Climate change and its impact on marine ecosystem and human life

OCEAN METABOLISM: A Toolkit Guide to Tackling and Monitoring Waste in Coastal and Island Tourism Regions

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2nd Ocean Observers Workshop
Sharing international marine science educational resources
29-30 Nov & 1 Dec 2021
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Context

THE PROBLEM

• Overconsumption of plastics and subsequent mismanagement of plastics waste.

• Cascading effects of plastic pollution on the natural systems.

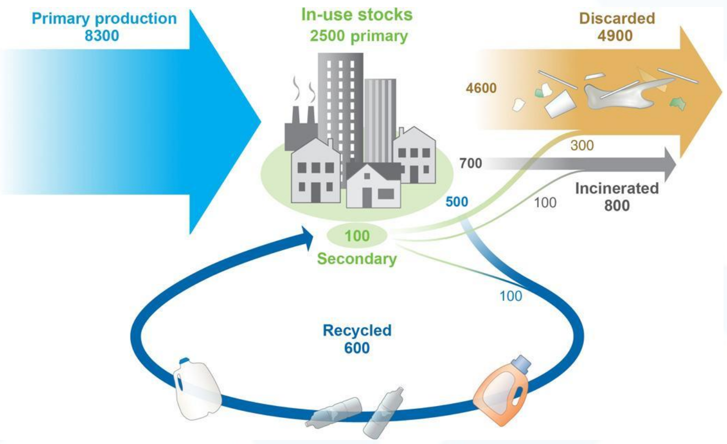
• Lack of data on plastic inflows (sources, pathways, types) into the ocean.

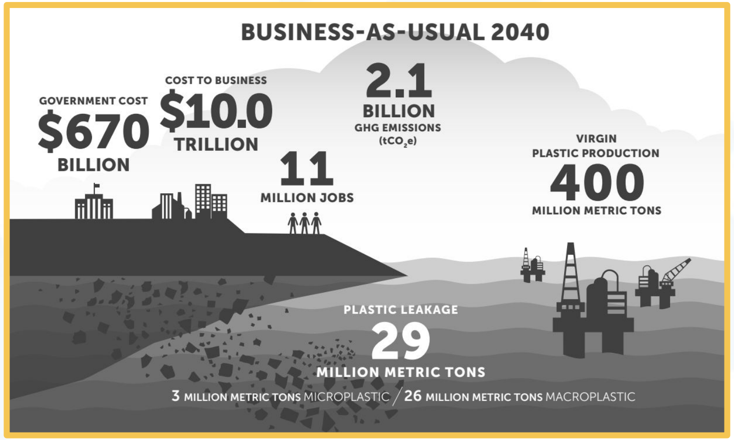
A POSSIBLE WAY-OUT

• Supplement the paucity of global analyses of plastic production, consumption, and fate.

• Supplement the lack of transparent and traceable material flows across their life cycle.

• Monitoring and reporting on pollution cycles in water bodies.



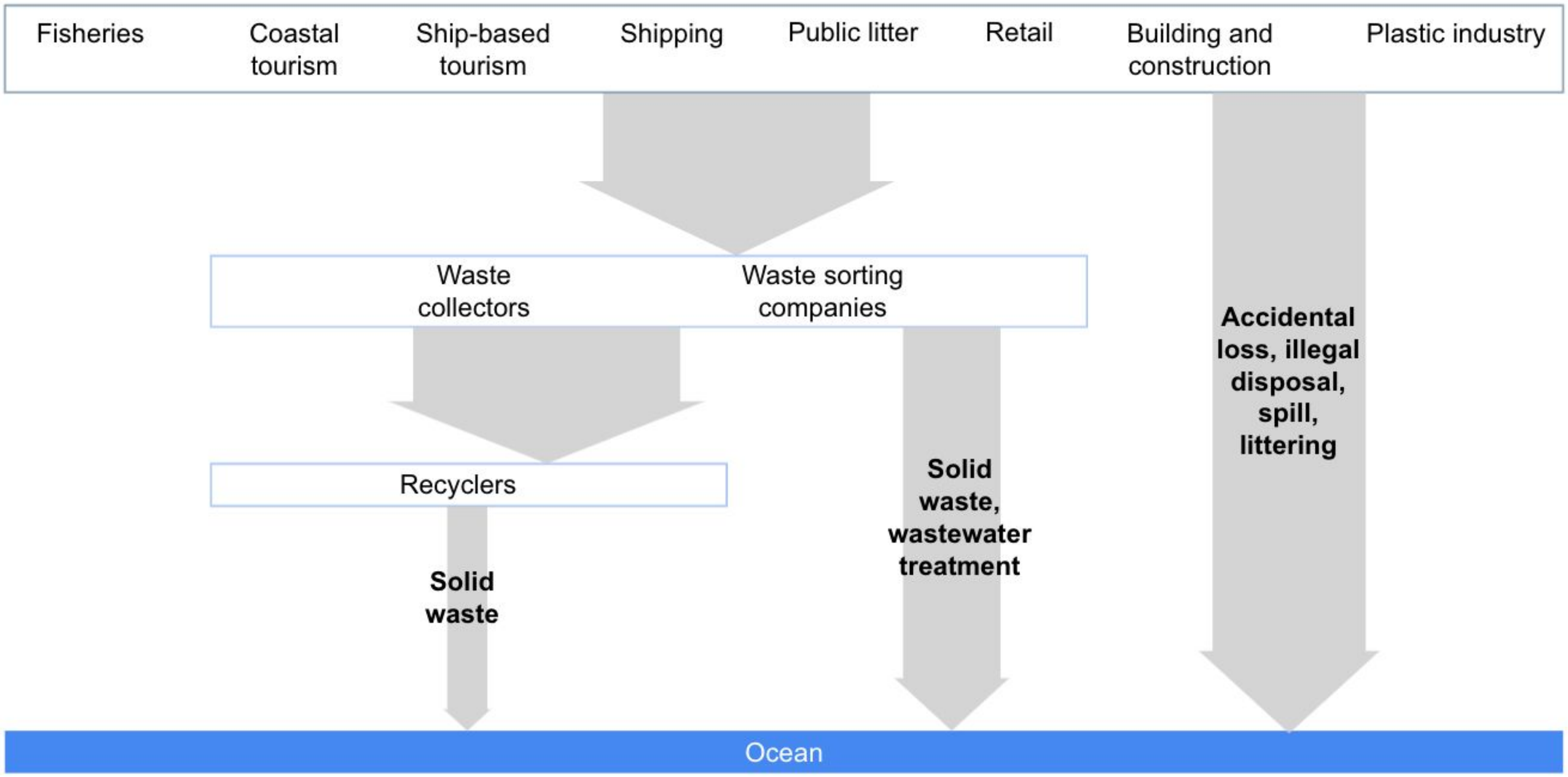


Sources and types of plastic pollution

Sectors	Plastic items	Entry points
Household (public litter)	Plastic shopping bags, beverage bottles, food wrapping, containers, tableware, cleaning supplies, clothing, sport equipment, and cosmetics.	Rivers, coastal
Retail	Containers, food wrapping, and plastic shopping bags.	Rivers, coastal
Tourism	Beverage bottles, food wrapping, tableware, sportswear, fishing equipment, sport equipment, and beauty care products.	Rivers, coastal, marine
Shipping	Food wrapping, tableware, beverage bottles, and containers.	Coastal, marine
Fisheries	Fishing equipment, including abandoned, lost or otherwise discarded fishing gear (ghost gear).	Coastal, marine
Building and construction	Window profiles, pipes, insulation layers, packaging, utensils, and plastic components (e.g., screws, bolt covers, silicones).	Rivers, coastal
Plastic industry	Plastic components and wrapping.	Rivers, coastal

Source: UNEP, 2016. Marine Plastic Debris & Microplastics.

Marine litter pathways



Macro-level monitoring: The transboundary issues of marine litter in border regions

Southern California - Baja California, US-Mexico coastline

OPEN ISSUES

- Limited traceability associated with different systems for material/pollution monitoring and accounting.
- Different policies and measures to allocate resources, and keep material flows accountable.
- Lack of information exchange across borders.
- Uneven use and communication of data analytics.

SURVEY QUESTIONS

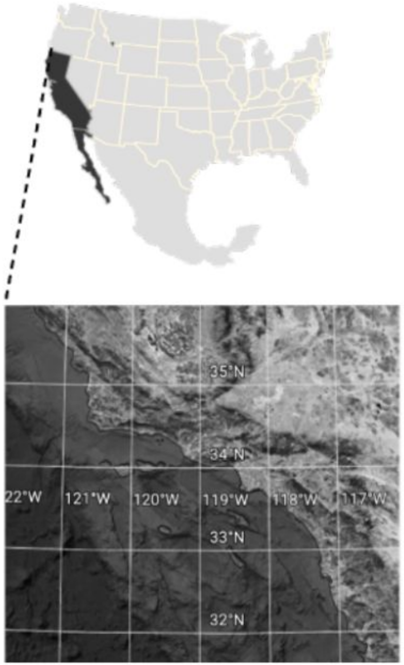
- What are the magnitude, location, and temporal variability of plastic accumulations?
- What are the composition, spatio-temporal distribution, and abundance of plastic accumulations?
- What are the main physical and anthropogenic processes influencing the transport and accumulation of plastics?

OBJECTIVES

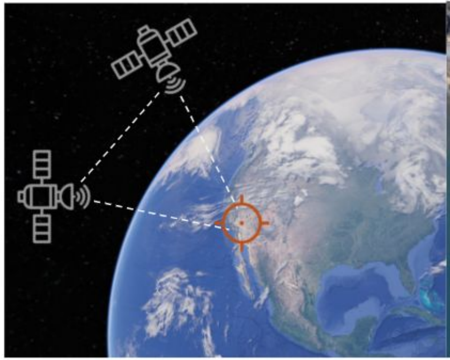
- Provide real-time or nearly real-time data acquisition, wide area coverage, and high spatial resolution.
- Provide a consistent global, harmonized system for assessing plastic particles swirling in transboundary waters.

Macro-level monitoring: The transboundary issues of marine litter in border regions

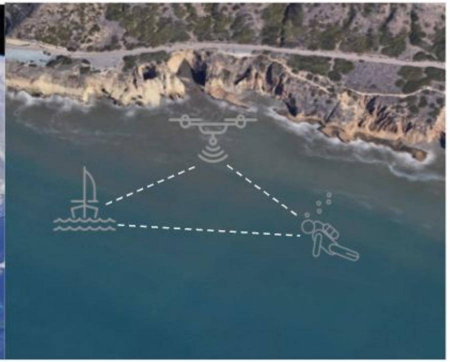
Southern California - Baja California, US-Mexico coastline



1.
Space-based earth observation of magnitude, spatio- temporal distribution, and accumulation of marine plastic pollution.



2.
In-situ marine pollution measurements combining available data on water quality and observations.



MONITORING METHODOLOGY

- Space-based observation of magnitude, spatio-temporal distribution, and accumulation of marine plastic pollution.
- Spectrometric analysis of observed pollution.
- Proximity sensing (e.g., sensors, drones) data acquisition on pollution.

COLLECTED DATA

- Satellite imagery of plastic pollution.
- Aerial photos of pollution.

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Meso-level monitoring: Survey of macroplastics on tourism beach

Zanzibar, Tanzania

OPEN ISSUES

- Paucity of data on sources and amounts of marine plastic pollution.
- Uncertainty about sources and pathways of marine pollution.

SURVEY QUESTIONS

- Where are the areas where litter is most prevalent?
- How much litter occurs in the selected study site?
- What is the litter composition (wet, recyclable, non-recyclable)?
- What are the principal types of material (e.g., plastic, paper, metal, etc.)?
- What are the principal litter items? •Does the amount of litter vary across different transects?
- What are possible variables that affect the input of litter at sea?

OBJECTIVES

- Capture spatio-temporal variability of beach and coastal plastic pollution over time (e.g., measurements can be repeated over several consecutive days and across time).
- Provide a more accessible litter assessment using basic, cost-effective tools (e.g., logbook, pencils, measuring tape, litter bags, and buckets).

Meso-level monitoring: Survey of macroplastics on tourism beach

Zanzibar, Tanzania

MONITORING METHODOLOGY

- In-situ assessment and quantification of plastic litter via litter counting (visual inspection of debris).
- Litter separation by material type and debris classification.

COLLECTED DATA

- Marine litter amounts (count and weight).
- Marine litter density (kg/transect).
- Photographic evidence.
- Information on sampling conditions (e.g., location, GPS coordinates, time, procedure).

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Micro-level monitoring: Microplastics ingestion in aquatic environments

Detroit River, Michigan

OPEN ISSUES

- Limited data on ecological and biological impacts of plastic on native species.
- Uncertainty about the translocation of microplastics across trophic levels.

SURVEY QUESTIONS

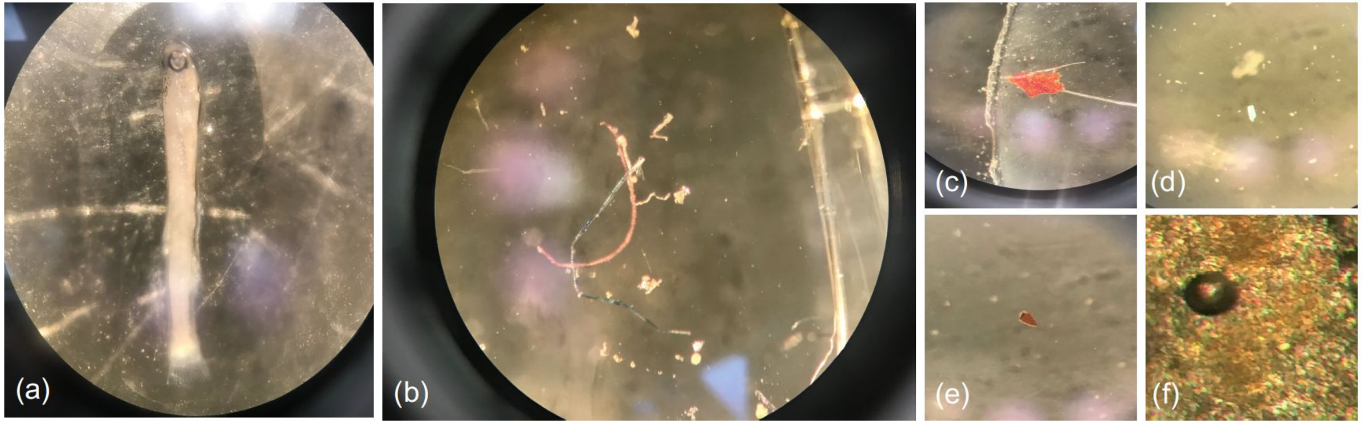
- What are the abundance, distribution, and variability of microplastics?
- What is the incidence of encounter between microplastics and native species (e.g., resulting in ingestion)?
- How does plastic pollution affect the subsistence (e.g., feeding behavior) of native species?

OBJECTIVES

- Quantify smaller fragments like microplastics and nanoplastics.
- Assess specific impacts of plastic pollution, such as the incidence of encounters between plastic particles and marine organisms, as well as related effects (e.g., biological effects, ecological effects, changes in fish feeding behavior, or debris translocation across trophic levels).

Micro-level monitoring: Microplastics ingestion in aquatic environments

Detroit River, Michigan



a. Sample: larval fish

b. Observation: fiber (red), fiber (blue).

c. Observation: fragment (red).
d. Observation: fragment (white).
e. Observation: fragment (red).
f. Observation: bead (black).

MONITORING METHODOLOGY

•Sampling of water.

•Sampling of shore sediments containing plastic particles.

•Sampling of fish, birds, bivalves, or crustaceans.

COLLECTED DATA

•Number and type (beads, fibers, fragments, films, or foams) of plastic particles.

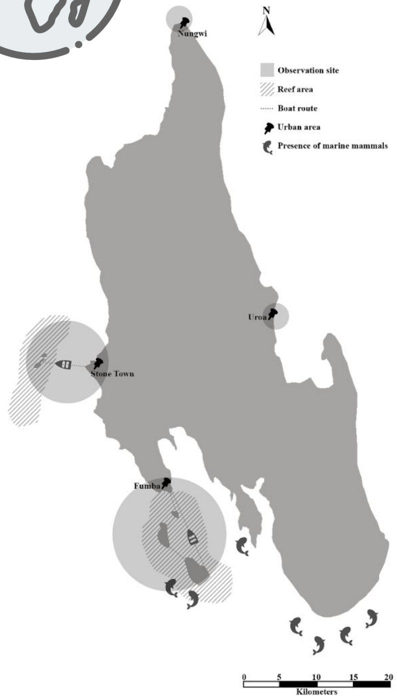
•Particle size (length and area).

•Dominant particle color (e.g., blue, black, red, or orange).

Focus: Plastic pollution on Zanzibar's tourism beaches, Tanzania

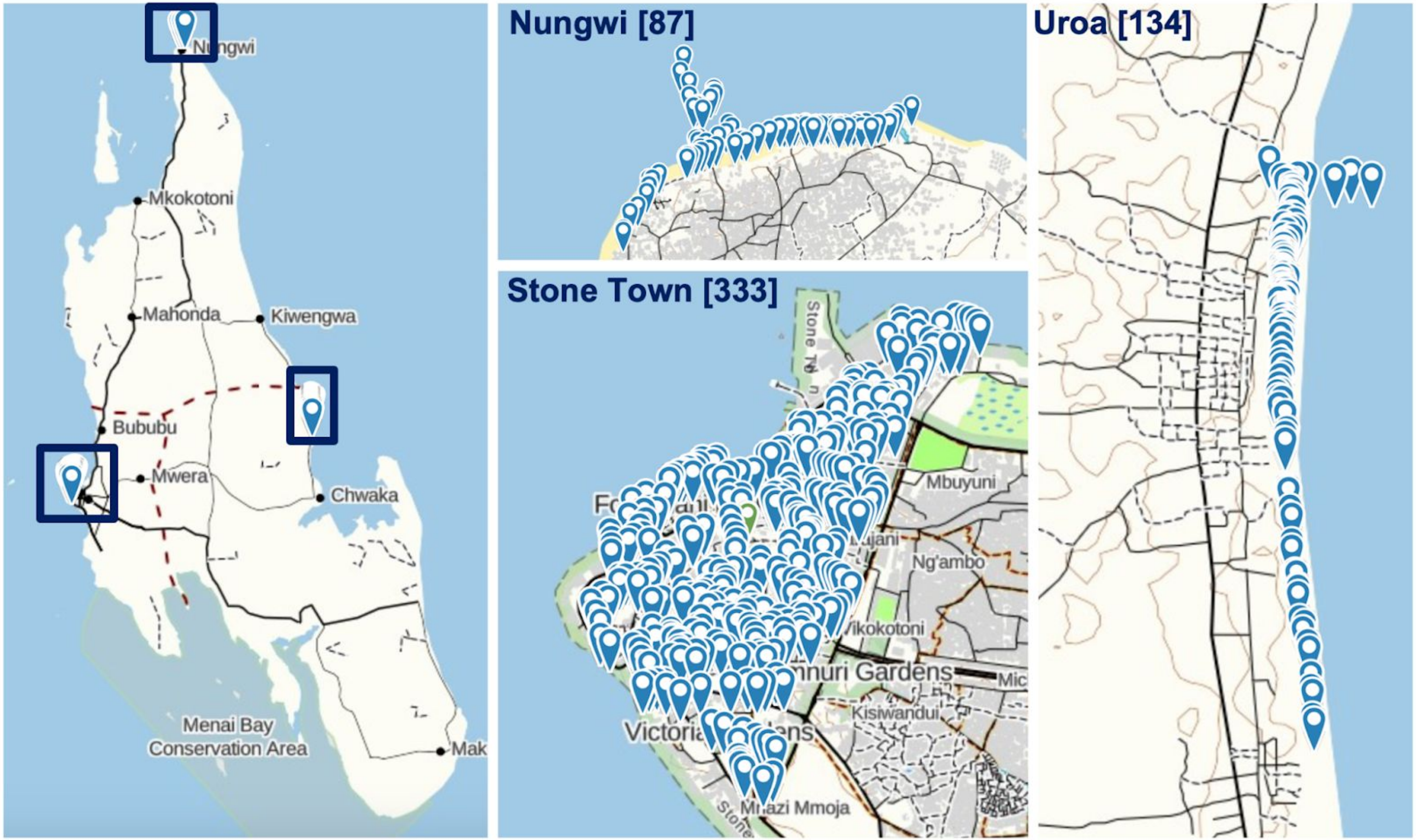
Research questions:

- **Why is it important to study coastal plastic pollution?**
- **What are dominant sources and types of mismanaged plastic waste?**
- **What is the role of tourism in plastic pollution?**
- **What are the main drivers of plastic pollution?**



Map of Zanzibar Archipelago and study sites on Unguja island.

Sampling locations



Expedition:

- Period: **June-July, 2018.**
- Mapped sites: **Stone Town, Nungwi, Uroa** (Zanzibar, Tanzania).
- Observed plastic items: **554.**

Sampling activities and tools

	Site preparation	Litter composition analysis	Source identification	Polymer composition analysis	Plastic debris weighing
Activities	•Marking site boundaries •Setting transects	•Recording GPS coordinates •Debris classification by material type (plastic, organic, other)	•Measuring distance from potential sources	•Visual inspection of plastic debris	•Weighing of plastic debris
Materials	•Flag markers •20-meter measuring tape •Strip transect •Digital camera	•Hand-held GPS unit •Digital camera •Datasheets •Pencils	•20-meter measuring tape •Datasheets •Pencils	•Datasheets •Pencils	•Portable scale (5 kg load capacity, 0.1 kg accuracy) •Datasheets •Pencils

Macro debris survey

Sampling:
Stone Town, Zanzibar

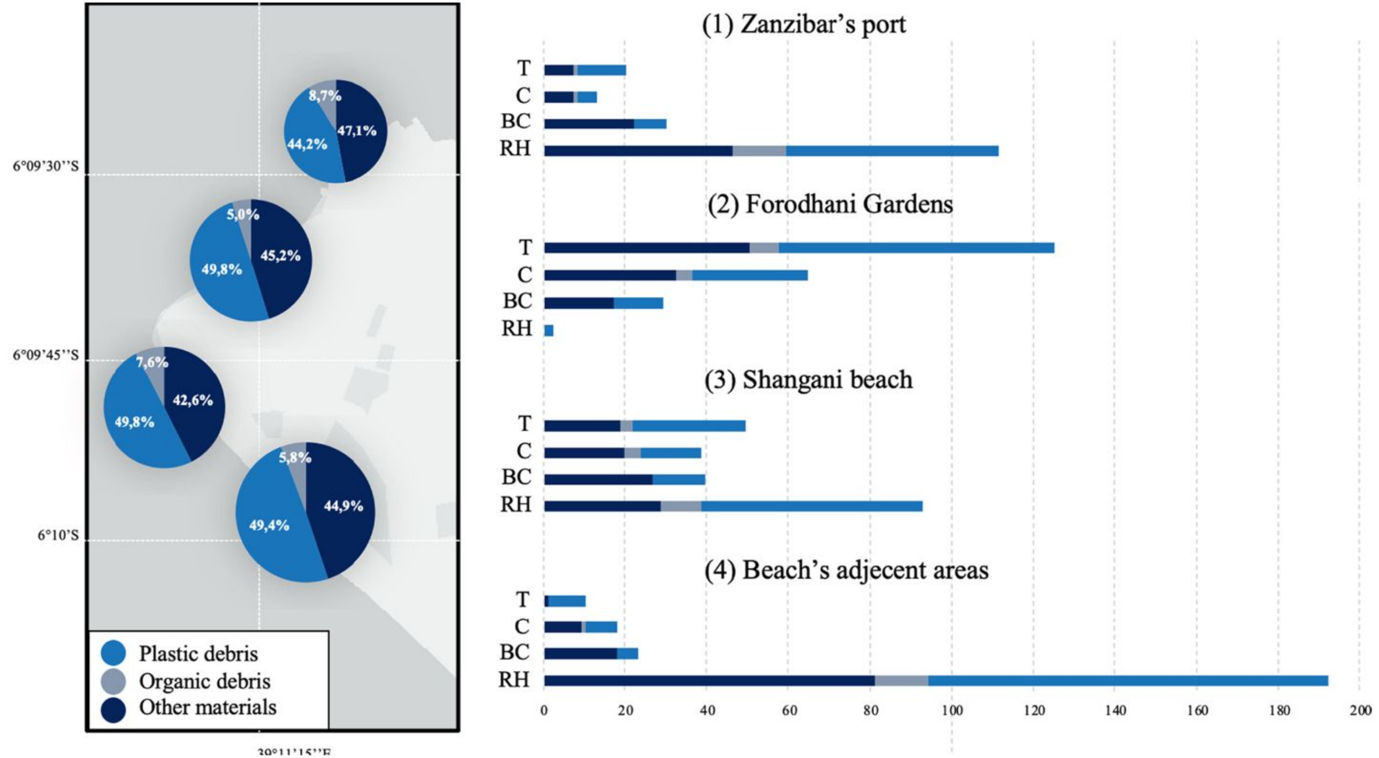


Fig. 2. Percentage (left) and count (right) of litter composition by source at the four sampling locations (T = tourism sector, C = commercial sector, BC = building and construction sector, RH = residential households).

Types and amounts of plastic litter

Sampling:
Stone Town, Zanzibar

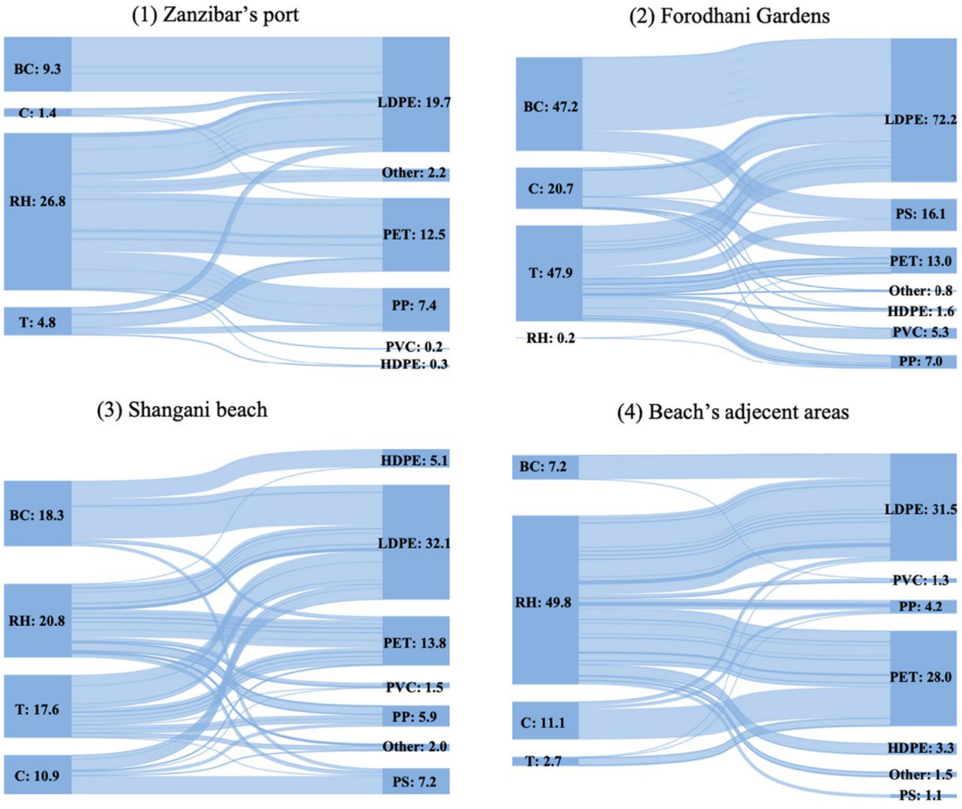


Fig. 3. Classification and abundance (kg) of polymer type by source at the four sampling locations (T = tourism sector, C = commercial sector, BC = building and construction sector, RH = residential households).

Symbol	Polymer	Common Uses
1 PETE	Polyethylene terephthalate	Plastic bottles (water, soft drinks, cooking oil)
2 HDPE	High-density polyethylene	Milk containers, cleaning agents, shampoo bottles, bleach bottles
3 PVC	Polyvinyl chloride	Plastic piping, vinyl flooring, cabling insulation, roof sheeting
4 LDPE	Low-density polyethylene	Plastic bags, food wrapping (e.g. bread, fruit, vegetables)
5 PP	Polypropylene	Bottle lids, food tubs, furniture, houseware, medical, rope, automobile parts
6 PS	Polystyrene	Food takeway containers, plastic cutlery, egg tray
7 OTHER	Other plastics (e.g. acrylic, polycarbonate, polyactic fibres)	Water cooler bottles, baby cups, fiberglass

Conclusions

- The results of marine litter monitoring should answer four main questions: (1) **the type and distribution** of land-based and sea-based sources of plastic pollution; (2) **the pathways and transport mechanisms** of marine pollution from source to sea; (3) **the amounts and types** of debris concentrations; (4) **the spatio-temporal variability** of these concentrations.
- Monitoring plastic flows present numerous benefits including **the identification and quantification of the outflows** leaving the system to assess **the ecological impacts and dislocated effects** of plastic use and consumption.
- Pollution monitoring can enable **detection of loopholes in the plastic's value chain**, including material losses during plastic production, handling, sector applications, and waste management of plastic waste.
- It can supplement the current lack of **transparency and traceability of plastic flows across their entire life cycle**, including information on plastic production and consumption, data on waste streams and recyclables, and plastic pollution sources and pathways, which altogether make the circular economy of plastics a hard-to-reach perspective.
- Data from marine litter monitoring can provide industrial stakeholders and policy makers with **practical implications and decisional support to strategic interventions on pollution management**, as well as to evaluate their effectiveness over time.
- Citizen science can supplement existing monitoring approaches via **collection and real-time sharing of geo-referenced information** on litter quantities to **provide timely information** on plastic pollution, **surveil** the management of solid waste in coastal areas and report any misconducts, **communicate** about the status of the local environment with competent authorities, and **engage** for a cleaner environment.

THANK YOU!

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