del Norte


Calbayog City, Samar


Tandag City, Surigao del Sur

Plastics Analysis and Characterization
Study in 6 project sites in the Philippines.

7 Knowledge, Attitude, and Practice (KAP) Survey Results

Results of the KAP survey highlight the purchasing habits of the respondents in buying plastic products in small quantities for their basic needs. Most plastic products bought are seasoning packages such as soy sauce and salt in single-film layer, and personal care items like shampoo and soap in laminated sachets. The frequent buying pattern of these packaged items, typically on a daily basis or more than once a week, is expected due to the small quantities involved.

This survey provided insights into the community's practices and awareness on solid waste management. Despite the majority that practices waste segregation, serious concerns on the limited knowledge on the purpose of segregation at-source, poor segregation infrastructure, and missed areas during waste collection reflect challenges that contributes to improper waste disposal of plastic wastes into the open environment.

Programs concerning the environment, particularly on the management of plastic wastes, are acknowledged. However, nonconformity with these policies persists, underscoring the crucial need to strengthen information and education campaigns on waste management. In addition, opportunities for plastic waste valorization should be intensified as final disposal through collection of the city LGU remains to be the preferred method for both low and high value plastic wastes.

The environmental efforts of the individual city LGUs of the studied cities and municipalities are commendable. However, more stringent enforcement of plastic ordinances, enhanced information campaigns, and strengthened collaboration between relevant stakeholders are essential in effectively managing solid waste.

A. Demographic Profile

Majority of the respondents in the priority cities and municipalities are female, except for Puerto Princesa City, where male respondents exceed the female interviewees by 10% (**Table 13**).

Table 13. Gender Composition of Respondents in Philippine Sites

City / Municipality	Male Respondents	Female Respondents
Bulan	19%	81%
Calbayog	15%	85%
Daanbantayan	24%	76%
Dipolog	36%	64%
Puerto Princesa	55%	45%
Tandag	9%	91%

The majority of the respondents from all cities and municipalities live within the priority barangays between 26 years to 50 years. A substantial duration of residence in a location reflects a strong familiarity with the environment and a deeper understanding of policy changes.

The size of households is essential to understand the amount and type of waste generated. Most respondents from Bulan, Calbayog City, Daanbantayan, and Tandag City have 5 to 10 members, while interviewed participants from the cities of Dipolog and Puerto Princesa belong to small households of less than 5 members.

Most of the respondents in Bulan, Daanbantayan, and Dipolog City receive a household monthly income between Php 1,001 to Php 5,000, while majority of the interviewed cooperators in Calbayog City, Puerto Princesa City, and Tandag City have a monthly income between Php 10,001 to Php 25,000 (**Table 14**). This income distribution among the cities and municipalities 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 living in five of the 6 cities and municipalities. In Calbayog City, most respondents are daily wage earners or those that do not receive a regular income.

Table 14. Monthly Income of Surveyed Households in Philippine Sites

Monthly Income (Php)	Bulan	Calbayog	Daanbantayan	Dipolog	Puerto Princesa	Tandag
25,000 and above	2%	9%	15%	4%	43%	7%
10,001 – 25,000	3%	**37%**	13%	10%	**57%**	**42%**
5,001 – 10,000	24%	33%	30%	30%	0%	36%
1,001 – 5,000	**64%**	18%	**42%**	**45%**	0%	13%
1,000 and below	8%	3%	0%	10%	0%	1%

While the frequency of purchasing plastic products in Philippine sites vary for each studied city and municipality, KAP survey reveals that majority of the interviewed households buy plastic items more than once a week or on a daily basis (**Figure 27**). Plastic products that are often bought include food seasonings in sachets and single-film wrappers such as soy sauce, salt, and vinegar, personal care items in laminated sachets, and beverages like instant coffee and soda in plastic bottles.

B. Waste Management

Waste segregation is primarily practiced in 5 of 6 study sites, with 94% compliance rate in Tandag City, and 65% compliance in Bulan. The cities and municipality of Calbayog, Daanbantayan, and Dipolog reported 73%, 70%, and 79% compliance rates, respectively. In Puerto Princesa practices 67% do not engage in waste segregation, while 33% are trying to adopt the practice (**Table 15**).

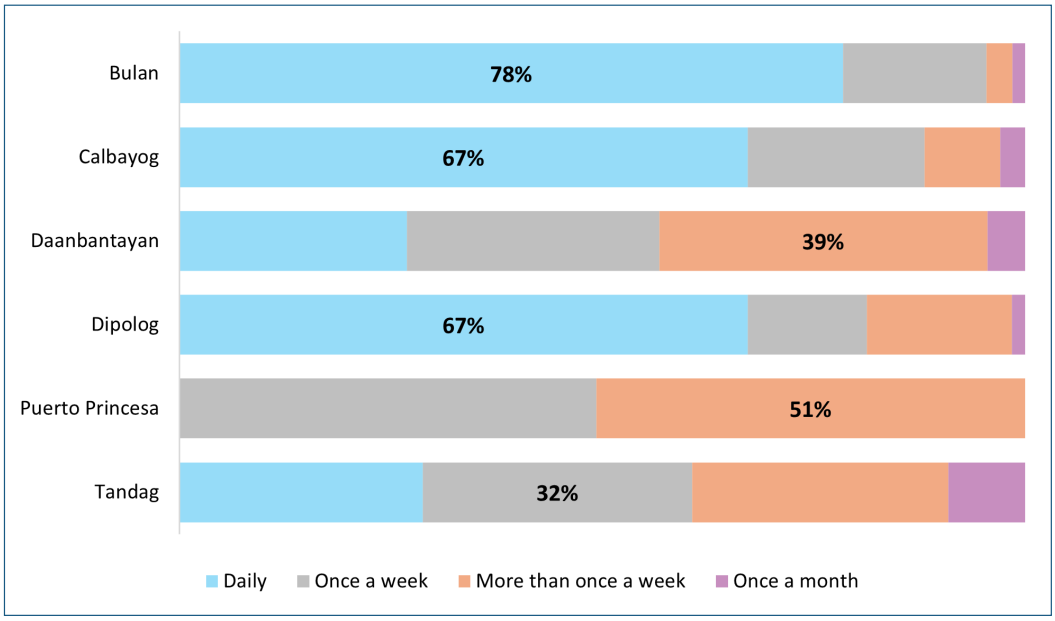

Figure 27. Frequency of Purchasing Plastic Products in Philippine Sites

Table 15. Waste Segregation Efforts in Philippine Sites

City / Municipality	Practicing segregation	Trying to adopt the practice	Not practicing segregation
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%

Respondents who do not practice or are trying to practice waste segregation cited several reasons for not involving themselves in this activity. The majority of interviewed participants in Bulan and Calbayog City claim occurrences of the garbage being mixed by collectors during waste collection, which renders their separation of wastes ineffective. In Puerto Princesa City, the main problem is attributed to the limited knowledge of the community on the purpose of waste segregation. Moreover, the lack of time and poor segregation infrastructure, evident by the lack of separate bins, further discourage residents to effectively sort their wastes.

The KAP survey reveals a wide range of responses on the frequency of waste collection in the priority barangays in Philippine sites. Collectively, the majority of the respondents report that they receive collection services not on a daily basis, but one to six times a week (**Figure 28**).

In addition, some of the participants claim to receive no collection services at all, which poses a critical concern as missed areas are potential reasons for improper waste disposal into the open environment.

Particularly in Tandag City, these inconsistencies, which are deviations from the city plan of daily collection of wastes, reveal issues on timely and effective information dissemination.

Regarding waste disposal, collection by the local government remains to be the preferred method of most respondents (**Figure 29**). Certain types of plastic wastes, such as PVC and PET, are typically sold to nearby junk shops, particularly in Bulan and Daanbantayan. Most plastic types are primarily collected and sent to the city or municipality's respective landfill or Residual Containment Area (RCA).

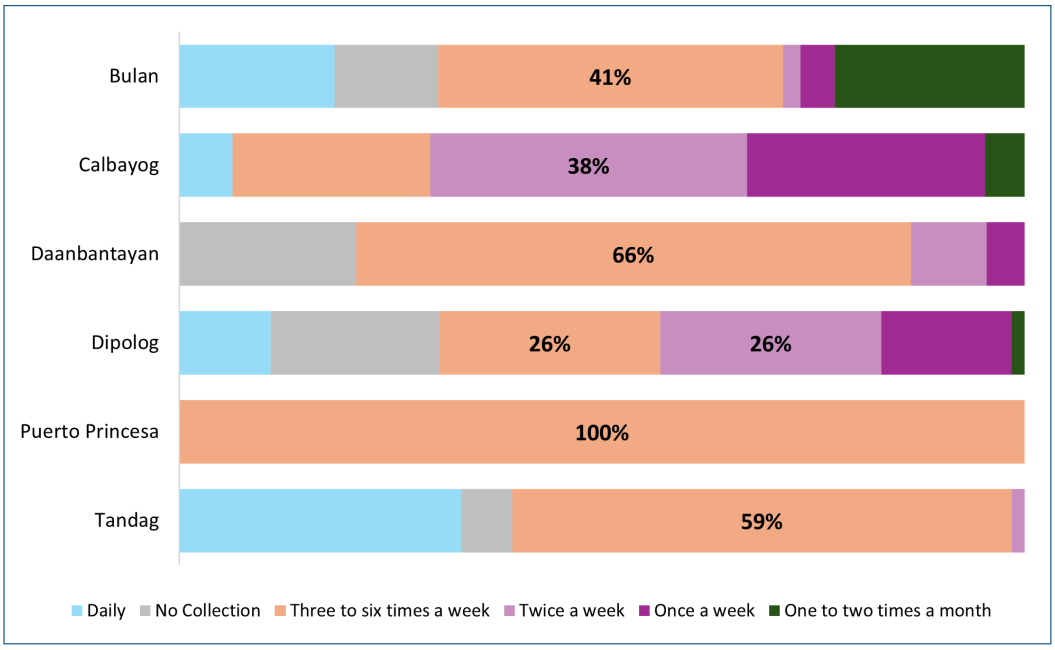

Figure 28. Frequency of Waste Collection in Philippine Sites

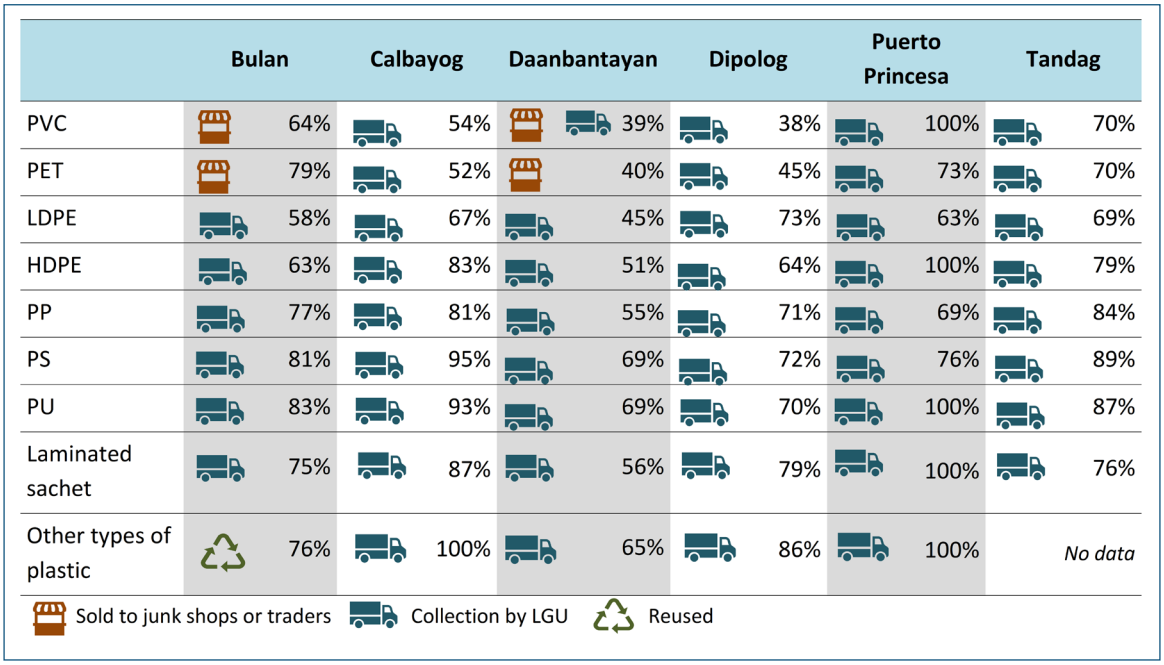

Figure 29. Waste Disposal in Philippine Sites – Plastic Waste

A similar pattern can be observed in the disposal of general waste (**Figure 30**). While collection by the local government is the primary choice for most respondents, some general waste like leftover food, paper and cardboard waste and glass bottles are commonly reused, burned, or sold to junk shops.

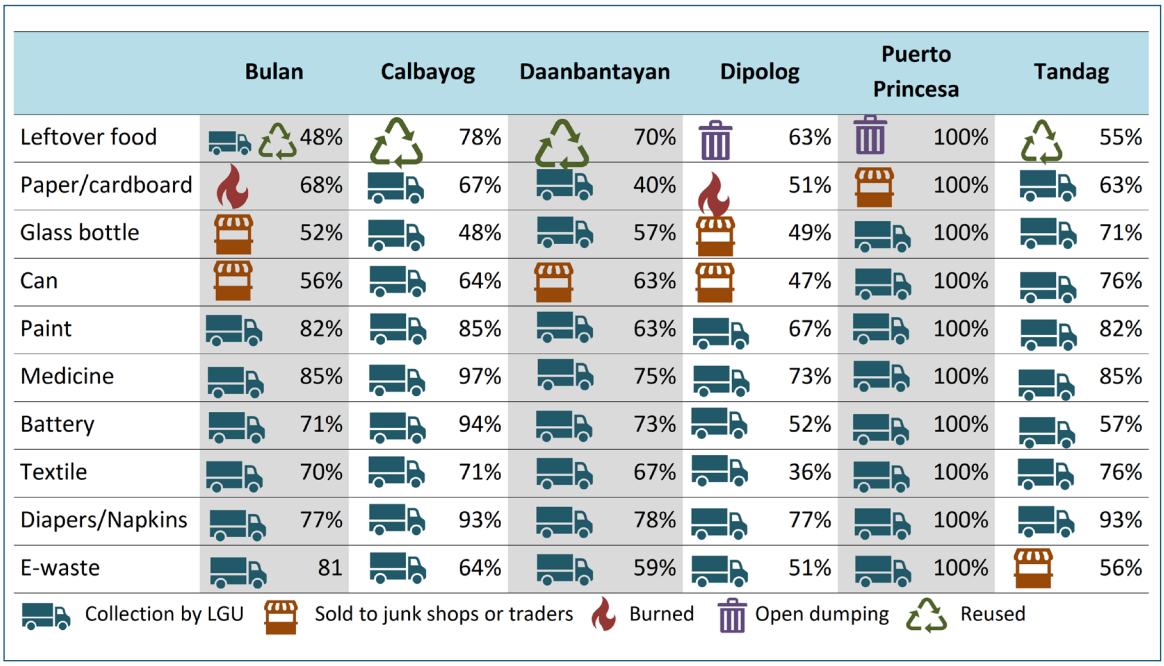

Figure 30. Waste Disposal in Philippine Sites – Non-plastic Waste

C. Environmental Status, Awareness, and Care

Although the KAP survey shows a variety of responses regarding the increase in environmental pollution over time, dominant answers reveal that there have been minimal to no environmental changes. In Daanbantayan and Tandag City, where most respondents claim to notice environmental change, the overall summation of the results still lean towards slight to no observed changes (**Figure 31**).

The majority of the respondents in all studied cities and municipalities are aware of the income opportunities from solid waste. Plastic, glass, and metal items are the common materials seen with substantial value (**Figure 32**).

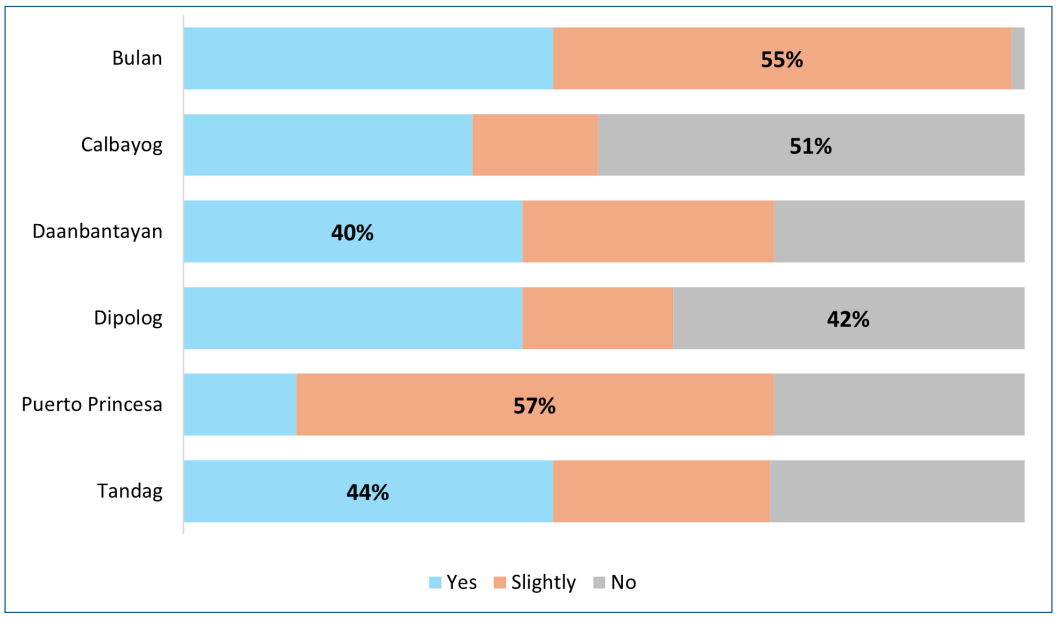

Figure 31. Perception on Environmental Pollution Increase Over Time

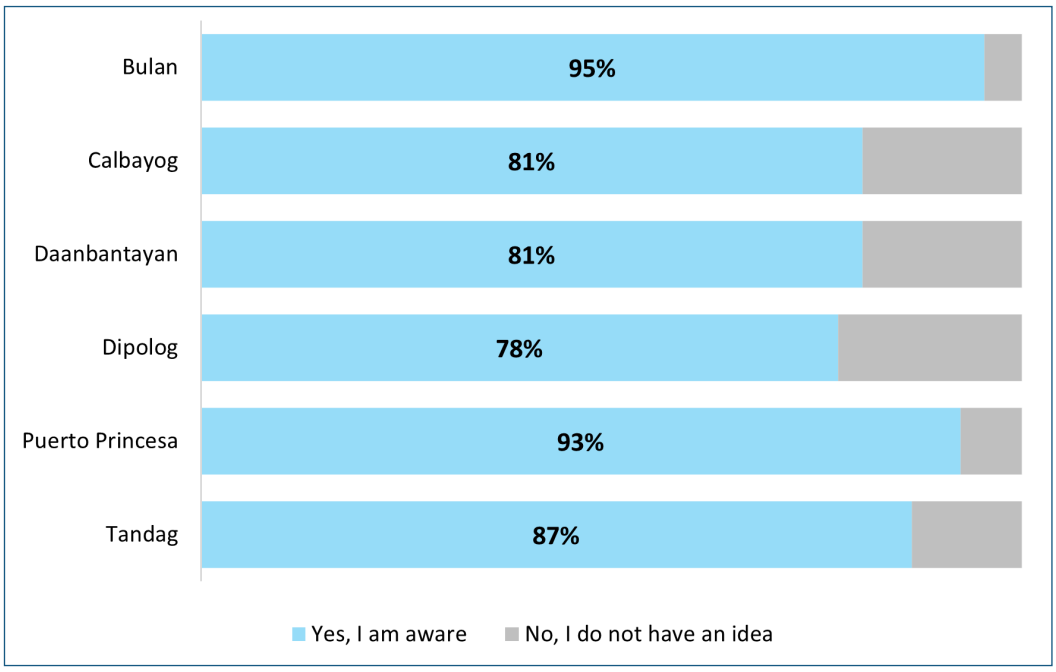

Figure 32. Awareness on Income Opportunities from Solid Waste

Apart from Puerto Princesa City, most of the respondents in the interviewed cities and municipalities are familiar with environment-related programs within their areas. Specifically in the cities of Dipolog and Tandag, street sweeping activities and river cleanups organized by community-based groups are cited as the known activities concerning the environment. On the other hand, the low level of awareness in Puerto Princesa City underscores the need for more effective and robust educational campaign strategies to encourage active involvement of the community (**Figure 33**).

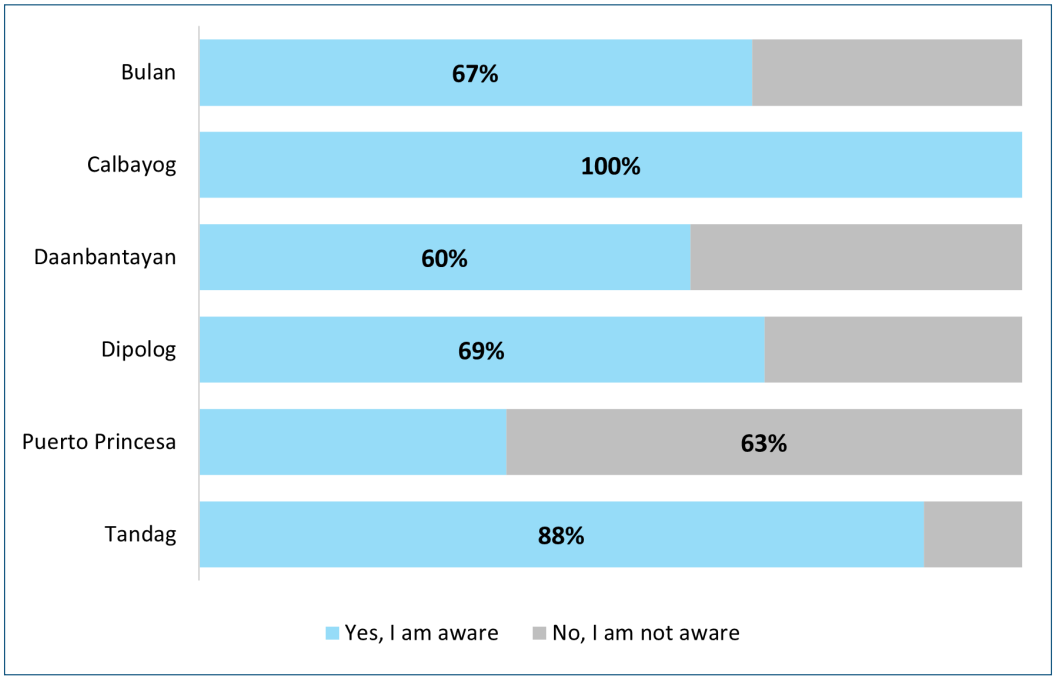

Figure 33. Awareness on Programs Related to Environment

Compared to the awareness on environment-related programs, plastic ordinances in the cities and municipalities appear to be less recognized, evident by the minimal difference of those who are aware and those who are not informed particularly in Bulan, Calbayog City, and Daanbantayan. In Puerto Princesa City, majority of the respondents, at 84%, are not familiar with their respective plastic-ordinances, whereas in Dipolog City and Tandag City, 67% and 82%, respectively, demonstrate notable level of awareness about their city's policies regarding plastics (**Figure 34**).

Common ordinances on plastic include "no to single-use plastics," and the use of reusable bags instead of plastic bags, especially in markets.

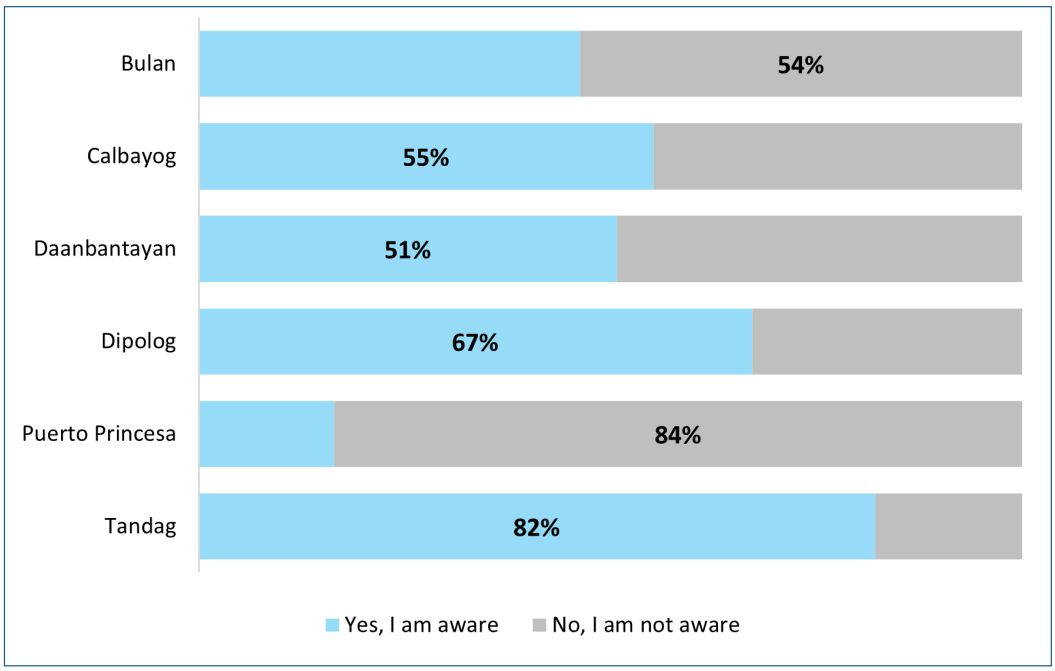

Figure 34. Awareness on Plastic-Related Ordinances

Regarding the impacts of these plastic ordinances, respondents from Daanbantayan and Dipolog City mostly observe these as effective, while majority of the interviewees in the cities of Puerto Princesa and Tandag find these policies to be unsuccessful in regulating the use of plastic products. In Bulan and Calbayog City, the gap between respondents who find these ordinances effective and those who do not is minimal (**Figure 35**).

Despite the passage of plastic ordinances in these cities, respondents report that individuals continue to use plastic products and plastic bags are still being issued in public markets, noting that these violations remain unpunished. These findings demonstrate the significance of stringent enforcement of policies to promote compliance with policies.

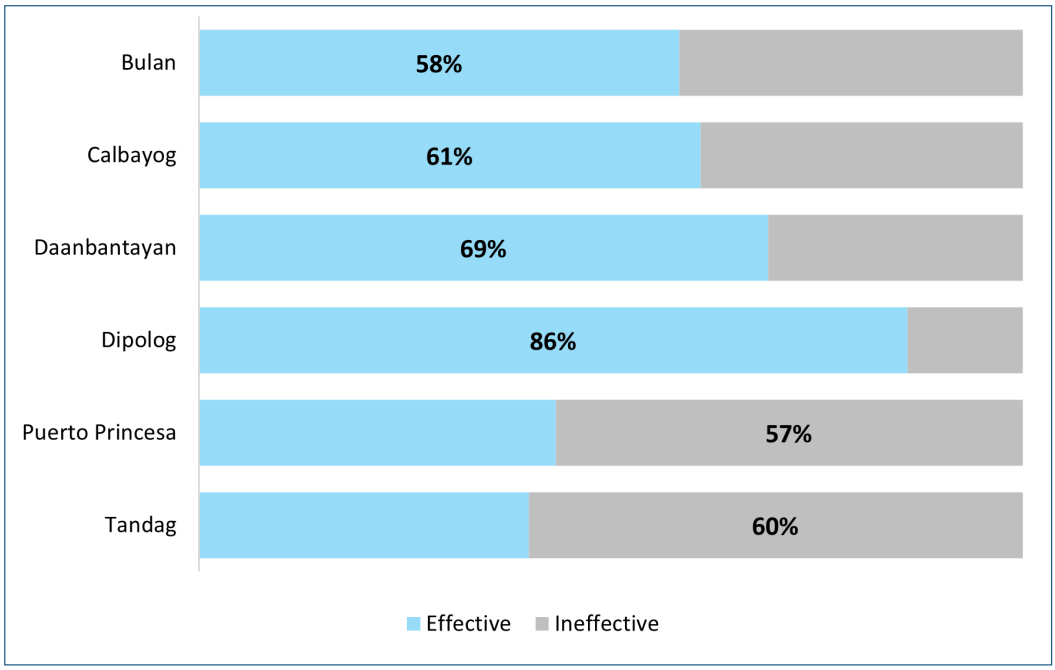

Figure 35. Perception on the Effectiveness of Plastic-Related Ordinances

The majority of the respondents in the study areas claim that they observe waste in their waterbodies. Common wastes observed are plastic bags, plastic bottles, single-film wrappers, and diapers and napkins (**Figure 36**).

In relation to the observed waste in waterbodies, majority of the respondents in these areas affirmed the conduct of coastal cleanup activities (**Figure 37**).

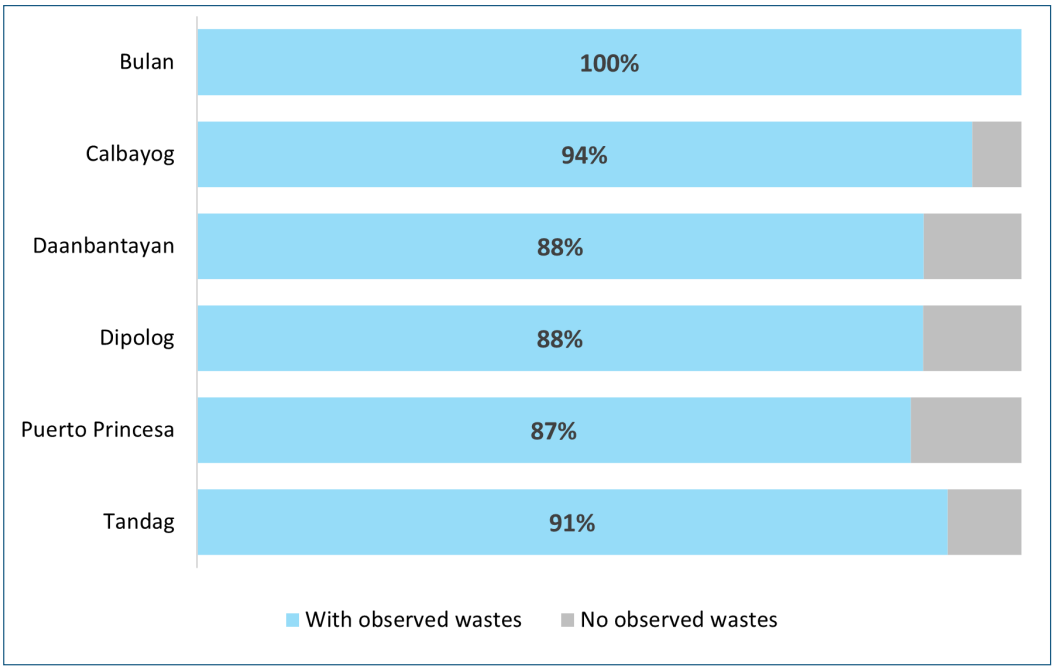

Figure 36. Observance of Waste in Waterbodies

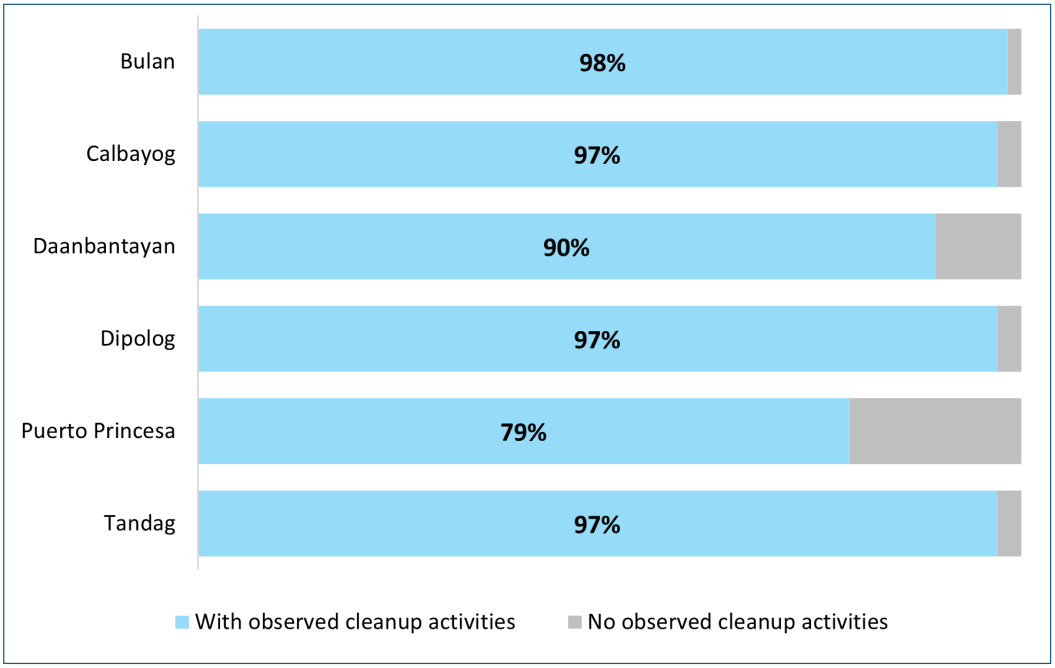

Figure 37. Conduct of Cleanup Activities within the Community

PACS Orientation in Bulan, Sorsogon.

Plastic Waste Value Chain Analysis 8

The plastic waste value chain in selected Philippine coastal cities and municipalities maps the pathway of plastics from generation to disposal (**Figure 38**). The value chain illustrates how the challenges within the solid waste management system accumulate, with each functional element adding to the potential leakage of plastic waste into the environment.

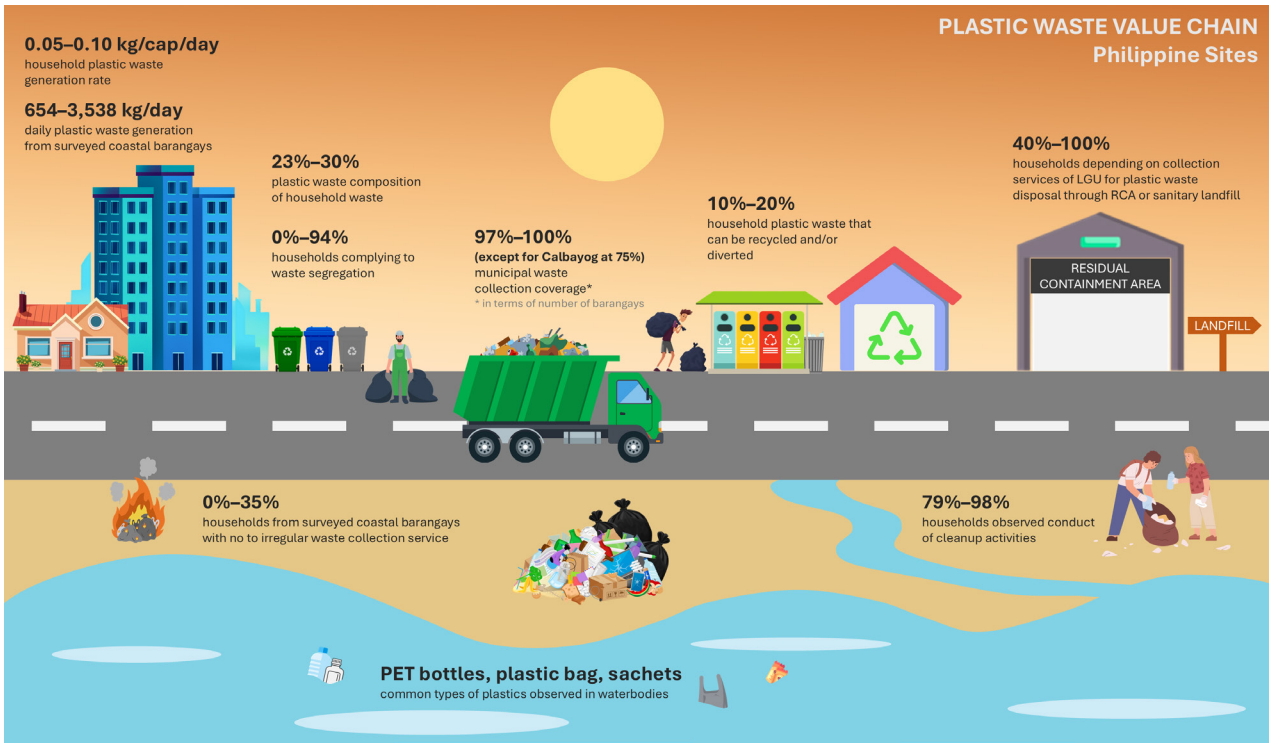

Figure 38. Plastic Waste Value Chain for Philippine Sites

A. Generation

In the surveyed coastal barangays across the Philippine sites, daily plastic waste generation from combined household and non-household sources ranges from 654 kg/day in Bulan to 3,538 kg/day in Dipolog City (**Figure 39**). Notably, household sources contribute the majority of the total solid waste generation, accounting for about 82% to 95%. Common types of plastic waste across all sites include diapers and napkins (4%-8%), PET items (2%-7%), and PP items (2%-3%). Additionally, other notable plastic waste comprises single-layer sachets (≤4%), heavily soiled plastics (≤4%), plastic bags (≤3%), and laminated sachets (≤2%).

Focusing on household waste, plastic WGRs at the Philippines sites vary from 0.05 kg/cap/day to 0.10 kg/cap/day (**Figure 40**). These rates are comparable to or double the pre-COVID-19 pandemic rates of about 0.04-0.05 kg/cap/day,[7] suggesting an increased reliance on plastic materials in post-pandemic daily life. These rates translate into household plastic waste generation of about 628 kg/day to 3,431 kg/day in the three surveyed coastal barangays at each site and scale up to 2,282 kg/day to 29,590 kg/day across all coastal barangays of the city or municipality (Section VI).

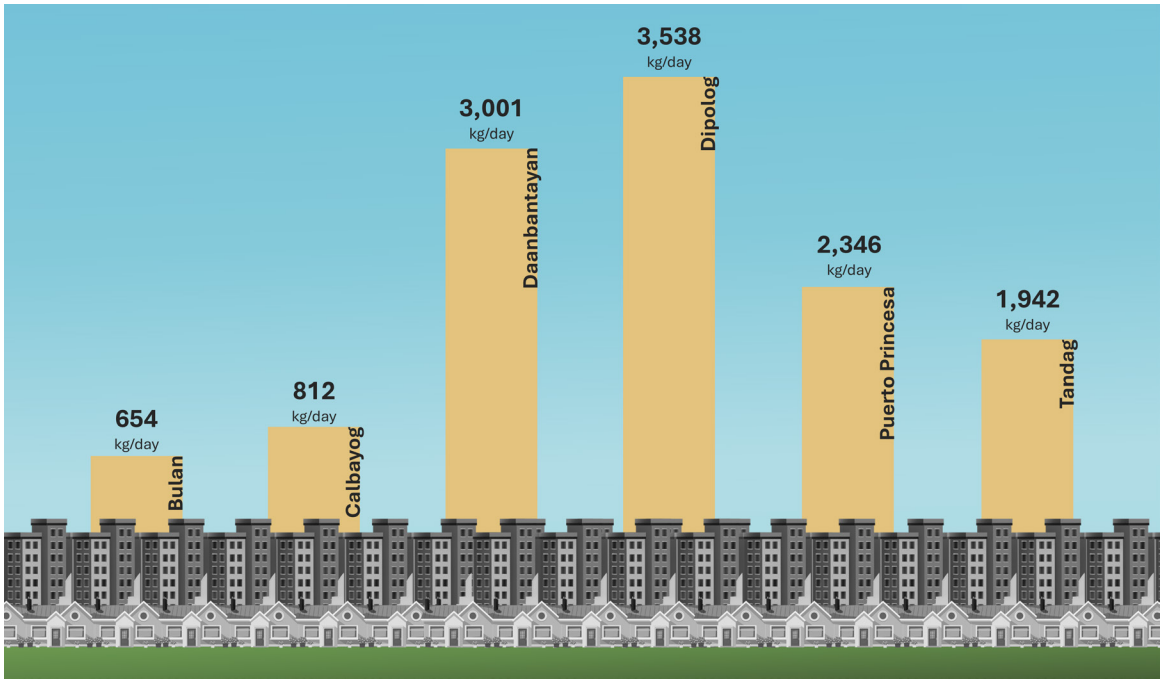

Figure 39. Combined Household and Non-Household Daily Plastic Waste Generation (kg/day) of Surveyed Coastal Barangays in Philippine Sites

[7] The plastic waste generation rate is derived from AMH database and secondary research (WWF Philippines, Inc., cyclos GmbH, and AMH Philippines, Inc., 2020).

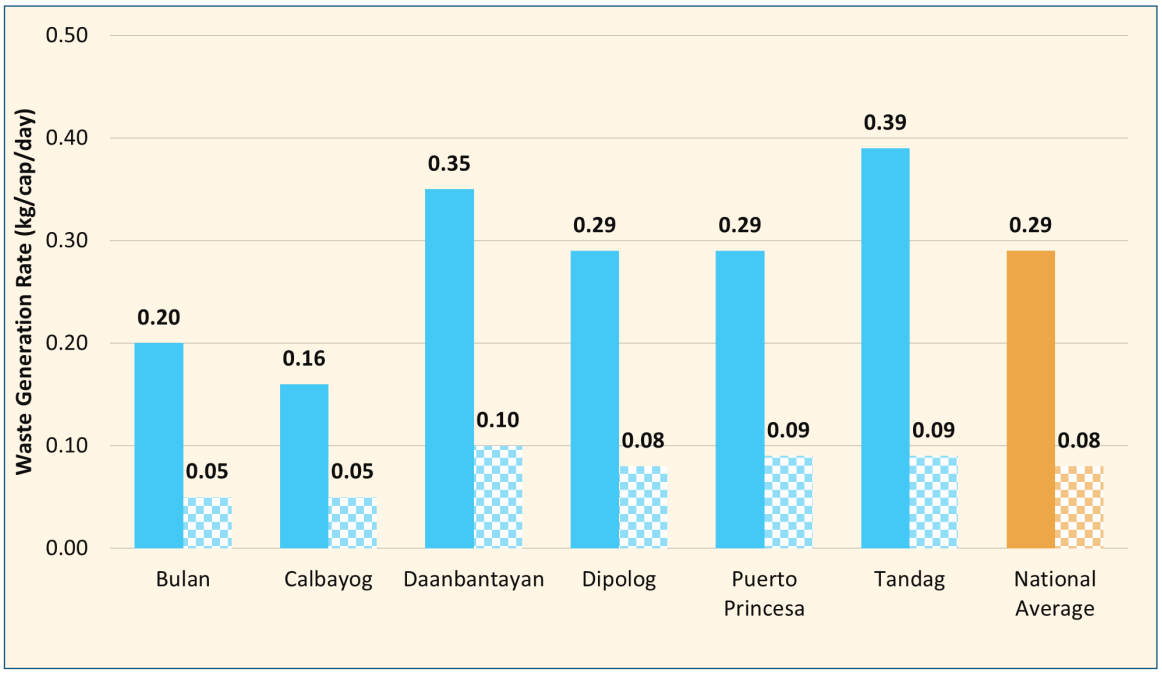

Figure 40. Household General and Plastic Waste Generation Rates (kg/cap/day) in Philippine Sites

Plastic waste accounts for about 23% to 30% of total household waste, with a national average of 27% (**Figure 41**). Common types of household plastic waste include diapers and napkins (5%-8%), PET items (2%-7%), and PP items (2%-4%). Additionally, other plastics with significant amounts include heavily soiled plastics (≤4%), single-layer sachets (≤4%), laminated sachets (≤2%), and plastic bags (≤2%). These amounts of common plastics reflect the prevalent use of single-use plastics among households in these coastal areas.

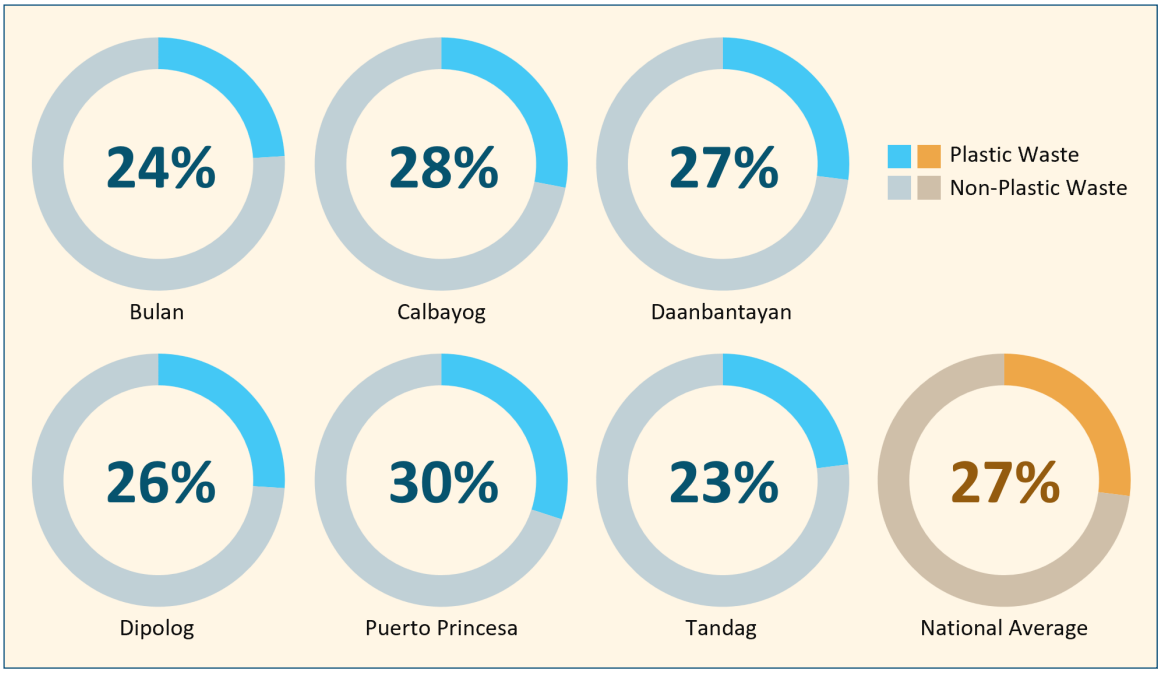

Figure 41. Plastic Waste Composition of Household Waste in Philippine Sites

Despite existing ordinances in the Philippine sites that prohibit or regulate the use of specific single-use plastics, including plastic bags and polystyrene utensils and containers (Section IV.A.2), small but notable amounts of such plastics continue to be generated in the surveyed coastal areas. This observation, based on the results of PACS, highlights the opportunity to strengthen policy implementation and community awareness to reduce these plastics.

B. Segregation

Local ordinances across all surveyed Philippine sites mandate a "no segregation, no collection" policy under the RA 9003 framework. Despite these regulations, compliance with waste segregation varies significantly as influenced by several challenges. Based on the results of KAP survey, the percentage of households fully complying with the segregation policy ranges from 0% in Puerto Princesa City to 94% in Tandag City, with a national average of 65% (**Figure 42**). Challenges to effective segregation include waste collectors mixing different types of waste during collection, lack of differentiated collection schedules for segregated waste, limited understanding of the benefits of segregation, and insufficient space or proper bins for segregating waste effectively.

In many instances, especially in remote areas, households use makeshift containers for temporary waste storage, which often fail to provide adequate containment (**Figure 43**). Such inadequate solutions can lead to waste leakage due to natural events or disturbances by stray animals.

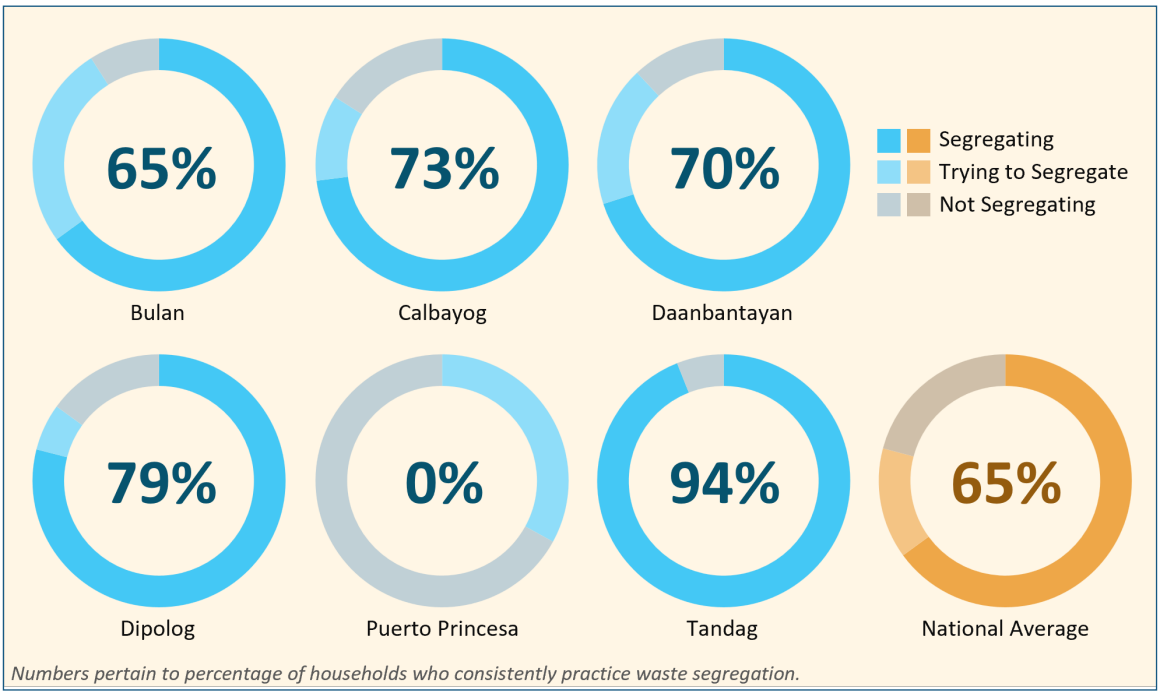

Figure 42. Waste Segregation Efforts of Households in Philippine Sites

Figure 43. An Example of Improvised Container for Temporary Storage of Waste Prior to Waste Collection in a Coastal Barangay in the Philippines

These challenges have a direct impact on waste diversion efficiency. When recyclable plastics are mixed with other types of waste, particularly biodegradable materials, they become contaminated. This contamination not only complicates the recycling process, but also increases the costs associated with recycling due to the need for additional cleaning procedures. In severe cases, the plastics may become entirely unsuitable for recycling, highlight the need for improved waste segregation practices to enhance recovery efficiency.

C. Collection

Based on the recent 10-year solid waste management plans across the Philippine sites, municipal waste collection coverage ranges from 75% to 100% of all barangays within each city or municipality, with a national average of about 95% (**Figure 44**). Coastal barangays exhibit variable collection coverage rates from 58% to 100%, averaging around 91% nationally. It is important to note, however, that a barangay is considered covered if there is a scheduled collection, but this does not guarantee that all areas within the barangay are reached, especially in rural or remote areas. Urban areas often benefit from more frequent waste collection compared to rural barangays.

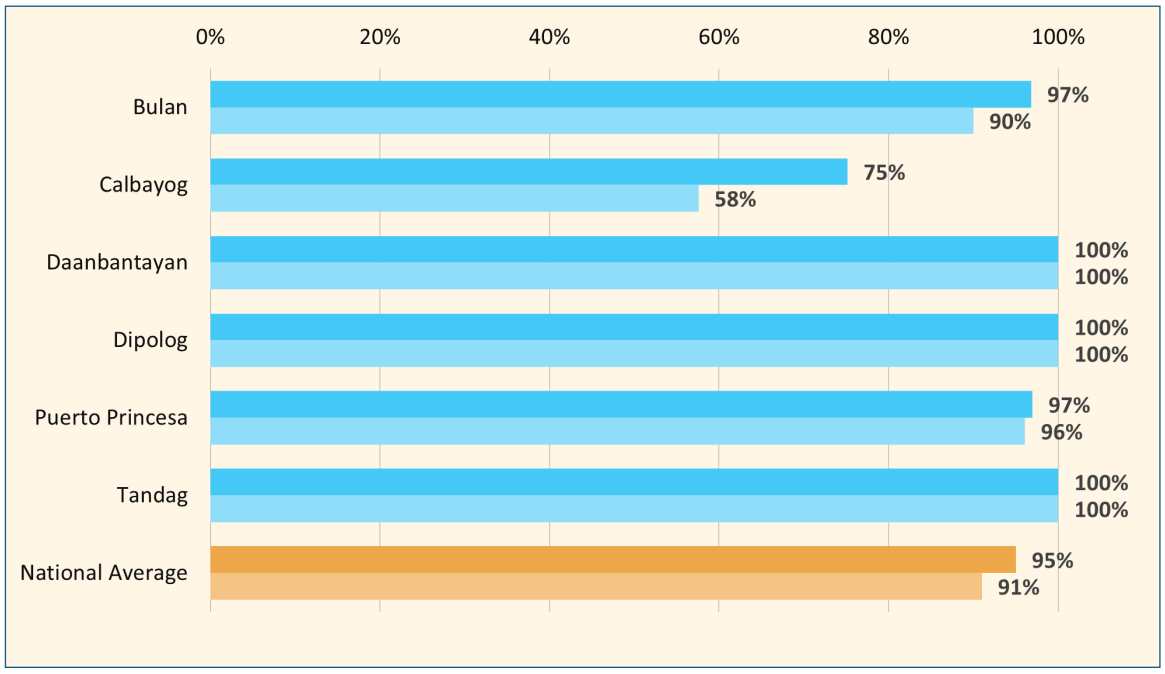

Figure 44. Municipal and Coastal Waste Collection Coverage in Philippine Sites

Despite the planned coverage for waste collection, the actual reach of collection services varies significantly. The results of the KAP survey reveal that up to 35% of households in the surveyed coastal barangays, with a national average of 16%, report that waste collection services do not reach them or have irregular waste collection schedule (**Figure 45**). This discrepancy between planned and actual collection frequencies can lead residents into engaging in improper disposal practices due to infrequent service, which in turn may result in overflow and unsanitary conditions.

In all the selected Philippine sites for the project, local governments are responsible for waste collection, with collected waste typically transported to the respective central materials recovery facility, residual containment area, or sanitary landfill.

D. Recovery

While there is a general widespread awareness among communities in the Philippine sites about the potential income from selling recyclable materials, the actual recovery and recycling of plastics remain limited. Based on the results of KAP survey, many households understand the benefits of recycling, yet there is a notable disparity in the actual diversion of plastics, especially recyclable plastics (Section VII). The data from PACS results indicate that 10% to 20% of household plastic waste, averaging 17% nationally, can be significantly diverted for recycling or reuse, including both recyclable plastics and residual plastics with potential for recycling (**Figure 46**).

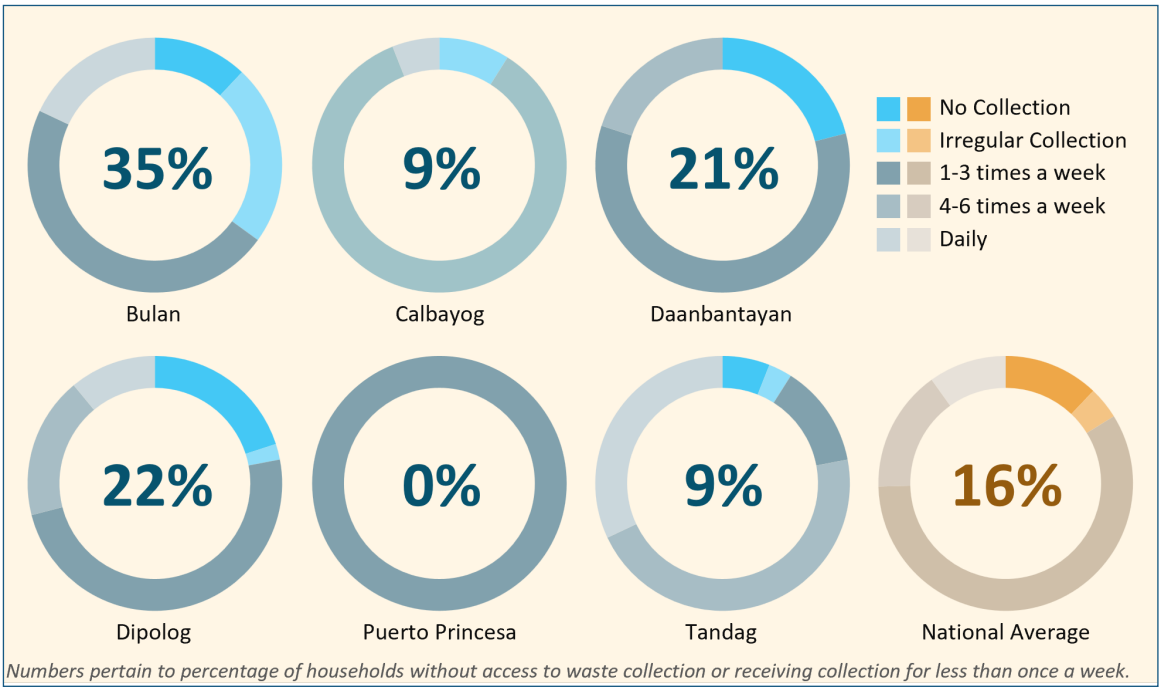

Figure 45. No Collection and Irregular Waste Collection at Surveyed Coastal Barangays in Philippine Sites

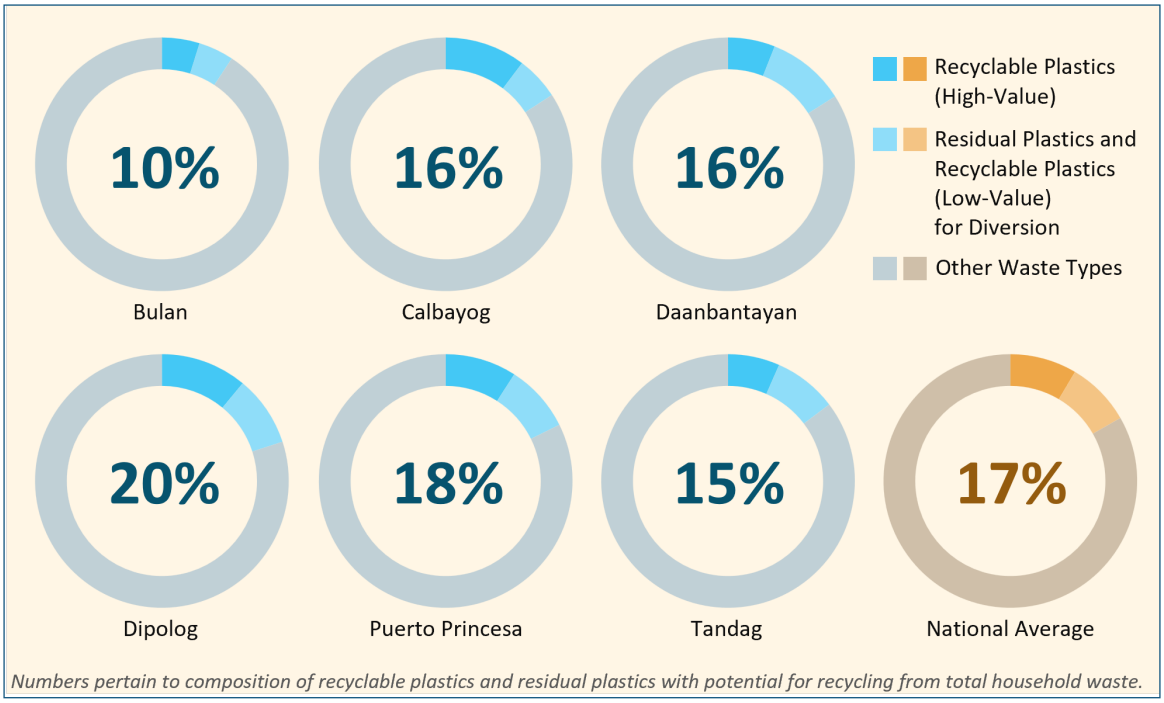

Figure 46. Plastic Waste Composition of Household Waste for Diversion in Philippine Sites

In many barangays across these sites, barangay MRFs are present or are served by their respective CMRF. These barangay MRFs, however, often primarily serve as storage locations rather than processing centers. Recyclables collected at these MRFs are typically brought to the CMRF or are sold to local junk shops and aggregators without undergoing substantial processing, limiting the effectiveness of recycling efforts. In addition, junk shops are integral to the waste recovery chain, who are commonly purchasing recyclable materials particularly high-value plastics like PET bottles and hard plastics (HDPE and PP). PET bottles are priced at Php 4.00 to 6.00 per kg, while hard plastics are priced at Php 5.50 to 8.00 per kg.[8] However, due to the unstable market price of plastic recyclables and the need for junk shops to collect large volumes of plastics to be profitable, some junk shops prefer to collect and sell metals rather than plastics. Aside from recycling, local governments also promote other waste diversion strategies, such as the trading of eco-bricks, which further involves the community in waste management efforts.

E. Disposal

In the surveyed Philippine sites, 40% to 100% of households rely on LGU waste collection services to manage common plastic waste (Section VII.B), which are typically disposed of through the respective RCA or sanitary landfill. Some sites further process collected segregated waste at their CMRFs, where it may be segregated further or processed for livelihood programs.

[8] Buying prices of recyclable plastics in junk shops are based on available data from Bulan and Daanbantayan.

The cities of Calbayog, Dipolog, and Puerto Princesa operate sanitary landfills. Reliance on landfill disposal, however, has led to capacity issues, particularly in Puerto Princesa where their landfill has already surpassed its capacity (**Figure 47**), prompting the exploration of alternatives such as new landfill sites or partnerships for co-processing of waste. Tandag City, meanwhile, operates an RCA within their ESWM Park, serving as a temporary storage prior to the completion of their sanitary landfill, with the first cell turned over in July 2024. Conversely, Bulan and Daanbantayan manage their waste through their CMRFs and RCAs. Bulan converts processable waste into RDF through a private facility, while un-processable waste is stored in the RCA before being transported to a distant landfill located in another province, presenting logistical and cost challenges. Daanbantayan utilizes residual plastics for local livelihood programs and plans to expand their RCA while developing their sanitary landfill.

Despite the operation of the disposal systems, a small but significant number of households in the surveyed coastal barangays resort to improper disposal methods, such as burning waste, open dumping, burying waste, or dumping directly into waterbodies. This presents ongoing challenges in waste management education and infrastructure adequacy, highlighting the need for continued efforts in improving waste disposal practices and facilities to prevent pollution.

F. Plastic Leakage

Plastics, due to their lightweight property, are particularly susceptible to leakage. When improperly disposed of, these plastics can be transported over long distances by wind and water currents, ultimately accumulating in lands, drains, and waterbodies. Despite existing regulations that prohibit or regulate certain single-use plastics, observations from PACS indicate that these materials are continued to be used. This ongoing plastic usage suggests enforcement gaps and the persistent availability of these plastics in local markets. Moreover, the discrepancies between the scheduled and actual waste collection frequency, especially

Figure 47. Puerto Princesa City Sanitary Landfill (Puerto Princesa City ENRO, 2024)

in remote and coastal areas, result in prolonged periods where waste remains uncollected. This accumulation often leads to waste escaping into the environment.

Recovery and disposal processes also contribute to the problem of plastic leakage. Most MRFs in these areas operate primarily as storage areas rather than processing facilities, while only segregating selected high-value recyclables for sale to local junk shops and aggregators. The lack of processing capability limits the effectiveness of waste diversion efforts. On the disposal end, inadequate practices intensify the risk of plastic waste entering waterbodies which negatively affect marine environments.

Under the third component of the project, beach monitoring is conducted quarterly to track marine litter along a 100-meter survey line divided into 20 transects of 5 meters each, with 4 transects monitored per quarter. From the first to fourth quarter of 2024, a total of 13,642 pieces of marine litter weighing 910 kg were collected from 12 monitoring sites across the six coastal cities and municipalities (**Table 16**). Of the total collected marine litter, plastics accounted for about 82% in terms of total quantity or 17% in terms of total weight, which highlights the significant amount of plastic waste leaking into the marine environment (PEMSEA, 2025). Based on the KAP survey, most respondents observe plastic waste in their local waterbodies including plastic bags, plastic bottles, single-use film wrappers, and diapers or napkins.

Tandag City recorded the highest collection of marine plastic litter with 45,233 grams, representing about 30% of the total records (**Figure 48**). Furthermore, 99% or 13,535 items of the total marine litter collected in the monitoring sites were identified as originating from domestic sources, which suggests the importance of proper waste management practices at the local level.

Table 16. Results of Beach Monitoring by Number and Weight in Philippine Sites from Q1 to Q4 of 2024 (PEMSEA, 2025)

City/Municipality	Monitoring Site	Marine Litter		Marine Plastics	
		By number (pieces)	By weight (grams)	By number (pieces)	By weight (grams)
Bulan	San Rafael	797	6,929	568	4,323
	Otavi	1,668	21,540	1,491	15,200
Calbayog	Carayman	1,131	38,948	1,033	32,446
	Malajog	1,165	13,893	543	9,963
Daanbantayan	Maya	1,212	38,704	854	19,202
	Agujo	510	6,990	241	2,154
Dipolog	Olingan	574	12,696	519	6,150
	Sicayab	406	16,367	334	10,324
Puerto Princesa	Tagbarungis	378	5,033	364	3,594
	Bantilinao	168	4,946	163	4,112
Tandag	San Agustin Sur	3,617	367,981	3,204	28,337
	Rosario	2,016	376,610	1,936	16,896
TOTAL		**13,642**	**910,637**	**11,250**	**152,701**

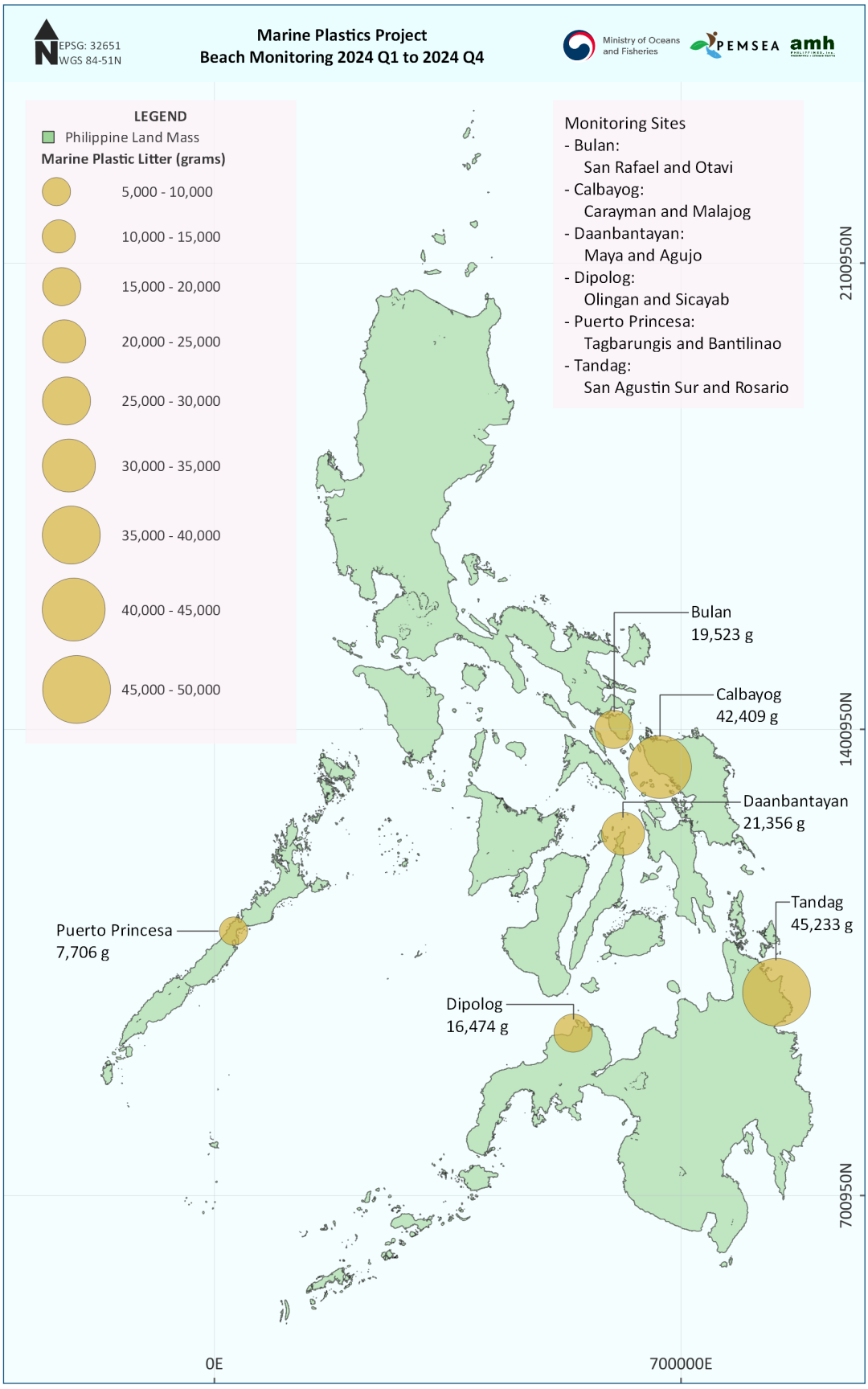

Figure 48. Marine Plastic Litter Recorded during Beach Monitoring from Q1 to Q4 of 2024 (PEMSEA, 2025)

To combat the issue of plastic pollution, the local governments have initiated measures such as regular community cleanup activities and the installation of trash traps along major rivers which aim to intercept plastics before they reach the sea. Information, education, and communication (IEC) campaigns to increase public awareness and education on proper waste management are also being conducted. These efforts are part of a broader strategy to mitigate environmental impact and reduce plastic leakage from local waste streams.

G. Challenges and Limitations

All cities and municipalities in this study face challenges with various aspects of their respective solid waste management framework (**Table 17**).

Table 17. Key Challenges and Recommendations for Philippine Sites

Component	Most Applicable Study Site	Challenges
Generation	All sites	• The results of the PACS showed that households account for the majority of the overall waste generation in all sites. Efforts for limiting generation of plastic waste may be hampered by consumption patterns. • The daily plastic waste generation for both household and non-household sources ranges from 654 kg/day in Bulan to 3,538 kg/day in Daanbantayan. Plastic WGR is found between 0.04 kg/cap/day to 0.10 kg/cap/day.
Segregation	All sites	• Segregation at-source is not fully practiced, as evidenced by the observed mixing of wastes during collection, the absence of separate collection services, and the lack of segregated bins and/or communal bins, as highlight
	Dipolog Daanbantayan Tandag	• The lack of time and limited awareness on proper waste segregation and its purpose are cited as challenges that further limit the practice of waste segregation.
Collection	All sites	• Although the collection coverage is high across the sites, the frequency of collection is low. The results of the KAP survey reveal that up to 35% of households in the surveyed coastal barangays, report that waste collection services do not reach them or have irregular waste collection schedule. Communities experience irregular collection schedules due to shortage of collection vehicles or unexpected breakdowns results in uncovered areas. • Urban barangays are prioritized while rural or remote areas receive minimal to no collection services, which encourages improper waste disposal into the open environment.

Table 17. Key Challenges and Recommendations for Philippine Sites (cont.)

Component	Most Applicable Study Site	Challenges
	Bulan Calbayog Dipolog Puerto Princesa Tandag	• The observed mixing of wastes, based on the KAP survey responses, discourage some households from practicing proper waste segregation.
Recovery	All sites	• Barangay and Centralized MRFs primarily function as storage for recyclable materials, without significant recycling activities. • Supporting MRFs (Section IV.C.4) lack appropriate technology and machines to convert recyclables into usable products.
	Dipolog Tandag Puerto Princesa	• Junk shops in the project sites prioritize metals and e-waste over plastic recyclables because metals have a stable market price, are heavier, and have a higher value per unit weight. Without baling machines, junk shops need to collect large volumes of plastics to make them profitable, which requires significant storage space to offset transportation and logistical costs.
Disposal	All sites	• The dependence of communities on local government disposal services, which results in waste being sent to sanitary landfills and RCAs, may soon lead to these sites reaching maximum capacity earlier than expected. • Some residents still engage in improper disposal practices such as burning of wastes, burying in the ground, or disposing of wastes in waterbodies.
Plastic Leakage	All sites	• Observance of plastic wastes such as plastic bags, diapers and napkins, laminated sachets, and single-layer films, remain prevalent in all study sites. • A total of 13,642 pieces of marine litter weighing 910 kg was collected from 12 monitoring sites across the six coastal cities and municipalities from the quarterly sampling of 2024. Of the total collected marine litter, plastics accounted for about 82% in terms of total quantity or 17% in terms of total weight based on the beach monitoring data.
Policy and Implementation	All sites	• Lack of policies on reduction of plastic wastes • Lack of compliance on "No segregation, no collection" policy, and the establishments of functional MRF in accordance with RA 9003.

Plastics along the coasts of Brgy. Zone 2, Bulan, Sorsogon.

A common problem across the study sites is the failure to achieve full compliance to waste segregation at-source due to observed mixing of wastes by the waste collectors, lack of segregating bins, and absence of separated collection. Respondents from Dipolog City, Tandag City, and Daanbantayan expressed the lack of time and limited awareness on waste segregation as major concerns. These findings indicate a lapse in the responsibility of both community members and the local government.

The shortage of collection trucks, which is occasionally caused by unexpected machine breakdowns, results in uncovered areas. Particularly in Puerto Princesa, larger truck sizes are not suitable in narrow streets, leading to missed collection. These major issues further prompt improper waste disposal into the open environment. The limited number of available and appropriate collection vehicles creates disparities in the frequency of collection between urban and rural barangays. Urban barangays are prioritized for daily collection, while rural and remote barangays are left to manage their own wastes, often resorting to convenient forms of disposal such as burning, burying in the ground, or disposing of waste into waterbodies.

Key challenges in waste recovery and diversion efforts are observed in the study sites. While most barangays have their respective MRFs, these facilities primarily function as temporary storage for recyclable materials, with no active recycling processes. Although they help with the effective separation of recyclables, without an efficient recovery system in place, they only delay the need for landfilling rather than significantly increase recovery rates. Recycling activities, such as composting and manufacturing products from recycled glass and plastic waste, taking place in the

supporting MRF structures (Section IV.C.4) are hampered by several factors. Particularly in Daanbantayan and Tandag City, the lack of appropriate recycling machines for further processing of plastics into usable products results in the failure to achieve significant plastic waste recovery rate. Difficulties in maintaining operations, limited manpower, and financial constraints for upgrading are major obstacles to sustaining these facilities in the cities of Dipolog and Calbayog. In addition, the preference of junk shops for high-value materials such as metals and e-waste further limit substantial diversion of plastic wastes.

The heavy reliance of communities on local government disposal services, which results in waste being sent to sanitary landfills and RCAs, may soon lead to these sites reaching maximum capacity earlier than expected. Collaborations with co-processing facilities, as seen in Dipolog City, can help manage the volume of waste directed to landfills. However, without a robust and effective waste management system that includes full compliance with segregation, extensive collection coverage, and an efficient recovery process, most waste will still end up in landfills or be left in the open environment, thus, significantly increasing plastic leakage.

In summary, observed challenges in the six Philippine sites highlight issues throughout the entire waste management system, from segregation to disposal. Addressing these challenges requires collaborative efforts from the community and the local government to achieve environmental sustainability.

Key Recommendations 9

Based on the findings from the baseline assessment on marine plastics, a summary of key challenges, along with strategic recommendations is presented (**Table 18**). These recommendations are developed to collectively address the priority challenges identified in the baseline assessment and enhance the effectiveness of waste management practices across the country, particularly at the selected sites.

Plastic wastes near the coasts of San Agustin Sur, Tandag City.

Priority Issues and Key Recommendations for Philippine Sites

BULAN

Priority Issue 1

Recovery

- Barangay MRFs function as mere collection points, without basic processing of recyclables
- CMRF cum RCA has limited equipment needed to effectively process waste, particularly plastics, into usable materials
- Limited partnerships and market access for recyclables restrict waste recovery efforts

Key Recommendations

- Enhance MRF capabilities by investing in additional processing equipment to increase waste diversion rate, particularly for residual plastics with potential for recycling
- Support and scale up upcycling and advanced recycling initiatives by allocating appropriate funds and engaging communities to optimize material recovery and reduce landfill-bound waste
- Establish stable, long-term partnerships with local, provincial, and regional industries and businesses to ensure a sustainable market for recovered materials and products from the CMRF

Priority Issue 2

Disposal

- Lacks a local final disposal site, forcing waste to be transported to another province, increasing costs, inefficiencies, and environmental risks

Key Recommendations

- Expand waste treatment options by increasing RDF capacity through public-private partnerships.
- Develop a long-term local disposal solution by either constructing a sanitary landfill or establishing a shared provincial landfill through municipal partnerships to reduce transport costs

CALBAYOG

Priority Issue 1

Collection

- The waste collection service of the city only covers 118 out of 157 barangays, leaving the remaining areas prone to improper disposal methods, such as burning and dumping of waste into the open roads and end up in waterways, drifts in Calbayog River and eventually floats into the sea
- Daily waste collection is concentrated in urban areas, with only 47 barangays, thrice to once a week only in rural barangays
- Uncollected waste in narrow roads which cannot be accessed by the dump trucks of the city

Key Recommendations

- Explore localized collection systems to reduce dependence on centralized collection of the city government
- Enhance waste collection efficiency by procuring trash traps to be installed in identified portions of Calbayog River, additional flat boats to collect ensnare trash in trash traps and smaller eco-vehicles to collect trash especially plastics in areas that are inaccessible by standard garbage trucks

Priority Issue 2

Recovery

- Barangay MRFs mostly serve as storage areas for recyclables, lacking the necessary facilities for recycling
- Despite MRF operations which employ plastic recovery schemes, collection by LGU still remains to be the most preferred form of disposal for all plastic waste among the households surveyed
- Low recycling rate due to inadequate plastic recycling machines. The City operates the Pilot, Central and Market MRFs, which are engaged in recycling/ upcycling activities that produce eco-bags, tarpacks, wallets, back backs, gowns, dresses, key chains, decorative items, frames, Christmas parols (special and ordinary) from recovered plastic waste but do them manually or "*mano-mano*". Due to limited production, excess plastic materials end up at the SLF

Key Recommendations

- Develop shared MRFs for clusters of nearby barangays, ensuring efficient waste recovery while addressing logistical challenges through coordinated collection efforts
- Establish MRFs as part of local livelihood programs with recycling facilities for on-site processing or designated areas for selling recyclable materials
- Upgrade the current operations in the central MRF by procuring additional plastic recycling machines like baling, hydraulic press brick and paver machines to produce new recycled products like eco- bricks, thus completing the plastic cycle and promoting a circular economy
- Strengthen public participation by introducing incentive-based programs alongside MRF operations

DAANBANTAYAN

Priority Issue 1

Segregation

- Despite the existing ordinance, waste segregation showed low community participation, driven by misconceptions about its purpose and the perception that it is a waste of time
- Although local policies impose penalties for non-compliance, enforcement has been inconsistent due to the lack of awareness and resources such as separate bins for segregated waste

Key Recommendations

- Implement a balanced system of incentives and penalties by recognizing compliant households and businesses through rewards while enforcing stricter and progressively increasing fines for repeated violations
- Improve the enforcement of waste segregation policies by providing barangays with adequate resources, such as separate bins for different waste types
- Expand information, education, and communication (IEC) campaigns by addressing misconceptions about waste segregation, emphasizing its benefits, and integrating interactive community activities to encourage participation.

Priority Issue 2

Recovery

- The municipality relies on distant facilities due to limited local processing capacity, adding logistical difficulties to waste management

Key Recommendations

- Enhance waste processing capabilities by investing in additional recycling equipment to reduce reliance on distant sites, minimizing transportation costs and logistical challenges while improving overall recovery efficiency
- Strengthen partnerships with manufacturers to implement EPR program, ensuring plastic waste is collected and processed efficiently

DIPOLOG

Priority Issue 1

Generation

- Household sources are significant contributors to waste generation in the city, with 0.29 kg/cap/day of general WGR and 0.08 kg/cap/day of plastic WGR
- Without an effective solid waste management system, the large volume of plastic waste generated will inevitably end up in waterbodies, worsening plastic leakage into marine environments
- Residents along the rivers are observed dumping waste directly into water bodies, exacerbating the plastic pollution

Key Recommendations

- Enforce a stringent implementation of City Ordinance No. 13 – 245 to minimize usage of single-use plastics through:
  - conduct of regular inspections to verify compliance
  - provision of incentives (e.g. tax incentives, business permits discount) to establishments that adopt alternative materials for single-use plastics such as reusable containers
- Offer incentives to local establishments and households that voluntarily adopt waste reduction practices such as discount programs for using reusable containers or community recognition programs for sustainable practice

Priority Issue 2

Collection

- About 22% of the surveyed households surveyed do not receive regular waste collection services, leading to improper waste disposal
- Due to accessibility, urban barangays are prioritized while rural or remote areas receive minimal to no collection services, further worsening the practice of improper waste disposal
- The observed mixing of wastes discourages some households from practicing proper waste segregation

Key Recommendations

- Assess the optimal collection routes and schedule by conducting time and motion study to improve waste collection coverage and travel time
- Conduct regular inspections of existing collection trucks to maintain optimal conditions and prevent unexpected breakdowns, ensuring that all barangays receive fair collection distribution
- Implement a stringent enforcement of segregated waste collection through capacity-building activities for waste workers on handling unsegregated wastes, and the conduct of inspections to verify compliance with segregated collection

PUERTO PRINCESA

Priority Issue 1

Collection

- High volume of uncollected waste, with about 16,000 MT/year or 18% of municipal solid waste remaining unmanaged
- Lower waste collection frequency than the expected or scheduled frequency
- Lack of separate compartments in collection vehicles or segregated waste collection schedules results in mixing of waste, limiting waste diversion efforts

Key Recommendations

- Increase collection efficiency by procuring additional collection vehicles, including smaller units for narrow streets, to improve frequency and coverage
- Strengthen and capacitate barangay-led collection systems to manage biodegradable waste and recyclables, in compliance with RA 9003
- Implement waste collection compartments in vehicles or establish a separate collection schedule for different waste types to maximize recovery

Priority Issue 2

Disposal

- The sanitary landfill in Barangay Sta. Lourdes has exceeded its capacity, which can affect waste collection efficiency, leading some residents to resort to improper open dumping and burning

Key Recommendations

- Expedite the identification and development of a new landfill site to relieve the current system's burden
- Accelerate plans for sustainable waste processing facility through public-private partnerships to reduce landfill dependency
- Integrate advanced waste treatment and recovery technologies into the new disposal facility to enhance waste diversion efforts

TANDAG

Priority Issue 1

Generation

- Household sources are the primary contributors to waste generation in the city, with 0.39 kg/cap/day of general WGR and 0.09 kg/cap/day of plastic WGR
- Household plastic recyclables and residual wastes with a potential for recycling are found at about 8% and 7%, respectively, with diapers and napkins, laminated sachets, and PET bottles as the most dominant plastic materials

Key Recommendations

- Intensify the implementation of City Ordinance No. 01 Series of 2020 to minimize usage of single-use plastics through:
  - conduct of regular inspections to ensure compliance
  - Offering incentives (e.g. tax incentives, business permits discount) to establishments that adopt alternative materials for single-use plastics like reusable containers
- Introduce incentives to local establishments and households that voluntarily adopt waste reduction practices such as discount programs for using reusable containers or community recognition programs for sustainable practice

Priority Issue 2

Recovery

- Low plastic recycling rate due to no end-use application or destination caused by inadequate plastic recycling equipment in the EWSM park, which only employs manual sorting and shredding of plastic residual wastes
- Only 7 of the 17 barangay MRFs are maintained, which primarily function as storage areas without any recycling activities

Key Recommendations

- Upgrade the current operations in the centralized MRF in the ESWM, incorporating additional recycling equipment like extruders and molders to further process and produce new recycled products such as chairs, and eco-bricks, completing the plastic loop and promoting a circular economy
- Explore markets for recyclables, particularly for recycled plastic products, to sustain operations of plastic recycling facility

While long-term improvements in solid waste management system and infrastructure are being explored, optimized, and developed, short-term interventions are also necessary to prevent further plastic leakage into the environment. From the baseline assessment, Tandag and Calbayog recorded the highest marine plastic litter, at 45,233 g and 42,409 g, respectively. These beach monitoring results, along with data from other sites, highlight the urgent need for interventions aimed at stopping plastic litter from reaching the oceans. Capturing leaked waste through regular cleanup activities can help reduce immediate pollution, while installing trash traps at river outfalls prevents plastics from reaching marine ecosystems. Additionally, recovered plastics need to be sorted further to identify materials for recycling and for disposal, enhancing waste diversion efforts. To reinforce these efforts, SBCC strategies should be regularly conducted to promote responsible waste management at the community level. Strengthening policy enforcement and ensuring consistent implementation are equally crucial, as existing regulations must be upheld to sustain waste management improvements and prevent further environmental degradation.

To further combat the issue of plastic pollution effectively, it is recommended that the strategies be localized to reflect the specific needs and conditions of the communities. The approach of developing local plan of action on marine litter ensures that the solutions are tailored to the unique environmental and socio-economic contexts of different cities and municipalities in the country. In addition, while the EPR Act is mainly focused on obliged enterprises, supporting them to achieve compliance to the target recovery rates, while establishing proper management and processing of recovered plastics, can significantly reduce the risk of plastic waste leaking into the open environment. Enhancing public-private partnerships in plastic management is also encouraged to facilitate effective waste collection, recovery, and disposal efforts. To ensure that the local actions work well, it is also recommended that the actions to achieve the milestones under the Roadmap for Management of Plastic Waste are integrated into local policies and action plans.

10 Conclusion

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

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

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