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and Nuclear Safety

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Report - Source to Sink Waste Sampling and Characterization in Nsidung and Atansinya Markets, Calabar, Nigeria

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Imprint

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Photo credits: Project PROTEGO
Project Website: www.projectprotego.org
Email: facco@adelphi.de

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1. Overview of activities

The Prevention of Marine Litter in the Gulf of Guinea (PROTEGO) project aims to address plastic pollution in West Africa by identifying key leakage points and promoting circular economy solutions through field-based diagnostics and community-inclusive strategies. This report presents findings from a source-to-sink waste sampling and characterization activity undertaken at the Nsidung and Atansinya Beach Markets in Calabar, Cross River State, Nigeria, both of which are located along the banks of the Calabar River and contribute to the riverine and marine pollution system. The aim is to support evidence-based solutions that reduce the inflow of waste into Nigeria's waterways and coastal ecosystems.

This source-to-sink sampling study, conducted as part of PROTEGO's Work Package 1, was carried out between March 25th and 28th, 2025. Two key market areas were selected for the sampling exercise: the Nsidung Beach Market (4.95222 N, 8.30967 E) and the Atansinya Beach Market, located approximately 500 meters apart along the riverbank.

Waste sampling was carried out on March 27th and 28th, 2025, aligned with the primary market days when vendor activity is highest. Vendor interviews were also conducted to better understand behavioral drivers of waste generation and disposal. A satellite image of the Nsidung Beach Market, showing the designated sampling site, is presented in Figure 1 below.

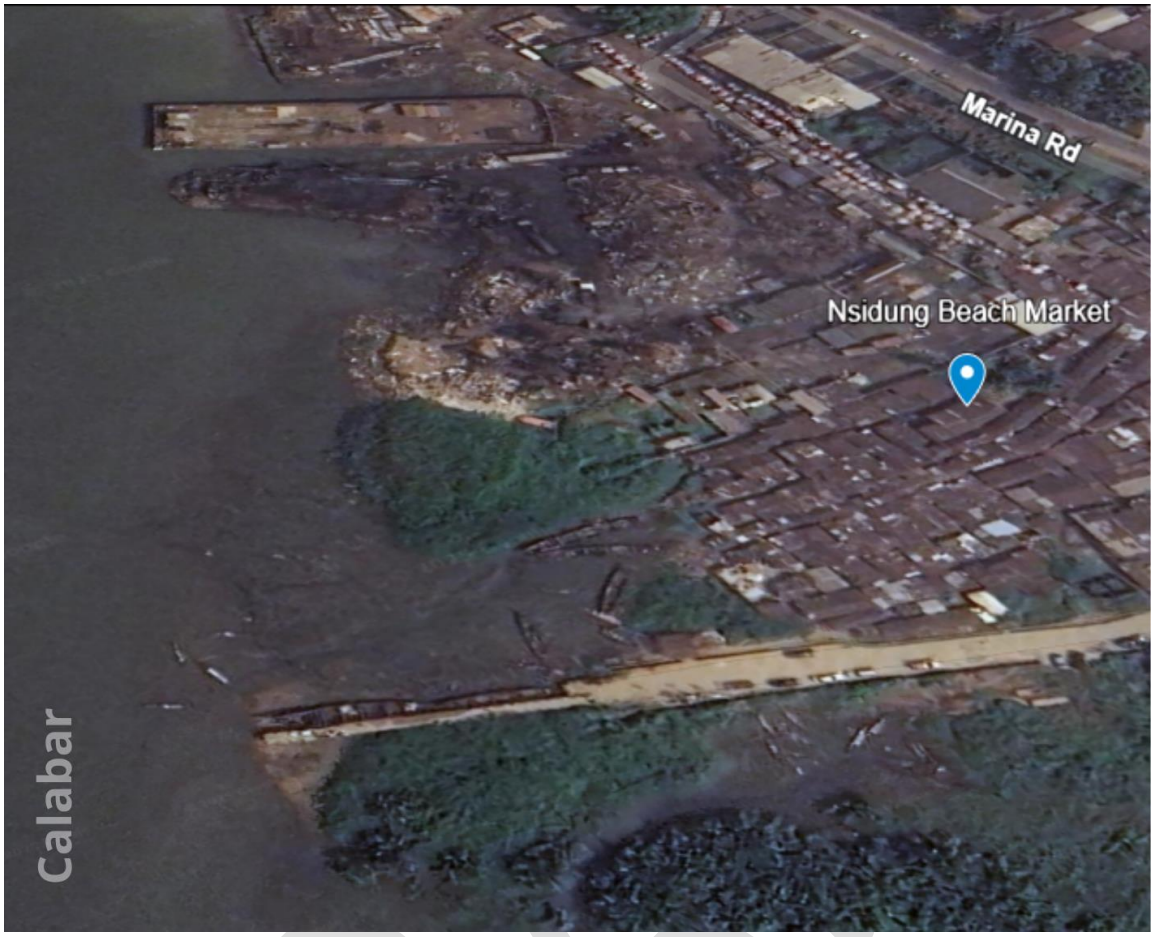

Figure 1: Satellite Image of Nsidung Beach Market, Calabar

This assessment was carried out by a multi-stakeholder team representing public, private, and community-based organizations. The collaborative nature of the activity enhanced local engagement and contextual understanding of waste challenges in the Calabar area.

Table 1: Field Team Members and Affiliations

Name	**Organization**
Clem Ugorji	PROTEGO Regional Coordinator
Victor Andrew Eyo	WASTE Africa (PROTEGO partner)
Juliet Odhikori	WASTE Africa (PROTEGO partner)
Precious Francis	NCIC (PROTEGO partner)
Tosin Ajide	NCIC (PROTEGO partner)
Sonigitu Ekpe	Ministry of Environment
Unyi Ikori Anne	Ministry of Environment
Obongawan Bassey Ekpenyong	Nsidung Market Leader
Alo Enene Sabastine	Cross River State Environmental Laboratory

Name	Organization
Ishiah Etteh	Volunteer

Sampling Objective

The objective of this activity is to conduct source-to-sink sampling and characterization to assess the types, sources, and pathways of solid waste generated at the Nsidung and Atansinya Beach Markets, both situated along the Calabar River in Cross River State, Nigeria. By identifying the predominant waste materials and tracking their movement from the point of generation to their eventual accumulation or disposal locations, the activity aims to inform sustainable waste management strategies and support the design of interventions to reduce waste leakage into aquatic systems.

The findings are intended to contribute to the broader goals of the PROTEGO project by enhancing understanding of localized pollution dynamics and enabling evidence-based policy and community-level action to prevent further degradation of Nigeria's inland and coastal water ecosystems.

2. Methodology

The source-to-sink sampling methodology at the Nsidung and Atansinya Beach Markets combined qualitative interviews with physical sampling and waste characterization to produce a localized and behaviorally contextual understanding of solid waste leakage into aquatic environments.

A total of 29 vendor interviews were conducted across both markets. Vendors were grouped for operational purposes as follows:

- Four vendor groups were selected from Nsidung Beach Market, including fish vendors, household product sellers, provision vendors, and food item sellers.
- Vendor Group 5, comprising women who purchase fish from local fishermen, was selected from Atansinya Beach Market, located about 500 meters downstream along the Calabar River.

The interview component captured vendor-reported information on the types of waste generated, methods of disposal, awareness of designated dumping points, and use of bags for storage. Interviews were semi-structured and conducted with individuals across a diverse range of product categories including fresh fish, provisions, foodstuffs, household items, and clothing. The majority of vendors interviewed at both sites were women.

Following the interviews, the team conducted physical waste sampling during market peak days (March 27–28, 2025) to ensure representation of typical waste generation flows. At both locations, plastic bags were distributed to selected vendors with instructions to collect all waste generated over the course of their market operations. Filled bags were tagged with the vendor group and date, then collected and transported to a designated sorting site. Figures 2 and 3 depict a group discussion with women on waste hotspots, and a vendor interview at Atansinya Beach Market respectively.

Figure 2: Group discussion with Atansinya Beach Market women on waste practices and key accumulation points

Figure 3: Interviewing a vendor at Nsidung Beach Market to understand waste disposal practices and sanitation challenges

At the sorting site, the contents of each bag were systematically emptied and categorized by material type (e.g., plastic, glass, textile, residual waste). Each category was counted and weighed. The classification followed standardized categories to allow for consistency across both markets. Notably, the characterization process required careful handling of small plastic fragments (e.g., sachet remnants, nylon pieces) and wet materials, which contributed to variable weight readings. The figure 4 and 5 below show the waste characterisation process done by the PROTEGO team.

This integrated methodology of behavioral interviewing and material sorting enabled the identification of both upstream behavioral drivers and downstream waste profiles, offering a holistic picture of how local waste disposal practices contribute to riverine and marine pollution.

Figure 4: PROTEGO Team sorting collected market waste by material type for characterization

Figure 5: PROTEGO Team reviewing the sorted market waste for characterization

2.1 Nsidung Beach Market - Waste Characterization Results

The consolidated waste sample from four vendor groups at Nsidung Beach Market yielded a total of 3,150 grams of waste, comprising 459 items. The average waste generation per vendor on a peak market day was calculated at 315 grams. Extrapolated annually, this equates to approximately 20.8 kilograms per vendor, based on a mix of major and minor market days.

The most significant contributor by weight was carton waste, which made up 27.8% (875 g) of the total. This was followed by glass bottles (16.5%), other plastic packaging (13.1%), plastic bags (12.2%), and water sachets (6.4%). Other noteworthy materials included textile waste (6.6%) and plastic signage (2.7%), highlighting the presence of both organic and inorganic residuals.

In terms of item count, nylon fragments and plastic bags were the most prevalent, with 117 and 64 pieces, respectively. These figures illustrate the widespread use of single-use and disposable materials, particularly for packaging.

Though some components such as straws, rubber bands, and cutlery appeared in smaller quantities, their persistent and non-biodegradable nature still poses a risk to the environment, especially given the market's proximity to the river.

This diverse composition of waste reinforces the need for targeted collection systems that address not only volume but also material-specific management strategies, especially for plastics and paper-based packaging that dominate both by weight and frequency. The table 2 below shows the detailed breakdown of the materials identified during the waste characterization, including their respective weights, percentage contributions, and item counts.

Table 2: Material Composition of Waste Collected from Nsidung Beach Market (All Vendor Groups)

Material	Item	Weight [grams]	Percentage(%)	Count
Plastics	Plastic bottles	113	3.6%	4
	Straws	0	0.0%	2
	Plastic bags	384	12.2%	64
	Water sachets	202	6.4%	53
	Other plastic packagings	414	13.1%	104
	Other plastic items (plastic cutlery)	6	0.2%	2
	Other plastic items (bottle labels)	35	1.1%	37
	Other plastic items (nylon)	102	3.2%	117
	Other plastic items (rubber band)	0	0.0%	2
	Other plastic items (razor cover)	0	0.0%	1
	Other plastic items (rubber case)	26	0.8%	1
	Other plastic items		0.0%	
Glass	Glass bottles	519	16.5%	2
	Other glass itmes		0.0%	
Paper and Cardboard	Paper	9	0.3%	15
	Carton	875	27.8%	41
	Cardboard		0.0%	
	Other papers (e.g. tissues)		0.0%	
Metal	Cans		0.0%	
	Alumium foil		0.0%	
	Other type of metal (Metal cap)	0	0.0%	2
Residual	Textile	209	6.6%	2
	Styrofoam	14	0.4%	3

	Plastic signage	84	2.7%	1
	Packaging tape	13	0.4%	5
	Shoe	145	4.6%	1
TOTAL AMOUNT OF GENERATED WASTE:		**3,150**	**100.0%**	**459**
Average per Vendor		315		
Waste/year during main days		16,380		
Waste/year during minor days		4,095		
Total annual waste per vendor		**20,790**		

2.2. Atansinya Beach Market - Waste Characterization Results

Waste characterization at Atansinya Beach Market was conducted with Vendor Group 5 over two consecutive market days. The summarized results presented here reflect the average waste generated per vendor, calculated from both Day 1 and Day 2 of sampling. Figure 6 shows the waste collection by PROTEGO team from Atansinya Beach.

Figure 6: Waste collection from Nsidung Beach Market for sorting and characterization

A total of 1,595 grams of waste was recorded across the vendor group, with 229 items categorized. With 70 vendors active during the sampling period, the average waste generation per vendor was approximately 22.8 grams. This value is notably lower than that of Nsidung Beach Market, reflecting the market's narrower business scope, which primarily involves the direct purchase of fresh fish without significant on-site processing or packaging.

The composition of waste was heavily skewed toward plastics. The largest single contributor was water sachets, which accounted for 60.4% (963 g) of the total weight and 180 individual pieces, indicating their widespread use and disposal. This was followed by other plastic packaging at 34.6% (552 g) and plastic bags at 3.7% (59 g). Only a single plastic bottle was recorded, and no waste was observed in categories such as glass, paper, metal, or residuals.

This pattern reflects Atansinya's limited commercial footprint and its dependence on plastic-based items for short-term use. The near-total absence of organic or mixed material types reinforces the need for plastic-specific waste management interventions at this site.

Table 3 presents the average material breakdown recorded across the two days of sampling at Atansinya Beach Market.

Table 3: Average Waste Composition from Vendor Group 5 at Atansinya Beach Market

Material	Item	Weight [grams]	%	Count
Plastics	Plastic bottles	21.00	1.3%	1
	Straws	0.00	0.0%	0
	Plastic bags	59.00	3.7%	8
	Water sachets	963.00	60.4%	180
	Other plastic packagings	552.00	34.6%	40

	Other plastic items	0.00	0.0%	0
Glass	Glass bottles	0.00	0.0%	0
	Other glass itmes	0.00	0.0%	0
Paper and Cardboard	Paper	0.00	0.0%	0
	Cardboard	0.00	0.0%	0
	Other papers (e.g. tissues)	0.00	0.0%	0
Metal	Cans	0.00	0.0%	0
	Other type of metal	0.00	0.0%	0
Residual	E-waste	0.00	0.0%	0
	Textile	0.00	0.0%	0
	Shoes	0.00	0.0%	0
TOTAL AMOUNT OF GENERATED WASTE:		**1,595.00**	**100.0%**	**229**
Average per Vendor		22.78		

3. Source-to Sinks analysis

The assessment identified significant contributions of unmanaged waste to the Calabar River, driven by inadequate infrastructure and informal disposal practices. Nsidung exhibited a higher waste load and material diversity, while Atansinya's waste was more concentrated in type but still environmentally impactful. The photos provided below illustrate the predominant waste types found at both sites.

Figure 7: Used water sachets

Figure 8: Green plastic sachets from single use items

Figure 9: Mixed paper and cardboard waste, including packaging materials

Figure 10: Soiled black plastic bags

Figure 11: Empty glass liquor bottles

Figure 12: PET bottles and residual containers

3.1 Nsidung Beach Market

The waste assessment at Nsidung Beach Market highlights a substantial and diverse waste footprint, both in volume and in types of materials generated. Based on vendor interviews and physical sampling, the site was identified as a critical leakage hotspot into the Calabar River due to widespread informal disposal practices and minimal containment or collection systems.

Vendor Behavior and Infrastructure Gaps

Interviews with 29 vendors revealed that:

- 11 vendors (38%) disposed of their waste directly into the river;
- 7 vendors used informal dumps, primarily behind the market;
- 7 vendors discarded waste randomly along roadsides;
- Only 8 vendors left their waste for collection by the sanitation team.

Bagging and containment were limited: 18 vendors did not bag their waste at all, while only 9 vendors consistently used plastic bags. This indicates that waste leakage is occurring at the source, before any collection infrastructure can intervene.

Field observations confirmed the presence of at least four informal dumps, which serve as secondary leakage points, particularly during tidal or rainy events.

Waste Generation and Composition

Sampling from four representative vendor groups showed that the average waste generation per vendor was 315 grams per day. Considering that Nsidung Beach Market operates with around 500 vendors across various activities on its two main market days (Thursday and Sunday) and an estimated of 50 vendors on the remaining days of the week, circulated for 52 weeks per year, the total estimated yearly waste generation is 20,475 kilograms (see Figure 5). Of this:

- Plastics accounted for the largest fraction at 8,333 kg (40.7%), with dominant subtypes including plastic bags (12.2%), other plastic packaging (13.1%), and water sachets (6.4%).
- Paper and cardboard contributed 5,746 kg (28.1%), mainly from carton packaging.
- Glass, mostly liquor bottles, made up 3,374 kg (16.5%).
- Residual waste, including textiles, plastic signage, and footwear, accounted for 3,023 kg (14.8%).

The item count was also high for single-use materials, with 64 plastic bags, 117 nylon fragments, and 53 water sachets recorded during the sampling highlighting the excessive use of disposable packaging.

Leakage into the Environment

Critically, an estimated 90% of total waste (18,427 kg) is being dumped into the environment, primarily into the river or surrounding open spaces. Only 10% (2,047 kg) is reportedly collected for disposal, as shown in the Sankey diagram (Figure 13). The lack of formal waste evacuation systems combined with poor vendor practices creates a direct waste stream into aquatic ecosystems.

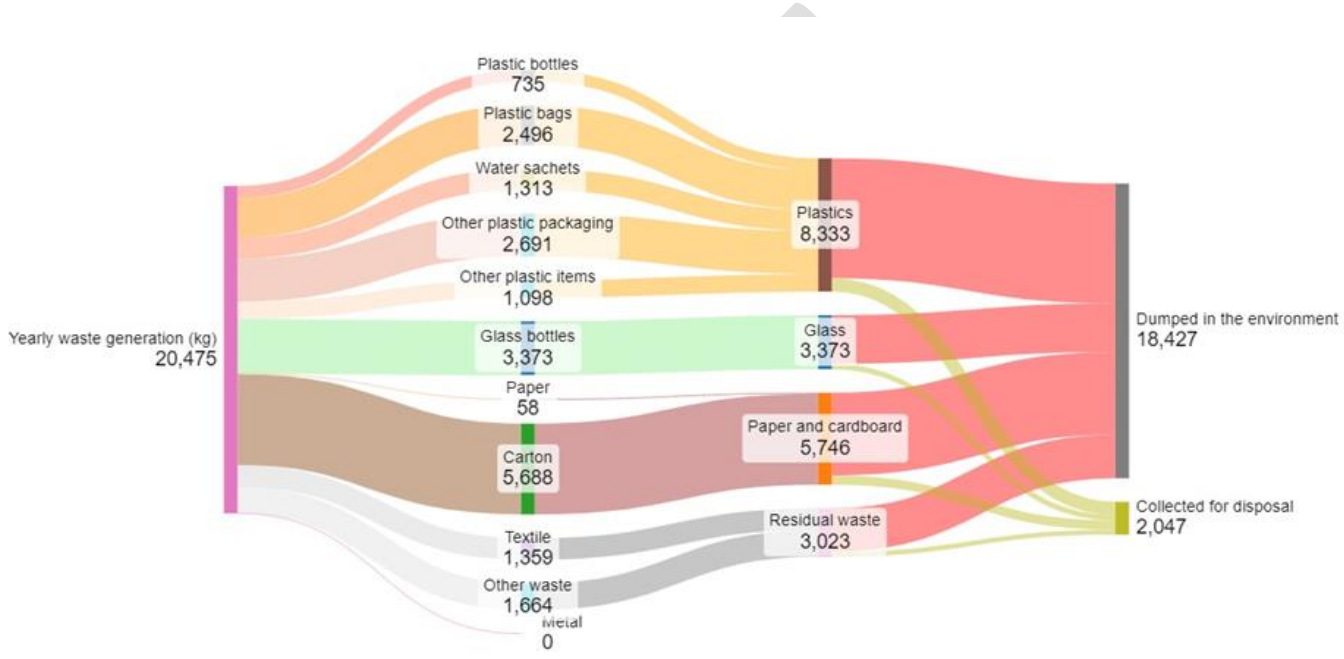

Figure 13: Annual Waste Flow from Nsidung Beach Market

3.2 Atansinya Beach Market

Compared to Nsidung, the Atansinya Beach Market displays a significantly lower volume and narrower range of waste generation. The market's structure composed primarily of fish buyers operating informally along the riverbank translates to limited on-site packaging, storage, or retail activity. This results in a relatively small but still impactful waste stream concentrated almost entirely in plastics.

Waste Generation and Material Composition

Based on interviews and sampling across Vendor Group 5 over two days, the average waste generated per vendor was 23 grams/day, totaling 1.37 kg/day across 60 vendors. Extrapolated across 365 days of operation, the market produces approximately 499 kilograms of waste annually.

The waste stream is composed exclusively of plastics (100%), with no notable presence of glass, paper, metal, or residual materials. The most dominant fractions include:

- Water sachets: 301 kg (60%)
- Other plastic packaging: 173 kg (35%)
- Plastic bags: 18 kg (4%)
- Plastic bottles: 7 kg (1%)

This profile reflects the limited use of diverse materials in daily market activity but underscores a high dependency on single-use plastic items.

Waste Disposal Practices and Environmental Leakage

As shown in the Sankey diagram (Figure 14), an estimated 90% of waste (449 kg) is dumped into the surrounding environment, including the Calabar River and adjacent swampy land. Only 10% (50 kg) is collected for disposal. Informal interviews noted that waste is often used to fill land or left exposed, making it highly susceptible to being washed away by tidal surges.

Despite some vendors reporting a shift toward bagging waste, partially influenced by local awareness campaigns, there is no structured waste collection system in place. Consequently, even positive behavioral shifts fail to prevent environmental leakage.

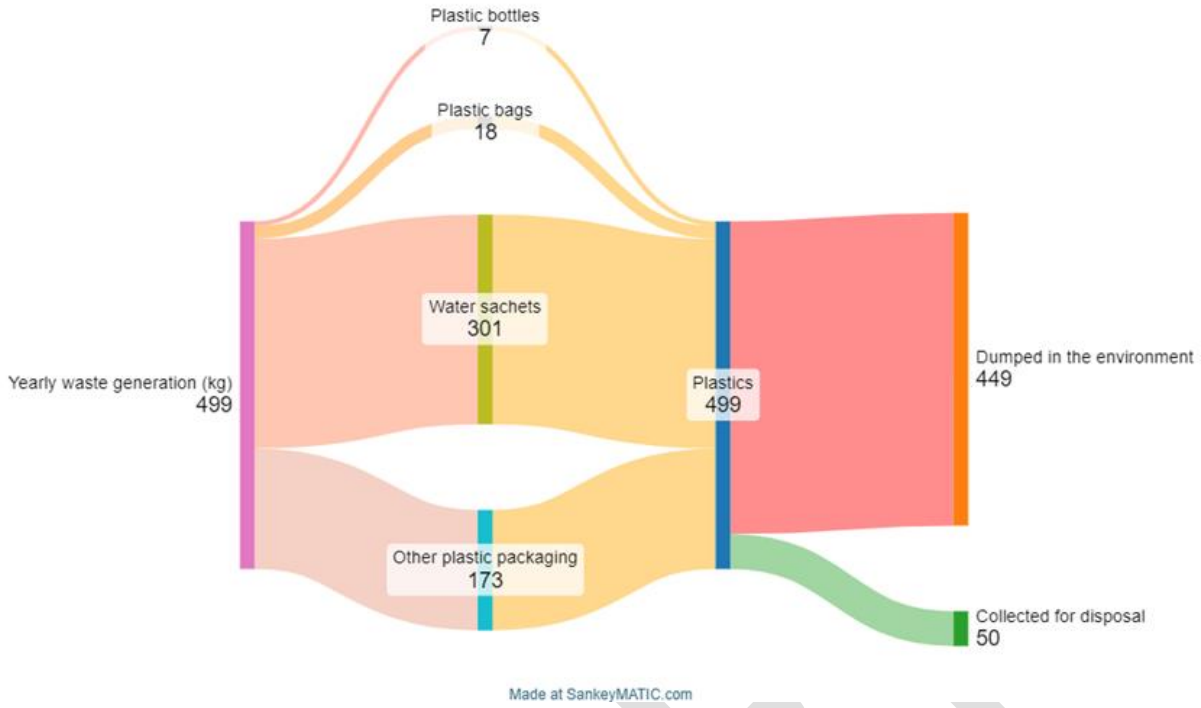

Figure 14: Annual Waste Flow from Atansinya Beach Market

4. Recommendations

This Source-to-Sink assessment reveals that both Nsidung and Atansinya Beach Markets contribute significantly to plastic pollution in the Calabar River due to the absence of structured waste collection and high dependence on single-use plastics. At Nsidung, where waste generation is higher and more diverse, the majority of waste, primarily cartons, glass, and various forms of plastic is dumped directly into the environment, with only a small fraction being collected for disposal. Atansinya, though smaller in scale, still contributes to environmental leakage, with 100% of its waste composed of plastics, mostly water sachets and flexible packaging.

To address these challenges, Nsidung requires investment in basic infrastructure, such as designated collection points, improved vendor awareness, and a transition to alternative packaging materials. Regular monitoring and light enforcement mechanisms could also encourage better compliance. At Atansinya, where activities are simpler, targeted interventions such as lightweight plastic recovery systems, community-led

cleanup initiatives, and reinforcement of awareness campaigns can yield measurable impact with minimal resources.

It is important to note that this assessment excluded organic waste, as this material lies outside the scope of the PROTEGO project. The results focus exclusively on non-organic materials such as plastics, paper, and glass. Furthermore, waste generation rates are based on observed daily averages and assume no seasonal variation throughout the year.

Together, the markets generate approximately 21 metric tons of non-organic waste annually, of which an estimated 90% enters the environment untreated. Addressing this leakage is critical for improving urban waste systems, protecting aquatic ecosystems, and advancing circular economy initiatives along Nigeria's riverine coastline.