CITIES AND MARINE PLASTIC POLLUTION
BUILDING A CIRCULAR ECONOMY

Course Handbook

An eLearning course on plastic waste management developed by the United Nations Economic and Social Commission for Asia and the Pacific for the Closing the Loop project.

Acknowledgements

This handbook was developed by the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) with contributions from our eLearning development partners. Course design was led by the UN-ESCAP Sustainable Urban Development Section's Closing the Loop team composed of Ms. Janet Salem, Mr. Andrew Charles, Mr. Alexander Lee-Emery and Mr. Samuel Ireland, under Section Chief Mr. Curt Garrigan. Online learning and graphics designed by Ms. Kewpie Wu.

Many thanks to our valued partners from the:

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- United Nations Environment Programme – Ms. Natalie Harms, Ms. Katrin Eitrem Holmgren, Mr. Jerker Tamelander, Ms. Kakuko Nagatani-Yoshida
- University of Leeds – Dr. Costas Velis, Dr. Josh Cottom
- Plymouth Marine Laboratory – Dr. Lauren Biermann
- Wageningen University & Research – Dr. Tim van Emmerik
- Ocean Conservancy – Ms. Keri Browder
- Women in Informal Employment: Globalizing and Organizing (WIEGO) – Dr. Sonia Dias, Ms. Taylor Cass Talbott, Ms. Lucia Fernandez
- Keio University – Dr. Yasushi Kiyoki, Dr. Shiori Sasaki
- Japan International Cooperation Agency – Mr. Kenichiro Koiwa, Mr. Shunsuke Nakamaru

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Course Introduction

Welcome to the Closing the Loop eLearning course - Cities and Marine Plastic Pollution: Building a Circular Economy.

Course Objectives

The purpose of this course is to share the latest knowledge and approaches to measuring and managing marine plastic pollution from land-based sources, in particular cities, for the achievement of local, national and regional goals related to sustainable development.

The overall objectives of this eLearning course are to:

- **Learn** about land-based plastic waste pollution issues in Asia and the Pacific.
- **Share** contemporary scientific and practitioner knowledge and assessment methodologies to better understand the plastics pollution challenge.
- **Explore** state-of-the-art technologies and techniques being used to measure and monitor plastic waste in municipal and marine environments.
- **Inspire** action to tackle practical challenges in municipal solid waste management systems for terrestrial and marine environments.
- **Equip** decision makers and practitioners with practical tools, policies and approaches for tackling plastic waste.

Course Structure

Expected completion time: 10 hours

Our eLearning Approach

This eLearning course was developed to support city-level capacity building on the topic of plastic waste management. The course is freely available and self moderated to allow the upmost flexibility for participants. Content is designed and reviewed by world-leading experts in the plastic waste sector with a particular focus on the Asia and Pacific region. For the most effective learning experience this handbook should be used to accompany the full online course. Closing the Loop has adopted a mixed-media learning approach combining text, videos and online activities to help build expertise. We hope this online course provides an enjoyable and fulfilling learning experience and we welcome feedback and further engagement with any of the topics and developers herein. Upon completion of the course participants will be rewarded with a certificate from UN ESCAP confirming achievement of the key learning objectives and outcomes.

This eLearning course was developed in Articulate 360 software and went live in June 2021. Please see https://www.unescap.org/projects/closing-the-loop for more information about the Closing the Loop project and enrolment.

Course Modules

1. Cities and Marine Plastic Pollution

2. The Plastic Value Chain

3. How to Measure Plastic Pollution

4. Detecting Waste from Land and Space

5. The Informal Waste Economy

6. Engaging Stakeholders to Address Plastic Waste

7. Local Action Planning

Course Development Partners

United Nations Economic and Social Commission for Asia and the Pacific

The Economic and Social Commission for Asia and the Pacific (ESCAP) is the most inclusive intergovernmental platform in the Asia-Pacific region. The Commission promotes cooperation among its 53 member States and 9 associate members in pursuit of solutions to sustainable development challenges. ESCAP is one of the five regional commissions of the United Nations. The ESCAP secretariat supports inclusive, resilient and sustainable development in the region by generating action-oriented knowledge, and by providing technical assistance and capacity-building services in support of national development objectives, regional agreements and the implementation of the 2030 Agenda for Sustainable Development.

United Nations Environment Programme

UNEP is the leading global voice on the environment. It provides leadership and encourages partnership in caring for the environment by inspiring, informing and enabling nations and peoples to improve their quality of life without compromising that of future generations. UNEP envisions a world without negative impacts from plastics, where no plastics damage the environment and human health, and the maximum circularity and benefits from plastic are attained through global and regional cooperation and collaboration.

Institute for Global Environmental Strategies

The Institute for Global Environmental Strategies (IGES) aims to achieve a new paradigm for civilization and conducts innovative policy development and strategic research for environmental measures, reflecting the results of research into political decisions for realising sustainable development both in the Asia-Pacific region and globally.

Women in Informal Employment: Globalizing and Organizing

WIEGO is a research action network that supports informal workers to organize and secure more decent work. In 2018 WIEGO began a five year project called the Reducing Waste in Coastal Cities through Inclusive Recycling project. The project works to support waste picker organizations around the world to secure more secure and decent work in ways that also maximize marine waste prevention. WIEGO's waste work focuses on strengthening the voice and raising the visibility of organizations of waste pickers and on pushing for inclusive, reliable waste systems. We think that now more than ever, we need to improve waste management at the source as a way to prevent plastic pollution.

Ocean Conservancy

Ocean Conservancy is working with you to protect the ocean from today's greatest global challenges. Together, we create science-based solutions for a healthy ocean and the wildlife and communities that depend on it.

In addition to mobilizing millions of volunteers through the annual International Coastal Cleanup (ICC), Ocean Conservancy leverages data and invests in additional science to better understand the sources of ocean plastics. In 2011, Ocean Conservancy convened leading researchers in an expert working group to establish a scientific baseline for the sources, fate and impact of plastics in our ocean. The resulting study by Jambeck et al. (2015) published in Science estimated, for the first time, the annual amount of plastics entering the ocean from land. In 2012, Ocean Conservancy launched the Trash Free Seas Alliance®, bringing together conservationists, scientists and members of the private sector to work together for pragmatic, impactful solutions to the problem, such as the launch of Circulate Capital – the world's first catalytic capital firm dedicated to keeping plastics out of the ocean, and Urban Ocean, a platform to engage city leaders on the issue.

Wageningen University & Research

Wageningen University and Research (WUR) consists of Wageningen University and several research institutes in the Netherlands. In recent decades, it has evolved into one of the world's leading universities in the fields of life sciences and environmental sciences. WUR is a leading supplier of scientific education in the healthy food and living environment domain with around 11,000 BSc. and MSc. students and more than 1,900 PhD students. This union of expertise leads to scientific breakthroughs that can quickly be put into practice and be incorporated into education. We do so by working closely together with governments and the business community. Our research and education are based on a fundamental scientific approach and accordingly strongly geared toward application in practice.

Plymouth Marine Laboratory

As a charity, Plymouth Marine Laboratory aims to develop and apply innovative marine science to ensure a sustainable future for our ocean. For over 40 years, we have provided evidence-based environmental solutions to societal challenges by applying cutting-edge, interdisciplinary research that benefits society and promotes stewardship of marine ecosystems. The impact of our science is far-reaching ranging – from highly cited scientific papers, to providing scientific evidence for policy, and training the next generation of marine scientists. Through the delivery of our science plan, we are also contributing to UN Sustainable Development Goals to promote healthy, productive and resilient oceans and seas.

Keio University

KEIO is the oldest institute of higher education in Japan founded in 1858. The university has ten faculties in the Tokyo-metropolitan area, Letters, Economics, Law, Business and Commerce, Medicine, Science and Technology, Policy Management, Environment and Information Studies, Nursing and Medical Care, and Pharmacy. Keio University opened its fifth university campus in Shonan Fujisawa (KEIO SFC) in 1990. The mission of SFC has been to offer education and research based on an entirely new concept. This future-oriented campus seeks to maintain a balance between modern technology and natural environment.

University of Leeds

University of Leeds, UK, is renowned for its interdisciplinary approach to problem-solving for global challenges, featuring university-wide collaboration platforms. Being among the 100 best universities worldwide, global thinking and expertise is distilled into tangible efforts to tackle the most important challenges for our society and collective future. Dr Costas Velis' research team at the School of Civil Engineering (2nd in the UK for research power; and within the top 50 in civil engineering worldwide), Faculty of Engineering and Physical Sciences, innovates on recovering resources from solid waste and enabling a global circular economy, whilst preventing risks to public health, such as from plastics pollution and wider waste mismanagement. The University is ranked 9th in the world (THE) for impact on the SDG 11, where Dr Velis' team contributed to the methodology for measuring the SDG 11.6.1 and the relevant Waste Wise Cities Tool. The award-winning team has over 30 years' experience in waste and resources management, building on a strong-track record of academic excellence, including research, publications/reports, and global collaborations – and recently focusing on modelling plastics pollution.

Interational Solid Waste Association

ISWA – the International Solid Waste Association – is a global, independent and nonprofit association, working in the public interest to promote and develop sustainable and professional waste management. The ISWA Task Force on Marine

Litter was formed in 2017 to explore and clearly establish the link between sound waste management treatment and the prevention of plastic waste reaching our oceans. The Task Force aims to prevent littering and dumping, develop practices for sound collection and disposal of municipal waste, and promote a global evaluation of efficient resource management.

Japan International Cooperation Agency

Japan International Cooperation Agency (JICA), an incorporated administrative agency in charge of administering Japan's ODA, is one of the world's largest bilateral aid agencies supporting socioeconomic development in developing countries in different regions of the world. JICA, with its partners, will take the lead in forging bonds of trust across the world, aspiring for a free, peaceful and prosperous world where people can hope for a better future and explore their diverse potentials.

Closing the Loop

Project Overview

Closing the Loop by the United Nations ESCAP in partnership with the Government of Japan aims to **reduce the environmental impact of cities in ASEAN by addressing plastic waste pollution in the marine environment**. In support of the **ASEAN framework of Action on Marine Debris** and the **G20 Osaka Blue Ocean Vision**, the project will make plastic waste management more circular and reduce the amount of waste entering the marine environment. Closing the Loop is working in four partner cities.

Closing the Loop has two broad objectives:

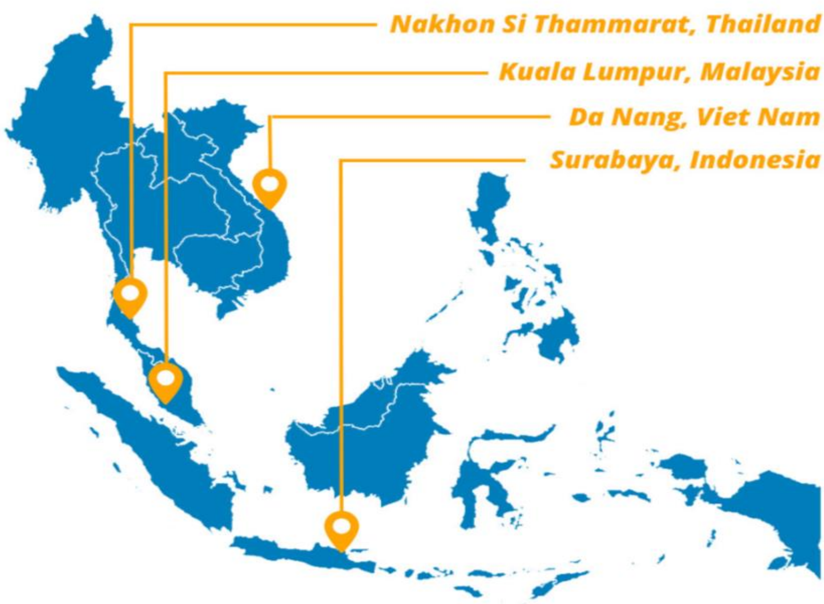
1. To develop an innovative digital tool that allows local governments to monitor and visualize plastic waste and identify hotspots with a view to improving management.
2. To work with each city to develop action plans, policies and investment strategies to address marine plastic litter.

This course was developed in support of the second objective and to facilitate local government capacity building on the topic of marine plastic waste.

Further Information

To stay up to date with the Closing the Loop Project and view all our resources and publications please visit our website: https://www.unescap.org/projects/closing-the-loop.

Additionally for more information on the work of the Sustainable Urban Development Section, please contact: escap-edd-suds@un.org.



Module 1: Cities and Marine Plastic Pollution - Building a Circular Economy

1.1 Module Introduction

Welcome to Module 1 - 'Cities and Marine Plastic Pollution: Building a Circular Economy'. This module will provide an introduction to the topic of marine plastic pollution and management. This includes: what is plastic and how is it used; the main causes and consequences of plastic pollution; the relationship between plastic and cities; and the global and regional policy context of efforts to stop plastic pollution. This module provides a stand-alone learning experience and aims to inspire participants to continue to further their understanding through completion of the full course.

Learning Objectives

- **To understand the impacts of land-based marine plastic pollution on the ocean environment.** Understand the environmental, health, food security and socio-economic impacts of marine plastic pollution on the ocean and its associated ecosystems and recognize the urgent need for intervention at the city level as part of a wider global effort to curb plastic leakage.
- **To understand the importance of cities as sources and solutions to marine plastic pollution and the benefits of adopting a circular economy based approach.** Critically evaluate the importance of Asia-Pacific cities as major land-based sources of marine plastic with reference to examples of how circular plastic waste management processes can and have been effectively implemented to reduce plastic leakage.

Developers:

- United Nations ESCAP
- Ocean Conservancy
- Japan International Cooperation Agency (JICA)

Expected Completion Time: 1hr

1.2 What are Plastics?

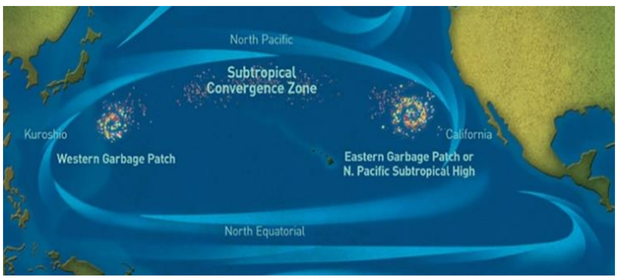
- Plastics are exceptional materials. They are **synthetic carbon-based polymers** and commonly derived from fossil fuels such as oil and gas. Their **high durability** and **versatility** coupled with a **low cost-of-production** has allowed plastic products to proliferate through every industry and country.

- Plastic was rarely used in consumer products prior to 1950. Since then, its production has increased exponentially, outpacing every other material and reaching **359 million tons in 2018** (PlasticsEurope, 2019). Plastic production primarily serves the **packaging** (146m tons), **building and construction** (65m tons), and **textile** (59m tons) industries (Geyer et al., 2017). Today over **1 million plastic bottles are sold every minute** across the world.
- The continued growth of plastic production is a key environmental concern because of the long time it takes plastic products to break down in the environment: estimates range from around **20 years** for a plastic bag, to up to **450 years** for a plastic bottle (NOAA, 2018), however it's widely acknowledged more research is required in this field. Most plastic products that have been produced are never reused, recycled or disposed of sustainably.
- This is especially concerning for **Single-Use Plastics (SUPs)** such as those used in the packaging industry and for personal protective equipment (PPE). These are characterized by their very short 'in-use' lifetime often only **minutes to hours**. In recent years and during the COVID-19 pandemic the scale of single-use plastic consumption has rapidly increased. Today approximately **1 million plastic bottles** are purchased every minute.
- All plastic products are made from one or many types of **plastic polymer**. This refers to the repeating molecules that make up different plastic materials. There are 6 main polymer types used in single-use plastic items**: low density polyethylene (LDPE)** – bags, trays, food packaging; **high density polyethylene (HDPE)** – shampoo bottles, containers; **polystyrene (PS)** – cutlery plates, takeaway trays and cups; **expanded polystyrene (EPS)** – hot drink cups, protective packaging;

Case Study: **The Great Pacific Garbage Patch**

One of the most significant consequences of this manmade crisis is the "**Great Pacific Garbage Patch**" an area blighted with an estimated accumulated debris of **705,000 tons** of non-biodegradable plastic. Here, ocean currents have drawn together plastic from all over the Pacific Ocean. This covers **1.6 million km²**, an area greater than Thailand, Vietnam, Malaysia, Cambodia and Laos combined. These factors are replicated in almost all oceans as circular currents known as **gyres** constantly bring floating debris together.

The GPGP illustrates the **highly transboundary** nature of plastic waste. Although the majority of plastic product use and wastage occurs **inland**, these activities are creating serious pollution challenges at sea. Garbage patches threaten **marine life**, **fishery health** and **seabirds.** Difficulties in sourcing waste and the common nature of ocean resources means that any sort of **accountability** or **coordinated cleanup action** remains difficult. The most effective way to halt the formation of these patches is to reduce the amount of unmanaged plastic entering waterways and the environment. This requires action upstream and on land to **address the sources** of plastic production, consumption and waste.



Garbage patches and ocean currents in the Pacific Ocean.

Source: NOAA, 2014

polyethylene terephthalate (PET)** – plastic water bottles; **polypropylene (PP)** – microwave dishes, bottle caps, plastic furniture, potato chip bags.

- To sustainably manage plastics, effective solid waste management systems are needed. Solid waste management is defined as the system of **collection, transportation, treatment and disposal of material waste products.** While the exact solid waste management systems vary between cities and countries its benefits are clear. Improved waste management systems are vital to protect **public health** and **environmental quality** and create **livelihood** opportunities for **sustainable, inclusive** and **livable** cities.
- The abundance of plastic coupled with poor waste management has contributed to a growing environmental crisis in ocean and freshwater systems. Over **1.3 million** and **9.7 million** tons of micro- and macroplastics respectively enter the ocean every year (Lau et al., 2020) (**11 million tons total**), adding to the **150 million tons** already circulating in the marine environment. This additional waste is enough to circle the Earth four times and the equivalent to dumping a garbage truck of plastic waste into the ocean every minute.
- The Asia-Pacific region is a hotspot for plastic pollution. It accounts for approximately **49.3%** of the global plastic production and **38%** of consumption. Translated to plastic pollution this relates to **31% of all macroplastics** and **44% of microplastic waste.** At present **90%** of plastic waste is not recycled (UNEP, 2018b).
- Approximately **1 million sea birds** and **100,000 marine mammals** including whales and dolphins are found dead each year from plastic waste **ingestion** or **entanglement.** In economic terms up to **$1.3 billion** is lost each year from Asian economies in **tourism, fisheries and aquaculture revenue loss.** While at a global scale total natural capital costs are estimated at **$13bn** (UNEP, 2014).
- Plastics in the environment are typically classified by size, **macroplastic** (>50mm), mesoplastic (5-50mm) and **microplastic** (<5mm). These have different environmental impacts and properties and need to be addressed in different ways.

Mismanaged plastic waste (top 10 countries in the world)

Country	Coastal population [millions]	Waste gen. rate [kg/ppd]	% plastic waste	% mismanaged waste	Mismanaged plastic waste [MMT/year]	% of total mismanaged plastic waste	Plastic marine debris [MMT/year]
China	262.9	1.10	11	76	8.82	27.7	1.32–3.53
Indonesia	187.2	0.52	11	83	3.22	10.1	0.48–1.29
Philippines	83.4	0.5	15	83	1.88	5.9	0.28–0.75
Viet Nam	55.9	0.79	13	88	1.83	5.8	0.28–0.73
Sri Lanka	14.6	5.1	7	84	1.59	5.0	0.24–0.64
Thailand	26.0	1.2	12	75	1.03	3.2	0.15–0.41
Egypt	21.8	1.37	13	69	0.97	3.0	0.15–0.39
Malaysia	22.9	1.52	13	57	0.94	2.9	0.14–0.37
Nigeria	27.5	0.79	13	83	0.85	2.7	0.13–0.34
Bangladesh	70.9	0.43	8	89	0.79	2.5	0.12–0.31

Note: kg/ppd, kilograms/person per day ; MMT, millions of metric tons.

Table 1. *Mismanaged plastic waste quantities by country. Source: Jambeck et al., 2015.*

- Plastic waste has been found in the very far-reaching corners of the planet, from 11,000 meters under the ocean in the **Mariana Trench to the top of Mount Everest**. The Deep-Sea Debris Database, which records data from more than 5,000 submersible dives at more than 4,000 meters deep, showed 3,425 items of man-made debris; **89% was single-use plastic products** (Chiba et al., 2018).

1.3 Plastic and Cities

- Asia's urban environments are **diverse**, **complex** and **dynamic** systems and the region is rapidly urbanizing. The Asia Pacific transitioned to a majority urban population in 2019 and accounts for approximately **54%** of all urbanites on the planet. By 2050 there will be an additional **1.2 billion** city dwellers in the region.
- Urban population growth is driven by **natural population growth**, **rural-urban migration** and the **expansion of urban development** into rural areas.
- The ASEAN region is home to **>300 million urban residents**, with urbanization rates varing between 24% (Cambodia) and 100% (Singapore). By 2050 approximately **205 million** new urban dwellers are predicted in ASEAN with around **50%** expected in rapidly expanding secondary cities.
- Cities remain important engines of **economic growth** and **social** and **cultural transformation** and are vital for **poverty reduction** and **sustainable development**. No country has achieved middle income status without urbanizing and at least **80% of Asia-Pacific's GDP** is dervied from urban areas (ADB). However, urban systems can be **environmentally exploitative** and cities are sites of stark **socioeconomic** and **spatial inequalities.**
- The high population density, a rising middle class and economic activity in cities relates to high levels of consumption and plastic pollution. Approximately **80% of plastic waste** is derived from **land-based sources** and over half from **urban centres** *(Lebreton & Andrady, 2019).*
- Cities are **highly concentrated in the coastal zone and around river systems**. Over **40%** of the global population living within 100km of the coast and in the Asia Pacific region populations live on average within 3km of a surface freshwater body *(Kummu et al., 2011).* Hotspots of both plastic waste, population and marine and freshwater ecosystems it is clear that cities are at the frontlines of tackling plastic pollution.
- Rivers, especially large rivers are an important pathway for plastic pollution to reach the ocean from inland. **Ten rivers in the world are responsible for up to 95% of riverbourne plastic pollution**, and **eight of them are in Asia**: Yellow, Hai, Pearl, Amur, Mekong, Yangtze, Indus and Ganges Delta *(Schmidt et al., 2017)*. The plastic crisis is therefore intimately connected with the Asia-Pacific region, its cities and policies.
- The Asia Pacific also has the **largest number of slum dwellers** of any region in the world. The provision of waste management and basic services to almost **600 million informal urban residents** is a key development priority to improve quality of life.

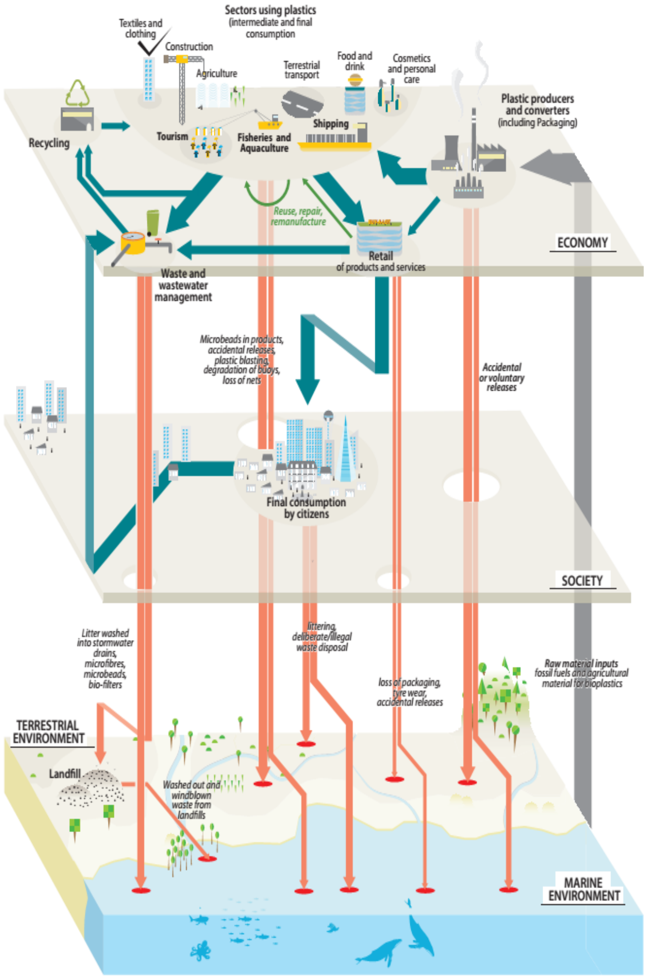


Figure 1. *Plastic environment-society-economy interactions and pathways. Source: Fabres et al., 2016*

- The informal economy generates income for more than **15 million people globally** and is a key contributor to city waste management services. The informal sector is a highly **productive labour force** across the global materials market and is estimated to collect more than **88 million tons of waste** for recycling per year (*Cook & Velis, 2020*).
- Creating effective urban waste management systems is one of the most important actions to prevent plastic pollution. **Inadequate and overwhelmed drainage systems**, **open dumping, littering** and **excess runoff** from collection points and landfills are the main drivers of land-based plastics leaking into rivers and marine environments.
- The flow of plastic waste through an urban system is called the **Plastic Waste Stream.** This is a linear flow of material and includes waste generation, collection and transport, intermediate treatment and final disposal. Waste streams are characterized by their **quantity** and **quality** (composition). Understanding **baseline urban plastic waste streams** and **municipal solid waste management capacities** is key to tackling land-based plastic pollution.
- **Improving existing waste management systems** is an important step towards reducing plastic pollution. These are **complex systems** and optimisation requires understanding many different aspects of municipal management.

- The most well-established city-level assessment methodology on waste and resources management is the 'Wasteaware' benchmark indicators *(Wilson et al., 2015).* This provides a comprehensive and standardised framework for assessing waste management in a city or municipality. It has been applied in over 70 countries worldwide.
- The assessment includes physical indicators, governance indicators, background information, and waste-related data:
  - **Physical Indicators:**
    - Public Health - Waste Collection
    - Environmental Control - Waste Treatment and Disposal
    - Resource Management - Reduce, Reuse and Recycle (3R)
  - **Governance Indicators:**
    - Inclusivity
    - Financial Sustainability
    - Sound Institutions and Proactive Policies
  - **Background Information:**
    - Country and city income and per capita income
    - City population
    - Total waste generation rates
  - **Waste-related Data**
    - Per capita waste generation rates
    - Waste composition
- If a city waste management system is failing to meet the needs of its citizens changes are required. Sustained, targeted and responsible investment in waste management systems over the coming decades will be necessary to meet the Sustainable Development Goals.
- Ocean Conservancy and Circulate Capital (*2020*) have identified five criteria to match cities and waste management providers with investors:
  - **Geography**
    Investors are focused on supporting local businesses in specific markets that are aligned with their objectives and mission. Find the investors and supporters that are looking to invest in your country. Get to know them and what they are looking for to assess their suitability as partners for local initiatives.
  - **Type of Capital**
    There are many forms of financial relationship to fund waste management solutions (equity, quasi-equity, direct loans etc.). Find out what form of funding investors can provide to understand whether it suits the needs of the small business ecosystem in your country. Different types of capital have different advantages and benefits for businesses. Similarly, it is important to understand your status of other forms of capital including natural and human capital.
  - **Scale of Investment**
    The level of funding for waste management solutions in your country will need to be

matched with the support investors can provide. Investors often look to make investments within a particular funding range and different providers will be needed from neighbourhood to city-scale.

- **Business Models**

  Help businesses attract investors by providing them the tools and resources to establish their growth strategy and prove their financial stability and return profile. Investors and

Case Study: **The Circular Assessment Protocol**

The Circularity Assessment Protocol (CAP), developed by Dr. Jenna Jambeck and her team at the University of Georgia, is a standardized assessment tool that aims to collect data to empower cities to determine what current plastic pollution mitigation activities are working, and, to inform decisions and interventions to improve circularity, including reducing litter and reducing the potential for plastics to reach waterways or the ocean.

The CAP guides on-the-ground data collection across seven different categories to characterize material management in local communities. CAP provides a snapshot of a city's circularity that can provide data for local, regional or national decision making and has been deployed through the Ocean Conservancy Urban Ocean Program..

The protocol consists of three phases delivered in collaboration with local stakeholders:

- Phase I – Pre-field analysis
  - Literature and data review.
  - Consumer analysis.
  - Interviews and training.
  - Data collection planning, permissions and logistics.
- Phase II – Field work
  - At each designated site data is collected on population, demographics, policies, geographic characteristics, climate and weather, and community events.
  - Semi-structured interviews with local retailers.
  - Litter transects over the highest population density areas.
  - Mapping and interviews with lcoal government.
- Phase III – Data analysis and reporting
  - GIS maps and quantitaive waste summaries.
  - Qualitative analysis of interviewee responses.
  - Recommendations to government and community stakeholders.
  - Final report and supporting data.

For more information see: https://www.circularityinformatics.org/

supporters look for evidence that they can confidently help the business grow and scale for the long-term.

- **Social and Environmental Impact**
  Investors today are looking for more than financial returns. They also want their partners to have a positive impact on the world around them. Help the businesses showcase their environmental, social and economic impacts. Metrics could include: tons of waste diverted from landfill or the environment and returned to a circular economy; tons of greenhouse gas emissions reduced; jobs created and livelihoods improved, especially for women and marginalized populations; benefits to cities' integrated waste management systems, including for organic and textile waste; and compliance with key environmental, social, and governance standards, including for climate change and human rights, such as those addressed by the UN Principles for Responsible Investment (PRI).

1.4 The Circular Economy and Plastic Policy

- The **Circular Economy** presents an alternative to the dominant **extract-use-dispose** linear economic model. In contrast, a Circular Economy considers waste as a **valuable resource**. It focuses on **minimizing consumption** and **maximising the productive life and value of existing products**. This reduces pressure on finite natural resources and the environment.
- The Circular Economy is an opportunity to create a sustainable system that **decouples economic growth from environmental degradation** while providing economic, social, and environmental benefits. At a global scale, a transition to a Circular Economy is estimated to provide more than **$1 trillion in material cost savings by 2025** *(World Economic Forum, 2014).*
- There are numerous strategies to achieve a circular economy, arranged around so-called '**loops**'. These connect different components of the economy to bring products and resources back into productive use instead of 'leaking' into the environment through pollution, incineration or landfill. The inner loops are shorter, typically requiring less resources to prolong the use of a product and so strategies which emphasise these are there considered more valuable:
  - **1st Loop - Maintain/Repair**
    This is the shortest loop and highest value. Here the idea is to maximise the productive lifespan of a product to ensure it remains in useful circulation for as long as possible. This can also be facilitated upstream in the product design phase with a greater focus on multifunctionality, durability and easy repair.
  - **2nd Loop - Reuse/Redistribute**
    The next highest level of value, in the 2nd loop the waste product is returned to a service provider and then redistributed for additional use. The product remains intact and of value to many users through mechanisms like renting, sharing, and second-hand markets.
  - **3rd Loop - Refurbish/Remanufacture**

In this loop the used item is returned to the product manufacturer. Any faulty components are replaced as needed and then the product is returned into the economy via service providers for distribution to new users.

- **4th Loop - Recycle**

  In the recycling process the waste product is disassembled into its usable materials and returned to the parts manufacturer. This material is then turned into a new product which continues to cycle through the economy. The effectiveness of recycling is highly dependent on the local waste management system and the material value of any wasted products.

- However, there are also many barriers to the circular economy.
  - **Information about product material composition and design is difficult to obtain.** With limited understanding or standardisation of products and waste solution providers cannot efficiently or accurately manage circularity in the supply chain.
  - **Products are designed for initial sale, not circularity**. End of life recycling is difficult when different materials are mixed, glued together or hard to disassemble.
  - **Business models are established for ownership** of products by consumers. Scaling shared use and repair mechanisms may require radically different business models and/or complementary services.
  - **Reverse logistics,** the process of moving waste products or parts back up the supply chain, are often **inefficient**. When it is very cheap to produce new products it can be difficult to concentrate secondary materials for sorting and remanufacturing.

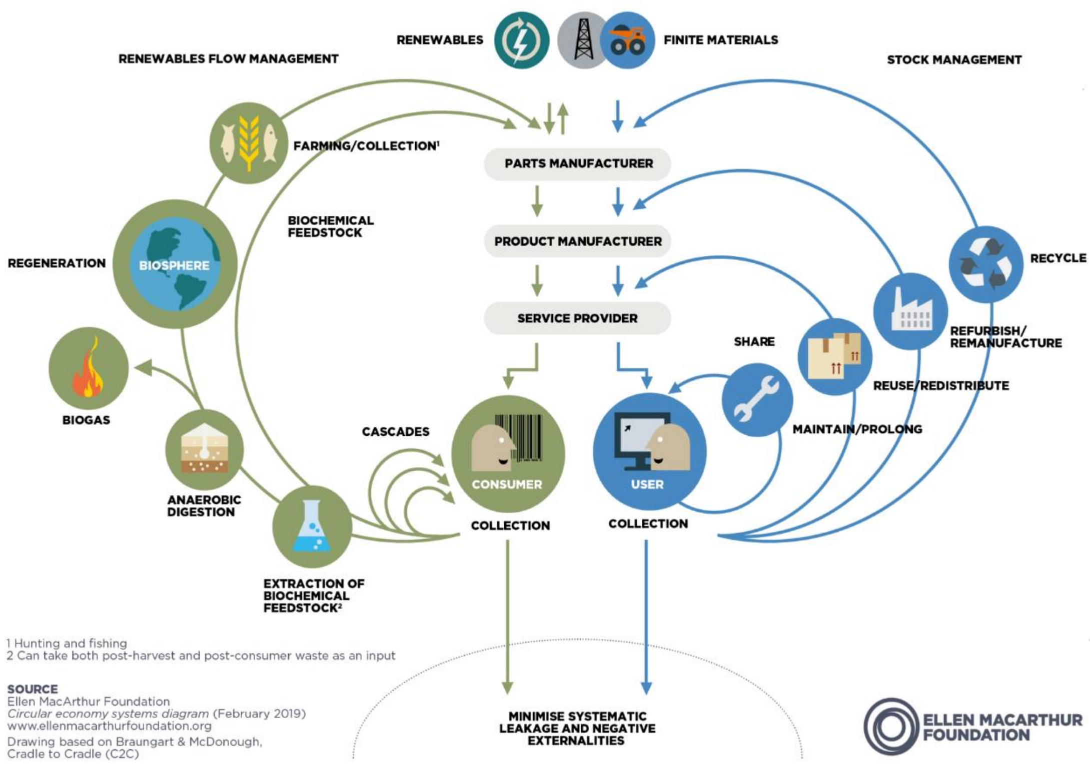


Figure 2. *A circular economy system. Source: Ellen Macarthur Foundation, 2019.*

    - **Sorting and processing stages of recycling are limited** by the quality and quantity of input materials. When waste item composition is difficult to identify or expensive to disassemble it is more difficult to develop economically sustainable business models.
    - **Poor sector linkages and incentive misaligment** makes it difficult to transition from the linear economic model. Market complexity and the different incentives at each stage of the value chain are a barrier to systems-wide change. For example, pastic producers and retailers benefit by differentiating new product designs for sales, which at the same time penalises end-of-life waste processors.
- Further benefits from circular economies include a stronger focus on **innovation**, **improved product lifecycles** and **job creation**, especially for the **informal waste economy**. All of these greatly benefit cities which are already focal points for waste, innovation and informal activity.
- The Circular Economy approach presents a strong case for reducing marine plastic waste. Keeping plastics in **circulation** and **maximising their productive use** will provide economic gains while reducing environmental impacts. It is estimated that **$80-120 billion** of plastic packaging alone are wasted each year *(Ellen MacArthur Foundation, 2016)*.
- Policy is an important tool for promoting Circular Economy to tackle marine plastics. Policy must be based on **robust scientific evidence**, contextualized by **environmental, socioeconomic and political realities**, **inclusive** and **sustainable**, and **ambitious, achieveable** and **enforceable.**
- The UN Environment Programme (2018c) identified 5 priority policy areas: (1) **Improve waste management systems**, (2) **Promote eco-friendly alternatives to single-use plastic**, (3) **Educate consumers to make environmentally friendly choices**, (4) **Enable voluntary reduction strategies**, (5) **Ban or levies on the use and sale of single-use plastic items.**
- Improvement in waste management systems results in more efficient and effective waste collection, source segregation, transport, treatment, energy recovery, resource recycling, and final disposal. Strategies to transition a more cirular economy are covered by the **9Rs** which addresses the entire value chain through 3 main components: the **useful** and **efficient application** of all materials (**Repurpose**, **Recycle**, **Recover**); **extending** the **lifespan** of a product and its parts (**Reuse**, **Repair**, **Refurbish**, **Remanufacture**); and the development of **smarter product use** and **manufacture** (**Refuse**, **Rethink**, **Reduce**) (Potting, et al., 2017).
- Tackling plastic pollution contributes to multiple **Sustainable Development Goals.** In particular: **SDG 11** – Make cities inclusive, safe, resilient and sustainable; **SDG 12** – Ensure sustainable consumption and production patterns; and **SDG 14** – Conserve and sustainably use the ocean, seas and marine resources for sustainable development.
- Several regional policy initiatives and frameworks have been developed to accelerate action on marine plastic waste in the Asia Pacific region.
    - The **Osaka Blue Ocean Vision (2019)** ratified by G20 countries aims to reduce additional marine plastic litter to zero by 2050 through a comprehensive life-cycle approach.

Circular economy

Increasing circularity

Linear economy

	STRATEGIES	
Smarter product use and manufacture	R0 Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product.
	R1 Rethink	Make product use more intensive (e.g. by sharing product).
	R2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials.
Extend lifespan of product and its parts	R3 Reuse	Reuse by another consumer of discarded product which is still in good condition and fufils its original function.
	R4 Repair	Repair and maintenance of defective product so it can be used with its original function.
	R5 Refurbish	Restore an old product and bring it up to date.
	R6 Remanufacture	Use parts of discarded product in a new product with the same function.
Useful application of materials	R7 Repurpose	Use discarded product or its parts in a new product with a different function.
	R8 Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality.
	R9 Recover	Incineration of material with energy recovery.

Figure 3. *Circular economy solutions – the 9R framework. Source: Potting et al., 2017.*

- The **Association of Southeast Asian Nations (ASEAN) Framework of Action on Marine Debris (2019)** addresses plastic pollution across four priority areas: (a) policy support and planning; (b) research, innovation and capacity-building; (c) public awareness, education and outreach; and (d) private-sector engagement.
- The **Coordinating Body on the Seas of East Asia (COBSEA) Regional Action Plan on Marine Litter (2019)**, was adopted by 9 countries to consolidate, coordinate and facilitate cooperation, and implement environmental policies strategies and measures to manage marine litter.
- The **Asia-Pacific Economic Cooperation (APEC) Roadmap on Marine Debris (2019)** is a voluntary commitment to promote (a) policy development and coordination; (b) capacity building; (c) research and innovation; and (d) financing and private sector engagement.

- Marine pollution is a **transboundary problem** whose solution requires regional coordination, national cooperation and local implementation. Plastic pollution streamed through transboundary river basins highlights the **shared regional accountability** for the plastic leakage into the ocean, and a **shared responsibility** to protect it. The **United Nations Convention on the Law of the Sea** is the most comphrehensive global scale legislation that compels nations to minimize marine pollution. This is coupled with the **Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal**. Initially developed in 1992 the Basel Convention was amended in 2019 to include plastic waste within its definition of hazardous waste.

- To develop international cooperation on plastic pollution and solid waste management JICA propose **4 models**: (1) **Direct Cooperation** – Continuous assistance and support from regional agencies, (2) **Local Government Tie-Up** – Links local governments from different countries to promote peer-to-peer learning on plastic management, (3) **Private Sector Tie-Up** – Links local government with private waste sector suppliers to establish Public-Private Partnerships, (4) **System-Building Support** – Supports **Integrated Solid Waste Management** by developing national-level systems that support local government coordination and development.
- Individual countries are also taking stronger actions, such as restricting the use of single-use plastics and developing ambitious national strategies and action plans. For example: Malaysia's

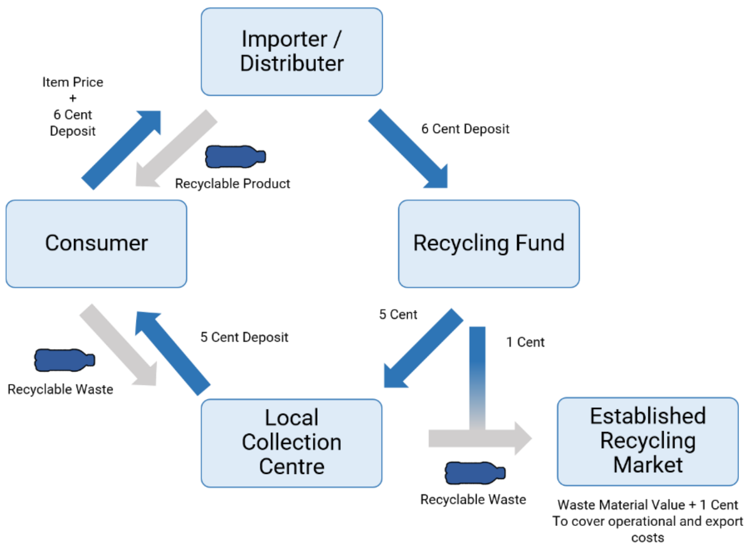
Case Study: **Container Deposit Schemes in Pacific Island Countries**

JICA implemented a circular economy solution to promote the recycling and recovery of plastic waste as part of their 'J-PRISM II'* project in the Pacific Region. First established in 2011, this project aims to enhance sustainable Solid Waste Management and is working in 9 Pacific countries until 2022 to strengthen human and institutional capacity and to promote reduce, reuse, recycling (3R) solutions.

Analysis of several existing Solid Waste Management systems identified scope to introduce a pilot Plastic Container Deposit Scheme (CDS) in the Republic of Marshall Islands, Republic of Palau, and Federated States of Micronesia. This aimed to reduce pressure on local waste management infrastructure and to return waste materials back to the larger regional recycling markets. For this to be feasible and sustainable a reliable amount of recyclable waste needed to be collected for export.

Working with public, private and civil society stakeholders a system was established to apply a 6 cent deposit on recyclable consumer goods. This 6 cents was then transferred from the distributers to local collection centres via a newly-formed recycling fund. Local waste dealers could then reimburse consumers with their deposit when they returned the recyclable waste products.

This resulted in increased plastic collection rates helping to prevent overflow within the local waste management system and also returned plastic materials that can be turned into new products.



For more information see: https://www.sprep.org/j-prism-2/home

Roadmap towards Zero Single-Use Plastics (2018–2030);Indonesia's **National Action Plan on Marine Debris (2017–2025)**; Vietnam's **National Action Plan for Management of Marine Plastic Litter by** 2030; and Thailand's **Roadmap on Plastic Waste Management (2018–2030)**. Methods and tools to develop national and city level action plans will be discussed in detail in **Module 7: Local Action Planning.**

- In the Asia-Pacific region **plastic taxes, bans and levies** have also been implemented. Viet Nam applies a **levy on retailers** for non-biodegradable plastic bags by weight while Fiji imposes a **levy on consumers** per plastic bag. Other countries have introduced **nationwide bans on single-use plastic.** Bangladesh was the first to do this in 2002, followed by Bhutan and Mongolia in 2009, India and Papua New Guinea in 2016, Marshall Islands, Palau and Sri Lanka in 2017, Vanuatu in 2018, and New Zealand in 2019. In 2017 China **banned imports of plastic waste** and, while this has led to short-term increases in waste to neighbouring countries, the region seems set to follow.
- Alongside legislative instruments, economic interventions such as **Extended Producer Responsibility (EPR)** are increasingly being adopted. EPR is defined as "*an **environmental policy approach** in which a **producer's responsibility** for a product is **extended** to the **post-consumer stage** of a product's lifecycle".* In practice this means producers take responsibility for collecting and/or treating their goods for recycling, commonly through takeback schemes or by providing financial support for waste management systems. This encourages companies to design products for reuse and recycling and corrects market signals by incorporating waste management costs into product prices.
- It is key that these technical and policy solutions cannot be enacted in isolation but as a **combination of mutually re-enforcing measures** to provide the greatest oppurtunity for sustainable reusults.
- The **2020 COVID-19 pandemic** has had an unprecedented impact on **waste management operations**, **consumer behaviour**, and **plastic production and consumption**. Driven by the mass production and uptake of single-use plastics for **Personal Protective Equipment**, **forced shutdowns of informal sector activity and recycling**, increased demand for **takeaway food products**, and **historically low oil prices** have **incentivized virgin plastic production at a global scale.** This poses a huge challenge for waste managers and even more so the **lack of available data** surrounding **production, consumption, composition** and **pollution.** As countries continue to deliver economic stimulus packages it is important to consider the recovery of the waste management sector.
- Everybody is accountable for the protection of the ocean, including the **public and private sector and individuals**. Accordingly, it is important to accelerate individual and collective actions through the **exchange of information, developments and proposals**. This is already being done through such initiatives as the **Asia-Pacific Day for the Ocean**, which brings together international organizations, governments, academia, the private sector, civil society and individual citizens.

Figure 4. *Solutions to plastic pollution. Source: ESCAP, 2020*

1.5 Module Summary

Key Takeaways

- Plastic products are **highly integrated in modern consumer economies**. They are **cheap, durable** and **versatile** materials and plastic waste products have been found in every corner of the world.
- Plastic waste has become a global environmental crisis. Taking **many years to break down**, plastic pollution is flooding into our waterways and oceans, **damaging marine life** and **costing hundred of millions of dollars** in environmental and economic externalities. **Immediate and effective action** needs to be taken to tackle the rising tide of plastic waste.
- The **Asia Pacific region** is a key source of global plastic waste. The region's rapidly growing population particularly in cities is driving **increasing rates of plastic consumption**. **Single-use plastics** in particular pose a major risk to asian economies and ecosystems.
- Cities are important engines of **economic growth** and are vital for **poverty reduction** and **sustainable development**. They are act as hubs for both plastic **consumption** and **waste** and for **policy innovations** and more **circular waste management systems.** Therefore cities are uniquely positioned to **enact long-term change** to preserve **marine** and **urban** environments and tackle plastic pollution across scales.
- The **Circular Economy** presents a sustainable alternative way to managing and disposing of waste. Strategies to **improve waste management services**, especially in cities, are key to reducing plastic leakage to the environment. However there are many actions that **policymakers, businesses, governments** and **individuals** can make to tackle plastic waste. This course aims to equip decision makers and practitioners with practical tools and knowledge to more effectively measure and manage plastics.
- Now is the time to engage with plastic pollution across the Asia Pacific region. Increasing numbers of countries and local authorities are making **ambitious policy commitments to tackle plastic waste** and **achieve sustainable development.**

- Marine pollution is a **global problem** whose solution requires **regional coordination** and **national and local cooperation on implementation**. Plastic pollution streamed through transboundary river basins highlights **shared regional accountability** for the leakage into the ocean, and a **shared responsibility** to protect it. As plastic waste markets are **local, national, regional** and **global** this issue must be addressed at all scales.

Learning Outcomes

- ***Participants recognize the need for urgent action.*** Demonstrate an evidence-based understanding of the need for urgent action on marine plastic pollution at different levels of governance and be able to identify the common impacts.
- ***Understand the issue of marine plastic pollution in the context of the 2030 Agenda for Sustainable Development and regional policy initiatives.*** Contextualize the issues surrounding marine plastics within wider policy frameworks including the 2030 Agenda, ASEAN framework of action on marine debris and Osaka Blue Ocean Vision.
- ***Understand the transformational role cities can play.*** Identify and effectively communicate the positive impacts that can be achieved with key interventions at the local level thereby highlighting the transformational role of cities in addressing marine plastic pollution through a circular economy lens with reference to real-world examples.

1.6 Module 1 Quiz

Question	Options
1. How much plastic waste enters the oceans each year?	A) 2 million tons B) 4 million tons C) 11 million tons D) 15 million tons
2. What is a Circular Economy?	A) A linear economic system that extracts, uses and wastes natural resources. B) An economic system that designs out waste and pollution, keeps products and materials in use and aims to progressively decouple economic growth from environmental degradation. C) An economic model which focuses investment in extractive industries to maximise natural resource consumption. D) A city waste management system based on recycling, landfill and incineration
3. Single Use Plastics are often in use for __ but can take __ to break down in the environment?	A) Hours, Minutes B) Months, Decades C) Minutes, Months D) Minutes, Hundreds of Years
4. What is the estimated economic cost of marine plastic pollution in Asia (by revenue loss)?	A) $10 million B) $100 million C) $500 billion D) $1.3 billion
5. Which of these is not a ratified *international* policy to tackle plastic waste in the Asia Pacific Region.	A) ASEAN Framework of Action on Marine Debris B) Vietnam National Action Plan on Marine Plastic Litter by 2030 C) COBSEA Regional Action Plan on Marine Litter D) Osaka Blue Ocean Vision
6. How much plastic waste is derived from urban areas?	A) 20% B) 40% C) 60% D) 90%

7. Ten rivers are responsible for ___ of riverine plastic waste and ___ of these are in the Asia Pacific Region	A) 40% 4 B) 50% 2 C) 70% 6 D) >90% 8
8. Plastic waste is ___ *(select all that apply)*	A) Environmentally Destructive B) Transboundary C) Expensive D) Preventable
9. What are the 3Rs in waste management?	A) Reduce, Reuse, Recycle B) Reduce, Burn, Return C) Repeat, React, Rewind D) Recycle, Return, Sort
10. Protecting our oceans from plastic pollution is the responsibility of ___	A) Individuals B) Private Sector C) National Government D) Everyone

1.7 Key Resources

Videos

Plastic Ocean: United Nations (7:28)
https://www.youtube.com/watch?v=ju_2NuK50-E

Closing the Loop: UN ESCAP (2:25)
https://www.youtube.com/watch?v=Hie3voACLQ0

17 Sustainable Development Goals: United Nations (1:25)
https://www.youtube.com/watch?v=0XTBYMfZyrM

Sustainable Development Goals Explained: Life below Water: United Nations (3:01)
https://www.youtube.com/watch?v=N3nnyj998BI

Sustainable Development Goals Explained: Sustainable Cities & Communities: United Nations (2:34)
https://www.youtube.com/watch?v=j7dzyJTw7Tc

What really happens to the plastic you throw away?: TED-Ed (4:06)
https://youtu.be/_6xlNyWPpB8

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Quiz Answers

Q1 – C, Q2 – B, Q3 – D, Q4 – D, Q5 – B, Q6 – C, Q7 – D, Q8 – A,B,C,D, Q9 – A, Q10 - D

Module 2: The Plastic Value Chain from Source to Sea

2.1 Module Introduction

Welcome to Module 2 – 'The Plastic Value Chain from Source to Sea'. This module has been designed to provide learners with an overview of the Plastic Value Chain including plastic production and recycling markets, and some of the key barriers to the waste market development. To strengthen the plastic recycling opportunities, it is important to understand the whole Plastic Value Chain and various factors influencing the value of virgin plastic and recycled plastic.

Learning Objectives:

- Participants gain an overview of the Plastic Value Chain from source to sea, its key actors and plastic leakage pathways
- Recognize that the mismanagement of waste is the largest attributor to plastic waste leakage and explore opportunities to develop more effective waste sector management.
- Understand the importance of involving multiple stakeholders in the plastic waste value chain to implement sustainable plastic waste management initiatives.

Developers: Institute for Global Environmental Strategies (IGES)

Expected Completion Time: 1hr

2.2 Overview of the Plastic Value Chain

- As the global **plastic production, consumption** and **waste** has soared in recent decades, the impact and risk to **global health, environments**, and **economies** have similarly increased. To identify the most effective measures to tackle plastic pollution it is important to understand the **Plastic Value Chain** and **involved stakeholders** all the way from **source** to **sea**.
- The **Plastic Value Chain** refers to the overall **process** of **inputs, actors, transformations** and **outputs** that produce **plastic products** and **waste** through the **consumption of resources** – this includes money, labour, materials, equipment, buildings, land, administration and management. It can be divided into the three key stages; **1) raw material production, 2) manufacture and use**, and **3) disposal and end-of-life treatment**. Many different business operators and service providers dealing with plastic are found at each stage.

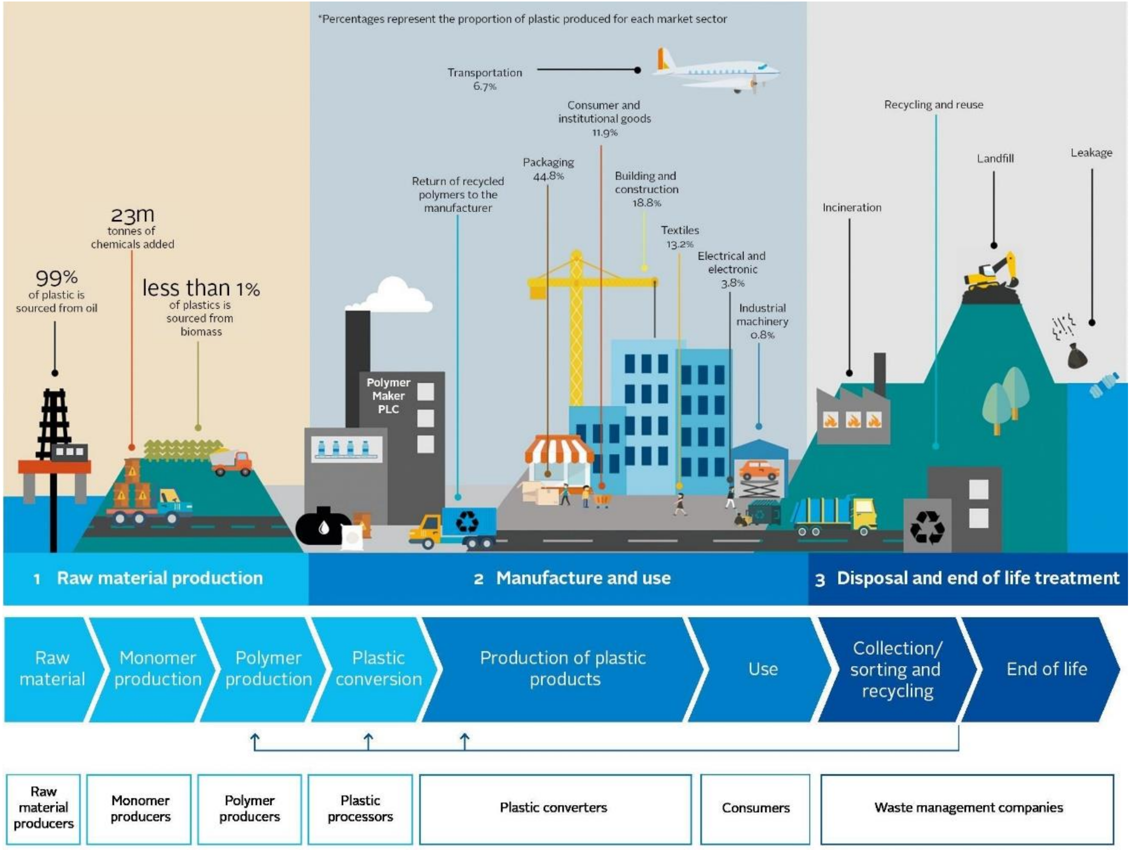

Figure 5. *Overview of the Plastic Value Chain. Source: Principles for Responsible Investment, 2019.*

Raw Material Production

- Most plastic is derived from **fossil fuels** such as **natural gas, crude oil**, and **coal**. The production of plastic begins with the distillation of crude oil in an oil refinery. One of these distilled products is a chemical called naphtha which is a crucial compound of many common plastics.
- Plastic currently accounts for **6%** of **global oil** and **gas consumption** (Ellen MacArthur Foundation, 2016). As oil and gas companies face increasing competition from **renewables** and **energy-efficient technologies** it is expected that the sector will increasing rely on plastic production, predicted to account for **20%** of **oil consumption** by **2050** (International Energy Agency, 2018).
- Out of **over 30 types of primary plastics** in common use, **5 plastic polymers** (PET, HDPE, LDPE, PVC, PP – See Module 1) account for almost **three-quarters production.** Above all, **polyethylenes (PE)** account for **36%** of all non-fibre polymers which is the **largest market share** of any plastic (Geyer, Jambeck, & Law, 2017).

Manufacture and Use

- Plastics are used a wide range of industries including: **packaging, automotives, electronics, textiles, construction** and more. In this way, plastic has become an important part of the global economy. Production has surged over the past 50 years, from **15 million tons in 1964** *(Ellen MacArthur Foundation, 2016)* to **359 million tons in 2018** *(PlasticsEurope, 2019)* and is expected to double again by 2040.

- With regard to the plastic usage, **four sectors** account for **three-quarters** of the **total plastic use**. **Packaging** is the largest plastic market share, accounting for **45%** of all plastic produced in 2015 (Geyer, Jambeck, & Law, 2017). Plastics have several key characteristics making them suited to producing convenience food and beverage products.
    - Plastics are **cost effective**
    - They're **durable** and **lightweight** which enables to save the transportation cost and energy
    - Plastics keep **food fresh** for a longer period and **protect goods** during transport and distribution.
    - They're **versatile** to be applied to a wide variety of foods.
- The **building and construction** sector is the second-largest user, accounting for nearly **19%** of plastics in 2015. The construction sector uses plastic for building components and packaging. They can be used in roofing, insulation, wall coverings, windows, piping, decks, fencing and railings.
- The third-largest plastic industry is **textiles**, accounting for about **14%.** Plastic is used to create synthetic fibres for different materials such as **polyester** and lycra. When clothes are washed, **microfibres** (microplastic particles <5mm) can easily leak into waterways and the marine environment.

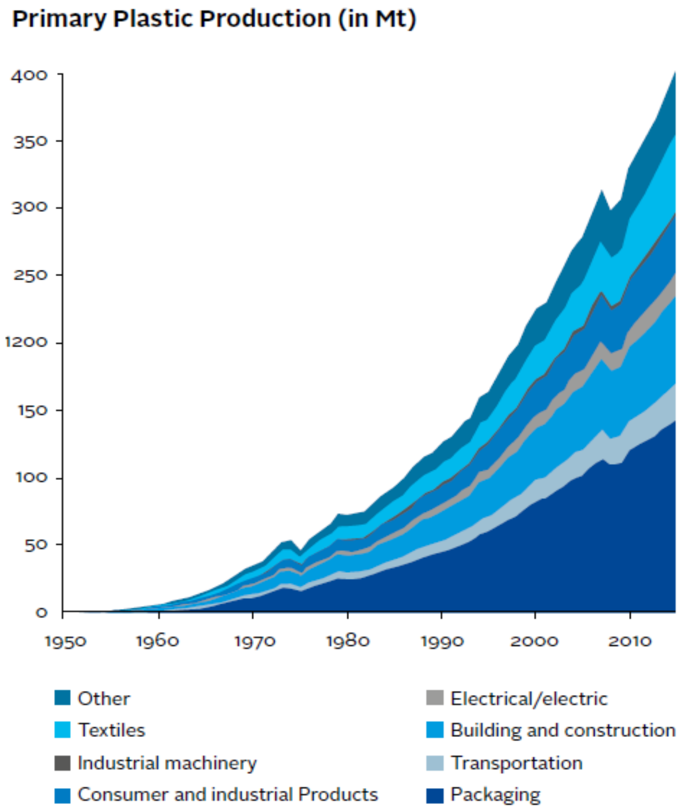

Figure 6. *Global plastic production levels by industry in 2015*
Source: PRI, 2019 (from Geyer, R., Jambeck, J.R. & Law K. L., 2017)

Disposal and End-of-life Treatment.

- The plastics industry has played an important role in **driving economic growth** and **technological advances** in many fields. However, this socio-economy also allows consumers to **dispose of plastic**

products easily and **quickly** and without considering the **adverse impacts** on **ecosystems** and **livelihoods**.

- In this way plastic pollution is a good example of an **Environmental Externality**. This refers to a situation in which the **environmental impact** of a product's production and consumption are **not accounted for** in its **market price**. The significant economic, social and environmental costs of plastic pollution are **uncompensated** and so are transferred onto **local governments**, **municipal waste systems** and the **environment**.
- **242 million tons of plastic waste** was generated in 2016. This waste primarily originated from **three regions—57 million tons** from **East Asia** and the **Pacific**, **45 million tons** from **Europe** and **Central Asia**, and **35 million tons** from **North America**. **Plastic packaging** is the largest contributor, accounting for over **141 million tons** of global plastic waste in 2015 (World Bank, 2018).
- Of the total plastic waste, only **9%** has been **recycling** and **12% incinerated**. The remaining **79%** was disposed to **landfill** or was released into the **environment** (Geyer et al., 2017). Approximately **8.3 million tons** of plastic estimated to enter the **oceans** every year (UNEP, 2018).
- Most plastic leakage takes place at the **disposal** and **end-of-life stages** of the Plastic Value Chain. In other words, the main driver of leakage is **mismanagement** of plastic waste.
- Though waste management infrastructure and systems vary globally, the need to **improve waste management** particularly in many middle and low income countries is clear.
- Plastics sent to the wrong treatment facilities are classified as **contaminants** which impact the **quality** of ouputs. The challenge is how to help consumers distinguish different types of polymers and separate them correctly for treatment.

Process and Method of Recycling and Recovery

- The most common resource recovery method is **mechanical recycling** where waste items are turned into new polymeric materials: for example **plastic pellets** that are **re-melted** and **moulded** to produce fibres, sheets and bottles.
- **Chemical recycling**, converts polymers into their constituent molecules through thermal processing such as gasification or pyrolysis or by chemical means (*solvolysis*). These molecules can then be used as feedstock for new plastics or other petrochemicals. Chemical recycling is far less established and more expensive but, unlike mechanical recycling, mixed plastic waste can in theory be treated without separation.
- Besides recycling, plastic waste can be used as an alternative fuel & raw material (AFR) in **waste-to-energy facilities** that use **thermal processing** such as incineration. This end-of-life solution can be promising where there is high waste material complexity and/or contamination, but is least desirable because valuable plastic material is lost.
- The structure of the recycled plastics supply chain varies significantly between countries, sub-national regions, and even cities and there are numerous operating models involving different

combinations of: **wholly municipal-operated services**; **wholly private sector services**; **joint public and private services**; **publicly-owned municipal services**.

- The **informal sector** also plays an important role in collection and processing plastic waste. Individuals or groups of **wastepickers** collect recyclable materials from households, commercial and industrial areas, collection points or dumping sites. This is then sold to **informal junk shops** or **aggregators** where the recyclable material is sorted and cleaned. The aggregated recyclables are sent to a mechanical processing facility and the outputs products are sold on to **formal larger recyclers** or **exporters**.

Waste Management Stage	**National Income Classification**		
	Low income	**Middle income**	**High income**
COLLECTION	- Informal sector plays a key role. - Mechanization of collection limited to wealthy urban areas. - Recycling likely to be informal or SME-led. Few municipal-led plastics recycling schemes in this context.	- Some municipal-led recycling schemes, particularly in urban areas. - Some mechanization of collection, particularly in urban areas. - Informal sector often plays a key role.	- Municipal-led plastics recycling schemes are common. - Collection systems are highly mechanized.
SORTING AND CLEANSING	- Manual sorting is common - Mechanical sorting is usually limited to balers for compaction	- Some mechanization - Where informal sector is active, manual separation is likely	- Highly mechanized and capital intensive to maximize recovery of valuable plastics
PROCESSING	- Waste plastics typically exported, although there may be some simple recycling processes used for plastics (e.g. manufacturing paving slabs from waste plastic bags)	- Waste plastics typically exported for recycling but there may be some local recycling.	- Waste plastics exported but local capacity in some countries for high-value plastics.

Table 2. *Overview of waste management processes by national income level.*
Source: OECD, 2018

2.3 Environmental Impacts across the Plastic Value Chain and Sustainable Development Goals

As stakeholders conduct different activities across the value chain, different types of environmental and social impacts emerge. Although plastic pollution is not a central issue under any specific SDG, addressing plastic pollution should still be considered an integral part of the 2030 Development Agenda. **Figure 7** highlights synergies with **SDG 3, 6, 11, 12, 13, 14, 15** at different stages of the plastic value chain.

Impacts at the Extraction, Transport, and Manufacturing Stage

- Amidst growing concern about the impacts of plastics on marine ecosystems there is another largely hidden dimension of the plastic crisis: **Greenhouse Gas Emissions (GHGs).** The extraction and transport of **fossil fuels** to create plastic generates significant GHGs and various toxic waste products. Sources include **direct emissions**, like methane leakage and flaring, emissions from **fuel combustion** and **energy consumption** in the process of drilling for oil or gas, and emissions caused by **land disturbance** when forests and fields are cleared for wells and pipelines. In 2015, emissions from **ethylene production** were **184–213 million tons of CO_2**, equivalent to **45 million passenger vehicles** driven for one year. These emissions are expected to rise as oil and gas producers focus more on plastic production and feedstocks (CIEL, 2019).
- The **manufacturing** of plastic is also directly energy and emission intensive and generates significant emissions through the **chemical refining process**. This is estimated to account for **400 million tons** of GHG emissions each year. Furthermore, there are thousands of **additives** needed to make plastic products. Several substances such as **bisphenol A** (BPA) and **cadmium/barium** and **lead stabilizers** have been the subject of controversy due to **health concerns** (OECD 2018).

Impacts at the Waste Management Stage

- In waste management systems plastics typically end up either **recycled**, **incinerated**, in a **landfill** or in a **dumpsite**. Each waste disposal solutions creates its own **environmental** and **economic challenges**.
  - Landfills are controlled areas where waste is stored. These have **limited site capacity** and require **investment** and **effective management** to ensure no **leakage** occurs.
  - Dumpsites are waste storage sites that are **oncontrolled** and **unsecured**. These can leak **waste** and **toxins** polluting surrounding land and waterways.
  - Incineration requires **less land** but is **expensive** and create **GHG emissions** and **air pollution**.
  - Recycling can be **expensive** but can also provide **sustainable incomes** from the sale of processed waste products and **mitigates greenhouse gas emissions** by reducing demand for new virgin plastics.
- Waste which fails to enter the waste management system caused by **littering**, **open burning** and **illegal dumping** presents another set of local challenges. These can be particularly difficult to act

on as data is often scarce, enforcement variable and they tend to require **long-term behavioural change** to address.

- It is estimated that **two billion people** do have access to waste collection services (UNEP & ISWA, 2015). and leakage drivers including **low collection coverage**, **inadequate disposal and management**, **open burning**, and **illegal dumping** can **occur together**. These are complex waste problems that require action and coordination across many **scales**, **industries** and **countries.**

Impacts at the Environmental Exposure Stage

- Plastic can take **centuries** to **fully decompose** in nature but degradation by **sunlight, wind**, and **waves** is a constant process. Large plastic items shed smaller **microplastic particles** that are almost impossible to recover. The studies revealed that microplastic can absorb pollutants from seawater damaging marine organisms with toxins that accumulate through the food chain (Worm et al. 2017).
- The proliferation of marine plastics has impacts not only on ecosystem but also on the viability of the **tourism** and **fishery industries.** The **total natural capital cost** of marine plastics to marine ecosystems is estimated at **$13bn per year.**
- At this stage, plastic issues concern **SDG2** on food safety and security, **SDG6** on water resources, and **SDG14** and **15** on marine ecosystems and biodiversity.

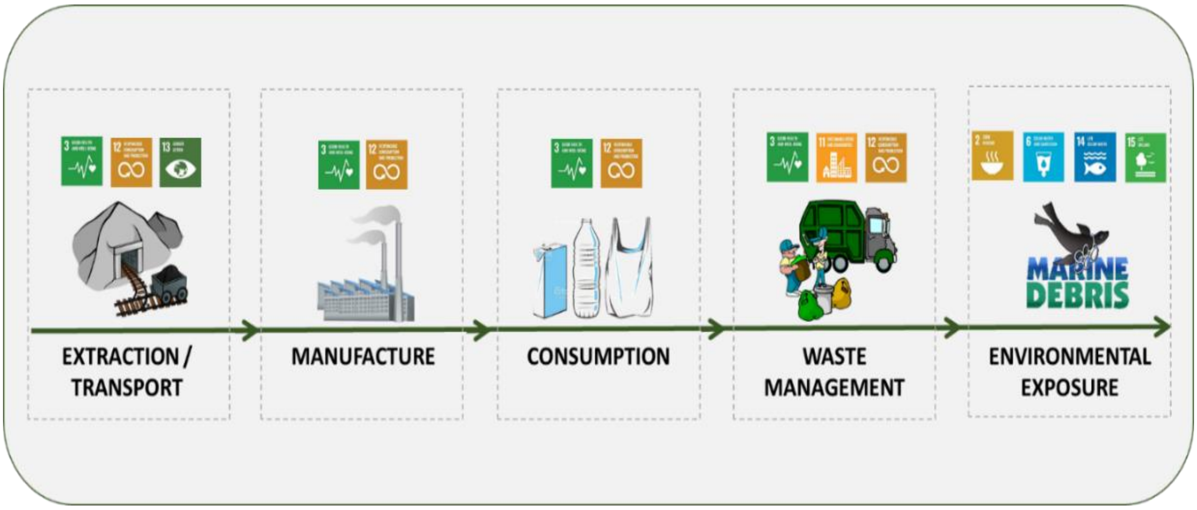

Figure 7. *SDGs are relevant at all stages of the plastic value chain.*

2.4 The Economics of Plastic Waste

The Global Market for Plastic Waste

- Approximately **13 Mt (4%)** of waste plastics generated each year are **exported** beyond their country for recycling and disposal. The major exporters are the **United States**, **Europe** and **Japan**, representing **73%** of global plastics waste exports (UN, 2017).

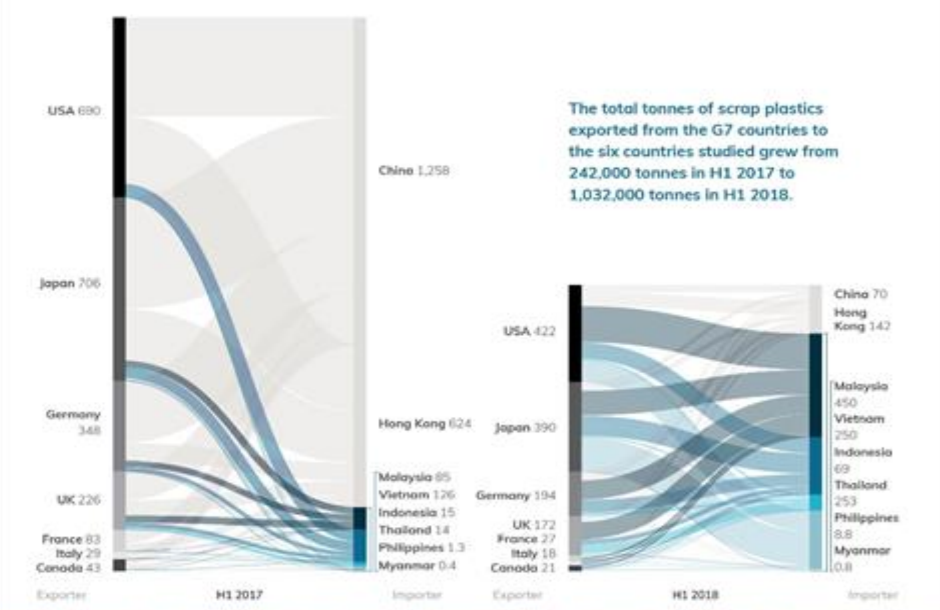

Figure 8. *Exports of plastic waste from G7 countries to China and South Asia. Source: GA Circular, 2019.*

- **International markets** have created a **complex system** of plastic waste trade, where the environmental and health impacts of plastic waste can often occur thousands of miles from the region of initial consumption.
- **China** and **Hong Kong** were the main international destinations for waste plastics until 2017 when import restrictions, via the '**National Sword**' policy, were implemented. This restriction resulted in the redirection of waste exports to other asian recycling markets, particularly in **South-East Asia**.
- Demand for recycled plastic feedstock is growing as countries implement pro-recycling policies. The value of recyclable plastic waste traded on the global secondary commodities market was **$35.4bn** in **2018** and predicted to exceed **$50bn** by **2024** (Research and Markets, 2018).
- However, the volumes of secondary plastic production are still very low resulting in **poor quality** and **inconsistent production**. As a result, many countries typically only recycle **less than 20%** of plastic waste, though this differs across regions.
- Key limitting factors for large-scale supply markets include: **highly decentralized systems**, a lack of **cohesive policy structures** to promote recycling, **limited access** to **technologies** and **capital**, a lack of **existing physical infrastructure**, and **limited waste management capacity**.

Economic Value of Waste Plastics: Virgin vs Recycled Plastic

- To develop plastic recycling policies, it is important to understand the current market for virgin and recycled plastics and how their value fluctuates. The **economic feasibility** of **recycling plastics** is highly dependent on the **comparative value** of **virgin plastic**.
- The value of virgin plastics varies between different polymers due to the energy, primary materials, and labour required to produce them (**Production Cost**). The largest part of this production cost is **oil prices**.

- **Low prices** for **fossil fuels** are likely to **discourage** the use of **recycled plastic**s as virgin products may be cheaper. To encourage recycled plastic use other market forces are required to reduce the relative cost of recycled plastic such as **incentives** or **subsidies**.
- According to GA circular 2020, the **global crude oil price** should be higher than **$70 per barrel** for the recycled plastics to be **competitive**.
- External factors which are beyond individual country's control can also influence the market. The 2020 coronavirus pandemic (COVID-19) has drastically and rapidly changed plastic consumption patterns and waste management operations which influence the global plastic recycling market.
- Although all kinds of plastic are technically recyclable, not all of them are economically feasible to recycle.

Market Side	Key Influences	Key Factors
DEMAND	Consumer Preference	Clothing (using synthetic fibres made of plastic) Replacement of metal and ceramic products such as construction materials, automotive parts Competing products (wood, paper, reusable items)
	Environmental Policy	Extended Producer responsibility (EPR) legislation Corporate social responsibility (CSR) agendas Public sector procurement policies favouring recycled content
	Enabling Technology	Extrusion and forming – enabling higher content of recycled material Product specification
SUPPLY	Policy	Legislation mandating weight or proportion of recycled plastics (creating an economy of scale) Extended Producer responsibility (EPR) legislation and trading platforms Customs (costs of administration and procedures)
	Technological and Financial Capability	Sorting (e.g. Near infra-red (NIR), X-ray) Flaking and washing / Extrusion and forming Logistics / transportation
	Operational Costs	Grid energy (or local energy generation in low-income countries) Real estate, Labour Collections (local authority), Processing, Logistics

Table 3 *Summary of main factors influencing the demand for recycled content and the supply to produce recycled resin. Source: adapted OECD, 2018*

- "**High-value**" plastics, like **PET bottles** and **rigid HDPE containers**, are easily sold into formal or informal recycling markets. This technology is well developed and mechanized. This allows the manufacturing of recycled plastic products at lower costs than using virgin material.
- "**Low-value**" plastics, like **single-use sachets**, **laminated packaging**, **polystyrene**, and **thin films** often struggle to find a viable market because they require more time, labour, and energy to process. The recycled plastic made of this kind is less competitive in terms of price and quality; thus more likely to leak into the environment.
- Even if a market exists, waste pickers and other collectors may avoid collecting low value plastics. Consequently, there is a **wide variation** in **recycling rates** between polymers. PET and HDPE is recycled at relatively high rates (**19-85% recovery**). PP, PS is much less frequently recycled (**1-21%**).

Case Study: **China's National Sword Policy and Regional Impacts**

China used to have the world's largest plastic recycling industry, representing over 50% of international trade for end-of-life plastic. China's economies of scale meant it was less expensive to produce recycled plastic products than virgin plastics. Over the past two decades, 170 million tons of plastic waste had been exported to China and Hong Kong, worth around $80 billion.

However, in 2017 the Chinese government informed the World Trade Organization (WTO) that it would ban solid waste imports including plastic waste to reduce environmental pollution and human health risks. This ban had a major impact on countries with high plastic consumption including Japan and the U.S. While small companies in China were forced to shut down due to lack of supply, large companies shifted their recycling market to focus on domestic waste. At the same time, Chinese recycling companies are using their expertise to increasingly investment in international plastic factories. These then export clean processed pellets and sheets to China where the large material demand still exists. This movement could improve the global quality of plastic waste sent for recycling.

The countries influenced by China's ban are not only large plastic consumption countries. Chinese recycling was substituted by South-East Asian countries such as Malaysia, Viet Nam, and Thailand. Increasingly imported plastic waste is sorted, cleaned, processed in these smaller countries who then export the recyled plastic material. Regionally distributed processing capacity is by far smaller than in China and companies will often operate without proper pollution control. As public opinion on plastic waste imports changes and the environmental and social impacts become more prevalent other asian countries have similarly started to ban plastic imports. Today the enforcement of these bans and tackling illegal or smuggled plastic scrap remains a key challenge.

Barriers for expansion of plastic recycling markets

- For recycled plastic to **compete** with virgin plastic products, **research** and **investment** in **demand and supply-side interventions** is required.
- Expanding plastic recycling markets is complex due to the existence of **accumulative economic, technical, environmental** and **regulatory barriers** (Table 4).

ECONOMIC BARRIERS	• Costs of collecting, sorting and processing waste plastics are too high due to small-scale operation, diversity of waste polymers, and contamination of post-consumer plastics. • Low demand for recycled plastics compared to virgin plastics • Limited and poor data on the plastic recycling sector attributed to the management by informal sector
TECHNICAL BARRIERS	• Low collection coverage particularly in middle and low income countries • Waste plastics are typically contaminated and mixed with other materials due to absence of source segregation practice, lack of indication on label, or absence of regulation • Problematic additives and pigmentation that cause pollution • Biodegradable plastics and degradability enhancers mixing with oil-based plastics for recycling deteriorates the output quality • Limited local collection schemes and treatment technologies
ENVIRONMENTAL BARRIERS	• Hazardous additives in non-food plastics such as waste electric and electronic plastics should not be recycled to make sensitive applications such as toys and food packaging • Potential competition between recycling and WtE incineration • Concerns over weak environmental standards for recycling in emerging markets
REGULATORY BARRIERS	• Regulatory burden of materials classified as waste demotivates recycling and recovery • Illegal trafficking of waste plastics • Poor law enforcement against illegal dumping and burning of waste plastics can undermine the market of recycled plastic

Table 4. *Barriers to the secondary commodities market for plastic.*

2.5 Towards a Plastic Circular Economy

- To stop the tide of plastic waste it it important to transition from the current **linear economy** to a more **circular** system. A **Circular Economy** describes a system where, rather than the usual "**make, use, dispose**" process, more and more **material** and **energy** from waste is **recycled, recovered**, and **reused**, to maximize the **productive lifespan** of products**.** This reduces demand for material and energy derived from fossil fuels and reduces the amount of waste entering landfills and the environment.
- However, recycling and recovery alone cannot significantly reduce of plastic pollution. Unless the rapidly rising rate of waste generation is addressed these initiatives will fail to address the source of the problem. **Upstream solutions** aiming at reducing and preventing the production of virgin plastics are needed.

- It is also important to increase **demand** for **recycled plastic feedstock**, enhancement of **Corporate Social Responsibility** and **Extended Producer Responsibility**, creation of **positive images** and **branding** for recycled products.
- All activities need to be supported by **policy** and **regulations** with **positive incentive** such as subsidy to encourage the use of recycled resin or with **negative incentive** such as taxation or bans to discourage the use and import of single-use plastics.
- Interventions can have **knock-on impacts** on stakeholders both up and down the plastic value chain. **Figure 9** shows the upstream impacts of providing a **price incentive** to recyclers for increasing their material collection. It is important for policy makers to consider the wider **direct** and **indirect consequences** of intervening in the value chain and take an integrated approach
- Given the diversity and scale of the challenges facing recycled plastics markets, a **range** of measures and interventions will be needed. This will require **close partnership** working amongst all **stakeholders**, including policy makers, regulators, municipalities, industry and communities (see Module 5).

Figure 9. *Flow of monetary incentive through the value chain. Source: GA circular, 2019.*

Plastic Production from Alternative Materials

Over **97%** of plastics come from **fossil fuel** sources (CIEL, 2017), with the remaining **1-3%** produced from **plant-based** sources (European Bioplastics, 2019) or **Bioplastics**. This term encompasses two broad concepts (Plastics Europe, 2016):

- **Biodegradable plastics**: plastic materials that can be broken down in the environment by microorganisms to form water and carbon dioxide / methane. These can be produced from either bio-based or fossil fuel sources and are suitable for composting instead of recycling.
- **Bio-based plastics**: plastics made from biological sources such as sugar cane, beet sugar, corn, potatoes, grains or vegetable oils.

- In some cases bioplastics can result in **lower GHG emissions** than fossil fuel derived plastics, but the impact of producing renewable feedstock depends on the context of where the crop is grown, the types of crop or waste product used, and the manufacturing location and process (PRI, 2019).

Case Study: **The Influence of COVID-19 on the Global Plastic Value Chain**

The 2020 COVID-19 pandemic together with low oil prices has created a range of setbacks for the ongoing global movement to tackle plastic waste. Circular economy initiatives and commitments by the plastics industry and national-level marine plastic prevention programs, especially those in South and South-East Asia, rely on recycling value chains to collect, clean and process the plastics for recycling. The abrupt slowdown of the plastic value chain has led to more plastics entering landfills and as such more plastic entering the environment and waterways.

Since the pandemic began in March 2020, recyclers across the five countries (Indonesia, Philippines, Vietnam, Thailand and India) have seen on average a 50% drop in demand for their products and 21% drop in sales prices. In many countries recycling was not considered as essential service; thus its operation was forced to be suspended during national and regional lockdowns. Many recyclers and businesses across the plastics recycling value chain are at risk of insolvency. Above all, those who are directly and indirectly involved in the informal sector have been the most affected as daily incomes from collecting and selling recyclables disappeared overnight. Small-Medium-Enterprise sector has also struggled due to the lack of cash flow.

Yet even before COVID-19, low crude oil prices were already adding significant downward pressure on post-consumer resin prices. Assuming the status quo, crude oil prices should be at least $70 per barrel for recyled material to be competitive. However these prices have not been seen since September 2018 (at date of publication). Combined, low oil prices and COVID-19 induced demand drops have seen the pricing differential narrowing across all recyclable plastics.

The volume of recycled plastics traded has reduced 50-65% on average along key stages of the value chain (recyclers, aggregators, junk shops, collectors). These impacts highlight the need for investment in the recycling value chain: to support improvements in efficiency and deploy new technologies, advance and safeguard the sector, and ultimately build a stronger and more resilient industry for the long term.

2.6 Module Summary

Key Takeaways

- It is estimated that **242 million tons** of **plastic waste** is generated globally per year and **8.28 million tons** of plastic leaks to the **marine environment** *(UNEP, 2018)*. Rising plastic pollution is attributed to increases in plastic **production**, **consumption** and **disposal**. Large plastic production and consumption are found in the regions of China, North America, and Western Europe in the sectors of **packaging**, **building and construction**, **textiles** and **transportation**.
- **Plastic recycling** is a key solution to combat plastic pollution. **Demand** for recycled content plastic as a feedstock is **growing**, as many countries set the policy and regulation to promote the use of products made with recycled plastic. The value of recyclable plastic waste traded on the global

secondary commodities market was **$35.4bn** in **2018** and predicted to exceed **$50bn** by **2024** *(Research and Markets, 2018*). However, volumes of secondary plastic production are still low due to the **immature supply market**, and waste operators limited by **finance**, **technology access**, **existing infrastructure** and **management capacity**.

- To develop plastic recycling markets it is necessary to consider both **supply** and **demand.** First, **operational costs** associated with **collection**, **sorting** and **processing** waste plastic should be minimized by **improving efficiency**. **Source segregation**, **green product design** and the development of **recycling technologies** are extremely important.
- It is also important to increase **demand** for **recycled plastic feedstock**, enhancement of **Corporate Social Responsibility** and **Extended Producer Responsibility**, creation of **positive images** and **branding** for recycled products.
- All activities need to be supported by **policy** and **regulations** with **positive incentive** such as subsidy to encourage the use of recycled resin or with **negative incentive** such as taxation, restriction, or ban to discourage the use of single-use plastic or import of plastic scraps, for example.
- Considering the **plastic recycling market** and **soaring virgin plastic production**, the development of recycling **alone** will **not** contribute enough to reduce global plastic pollution. It is important to build a stronger and more **resilient industry** and **society** where plastic inputs and consumption are reduced. **New business models** that do not depend on oil-based plastic will have to be adopted on a widespread scale, the **hazardous substances** in plastic products will have to be **eliminated** or **treated** before being released to the environment, and available resources will have to be used much more **efficiently**.
- Moving towards a **sustainable** and **circular plastic economy** requires a holistic approach and changes at each stage of the plastic value chain. This will involve players of all sizes, from the **public** to **private** sectors and at **local** to **international** levels.

Learning Outcomes:

- Be able to **describe the Plastic Value Chain** from source to sea.
- Be able to **identify the key factors** that **prevent** and **promote** the development of **plastic recycling markets.**
- Be able to **propose methods or approaches** to reduce plastic pollution at different stages of the Plastic Value Chain
- Be able to **explain key factors** that influence the relative value of **virgin versus recycled plastics**.

2.7 Module 2 Quiz

Question	Options
1. Most plastic products are derived from __	A) Crude oil and natural gas B) Plant-based Sources C) Recycled materials D) Coal
2. Plastics production is a major source of Greenhouse Gas Emissions (GHGs)	A) True B) False
3. Which of these factors does **NOT** directly influence material value in waste plastic markets?	A) COVID-19 response measures B) Plastic waste trade agreement C) Marine ecosystems D) Change in consumption pattern
4. Which SDGs are related to activities across Plastic Value Chain?	A) SDG 3 (good health and wellbeing) B) SDG 6 (clean water and sanitation) C) SDG 13 (climate action) D) SDG 14 (life below water) E) All of the above
5. Which of these are examples of a Negative Incentive? *(select two)*	A) Plastic bag ban B) Subsidies for recycling C) Investment in waste management technology D) Point-of-use charge for Single Use Plastics
6. Which industry uses the largest amount of plastic products?	A) Textile B) Packaging C) Construction D) Transportation
7. The Informal Sector is a ___ component of the Plastic Value Chain *(select two)*	A) Universal B) Expensive C) Overlooked D) Important
8. Which common plastic waste items have high recycling value?	A) Polyester Clothing B) LDPE Plastic Films

	C) PET Plastic Bottles D) None, plastic waste is valueless
9. At which stage in the Plastic Value Chain does most plastic leakage occur?	A) Fossil Fuel Extraction B) Plastic Manufacturing and Transport C) Waste Management and End-of-Life Disposal D) It's the same for each stage
10. Transitioning to a circular economy will require the participation of ___	A) National Government B) Civil Society C) Private businesses D) All of the above

2.8 Key Resources

Videos

Quartz, 2019 "China is forcing the world to rethink recycling" (9:07) https://www.youtube.com/watch?v=8HROn34sDRk

Roundtable. 2019. China's Recycling Ban: A global recycling wake-up call? (26:12) https://www.youtube.com/watch?v=7PoagpRIfJM

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Quiz Answers

Q1 – A, Q2 – A, Q3 – C, Q4 – E, Q5 – A,D, Q6 – B, Q7 – C,D, Q8 – C, Q9 – C, Q10 - D

Module 3: How to Measure Plastic Pollution

3.1 Module Introduction

Welcome to Module 3 – 'How to Measure Plastic Pollution'. This module will provide an overview of the key approaches that urban practitioners can adopt to measure plastic pollution. This includes basic data requirements, comparative methodologies and how policy makers can interpret these results to make decisions.

Learning Objectives:

- Understand the systems approach to measuring plastic waste flows and how this is related to plastic pollution hotspots and field measurements.
- Appreciate the need for developing plastic pollution baseline assessments and the merits they bring.
- Recognize there are tools available to establish a plastic pollution baseline and learn the basic data needed to run them.
- Understand how these results can be used to inform policies and investment decisions at a city level (such as local and regional action plans).

Developers:

- University of Leeds
- International Solid Waste Association

Expected Completion Time: 1 hr 30m

3.2 Understanding Plastic Pollution Sources, Pathways, Hotspots and Sinks

- **Targetted and scientifically-robust data collection** is a key pre-requisite to inform the planning, implementation and review of plastic waste interventions. Without reliable data on the **quantities, composition, sinks** and **sources** of plastic emissions, interventions risk failing to tackle the root causes of plastic waste leakage.
- The **plastic value chain** and **circular economy** models illustrate the full life cycle of plastic products from production to waste disposal.
- When plastics are at the end of their first use they become waste products that must be managed by **local systems** of **collection, processing** and **disposal.** However, this waste material remains useful and has an **inherent value** that can re-enter the economy.

- This is most commonly achieved through the process of **recycling** and even in cases where this is not possible some value can always be recovered through **waste-to-energy**.
- In practise these two management solutions are not so simple to implement. The **quantity** and **quality** of waste products varies greatly in different **locations** and in different **waste management systems.** Importantly, in many cases cities lack the relevant basic data to identify how plastic pollution is entering the environment and in what quantities.
- Taking steps to improve our overall understanding of plastic waste and developing **accurate** and **feasible measurement methodologies** will be vital to support a transition to a circular economy. To ensure a common understanding of plastic pollution it is useful to determine a number of key concepts that will be explored in this module.
- These are plastic pollution:
    - *Sources*
    - *Pathways*
    - *Hotspots*
    - *Sinks*
- Plastic pollution is a problem that must be tackled at its source. This requires identifying and characterising two important factors: (1) The **location** where plastic is first released into the environment; and (2) the **underlying reasons** driving this leakage.

Taking a Systems Approach to Waste Management

- A **Systems Approach** attempts to understand the processes and relationships between different components of the economy and the waste management system, and to acknowledge that changes in one will impact the other.
- Taking a **broader perspective** before diving into the details can help inform our overall understanding of the **waste management system** and **socioeconomic context**. Some common considerations include the general level of **consumption** and **waste generation** in a city, how and where these processes are occurring, the most common waste management **solutions**, and the wider **environmental context.**
- Existing economic and waste management systems are **failing** to deal with the growing problem of plastic pollution. They will require wider systems transformation alongside supporting sustainable waste solutions. It is only by using this systems thinking that the source of the problem can be addresses and a circular economy can be realised.
- The current system requires action across four areas:
    - **Complex Materials and High Consumption**
      Growing per capita consumption levels across the world are putting increasing pressure on urban and rural waste management systems. Similarly the increasing use and production of complex products formed of different materials presents a unique challenge for waste processing and disposal.
    - **Insufficient Waste Services and Infrastructure**
      Due to poor waste service provision, uncollected waste is the largest contributor to plastic pollution.

In future, as the Asia-Pacific region continues to grow and urbanize greater investment will be required to ensure sufficient waste management capacity.

- **Undeveloped Recycling Markets**

  Low demand for recycled goods means even in situations where recycling is technically feasible, national and international markets and supply chains remain underdeveloped.

- **Knowledge Gaps: Science, Engineering and Policy**

  Research, practical experience, and innovation in the field of plastic pollution is important for developing cost-effective and impactful solutions. It is also important to establish a common language and toolkits for assessing plastic pollution conditions.

How Does Plastic Enter the Environment?

- The issue of where and how plastic pollution entering the environment is a complex one. Different **income levels**, **economic activities**, **geographies** and **behaviours** create a range of **interconnected drivers** that control the flow of plastic pollution.
- It is important to try and disentangle these factor and starting by identifying the specific **points of entry** for waste products into the environment. The four most common entry points are:
  - Littering of plastic waste items, such as plastic bags and plastic packaging is a serious problem. In urban areas or beaches this can remain uncollected and unmanaged to easily enter the environment.
  - Sea-based activities such as shipping, fishing and recreation can result in plastic waste leaking directly into the ocean.
  - Fishing nets in particular are a common form of ocean-source plastic waste.
  - Surface run-off is the process of plastic transport over land due to environmental processes like wind and rain. This often occurs in exposed dump sites or poorly contained landfills.
  - Plastic pollution is directly dumped to rivers or land for waste disposal. Illegal dumping in this way is common in areas with poor waste management services.

Solid Waste Management Systems

- Whilst creating a circular economy remains the long-term goal, cities must first address the main reason why plastic is being emitted into the environment **- failings** in the **solid waste management system**.
- An estimated **2 billion people** currently lack any form of solid waste collection, leading to them having to resort to practices such as **indiscriminate dumping** and **open burning**. Without first solving this systemic failure and actually collecting the waste, a circular economy will always be out of reach.
- Even if waste collection is in place, the methods used to **store**, **transport** and **dispose** of waste can still lead to **plastic pollution**. These emissions depend both on the **local infrastructure** and **practices used**.
- The two main waste management failings that cause plastic leakage are: **uncollected waste** piling outside bins, and **insufficient disposal** at dumpsites.
- It is essential that the localised waste management infrastructure and practices are studied in detail to understand the sources of plastic pollution emissions.
- Cities and their associated waste management systems are the largest sources of plastic pollution. They are under particular strain due to three key drivers:
- Solid waste management and infrastructure is **expensive** and can require a large proportion of a **municipalities budget**. This can place it in competition with other essential services such as clean drinking water or electricity. Necessary investments in sound waste management services have been delayed for far too long.
- The **rapid urbanisation** and **growth** of cities means existing waste management infrastructure can quickly become overstretched and outdated. This is further compounded by the fact urban areas generally produce more waste per capita.
- **Informal settlements** are common features of cities but they often lack waste collection services. This has a disproportionate social, health and economic impact on the most vulnerable communities of cities who remain at risk.

The Informal Waste Sector

- Though there is a close link between the scale of mismanaged waste and poverty, the presence of waste also supports a wide range of livelihoods.
- A global cohort of approximately **11 million waste pickers -** informal recycling sector workers **-** plays a crucial role in recovering resources from waste and mitigating poverty.
- Waste pickers operate collecting recyclables in four main locations:
    - at dumpsites and transfer stations
    - on streets colleted from the ground or waste bins
    - directly from formal waste collection vehicles
    - door-to-door collection
- It is possible that these individuals recover more than half (**58%**) of all of the plastic waste collected for recycling on earth, approximately **90Mt**.

- Of course, as well as their contribution to resource recovery, the informal recycling sector mitigates **plastic pollution**. Every piece of plastic waste collected by waste pickers is one less piece of debris that may find its way into the environment.
- A global review by Cook & Velis (2021) predicted the quantities of recycling feedstock reclaimed by the informal sector each year. In upper-middle-income and lower-middle-income countries **plastic products make up 33% of total recyclable waste** collected by waste pickers.
- The role of the informal sector is explored in more detail in **Module 5**.

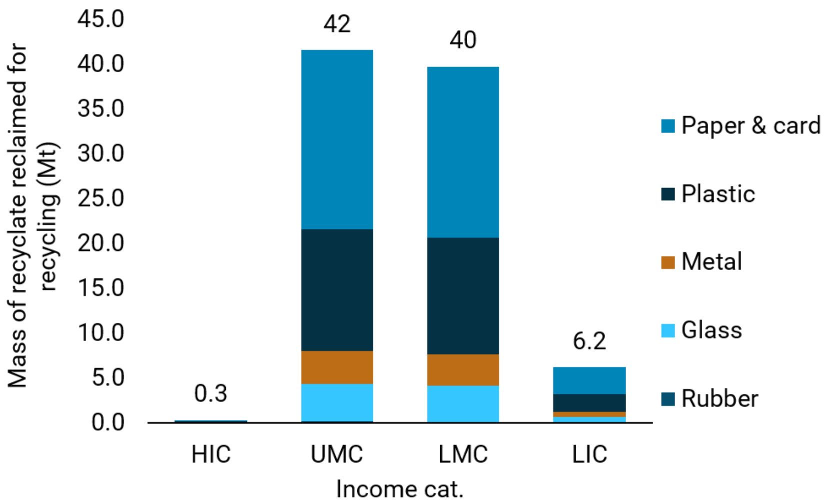

Figure 10. *Waste recycling feedstock reclaimed by the informal sector by material and country group. Source: Cook & Velis, 2021.*

What is Open Burning?

- Open burning of waste is a common method of **waste disposal** across the world. This issue is only just beginning to receive attention, yet it is possible that up to **1 billion tonnes** of waste is burned each year.
- Open burning presents another important form of **atmospheric plastic pollution** that is damaging to both people and the environment.
- In many cases, waste is burned simply as a method of disposal and small-scale street fires are common in some parts of the Global South. However, there are many other purposes for burning waste.
- The open burning of plastic waste takes place at a lower temperature compared to formal incineration. As a result, many harmful chemicals in plastics are created and released into the atmosphere. These toxic emissions are a major **health risk** for nearby communities and waste workers who breathe them in and can remain in the environment for long periods of time.
- There are eight main reasons for the phenomena of widespread open burning:
  1. **Disposal of Household Waste or Street Sweeping**
     One of the most common reasons for open burning is to facilitate the easy disposal of waste materials that may otherwise be difficult to remove. This can occur across a range of scales and performed informally by individuals and households or by waste service providers.
  2. **Access Metals in Bonded Assemblies**

For valuable mixed-material waste items open burning can be a way to expose different materials. Fox example, plastic-coated electrical cables can be burnt to remove the insulation and reveal valuable copper inside.

3. **Fuel Poverty**

   In some cases waste and plastics can be used as a source of fuel for warmth or cooking. This is more common in communities where purchasing fuel is expensive and time-consuming.

4. **Destroy Pathogens**

   Despite the toxic emissions from burning waste sometimes this is a trade-off to prevent a worse environmental hazard. In this case medical waste is taken outside and burnt to reduce the risk of pathogen infection.

5. **Incineration**

   Although open burning often takes place directly on the ground in many cases this is performed using rudimentary containment structures. These brick-built incinerators can be commonly found outside medical centres.

6. **Dispose of Reprocessing Residues**

   Residual waste materials from industrial activity are often burnt for disposal.

7. **Land Disposal Surface Burning**

   Fires at exposed landfill sites are a common occurrence. These can be started deliberately for the reasons previously mentioned or accidently. The decomposing waste at landfills can often produce high methane levels which increases the risk of uncontrolled fires.

8. **Organised Scrap Fires**

   Larger scale organised fires are also common. These can be found at material recovery facilities (MRF) or waste-to-energy plants.

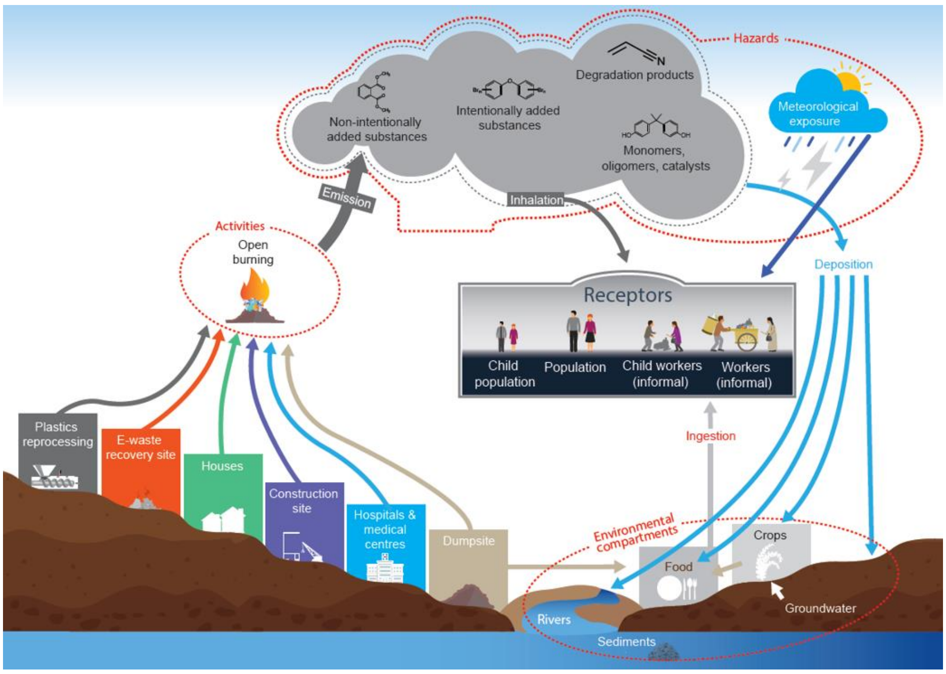

Figure 11. *The open burning cycle for municipal solid plastic waste. Source: Cook & Velis, 2021.*

What is a Plastic Pollution 'Source'?

- A plastic pollution source refers to the **point of emission** when plastic waste **transitions** from being **managed** to being **unmanaged**.
- It is where a plastic item is released into the environment due to the failures of the various systems and behaviours that keep plastic waste under control.
- These sources occur normally as a result of inaction or **failing waste services** and **infrastructure**.
- It is very important to understand **how, where** and **why** plastic enters the environment. This is because once plastic becomes unmanaged it is very difficult and expensive to **control**, **retrieve** and **remove** this pollution.
- High rates of **transport** for plastic waste items, combined with the high likelihood of item **fragmentation** into increasingly smaller particles, means the **logistics** and **costs** of taking steps at later stages are often unfeasible.
- Tackling plastic waste at the **source** is the **first** and **best place** to reduce its impact.
- Although in some cases plastic pollution will only have a single source, from which it flows directly into the ocean.
- **Secondary sources** including at accumulation hotspots like bridges and dams can offer another chance for interventions.

What are Plastic Pollution 'Pathways'?

- A plastic pollution pathway is defined by the movement of the plastic waste once it is released into the environment.
- This typically refers to plastic waste in motion in rivers and streams however there are four common types of plastic pathway:
    - Movement Over Land *(by wind and rain)*
    - Movement in Small Drains
    - Movement in Large Drains
    - Movement in Canals and Rivers
    - Movement in Oceans
- Plastic pathways are **often mixed** and most plastic items will experience a number of **different sequential pathways.** This means that the impacts of plastic waste can be felt far from its initial source, both in **space** and **time.** The best way to act is to prevent the plastic item from entering the environment to start with.

What are Plastic Pollution 'Sinks'?

- Plastic pollution sinks are the locations where the **continued transport** of plastic waste to another environmental location is **unlikely** or **impossible.**
- These sinks can be:
    - Temporary Sinks
      Example: plastic waste settles on a riverbed or becomes entangles in aquatic vegetation.
    - Permanent Sinks

Example: plastic waste is destroyed at an incineration plant or is disposed in a controlled landfill.

- The identification of sinks depends on the chosen **spatial** and **temporal scales**. For example, when looking a local stream over several weeks a patch of nearby river vegetation which traps plastic may be considered a sink. However, if you were to consider this same system at a river basin level or over many years this impact may become negligible.
- Plastic pollution sinks can be found in the three main environmental compartments: aquatic sink, atmospheric sink, land sink

What are Plastic Pollution 'Hotspots'?

- At a city level, plastic waste hotspots are areas that have a **high concentration of plastic waste** *(in comparison with the areas around it*).There are three main types of hotspot:
  - **Source Hotspots -** These are locations **emitting** large amounts of plastic waste into the environment. *Example: An city neighbourhood with no waste management services.*
  - **Pathway Hotspots-** These are locations **transporting** large amounts of plastic waste. *Example: A larger river running through the centre of a city.*
  - **Sink Hotspots -** These are locations / infrastructure where large amounts of plastic waste is **accumulating** with little or no likelihood of being moved. *Example: Dam infrastructure that blocks waste flowing through a river.*
- A hotspot can be further characterised based on its:
  - **Polymer Type -** It can be useful to know if a hotspot is composed of a single or a few specific polymer types. *e.g. a sink hotspot near a sports park is characterised by its high composition of PET plastic bottles.*
  - **Application Type -** It can be useful to understand when hotspots are created due to the prevalence of a specific activity or product application. *e.g. a source hotspot around a market area is formed by citizens buying, selling and consuming food products at the local stalls.*
  - **Sector Type -** It can be useful to understand when hotspots form due to high waste generation activities of a specific sector. *e.g. a pathway hotspot where an estuary meets the busy beach is generated as a result of the activities of the local tourism sector.*
- See United Nations Environment Programme (2020). National guidance for plastic pollution hotspotting and shaping action for further guidance on characterising hotspots.
- Hotspot assessments are important for the **prioritization of interventions** to mitigate plastic pollution. These can focus on the most relevant **geographic areas**, **plastic polymers**, **applications, industrial sectors** or **waste management stages** causing plastic leakage.
- While it is important to understand where plastic accumulates in **hotspots** it can also be useful to consider where it is already **well managed.** These so-called '**notspots**' can often have lessons for waste management providers and can help to inform local government priorities.
- In practice, plastic hotspots, sinks, pathways and sources **combine** over a range of scales and locations. These are **complex systems** that must be understood to ensure cities can select the best possible course of action to address pollution.

Challenges in Measuring Plastic Pollution

- When deciding which methods to use and develop it is important to understand its key **limitations** and possible **mitigation**. There are several important challenges that can reduce the **accuracy** and **efficacy** of measuring plastic waste.
  - We can **only measure what we can collect -** *It is particularly difficult to measure uncollected waste or open burning.*
  - Plastic items exhibit very **high variability** in terms of materials, shapes, uses, and sectors.
  - Plastic pollution is **dynamic** and **rapidly changing** yet in situ measurements provide only a snapshot in time and space.
  - Plastic items **change, degrade** and **fragment** over time.
  - Because plastic pollution is often found and measured **far from its point of emission** it can be difficult to make confident links to specific sources and sinks.
  - Plastic pollution only emerged recently as a priority for waste providers. There is often a lack of **reliable data** (if it is available at all).

From Problem to Solutions

- With recent advances in technology, research and data surrounding plastic pollution there is now a unique opportunity to take a scientific and quantitative approach to plastic waste management. This is needed to provide a robust and scientific evidence base for future policy making.
- Completing a **baseline assessment** to quantifies and measure plastic pollution is an important first stage to finding local and effective solutions.
- There are **four important steps** to understanding the sources of plastic pollution in a city:
  1. First take a detailed look at the **solid waste management system**. Key failings here are the main likely cause of plastic release into the environment.
  2. Next understand the local **cultures, practices** and **socio-economic contexts** surrounding plastic item production, consumption and waste. This includes the scale and role of the informal recycling sector or public attitudes towards littering.
  3. It is then important to consider **all possible sources,** not just those easy to measure. For example, open burning of waste is easy to ignore as it occurs in a dispersed manner and leaves little evidence. However, in some cities this can be one of the primary and most damaging disposal methods for residents.
  4. Finally, accurate plastic sources requires gathering **reliable, up-to-date data** on all of the above.
- A plastic pollution baseline assessment must:
  - Understand the **hotspots** and **flows** of plastic pollution.
  - Assess the **relative importance** of the different components and driver of plastic pollution.
  - Provide **comparability** between locations.
  - Link to possible **engineering** and **policy interventions**.
  - **Benchmark** to track progress and measure the effectiveness of chosen interventions.

3.3 Tools to Measure Plastic Pollution

- Recent advances in the scientific understanding of unmanaged plastic waste have led to the development of a wide range of **tools** that can be applied by cities to better understand their relevant **plastic sources, hotspots** and **pathways**, and model the **effectiveness** of **potential interventions**.
- When mapping plastic pollution flows first the **scale of the assessmen**t needs to be decided. This can vary from countries, to regions, cities or even neighbourhoods. There are two types of resolution to consider: **temporal resolution** – the defined time period for modelling and sampling, and **spatial resolution** – the geographic scope of investigation.
- Larger scales can be used as a means of identifying **important hotspot areas** where critical action is needed. Alternatively, smaller municipality or neighbourhood scales can focus on understanding the **specific failings** in a solid waste management system that give rise to plastic emissions.

Baseline Assessment Toolkits

- Selecting the most appropriate toolkit will depend, among other factors, on the **project scale** and **level of detail**, chosen **research questions**, **socioeconomic** and **environmental context** and **available resources**.

The SPOT Model

- The Spatio-temporal quantification of Plastic pollution Origins and Transportation (SPOT) model, is a fully integrated GIS-based model for highlighting hotspots of plastic pollution.
- Key Features:
  - Regional, country or global scale.
  - Models waste flows for municipalities and can highlight key differences in waste management across a country.
  - As a GIS-based model SPOT can accurately map the flows of plastics in the environment over time.
  - SPOT can quantify and measure all hotspots types, including the source of emissions, likely pathways of transportation and locations of plastic accumulation on land and in sea.
  - Compatible with input data from SDG indicator 11.6.1.
- For more information see: https://plasticpollution.leeds.ac.uk/toolkits/spot/

The Plastic-to-Ocean (P2O) Model

- The P2O model is a global-scale plastic pollution model that was developed by PEW Charitable Trusts and System IQ and endorsed by the United Nations Environment Program. The results from this model were published in the international journal Science in 2020.
- Key Features:
  - P2O is a lifecycle model which evaluates the entire plastic value chain and creates simulations based on possible future patterns of production, consumption and waste management.

- The model characterizes key stocks and flows for land-based sources of plastic pollution across the entire value chain. It models municipal solid waste macroplastics and four sources of microplastics.
- Crucially, it provides estimates of global plastic waste inputs into the environment.
- This paper found it was possible to reduce the amount of plastic pollution by 80% by 2040 through the implementation of measures across the plastics value chain.

- For more information see: https://www.pewtrusts.org/media/assets/2020/07/breakingtheplasticwave_report.pdf

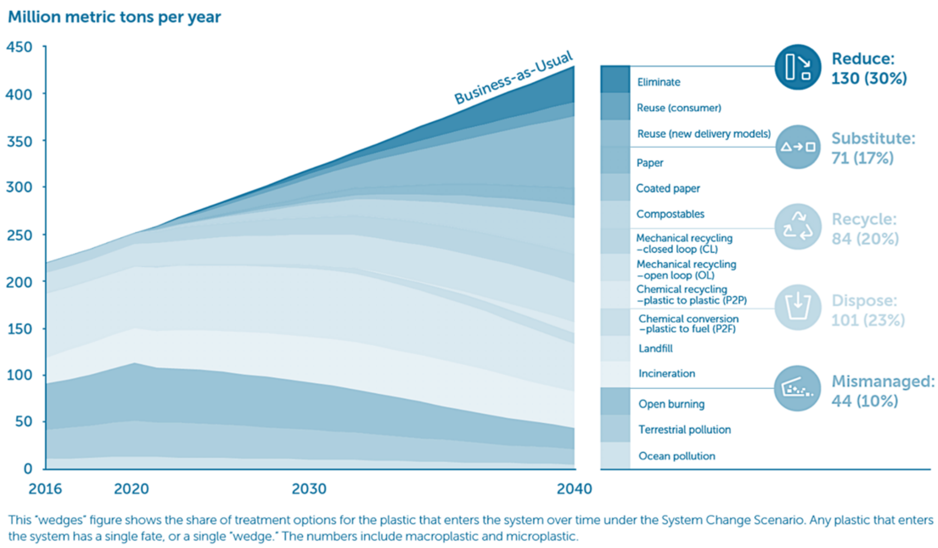

Figure 12. *Pathways to a 40% reduction in total plastic waste by 2040. Source: Pew Charitable Trusts & SystemIQ, 2020.*

The Plastic Pollution Calculator

- The Plastic Pollution Calculator (PPC) was developed by the University of Leeds as part of the ISWA Task Force on Marine Litter.
- Key Features:
  - The Plastic Pollution Calculator analyses a local solid waste management system and combines this with socioeconomic, geographical and meteorological factors.
  - The calculator can be applied at a range of spatial scales from city neighbourhoods to entire regions and whole islands if data is available. This allows for intra-city analysis and comparisons to identify plastic pollution hotspots and areas for improvement.
  - The Plastic Pollution Calculator represents the most comprehensive and high resolution quantification of interlinked sources, pathways and hotspots at a city scale.
  - These results can be used to establish a baseline for plastic pollution and to prioritise specific locations and interventions for policy makers.
- The Plastic Pollution Calculator has been deployed in four cities by United Nations ESCAP to develop baseline assessments of plastic pollution for the Closing the Loop project.
- The PPC creates a conceptual framework which brings together the different components of the solid waste management system and models the fluxes and interactions between them.

- The PPC is a data-intensive model and can be implemented over a defined area and time period in six steps.
  1. Describe the District using Land, Sociodemographic, Geographic, and Waste Management Typologies.
  2. Estimate the Waste Generation and Composition for each Land Use
  3. Conduct Material Flow Analysis to Model the Waste Management System
  4. Introduce Temporal Factors
  5. Estimate Leakage to the Environment and Waterways based on Transfer Coefficients
  6. Identify Action Measures and Conduct Scenario Analysis
- Plastic pollution calculator outputs: pathways, waste composition, item emissions by land use and activity, item emissions over time, spatial distribution of emissions, key statistics and results dashboard
- As well as being important for broadening our wider understanding of plastic pollution this should be used for two main purposes:
  - **To Identify and Prioritise Hotspots for Interventions**
    The PPC provides GIS mapping outputs of plastic pollution within defined administrative boundaries. In this example it has been applied to the island of Bali to identify hotspot districts.
  - **To Identify and Compare the Impact of Possible Engineering and Policy Interventions.**
    The PPC conceptual framework allows users to model and quantify the impact of different potential solutions on plastic pollution. This can help to inform the next steps for governments to tackle plastic waste.
- For more information see: https://plasticpollution.leeds.ac.uk/toolkits/spot/

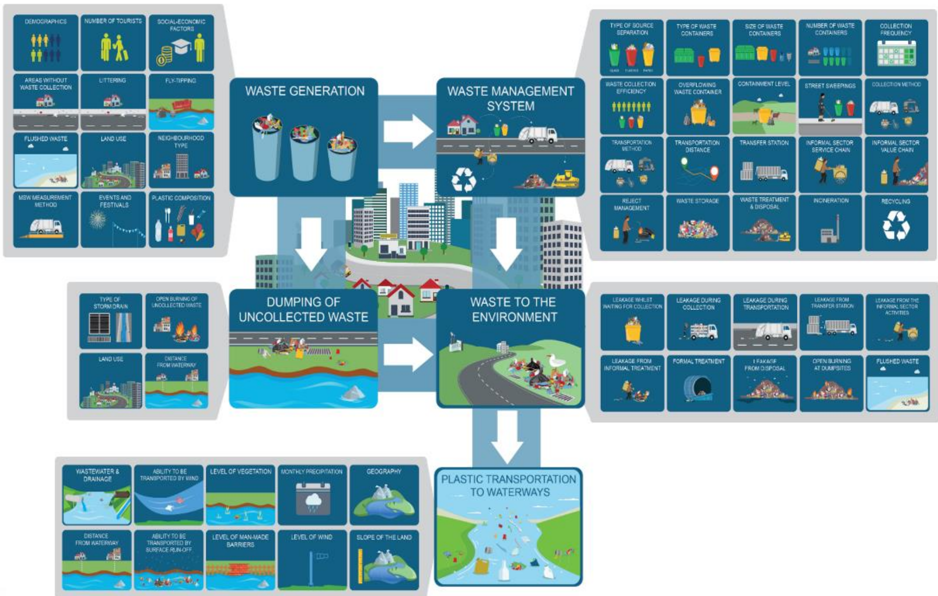

Figure 13. *The Plastic Pollution Calculator conceptual framework.. Source: University of Leeds, 2020.*

The Waste Flow Diagram

- The Waste Flow Diagram (WFD) was developed by GIZ, University of Leeds, Eawag-Sandec and Wasteaware. It is a rapid assessment tool for cities that visualises waste flows.
- Key Features:

- ○ The WFD is an excel-based model that maps municipal waste and quantifies the sources and fates of plastic waste entering the environment.
- ○ It uses a simple observation based approach for data inputs.
- ○ Harmonised with SDG 11.6.1 *The proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated.*
- ○ It is compatible with Waste Wise Cities tool and has successfully been applied in cities in Indonesia, Algeria, Kenya, Mexico and Morocco.

- For more information see: https://www.giz.de/expertise/html/62153.html

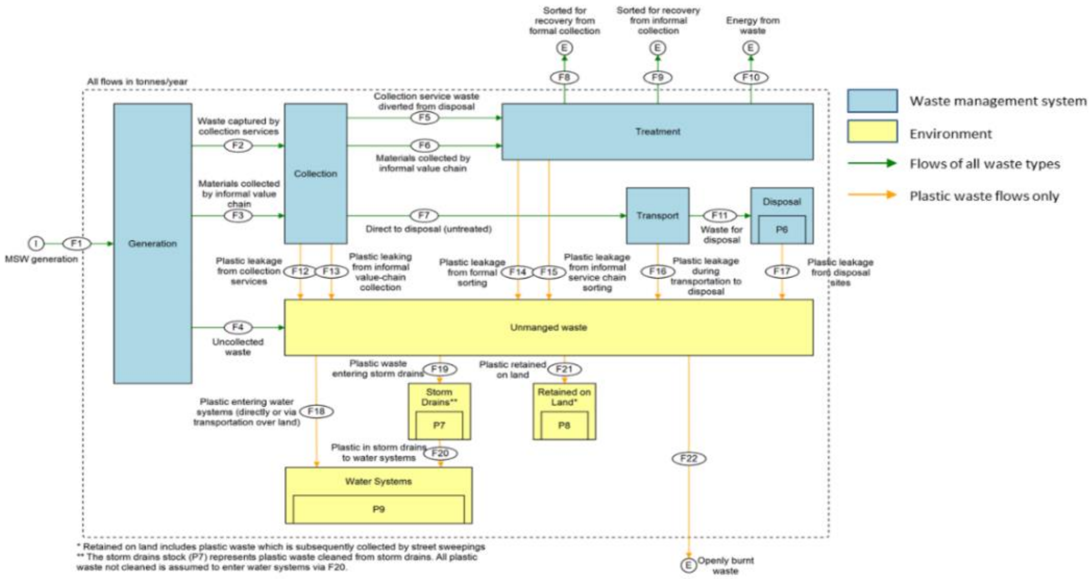

Figure 14. *The Waste Flow Diagram tool framework. Source: GIZ & University of Leeds, 2020.*

The Waste Wise Cities Tool (WaCT)

- The Waste Flow Diagram Tool was made to be complementary with the Waste Wise Cities Tool (WaCT) by UN-Habitat. This is linked to the monitoring of SDG 11.6.1.
- This is a larger package that aims to help city governments assess the environmental performance of their municipal solid waste management systems. It is possible to do a simple quantification of plastic pollution in cities by running the WaCT and supplementing it with the WFD for observational assessments of plastic pollution.
- The tool is designed to:
  - ○ Ensure that city data collection is reliable, high quality and informed by the latest science.
  - ○ Ensure that the waste management system assessment process is applied consistently and allows for regional and global comparisons and best practices.
- Joining the Waste Wise Cities Network provides cities with guidance on implementation of WaCT assisted by UN-Habitat. Support is given across four action areas:
  - ○ Waste Data and Monitoring *(e.g. feedback on available data, support in collection of data with Waste Wise Cities Tool)*

- ○ Knowledge Sharing *(e.g. Waste Wise Newsletter, City-to-city Partnerships, Waste Wise Academy)*
- ○ Advocacy and Education (e.g. educational toolkit, awareness raising materials)
- ○ Project Finance and Bankability Support (e.g. for drafting project proposals, marketplace)

- For more information see: https://unhabitat.org/waste-wise-cities

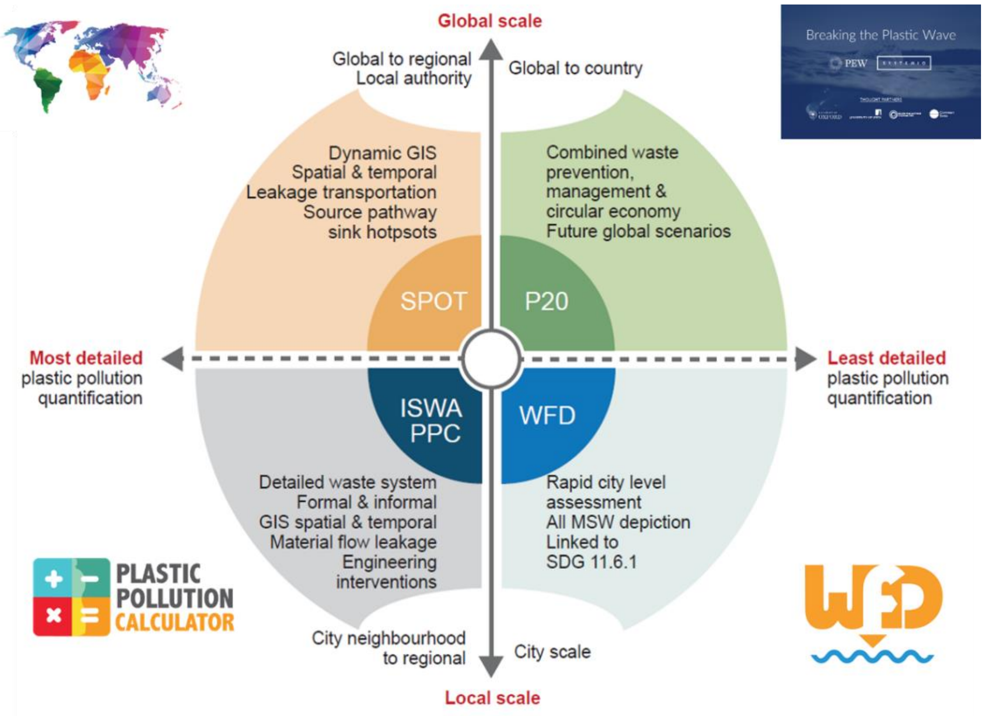

Figure 15. Plastic pollution toolkit summary.

3.4 Module Summary

Key Takeaways

- Plastic pollution flows and their measurement are the result of complex phenomena, but they can be easily understood with the suitable knowledge and engineering tools.
- New plastic pollution flow quantification tools suitable for baseline assessment and future benchmarking now exist and are available to use.
- Systems are interlinked and what is detected in the environment is a snapshot in time and space – as plastics move and transform in the environment other communities are impacted that are different from those where the pollution initially emerges.
- Open burning of solid waste including plastics is part of the plastic pollution challenge and needs to be addressed in any assessment and identification of interventions / solutions.
- There are always solutions to obtain the basic data inputs required but you need to cross-check (quality assure) your data and estimates.
- Locally adapted and evidence-based solutions can be identified by applying the baseline/ benchmarking / measurement flow assessment tools.
- Preventive actions go to the very point of the first release into the environment, avoiding subsequent flows and transformations (breaking down, fragmentation).
- Absence of basic provision of waste and resource management services and infrastructure is often the major reason for plastic pollution.

Learning Outcomes:

- Differentiate between the concepts of source, pathway, receptor (sink) and hotspots for plastic pollution and explain how they are interlinked.
- Differentiate between the forms of plastic pollution (littering, fly tipping, open burning, open dumping, dumpsites, marine litter); the role of rivers and drainage infrastructure; and the movement and transformation of waste in the environment.
- Be able to explain and identify the main interlinkages between the different factors affecting plastic pollution flows and understand measurements and flows in the environment are temporal and spatial snapshots.
- Be able to understand and collect the input data needed for running plastic pollution baseline measurement toolkits, such as the ISWA Plastic Pollution Calculator (neighbourhood, to city, to region level) and the University of Leeds SPOT model (municipality/city to country level).
- Be aware of common pitfalls and mistakes in assessing plastic pollution and in collecting data for baseline methodologies, as for example those related to waste arisings, waste composition and open burning or the role of the informal recycling sector.
- Be familiar with the outputs of the plastic pollution assessment tools and able to use them for planning purposes.

3.5 Module 3 Quiz

Question	Options
1. What are some examples of first entry points into the environment for plastic pollution?	A) Run-off from dumpsites and poorly contained landfills B) Material travelling from drains into rivers C) Littering D) Sea based activities such as shipping and fishing E) Dislodged plastic waste that has entangled in river vegetation
2. Why is the open burning of waste performed?	A) To reduce the risk of pathogen infection B) To reduce the mass and volume of waste C) To expose valuable materials and metals found in waste products D) All of the above
3. What is a Plastic Pollution Pathway?	A) An uncontained landfill site which leaks plastic B) Littering C) The medium (e.g. a river or stream) through which high amounts of plastic waste and transported into the environment D) A local hotspot produced by tourist activity
4. Which of the following are challenges for collecting and measuring plastic pollution?	A) Plastic measurements only provide a snapshot of pollution in time and space B) It can be difficult to link plastics found in the environment to their original source C) Plastic waste items fragment and degrade once in the environment D) Reliable existing data on plastic pollution is often unavailable E) All of the above
5. What is a Plastic Pollution Sink?	A) A river which transports high volumes of plastic waste B) A location which leaks plastic waste into the environment C) A location where it is unlikely or impossible for accumulated plastics to be further transported D) A city drainage network
6. Quantification toolkits should be chosen based on____	A) Global-scale plastic predictions B) A suitable level of scale and detail within the defined geographic boundaries C) Ability to quantify pollution into open burning D) Ability to calculate waste composition
7. Locations which you consider plastic waste hotspots are always the same when assessing pollution at larger spatial and time scales?	A) True B) False

8. Which of the following are important data inputs for measuring and modelling plastic pollution?	A) Per capita waste generation B) % plastic waste composition C) Waste collection service coverage D) Population density E) Open dumping F) All of the above
9. By understanding pollution 'source hotspots' local authorities will be able to _____	A) Intervene upstream before plastics are released into the environment B) Invest in river booms to collect waste C) Know where to best build new recycling plants D) Stop informal waste collecting
10. The ISWA Plastic Pollution Calculator results include ____	A) Insights to contextualise waste found in the environment by cleanups B) Explanations on hos sources, pathways, stocks, flows and hotspots are interlinked in a city or region C) Quantification of plastic pollution over time, including incorporating climate and religious events D) Linking plastic pollution to locally adapted engineering interventions and solutions E) All of the above

3.6 Key Resources

Videos

ISWA. (2018). Preventing Marine Litter – Global priorities. Waste Wise Webinar *(48:30)* https://www.youtube.com/watch?v=0wwUngc-xqE&ab_channel=beWasteWise

Velis, C. & Zabaleta, I. (2020). Introduction to the WFD *(10:08)* https://www.youtube.com/watch?v=g_jLS2lMpqc&ab_channel=MunicipalSolidWasteManagement

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Velis, C. & Cottom, J. (2021). Closing the Loop - How to Measure Plastic Pollution Part 2 *(29:05)*

Zabaleta, I., Velis, C., Cottom, J. (2020). Applying the Waste Flow Diagram *(11:55)* [*https://www.youtube.com/watch?v=dCu6YaUANbY&t=6s*](https://www.youtube.com/watch?v=dCu6YaUANbY&t=6s)

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https://doi.org/10.31224/osf.io/qwy4d

Quiz Answers

Q1 – A,C,D Q2 – D, Q3 – C, Q4 – E, Q5 – C, Q6 –B , Q7 – B, Q8 – F, Q9 – A, Q10 - E

Module 4: Detecting Plastic Waste from Land and Space

4.1 Module Introduction

Welcome to Module 4: Detecting Waste from Land and Space. This module explores the different methods and approaches that researchers around the world are using to detect and classify floating plastic in rivers and coastal waters. Notably: the use of cameras, counters, satellites and machine learning techniques. Freely available online resources, software and satellite data is used to demonstrate the space-based component of this module.

Learning Objectives:

- **Understand how plastic waste leaks into the marine environment and how this can be monitored.** Specifically: how can new methods and data be used to expand our understanding of local waste contexts? and what are the strengths and weaknesses associated with these different methods?
- **Explore a range of 'tried and tested' ground-based techniques** including visual counting, net sampling and mounted cameras, and develop an understanding of how these data can be applied for plastic waste detection in rivers.
- **Share knowledge on the range of free high resolution satellite data** that are available and how they can be applied for plastic monitoring in example marine and riverine environments.
- **Provide information on introductory machine learning approaches -** strengths and limitations, and the requirements to develop your own approach.
- **Understand how to plan and implement tailored workflows** including identifying the most effective tools and data sources, and learn how to navigate the trade-offs between practical limitations, resources, and available technologies.

Developers:

- Plymouth Marine Laboratory
- Wageningen University and Research
- Keio University

Expected Completion Time: 3 hrs

4.2 Detecting Plastic Waste from Land

- **Targeted and scientifically-robust data collection** is a key pre-requisite to inform the planning, implementation and review of plastic waste interventions. Without reliable data on the **quantities, composition, sinks** and **sources** of plastic emissions, interventions risk failing to tackle the root causes of plastic waste leakage. **Data** reveals the different dimensions of urban plastic pollution and allows a city to evaluate the effectiveness of measures taken.
- Plastic waste detection can be delivered using a wide variety of methodologies each with their own unique strengths and weaknesses that must be considered based on the **local context** and **data**

needs. This is to ensure the most effective allocation of resources with the highest mitigation potential.

- This modules focusses on the detection of **macroplastics**. These are defined as all plastics **>=5cm**. This can be specific items, such as bottles and bags, but also hard/soft/foam fragments.
- Macroplastics are harmful to the **environment** and **human livelihoods**. Examples of negative impacts include: (1) harm to aquatic animals and plants (fish, birds, mangrove forests), (2) damage to shipping vessels, (3) losses in tourism revenues due to pollution, (4) increased urban flood risk through blockage of urban water infrastructure. Macroplastics from land-based activities are also the main source of marine plastic litter and microplastic particles in the aquatic environment.
- Yet **riverine macroplastics** are **understudied** compared to ocean plastic or microplastics. **Monitoring and data collection is crucial** to increase the understanding of macroplastic sinks, sources and pathways. In turn, this can be used to **optimize prevention, reduction and mitigation strategies.**
- Rivers play an important role in the transport of plastics from land into the ocean. Plastics are found in all compartments: **floating at the surface**, on the **riverbanks**, **suspended in the water column**, and in the **sediment**. Specific methods are needed to collect data in each compartment.
- **Land-based primary data collection** is the most common form of plastic waste monitoring and there is a wealth of published literature on best practices for measuring in this way. The main methods discussed here are: (1) **Net Sampling**; (2) **Litter Traps**; (3) **Riverbank/Beach Cleanup**; (4) **Visual Counting**; (5) **Drone Observations**; (6) **Fixed Cameras**; and (7) **Citizen Science**.
- Methods can be categorized into: (1) **active sampling methods**, (2) **passive sampling methods**, and (3) **visual observation methods**.
    - **Active sampling** methods use **nets** deployed from boats or bridges to collect samples. They can be used for both **floating and suspended plastics**. Active sampling can give information on **plastic concentration**, **item types, polymer types**, and **mass/size distributions.**
    - **Passive methods** collect samples at locations where waste **already accumulates**, such as on **riverbanks**, in **litter traps**, or at **hydraulic infrastructure** (dams, weirs, etc.).
    - **Visual observation methods** focus on counting floating or riverbank plastics. This is commonly performed by citizen scientists or students sampling from bridges.

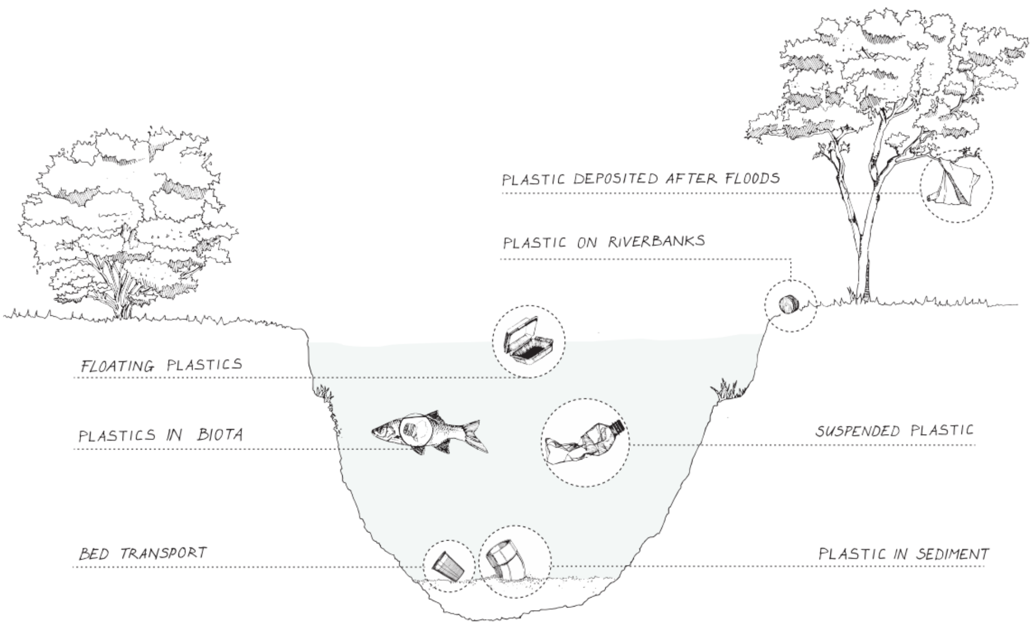

Figure16. *Plastic waste in the river environment. Source: van Emmerik, 2020*

- It is important to consider that many of these methods are providing a **snapshot** in **space** and **time**. Due to the **highly mobile nature** of plastic waste, **repeat measurements** are often critical to mitigate uncertainty.
- In the end, there is **no single solution** for river plastic monitoring. It all depends on the sampling workplan and demands of the project. In many cases taking a **combined approach** that brings together data from multiple methods can provide the most complete picture of a local plastic waste context.

Method 1: Net Sampling

- **Net sampling** is a common way to gather data on the **quantity** and **composition** of **floating** or **suspended** plastic waste. To obtain a plastic concentration value you need to quantify the mass of plastic collected and the flux of the waterbody. Nets can be deployed from bridges or boats and the net size and position can be adapted to gather different types of plastic waste.

Advantages:

- Low tech and capacity requirements
- Quick and targeted applications
- Flexible (bridge or boat, surface or subsurface)
- Samples offer options for further analysis (item and mass distributions, polymer type)
- Removes plastic from the environment

Disadvantages:

- May need additional equipment or infrastructure
- Can be unsafe in high velocity or high traffic rivers
- Sampling plastics from deeper in the water column is still challenging
- Targeted locations and so difficult to effectively upscale

Method 2: Litter Traps

- **Litter traps** are a method of passive sampling which collects plastic waste from a **fixed location** over a **set period of time**. These are often implemented at **manmade** or **natural barriers** such as dams, booms, or narrow channels.

Advantages:

- Low tech and capacity requirements
- Uses existing infrastructure
- Allows for rapid identification of existing waste accumulation hotspots which can be traced upstream
- Allows creation of long-term datasets
- Samples offer options for further analysis (item/polymer types)
- Removes plastic waste from the environment

Disadvantages:

- Constrained by available infrastructure
- Unflexible and restricted by hydrology (e.g. not applicable for large rivers or areas with high boat traffic)
- Difficult to estimate transport fluxes or emission rates
- Hard to account for the impact of environmental variability (wind, hydrology)

Method 3: Riverbank/Beach Cleanups

- **Riverbank and beach cleanups** refer to the process of **directly removing plastic** from the environment. These events tend to require **lots of personnel** and can take **many hours to**

complete. However they allow for the **collection and compositional analysis** of large amounts of plastic waste. Cleanups are also a strong way to facilitate **citizen engagement** on the issue of marine plastic waste.

Advantages:

- Low tech and capacity requirements
- Allows for rapid assessments
- Easy to upscale
- High visibility and builds public awareness
- Low cost
- Also removes non-plastic waste

Disadvantages:

- Difficult to confidently identify plastic sources and pathways
- No transport flux or emission estimates
- Can only complete in accessible areas
- Poor sample representativeness or harmonization. e.g. there may be large amounts of uncounted waste upstream/downstream and only provide a snapshot

Method 4: Visual Counting

- **Visual counting** methods focus on **floating** or **riverbank** plastics. For floating plastics, observations are usually performed from **bridges**. All plastic items flowing past are recorded for a **specific duration** (1, 2, 5, 10 minutes), and normalized to **items/min** or **items/hour**. Typically a bridge will be divided into different **sampling areas** with each count being performed **multiple times per sampling session**. For riverbank plastics, all items are counting and collected within a **100 m by 25 m sampling area**, and normalized to **items/km** riverbank.

Advantages:

- Low tech and capacity requirements
- Quick, easy, and consistent data
- Suitable for monitoring by students or citizen science and can help build public awareness
- Insights into order of magnitude of transport, emission and item types

Disadvantages:

- Only floating or riverbank plastics
- Observer bias and human error
- No data on plastic waste mass
- Limitted data on composition
- Requires safe bridge or counting location

Figure 17. *Visual counting methods from a riverbank (a) and bridge (b). Source: van Emmerik, 2020.*

Method 5: Drone Observations

- **Unmanned aerial vehicles** (UAVs) such as **drones** are increasingly being used for environmental data collection. These present new innovations in remote sensing technology and can **rapidly gather data** for a **large spatial area**. These produce **image** and **video outputs** which can be analysed manually or increasingly using **automated machine learning** and **AI** methods. Best practice examples often fly the drones **at low altitude** (10-20m) for best quality images and complete multiple passes of the same area.

Advantages:

- Flexible application - No need for a bridge or many participants
- Unbiased raw data
- Quick surveying
- High spatial coverage
- Can sample less accessible regions

Disadvantages:

- Often requires sampling or land access permits
- Data processing can be time consuming (if manual) or require high technical capacity (if AI)
- RGB images are not the best for detecting plastics
- AI requires large training datasets

Method 6: Fixed Cameras

- **Fixed cameras** represent a way to **automate** the image and video data collection methods at a fixed location. These must be installed on **bridges** or **riverbanks** with a measured distance to the water level. These are most applicable for **AI analysis** as the camera continuously gathers training data and can improve its own detection rates over time. Establishing the AI component requires a **labelled training dataset**, **machine learning algorithm** and **testing and validation process**.

Advantages:

- Potential for long-term monitoring
- Potential for upscaling
- Automation of data collection and analysis
- Unbiased raw data

Disadvantages:

- Substantial amount of manual processing needed to begin
- AI models are specific to the camera location and often not very transferable
- Fixed location
- Relatively expensive and need to protect from environment and theft
- Setting up hardware and software can require high technical capacity

Method 7: Citizen Science

- **Citizen science** is not a method itself but refers to the engagement of **members of the public**to participate in **scientific data collection** (often through visual counting or riverbank sampling methods). **Students** at all levels are most commonly used to collect citizen science data.

Advantages:

- Suitable for upscaling over time and space
- Large-scale monitoring
- Low cost and low capacity
- Community engagement and public awareness
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Disadvantages:

- Dependent on volunteer data collection
- Limitations on what can be asked (complexity and time commitments)
- Quality control and human error
- Needs strong local networks

METHOD	QUALITY	COST-EFFICIENCY	UPSCALING
Visual counting	++	$	+++
Net sampling	++	$$	+
Other sampling	+	$	++
Drones	+++	$$$	+
Cameras	++	$$$$	++
Citizen science	++	$$	+++

Table 5. *Land-based plastic detection methods comparison.*

METHOD	Riverbank	Floating	Suspended	Sediment
Visual counting	✓	✓	✗	✗
Net sampling	✓	✓	✓	✓
Other sampling	✓	✓	✓	✗
Drones	✓	✓	✗	✗
Cameras	✓	✓	✗	✗
Citizen science	✓	✓	✗	✗

Table 6. *Suitable methods by target plastic type.*

Case Study: **NOAA Marine Debris Program - Monitoring and Assessment Project: Get Started Toolbox**

The Marine Debris Monitoring and Assessment Project, MDMAP, is a citizen science initiative that engages National Oceanic and Atmospheric Administration (NOAA) partners and volunteers to survey and record the amount and types of marine debris found on shorelines.

The 'Get Started Toolbox' contains many resources to guide data collection including:

- Shoreline survey tutorials and training.
- Field datasheets and photo gallery for waste item classification.
- Access to the MDMAP plastic waste database and user guide.
- Data and analysis and visualisation templates for Microsoft Excel
- Shoreline monitoring FAQs

For information see: https://marinedebris.noaa.gov/research/monitoring-toolbox

4.3 Detecting Plastic Waste from Space

- **Satellites** are machines suspended in orbit around the earth in order to collect information. In 2020 there were approximately **2,666 operational satellites** circling our planet. These are largely commercial satellites used by the communications sector, however 446 (27%) are designated for use in the field of **earth observation** (WEF, 2020). This represents a mix of **government** and **commercially-operated** satellites.
- Satellites collecting **optical data** offer a unique perspective from which to observe the problem of plastic litter in the marine environment. Analysis can provide insights over **large spatial areas** and shed light on the **transboundary nature** of plastic waste, all **without** the **financial** and **administrative costs** associated with traditional data collection methods.
- While past research studies struggled to effectively demonstrate the use of satellites for plastic detection, today floating accumulations of plastic can be **accurately detected** using **free satellite data** and **software**. This technology is **rapidly developing** and increasingly presents a **feasible alternative** for large-scale land monitoring.
- General **limiting factors** to the use of satellites include the **temporal, spatial and spectral coarseness** of observations (low resolution) and **high technical capacity requirements**.
- When applying to river systems some key determining factors are:
    - How **cloudy** is the area of interest?
    - What is the average **width** of the river?
    - How **long** is the river and are there any known **plastic hotspots**?
    - Can **primary field data** be collected to **validate** satellite analysis?
    - Are there any **'Aggregators'** present? (*e.g. floating plants that become entangled with plastic waste*)
    - How **turbid** is the water? (*is it clear or is there lots of suspended sediments?*)
    - What are the **temporal requirements** for sampling *(frequency of satellite images)*?

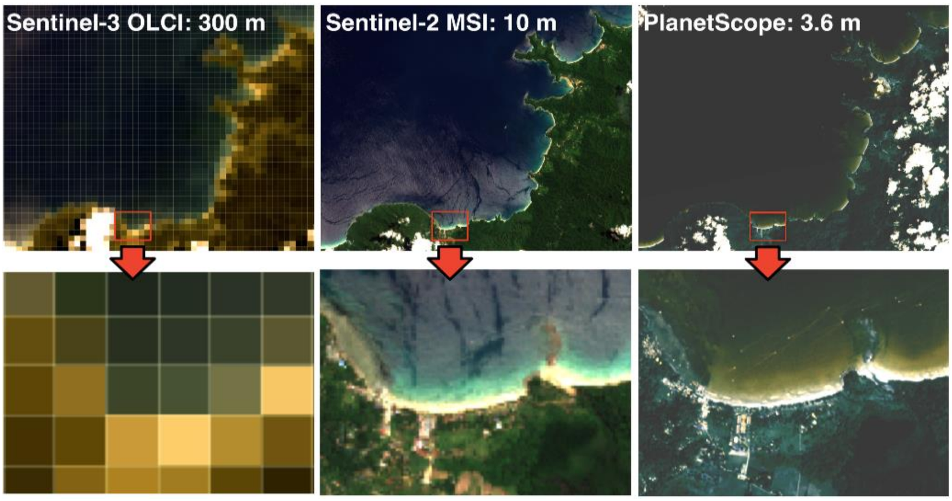


Figure 18. *Example satellite imagery sources and resolutions. Source: Biermann, 2020*

Satellite Data Sources

- Though many satellites gather information that can be used for environmental monitoring, this module will only focus on satellite data that is: (1) **freely available** to **download** and **use**, and (2) **high enough spatial** and **temporal resolution** to detect plastic waste.

- Different satellites use a range of different **sensing instruments** and **orbits** to collect data. Therefore the **spatial resolution** (level of detail of images, pixel size) and **temporal resolution** (frequency of observations over the same area) will vary by satellite.
- The **Copernicus Programme**, which is funded by the European Commission, gathers earth observation data from around the world for the European Space Agency and provides this online for **free**. This aims to produce a **global, continuous, autonomous** and **high quality earth observation dataset**.
- The **Sentinel Satellite missions** are a series of 7 satellites that carry a range of technologies for land, ocean and atmospheric monitoring. Most relevant for plastic waste detection is **Sentinel-2**.

Sentinel-2 Satellites

- Launched in 2015 and 2017, the Sentinel-2A and 2B Earth Observation satellites from the European Space Agency (ESA) are equipped with **multi-spectral sensors** and can detect the presence of floating objects in coastal waters.
- Sufficiently **high spatial and spectral resolutions** allows the identification of small to large **boats** and **vessels,** rafts (floating patches) of **sargassum seaweed**, **navigational hazards** like **floating timber**, **oil rigs, sandbanks**, and patches of **floating macroplastic**.
- Although Sentinel-2 was primarily designed for **terrestrial applications** including land classification, crop monitoring and for emergency services (forest fires), coverage also includes **coastal waters** every **2 to 5 days**.
- Sentinel-2A and Sentinel-2B have **accessible data going back several years**. However, because the Sentinel-2 satellites are **optical satellites**, they cannot collect data through **clouds**, or at **night**. This **limits data coverage** in time and space. Ideally the satellite images selected to be analysed will have **<10% cloud cover** for the area of interest.
- Even at high spatial resolution (10m x 10m) detection is still reliant on **larger marine features** like **fronts** (boundaries between different water masses) or **eddies** to **gather debris into patches** that are big enough to be seen from space. In the marine environment, natural and waste material tends to be brought together by ocean and coastal currents. These generate large patches of **mixed objects** including natural plant debris and macroplastic litter.
- Depending on the materials composition of these patches, **as little as 30% of the pixel** (3m x 3m) needs to be filled for detection to be possible.
- Thanks to the **spatial and spectral resolution** of Sentinel-2 data, these satellites are good candidates for detecting patches of floating debris in wide rivers and coastal waters.
- The **Multi-Spectral Instrument** (MSI) aboard Sentinel-2 collects imagery at a **spatial resolution of 10m** (pixel size is 10m x 10m), and over **12 bands** that range from the visible part of the **electromagnetic spectrum** (red, green and blue wavelengths of light) into the **near infra-red** (NIR) and **shortwave infra-red** (SWIR). In each image pixel the MSI provides reflectance values for each wavelength band.
- Different materials record different reflectance values helping to create a **unique spectral signature**. It is therefore possible to assess if the floating materials detected by Sentinel-2 are macroplastics, or natural materials such as seaweed, sea foam or driftwood.
- In contrast with water, which is characteristically efficient at absorbing near infrared (NIR) to shortwave infrared (SWIR) light, **floating materials** including **macroplastics** and natural materials like seaweed and foam **reflect in the NIR**. Matching the MSI values for a specific pixel to

the unique spectral signatures of plastics and other material can provide information on waste composition.

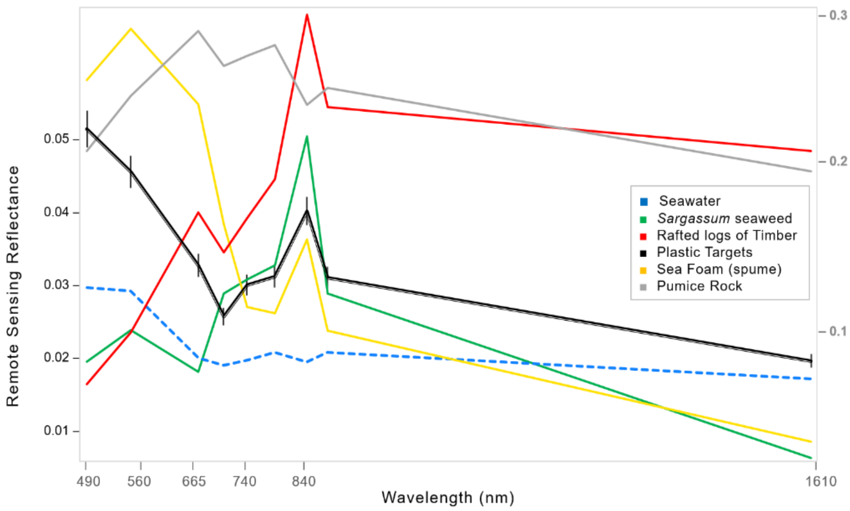


Figure 19. *Material spectral signatures from hyperspectral satellite data collection. Source: Biermann et al., 2020*

Processing and Analysing Satellite Data – Sentinel 2

- The processing of satellite imagery from raw data into macroplastic quantities occurs in 3-stages.
  - **Exploring**

    Users review the **availability** of **satellite imagery** and **existing literature** on plastics for their location and similar locations. The **EO Browser** (https://apps.sentinel-hub.com/eo-browser/) is useful tool to identify which types of satellite imagery are available for select regions and time periods. Using a **Near-Infra-Red band setting** when comparing satellite imagery options can make it easier to visually identify possible plastic patches. Once the relevant satellite images are identified, ideally those with low cloud cover and identifiable features such as fronts, river plumes or eddies, the images can be downloaded for free from the **Copernicus Open Access Hub** (https://scihub.copernicus.eu/).
  - **Data Processing**

    Downloaded satellite imagery must be **atmospherically corrected**. This is the adjustment of spectral data to account for the impact of the atmosphere on reflectance values. Pre-processed is often available as 'Level 2' data that can be downloaded in the same way and from the same sources as normal satellite imagery.

    The European Space Agency (ESA) have developed a series of toolboxes for working with data from the Sentinel satellites. The toolboxes share a common architecture called the **Sentinel Application Platform (SNAP)**, which supports all Sentinel satellite sensors, plus others (including MERIS, MODIS, Landsat). Functionalities of SNAP primarily involve **image display** and **navigation**, **band arithmetic**, and **spectral analysis**.
  - **Classification**

    Once the suspected patches of floating plastic have been identified **spectral analysis** is needed to detect if this material is plastic or if it is comprised of other waste or plant debris. The **SNAP 'spectrum view' tool** can be used to identify the spectral values for the selected pixels and see how these match the unique spectral signature of plastic waste.

This can be accelerated and automated using **machine learning algorithms** such as a Naïve Bayes Classifier model.

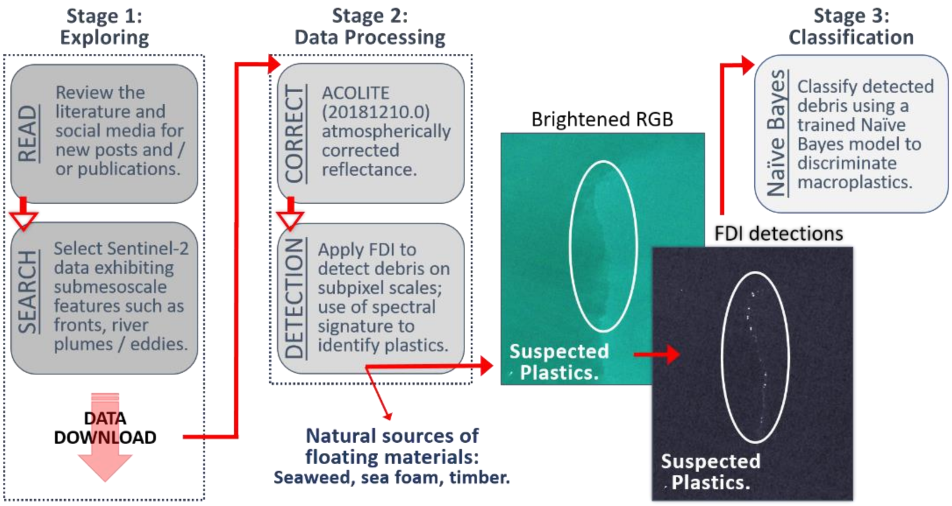


Figure 20. *Sentinel-2 data workflow. Source: Biermann et al., 2020*

4.4 Machine Learning

- **Machine learning** is the application of **artificial intelligence algorithms** for problem solving. Algorithms are **computer programs** which have the ability to **learn** to analyse data and to **improve their performance** with experience. This allows machines to perform **increasingly complex tasks** and has created opportunities for new learning across a **wide range of industries**.
- You may have already experienced Machine Learning in your day-to-day life. For example: **Siri, Alexa,** and **Google Assistant** are reducing entry barriers to our online world, from knowing how to spell and search, to knowing how to speak. Other examples like **Netflix** and **Amazon** allow you to filter through endless categories of offerings to find out what's 'tailored' to your habits. Furthermore, combining **Computer Vision** with control systems opens the door to **autonomous machines** such as self-driving cars.
- Machine learning can be applied to the problem of plastic waste detection by **automating the analysis of datasets**. The most common example is the use of AI to automatically identify plastic waste items in **images** or **videos.** This detection can recognize different **item types** and **quantities** of plastic waste to inform policies and decision making.
- One of the most important stages in creating a machine learning system is the development of an algorithm. Computer algorithms define the **rules**, **calculations** and **processes** for completing a **specific task.** These vary in terms of **complexity** and **application**, and typically machine learning algorithms used for detailed image recognition are complex.
- When creating algorithms inspired by human learning, there are **different schools of thought**. Each of these "tribes" have developed their own "master algorithm" to mimic or replicate that "learning" in a mathematical way.
- Until about 2010, each of these methodologies returned fairly similar performances. However since then deeper networks, more powerful GPU, and very importantly – **more data** have allowed rapid expansion of machine learning capabilities**.**
- For any machine learning to create automated plastics detection and classification, it is extremely important to ensure you have a robust **training dataset**. This is often the **limiting step**, as collection of enough training data needs a lot of accuracy, work and time.

- Why is the training data so important? All machine learning algorithms or models can only be as good as the data they are trained with – just like humans, these algorithms need to be trained with enough data to be able to **apply that learned knowledge to real world examples**.
- The exact amount of data required for your machine learning work depends on many factors, such as:
    - **The complexity of the problem**, in other words, the unknown underlying function that best relates your input variables to the output variable.
    - **The complexity of the learning algorithm**, in other words, the algorithm used to inductively learn the unknown underlying mapping function from specific examples.
- Some good advice for those who are considering using machine learning for detection of plastics in their river or coastal systems: it is likely that something similar has been done before and **published in the scientific literature**. Look at studies on problems similar to yours to:
    - Guide selection of the type of machine learning approach or model,
    - Learn from their work how their training data were collected and selected,
    - Derive a baseline aim or estimate for the amount of data that may be required in your own investigations.
- Always keep in mind that machine learning is a **process of induction**. The model can only capture what it has seen. If your training data does not include **edge cases** (data which is less likely to occur), they will probably not be supported by the model.
- Biermann et al. (2020) outlines the first example of floating macroplastic detection using Sentinel-2 satellite data. Combining the Sentinel-2 Multi-Spectral Instrument (MSI) with a novel Floating Debris Index (FDI) the team from Plymouth Marine lab managed to develop a machine learning algorithm to identify marine plastic waste in four coastal locations: Accra, Ghana; Da Nang, Vietnam; Gulf Islands, Canada; and Isle of May, Scotland. In all cases the floating aggregations were detectable at a sub-pixel scale and the presence of plastic was distinguishable from natural material such as seaweed and seafoam. The use of AI allowed for automated plastics classification which showed a prediction accuracy of 86%.

The Sentinel-2 Satellite.
Source: European Space Agency

4.5 Workflows – Choosing the Right Approach

- For any plastic monitoring exercise it is important to select the **most effective approach** and **data** for the task. Adopting a **sampling workflow plan** can ensure that the chosen methods are **appropriate** and **feasible** and that the final data outputs effectively address the **key research questions** and **data gaps**.
- A plastic monitoring workflow is a 5-step process which defines in turn:
  - **Research Questions and Data Needs**

    In the first stage city stakeholders must outline the **key questions** which need to be answered to strengthen understanding of the local waste management and possible interventions. These questions can be fairly broad to begin (*How much plastic waste is generated by my city each year?)* and refined as you progress through the workflow (*Which items are most prevalent in the waste stream? Which city districts create the most waste? etc.)*.
  - **River and Basin Characteristics**

    The physical characteristics of a river system will impact the feasibility of different monitoring techniques. Some key questions to ask include:
    - Where along the river do we want to monitor? (*upstream/midstream/downstream/coastal*)
    - How wide is the river?
    - How fast does the river flow?
    - How turbid is the river? *(the amount of suspended materials)*
    - Is the river prone to flooding?
    - What waterbody does the river run into?
    - How engineered is the river? *(dams, weirs, flood defence, diversions)*
    - How accessible are the different areas of the river for sampling?
    - How busy is the river? *(boats and other river traffic)*
    - How large is the drainage basin? *(the total area in which rainfall enters the river system)*
  - **Available Resources**

    Any monitoring effort will be constrained by the level of resources available to a project. This includes not only **financial resources**, but also **technical capacity**, **human resources**, and **time**. Different methods require different availability for each resource and must also be considered within the wider project budget availability and goals. Developing an ambitious sampling plan is only useful if it can be practically implemented.
  - **Data**

    Different research questions and methods require and produce different types of data. It is important to ensure that the outputs for both are **consistent** as much as possible. Similarly it is important to consider the potential to **standardize results** for **comparison** and the possibility of creating or contributing to datasets at **larger temporal** and **spatial scales**. Due to the **dynamic nature** of plastic waste often it can often be better to employ a **smaller** number of methods that generate **scientifically-robust and consistent data** than trying to take lots of different types of data snapshots at different times and places.

- **Analysis and Dissemination**

  A process of analysis is required to distill the **raw data** into **succinct messages** and **evidence** to **support policy makers.** The exact process of analysis will vary dependent on methods but can range from **basic statistics** (*such as determining the most common plastic items, average concentrations, waste flow over time, etc.*) through to **AI** and **Geographic Information Systems (GIS)**. The **multisector** nature of plastic waste means data is often of interest to a wide range of stakeholders. Outputs often have high potential for regional knowledge sharing, communications and awareness raising and can reflect well on a city. Ensuring maximum reach requires **clear visualizations** of data and development of a **communications strategy**. It is often useful to understand which platforms and systems the research outputs will be hosted on to help with compatibility.

Figure 21. *Plastic sampling workflow. Source: Biermann & van Emmerik, 2020*

4.6 Marine Litter Monitoring and Assessment

- Monitoring plastic pollution over land, in waterways, on beaches and in the marine environment is crucial to assessing the **extent** and **impact** of **marine litter**, devising **mitigation methods** to reduce inputs, and **evaluating** the **effectiveness** of these measures.
- The use of **reliable** and **comparative** sampling methods is key for robust monitoring.

One-off Plastic Data Collection

- One-off plastic pollution surveys or rapid assessments are a common data collection method that typically occur just once, or a few times over a fixed duration. These are usually designed with a specific end goal in mind and for data collection under time pressure.
- Many university studies and research programmes are one-off survey programmes and though these methods are often not the best tool to examine long-term time trends, they are ideal for situations where there are only limited resources available.
- The data from one-off surveys can provide useful snapshots of litter in a habitat or region and may inform longer-term litter monitoring programmes.

- The information gained from monitoring programmes is usually gathered for the purpose of informing policy decisions to reduce marine litter in the area. Long-term monitoring programmes are the most useful type of survey to detect changes through time and responses to policy change.

International Methods and Approaches

- International guidance is available to support selection of robust sampling methods and indicators for different habitats, including the 2019 Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) 'Guidelines for the Monitoring and Assessment of Plastic Litter in the Ocean'.
- The GESAMP Guidelines provide a toolbox of definitions, size categories, and recommended sampling approaches for different compartments and plastic sizes. The Guidelines ensure replicable and robust monitoring and allow countries to develop their monitoring programmes over time in line with national priorities and available resources.
- The Guidelines include:
  - Recommended sampling methods for micro- and macroplastics on the shoreline, for sea surface and water column, seafloor and for biota.
  - Recommended methods for sample processing, and analysing chemicals associated with plastics.
  - Steps to improving monitoring and assessment, managing data and developing effective indicators.
- UNEP has developed guidance on 'Monitoring Plastics in Rivers and Lakes: Guidelines for the Harmonization of Methodologies' to complement the GESAMP Guidelines. The Guidelines will be available on the website of the Global Partnership on Marine Litter (GPML).
- Harmonization of national marine litter monitoring programmes entails defining specific common objectives, common core indicators and recommended methods and data standards. Harmonization ensures robust data collection combine and enables **comparability** of data to detect significant changes in space and time and across borders.
- National monitoring is considered the most important level, with national ownership of the process and monitoring designed to meet national priorities and needs. Regional monitoring builds on existing institutions such as intergovernmental mechanisms of Regional Seas that enable countries to share good practices and coordinate approaches to monitor transboundary marine litter trends over time.
- The Regional Action Plan on Marine Litter of the Coordinating Body on the Seas of East Asia (COBSEA) identifies robust monitoring and assessment as indispensable to identify marine litter status, trends and impacts for effective interventions. COBSEA countries are currently developing Regional Guidance on Harmonized National Marine Litter Monitoring Programmes, in line with globally established guidelines.

- Other regional plastic action plans include: the Mediterranean Action Plan developed an integrated monitoring and assessment programme and facilitates regular national data reporting through the IMAP Pilot InfoSystem; and the Pollution Monitoring Regional Activity Centre (POMRAC) of the Northwest Pacific Action Plan (NOWPAP) which monitors marine pollutants and publishes the regional State of the Marine Environment Report.

Case Study: **Integrated Land and Space Monitoring: The 5D World Map system**

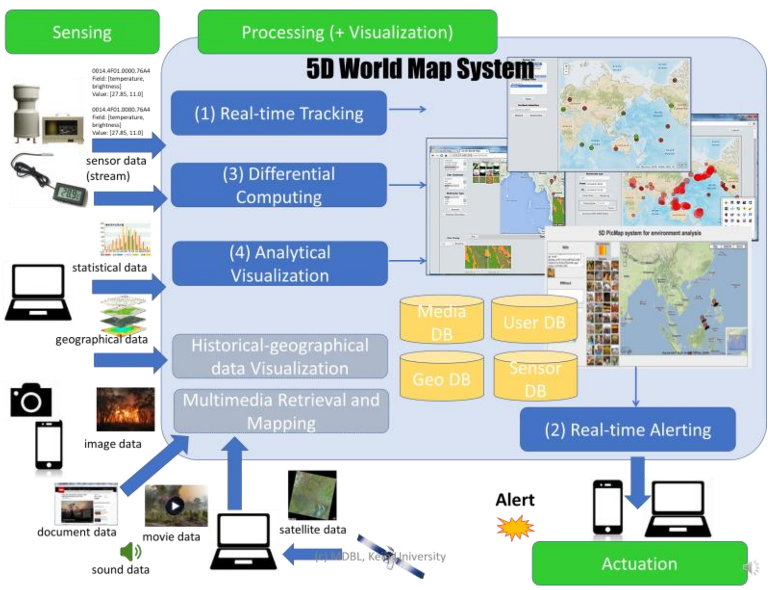
The 5D World Map System (5DWMS) is a project by Keio University in Japan. It is a multi-dimensional global knowledge platform and has been developed to collect and analyse 'real time' data on SDGs-related phenomena. The system integrates the visualization of remote sensing data with multimedia (images, videos, etc.) with the goal of supporting community-based data sharing, awareness building and evidence-based decision making.

This is built on a conceptual 'Sensing-Processing-Actuation' architecture.

- Sensing: The 5DWMS is designed to incorporate many different types of data inputs from multimedia images and videos to statistical datasets and sensor inputs.
- Processing: This wide variety of inpouts are then integrated into a single system and visualized using an online platform. From here data can be analysed using machine learning algorithms or real time analysis. The 5DWMS is unique in its ability to bring together and visualize a diverse range of data sources to create new insights.
- Actuation: Data processing and analysis should be used to inform specific actions in mind. This process is integrated through a real-time alert functionality and compatibility with long-term monitoring data sources.

The five dimensions of the 5DWMS are: physical space (3-dimensions), time (1-dimension) and semantic space (1-digital-dimension).

For marine plastic waste the 5DWMS utilizes machine learning to analysis photographs and automatically detect the presence or absence of plastic waste. Uploads of plastic imagery can also be identified and visualized based on specific picture characteristics, spatial region and select time periods. At a large enough scale and with enough diversity of data inputs the 5DWMS can be used to compare plastic waste leakage and hotspots between cities. The data search feature can also be used to identify plastic images based on picture characteristics, spatial region and select time periods.



4.7 Module Summary

Key Takeaways

- **Measuring** and **monitoring** plastic is a key component for plastic mitigation. **Data** is essential to gain a good understanding of local **plastic sinks, sources** and **pathways** and can be used by cities to identify which **policies** and **interventions** will be most effective.
- Plastic detection can be performed from **land** and **space**, using a wide variety of different sampling methods that can be tailored to any local context. The main land-based methodologies are: (1) **Net Sampling**; (2) **Litter Traps**; (3) **Riverbank/Beach Cleanup**; (4) **Visual Counting**; (5) **Drone Observations**; (6) **Fixed Cameras**; and (7) **Citizen Science**.
- Plastic detection methodologies can be categorized as either: (1) **active sampling**, (2) **passive sampling**, or (3) **visual observation**s.
- Each methodology has its own unique **strengths** and **weaknesses**, both in terms of **data outputs** and practical constraints including **financial** and **human resources**. Adopting a **workflow approach** can be used to formulate a **robust sampling plan** and **inform decision making** regarding the different method options. The plastic workflow is a **5-stage process** addressing in turn: **research questions**, **river characteristics**, **resources**, **data**, and **analysis and dissemination**.
- Using **satellites** to detect plastic waste presents a new innovation in the field of plastic waste monitoring. **Freely available** satellite imagery can be **analysed** and **automated** to monitor and detect plastic in a wide variety of geographies.
- The **Multi-Spectral Instrument**, hosted on the European Space Agency **Sentinel-2** satellite is a good candidate for satellite plastic detection. This can identify the presence of plastic waste within pixels by recognising the **unique spectral signature** of plastics. Sentinel-2 data is freely available at a global scale with many years of past data that can be assessed.
- **Machine learning** and **artificial intelligence** technologies have potential to provide **automated** and **accurate data analysis**. These have been commonly applied to images and videos collected from land, drone and space, used to identify and quantify the amount of plastic waste. These is largely limitted by the **high data requirements** and **complexity of algorithm development**. Yet as data availability and collection increases rapidly it is becoming easier to develop, train and apply these tools. A machine learning system uses a **training dataset** of classified images to 'learn' the process of how to detect plastics which it then applies to new images.
- **Integrated platforms** are increasingly being developed to **host** and **analyse** many different types of plastic data. The **5D World Map System** by Keio University presents one example of a free online system that can be used to complete machine learning imagery analysis for the purpose of plastic waste management, and to compare across wide spatial and temporal scales.
- Though a wide **range** of **powerful monitoring tools** exist there is **no single solution** to detecting marine plastic. It all depends on the local context and available resources. In many cases **combining multiple methods** can provide the most **complete picture** of plastic waste management conditions.

Learning Outcomes:

- **Foundational knowledge** for incorporating digital and space-based resources for applications around plastics monitoring.
- The **ability to engage with datasets** as well as **practical tools** including **online resources** and **free software** for detecting and monitoring of floating plastic waste in rivers and coastal waters.

- **Skills** for making **informed decisions** on collection and assessment **methodologies** to better understand the plastics pollution challenge in your own city or region.
- **General understanding** of how machine learning techniques and approaches can help monitor and incorporate ground and citizen-sourced data.

4.8 Module 4 Quiz

Question	Options
1. In which two ways do macroplastics harm animal life?	A) Plastic entangles animals B) Plastic provides new habitats C) Plastic reduces tourism D) Animals consume plastic material
2. Which of these is a PASSIVE sampling method?	A) Floating net sampling B) Fixed camera monitoring C) Beach waste collection D) Boat net sampling
3. A Multi-Spectral Instrument detects which types of data?	A) Just visible light B) Just infra-red wavelengths C) Reflectance within a defined range of spectral bands D) Just radio waves
4. Which of these sampling methods requires the highest amount of technical expertise?	A) Visual Counting B) Automated AI Image detection C) Litter trap D) Riverbank waste collection
5. Which of these sampling methods is most easily applied to citizen science data collection?	A) Fixed camera sampling B) Litter traps C) Visual Counting D) Satellite detection
6. Which of these sampling methods is safest?	A) Drone sampling B) Bridge net sampling C) Boat net sampling D) Riverbank waste sampling

7. Which of these sampling methods can be used to sample plastics that are suspended in the water column?	A) Satellite detection B) Bridge net sampling C) Visual counting D) Beach waste collection
8. Which of these sampling methods is easiest to quickly upscale to a city level?	A) Bridge net sampling B) Visual counting (citizen science) C) Boat net sampling D) Beach waste collection
9. At what spatial resolution does the Sentinel-2 satellite collect data?	A) 1km x 1km B) 500m x 500m C) 100m x 100m D) 10m x 10m
10. The most effective approach for monitoring plastic pollution uses ____	A) Only riverside sampling B) Only satellite sampling C) A combination of methods D) Only bridge sampling

4.9 Key Resources

Data Sources

To view satellite data online on EO Browser: https://apps.sentinel-hub.com/eo-browser/?zoom=10&lat=41.9&lng=12.5&themeId=DEFAULT-THEME

To download Level 1 or Level 2A (atmospherically corrected) Sentinel-2 data from the open access hub for free: https://scihub.copernicus.eu/dhus/#/home

To download the ESA Sentinel Applications Platform (SNAP): http://step.esa.int/main/download/snap-download/

Videos

Biermann, L., 2020. Closing the Loop: Detecting Plastic Waste in Satellite Images *(28:00)*

Biermann, L., 2020. Closing the Loop: Detecting Plastic Waste in Satellite Images – Data Analysis Walkthrough *(34:00)*

Biermann & van Emmerik, 2020. Closing the Loop: Workflows for Macroplastic Monitoring *(52:00)*

van Emmerik, T., 2020. Closing the Loop: Macroplastic Monitoring in Rivers (*41:00*)

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Vriend P, et al. (2020) Rapid Assessment of Floating Macroplastic Transport in the Rhine. *Front. Mar. Sci.* 7, 10. https://doi/ 10.3389/fmars.2020.00010

On Machine Learning:

Barakbah, A. R., & Kiyoki, Y. (2010). An image search system with analytical functions for 3D color vector quantization and cluster-based shape and structure features. *In Information Modelling and Knowledge Bases XXI (pp. 168-187). (Frontiers in Artificial Intelligence and Applications; Vol. 206)*. IOS Press. https://doi.org/10.3233/978-1-60750-477-1-169

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Quiz Answers

Q1 – A,D, Q2 – B, Q3 – C, Q4 – B, Q5 – C, Q6 – A, Q7 – B, Q8 – B, Q9 – D, Q10 - C

Module 5: How do we engage with the Informal Waste Sector?

5.1 Module Introduction

Welcome to Module 5 – How do we engage with the Informal Waste Sector. This module will provide an overview of the informal waste sector, its contribution to city solid waste management and how to identify key actors for engagement.

Learning Objectives

- **Understand the role of the informal economy and waste pickers** as local environmental actors in preventing and managing marine plastic pollution.
- **Waste economies as hybrid economies -** Understand the importance of including informal waste actors and their associations in waste management data, policies, planning and systems.
- **Identify the research and capacity gaps that can be filled though the engagement and inclusion** of the informal waste sector and lead to improved waste management systems.
- **Understand the key approaches for integrating waste pickers** under a decent work agenda (namely: rights to work, social protection, access to social dialogue, gender equality)

Developers: Women in Informal Employment: Globalizing and Organizing (WIEGO)

Expected Completion Time: 1 hr 30m

5.2 A Short History of the Informal Waste Sector

- **Waste has been an important resource for poor workers for centuries.** The cities of 19th century Europe and North America were populated with thousands of chiffoniers and scavengers (as they were called in Paris and New York City) who gathered urban waste. The waste of these pre-industrial societies was largely organic and biodegradable but even so, some system of collection was needed and thus children, women, and immigrants eked out a living sweeping pathways and collecting night soil while cart men collected glass and rags for factories.
- **The start of the 20th century saw the birth of modern municipal solid waste management**. New legislation to address **poor sanitation** and **disease** restricted access to waste and informal collection and collectors became **increasingly stigmatized.** While some workers found employment as formal collectors many municipal waste systems left **no room for sustained inclusion of the urban poor**.

- Although waste produced by modern cities is radically different from pre-industrial society the **activities of waste picking in many low and middle-income cities remain virtually unchanged.** There is a prevalence of work in **open dumps** and\or in **poor conditions**, and a vision of modernization at odds with **waste as source of livelihood.** The **stigmatization and lack of social recognition** for waste workers and increasingly **restrictive urban legislation that penalizes informal workers**, particularly women, exposes an exclusive form of waste management common in the global north and south.

Figure 22. *Informal waste pickers in 19th Century New York. Source: Library of Congress, 1896*

5.3 Mythbusting the Informal Waste Sector

- The waste pickers of today **collect, sort and/or process household, commercial** and **industrial waste** on the **streets,** in **co-ops,** in **recycling facilities** and in **open and controlled dump sites**. Across the globe key myths have tended to underpin policy and practices relating to waste pickers. However, these myths have strong negative effects, not just for waste pickers, but also on the development and implementation of sound waste management policy.

Myth # 1 – Waste Pickers are a nuisance and bring no contribution to cities.

- The vision of modern solid waste systems is often associated with mechanization and advanced technology. In this approach, informal waste picking is seen as an outdated and primative method of work that is largely ineffective.
- Yet many studies contradict this view and stress the **environmental and economic contribution** of urban waste pickers. They effectively **subsidize formal waste collection** and often **provide for unserviced communities.** The high recovery rates of informal recyclers is a *'**positive externality** which the municipality enjoys without having to pay as the environmental gain is a by-product of the economic interests of informal recyclers'* (Scheinberg et al., 2010).

- Waste picker collection **provides raw materials** at **low prices** to recycling industries thus contributing to **resource conservation, pollution reduction, and climate change mitigation.** While informal waste pickers do help prevent marine pollution, their impact can be dramatically increased when they are integrated into more formal waste management systems.

Myth # 2 - Waste pickers are not organized.

- The idea that waste pickers are not, or cannot be organized is one of prevailing myths about the sector. Though much work is done on an **individual** or **family basis**, WIEGO findings indicate pickers develop **work specializations** (street picking, doorstep picking, sorting, etc.) and **establish territories** based on agreements they may make with shop owners or residents.
- Waste pickers are increasingly forming organizations such as **cooperatives, associations, unions**, and **micro enterprises**. These help secure better work and social protections for workers - a critical need in an industry that is otherwise known for substandard labour conditions. Organizations can be built upon by policy makers to inform the ways cities formalize and modernize their waste systems.

Myth #3 - Waste pickers are poor victims.

- Informal workers are often seen as victims and usually only engaged at the level of social service departments or by the police.
- This lack of understanding about waste picking as an occupation ignores that they are **important economic actors** and **independent decision makers** within the solid waste value chain. Therefore waste pickers should be involved as **one of the main stakeholders** and **innovators** in waste management. For example in Pune, India itinerant buyers make extensive use of cell phones to make their dealings, showing a great level of entrepreneurship and adaptation.

Waste pickers reclaim and recycle waste for raw materials and packing materials – thereby contributing to the reduction of carbon gas emissions.

Photo by Jonathan Torgovnik/Getty Images Reportage

- Identification of waste pickers´ **strengths**, **challenges**, **coping mechanisms** and **strategies** are fundamental to help them secure sustainable livelihoods and learning more about informal waste activity. There is a shift of thinking required to stop viewing waste pickers as victims, to engaging with them as **key stakeholders** that provide a valuable service.
- That said, issues such as criminal activity, exploitation by middlemen and emerged elites, child labour and high occupational health risks need to be openly challenged if cities are to develop all-round **sustainability** and **prosperity**.

Myth # 4 - Informal waste picking is not linked to the formal economy.

- Over **75%** of waste pickers reported that **formal businesses** are the main buyers of products. The picture that emerged from WIEGO's Informal Economy Monitoring Study, across the 5 cities, is of extensive backward and forward linkages between different informal and formal actors and varying degrees of integration within waste systems. Pickers reported that they provide a wide range of services including: **waste removal**, **transportation**, **recovery of recyclables**, **value-aggregation**, **semi-processing**, **composting** and **biogas production**.

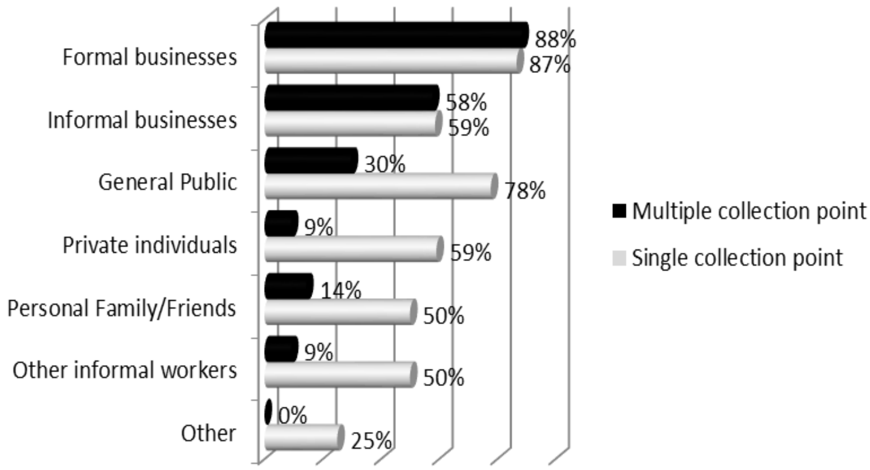

Figure 23. *Informal collection service interactions with formal economy and civil society actors. Source: Dias & Samson, 2016*

Myth #5 - Waste pickers are not capable of following safety protocols.

- The burden of occupational and health safety is usually placed on informal waste workers with a focus on **personal protection equipment** (PPE). Often waste pickers are blamed for not complying with safety and hygiene measures. However, grounded experiences with WIEGO's Cuidar and the Reducing Waste in Coastal Cities projects indicate that when given access to ongoing **training on occupational health and safety**, and access to **adequate, durable and comfortable protective equipment**, waste pickers respond positively to the adoption of safety protocols and PPE.
- With the 2020 coronavirus pandemic, it has become clear how important formal and informal waste collector services are to **public health** and how important **waste infrastructure**, **collective protection equipment**, and **citizens' proper waste handling** are for waste worker safety.

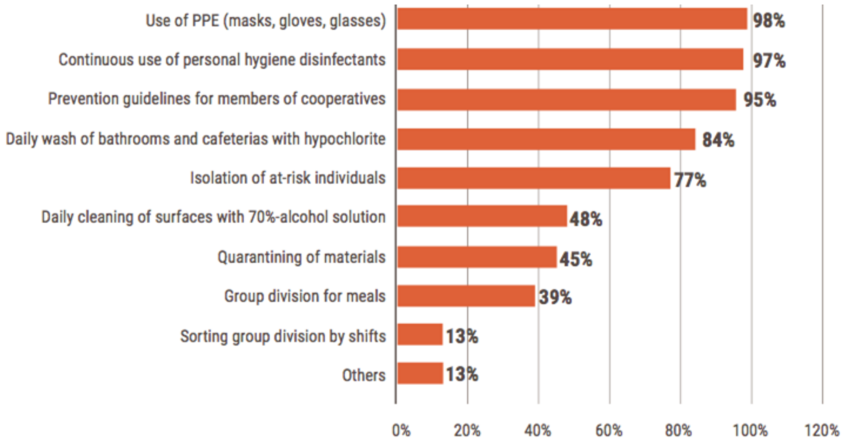

Figure 24. *Wastepicker readiness to improve safety protocols and adopt contagion prevention measures. Source: Dias et al., 2020*

Myth # 6 - Waste Picking only exists in under-developed waste systems.

- Waste management systems in developed economies are experiencing **increased consolidation of waste management actors** and **declining opportunities for small businesses**. Many of these cities are now struggling to reform their waste management to be more inclusive of small businesses and informal workers. Similar to developing waste systems informal workers play a key part to fill gaps in waste collection and subsidize waste services with little recognition.
- The **Global Alliance of Waste Pickers** is a global network of waste picker organizations from both the **north** and **south** to promote inclusive waste management. They aim to provide opportunities for informal workers to organize and promote low-barrier entry points for formalization.

5.4 Inclusive Waste Management

- **Inclusive waste management** is a concept describing systems that are able to **advance waste pickers in recycling and reuse value chains** - adding value to discarded materials, while also securing more **decent work conditions** and **social protection** for workers. Within this concept, integration or inclusion should be viewed as an **ongoing process** rather than as a one-time activity to absorb workers. The informal sector is proving to be a **persistent feature** of modern cities and waste management systems, including in systems that are considered highly developed and formalized. Inclusion can be seen as a **pro-poor process of integrating informal workers** into better working conditions while also identifying and filling gaps in waste management. However, it is unrealistic to see inclusion as a process to eliminate informality altogether.
- Integration and inclusion of the informal waste sector does not look the same from one city or country to the next, nor is any one strategy necessarily the best. Every place has its own **cultural**, **geographical**, **social** and **economic context** that can help determine what the best approaches to inclusive waste management may be. However, there are some important common features of **inclusive versus exclusive** waste management systems.

- **Inclusive systems** promote waste management opportunities that provide **low-barrier entry points** for formal or improved work and social protection.
- **Inclusive systems resist global trends** towards the **consolidation of wealth** in city waste management systems which are increasingly monopolized by one or few powerful waste actors.
- **Exclusive systems** tend to **lack transparency** in **financial flows**, **material flows** and in broader **planning processes.** Entry into exclusive systems thus traditionally requires a very **high capital input** to be able to compete and often also reliance on a workforce that lacks adequate labour rights or social protections.
- **Exclusionary systems** are also seeing growth of **waste automation**, which further **undercuts labour unions** and other **basic social and labour protections** for workers.
- **Inclusive systems** by contrast **reserve formal opportunities** like contracts, infrastructure and social protection for **local waste sector actors** like waste picker cooperatives. These groups tend to promote universal social protections, open planning processes, fair distribution of profits, and environmental and labour justice.

- Waste management is a key component of several Sustainable Development Goals, particularly **SDG1** ("*No Poverty*"), **SDG6** ("*Clean Water and Sanitation*") and **SDG12** ("*Responsible Consumption and Production*").
- Today informal waste workers face many challenges to their livelihoods, including:
  - An increasing reliance of cities on **waste-to-energy** and **heavy infrastructure** solutions to modernize waste management. Importing external actors and solutions rather than maximising the potential of existing organizations and works risks **displacing livelihoods** for the urban poor.
  - **Unsanitary working conditions**, especially at open dump sites pose a major health risk to waste pickers.

ILO estimates indicate 15-20 million people worldwide earn their living by recycling waste. Recycling reduces emissions 25 times more than incineration does.

Photo by Juan Arredondo/Reportage by Getty Images

- Urban cleanliness campaigns, despite good intentions, can often **restrict informal workers** from accessing public spaces and waste by "*containerization*", or the locking of trash cans. These strategies aim to hide the symptoms of poverty but often exacerbate the conditions of those most vulnerable by preventing them from working freely.

- Given these threats, WIEGO's work focuses on strengthening the voice and raising the visibility of organizations of waste pickers to push for **inclusive, reliable waste management systems**. Now more than ever **improving waste management at the source** is a key way to prevent plastic pollution and the informal sector has a valuable role to play.
- Achieving the longer-term goals of a fairer recycling and waste management value chain requires: (1) the adoption of the International Labour Organization (ILO) **Decent Work Agenda** to respect workers' rights to access waste as a source of livelihoods; (2) ensuring **social protection** for vulnerable waste picker groups; (3) creating adequate **waste infrastructure**; (4) adopting ambitious **occupational health and safety measures**, and (5) ensuring **fair payment** for waste collection and sorting services.

Figure 25. *Wastepicker climate justice and livelihoods march, India. Source: WIEGO, 2020.*

5.5 WIEGO: Reducing Waste in Coastal Cities

- In 2018 WIEGO began a five year project called [Reducing Waste in Coastal Cities through Inclusive Recycling](). The project works to support waste picker organizations in 4 countries: Ghana, India, Senegal and Argentina to **promote secure and decent work** in ways that also **maximize marine waste prevention**.
- Early assessments identified 10 keys ways waste pickers already contribute to preventing plastic and marine waste (**audio clips from informal waste workers)**.
- Thanks to the workers from the following organizations for lending their voices to this presentation: Kpone Landfill Association, Ghana; Lainehskhem Self Help Group, India; South Africa Waste Pickers Association; Nigeria Waste Pickers; ORIS, Brazil; Amelior, France; Sure We Can, USA; The Binners Project, Canada; Ground Score Association, USA.

- The process of identifying specific marine-friendly interventions for the informal sector is not straightforward. It can be hard to know **how** or **why** waste is ending up in the ocean, especially for waste pickers who may not know much about the broader waste systems beyond their own role. Therefore capacity development to support pickers to **understand** the entire waste management system, and to **identify the gaps and opportunities** within it, is a key approach of the project.

Mangaluru, India

- Mangaluru is a coastal city of over 500,000 residents in Karnataka State, Southwest India. The **Hasiru Dala** is an established waste picker organization from Central India that, through the Reducing Waste in Coastal Cities project, has been able to expand their work into Mangaluru.
- The project began by teaming up with a local organization to **survey** the city for **marine waste hot spots**. They travelled the city on bike, boats, car and foot, geomapping large accumulations of waste along the city's waterways and tracing those hotspots back to the source communities and markets. Hasiru Dala also conducted an **enumeration of waste pickers**, identifying the workers who could help to improve the system.
- Based on these baselines several sites were identified with the local government for waste management improvement. Hasiru Dala has helped establish a system of **door-to-door waste collection** in which waste pickers are paid user fees from households. They sort out recyclable materials and sell them at a new **Dry Waste Collection Centre** provided by the government. They also collect waste directly from markets where materials were previously dumped into waterways. Because the project was initiated by Hasiru Dala, a well-respected and recognized waste picker organization, the government was much more open to working with the informal sector than it otherwise might have been. Supporting **existing waste picker organizations** to orient some of their work toward addressing marine waste can yield **quick** and **significant** results.
- Waste management in Mangaluru is further contextualized by **India's single-use plastics ban**. Informal waste picker organizations like Hasiru Dala have been able to benefit from these policies as companies and residents have more incentive to contract workers for zero waste events. Here

Figure 26. *Zero waste events services provided by informal waste workers from Hasiru Dala. Source: WIEGO, 2020.*

waste pickers provide **collection, composting, recycling** and **reusable dishware** for events of up to 500,000 people. These waste pickers also offer **public education** to help communities comply with the bans.

Accra, Ghana

- The **Kpone Landfill Waste Pickers Association** is a group of 300+ waste pickers from Accra, Ghana. Like many of the unsanitary landfills throughout the world, Kpone Landfill is scheduled to be **decommissioned** and replaced with a **sanitary landfill** that prohibits the entry of waste pickers. These workers need to find **viable livelihoods** outside of the landfill.
- WIEGO conducts ongoing training with the group to help them build **collective identity**, **environmental awareness**, **advocacy**, **democratic governance structures**, **leadership**, **conflict resolution mechanisms**, and a broader understanding of the city's waste management system outside of the landfill where they work.
- To strategize livelihood opportunities that also prevent marine waste pollution, the Kpone Waste Pickers first visited the areas where waste was entering the ocean.
- By **tracing a canal** from the beach to a nearby community and **interviewing residents**. they learned the only waste management option was a **dumpster** provided by a **private company**. The dumpster was not **emptied frequently enough** and was always overflowing, leading to **illegal dumpsites** that the **rain** was constantly washing down to the ocean.
- The pickers decided to collect waste door-to-door and **gather information** to help them understand how best to develop a viable collection service. They staged two major collection events to understand: (1) **How many waste pickers are required** and how **much waste is generated** by households? and (2) what is the **recyclable value** of this waste? They also took note of **infrastructure needs** and how to **approach community members**.
- They discovered that, like other low income communities, the waste generated by the community was **low-value.** But while financing doorstep collection exclusively from the sale of recyclables would be impossible, they discovered that many people would be **willing to pay** for a **reliable waste collection service**.

Figure 27. *Waste pickers at Kpone landfill site.*
Photo by Dean Saffron.

- **Government support** is required to provide **land** to **sort** and **store** recyclables and also to fund the **disposal of non-recyclable waste**.
- The Kpone Landfill Waste Pickers Association are now using their **collection data** and **advocacy training** to develop **proposals** for **formal support**. They are now devising new methods to establish **multi-stakeholder platforms** to ensure their demands heard.
- Waste pickers are **well placed** to provide these services to **low-income areas** as they often come from and **understand** these communities. They also tend to operate **smaller**, more **manual equipment** which better reach **narrow** and **dense residential zones**.
- These waste picker services are typically **less expensive** than large private waste hauling companies. If governments are willing to contract waste picker organizations to cover larger portions of a city they can often also afford to **subsidize waste collection** in slums and other low-income neighbourhoods. This is how waste is collected in slum communities in Pune, India, by the SWaCH Waste Picker Cooperative.
- Ultimately governments and companies responsible for producing plastic waste should be obligated to ensure that low-income communities can **afford** or **be provided** with **adequate waste collection**.
- Waste collection and management, including litter management, is an **essential service** and should be fully funded by workers with **decent remuneration** and **working conditions**. This is a key challenge for the future of solid waste management and will require action across multiple scales and actors to facilitate change.

Barriers to Informal Sector engagement on Marine Waste

- There are several key challenges to integrating the informal sector with marine waste initiatives, and solid waste management in general:
  1. Plastic litter and marine waste often **lack value** for recyclers and scrap dealers and so fail to create economic incentives for waste pickers.

Waste pickers supply solid waste collection in many cities in developing countries – at little or no cost to city budgets – while diverting tons of material from landfills.

Photo by Juan Arredondo/Reportage by Getty Images

2. There is a **lack of available data** on where gaps exist in the waste management system, especially related to marine waste leakage, make it especially hard for waste picker groups to identify new niches in the waste system.
3. There is a **lack of inclusive planning processes**, **transparency** and therefore **trust** within existing waste management infrastructure. It is critical that inclusion policies collaborate with all levels of the informal sector and that there be transparency about which actors benefit from the system and by how much.
4. The **social stigma** surrounding the informal sector is largely due to society's lack of understanding about the importance of these workers and the role that waste plays to support livelihoods for society's most marginalized.
5. Finally, inclusive initiatives too often overlook the most **vulnerable workers**, especially **women.** Itinerant buyers, waste workers with vehicles and familiarity with smartphone technology, scrap dealers and aggregators are increasingly included in development initiatives. But **pedestrian street pickers** and **landfill pickers** continue to be largely overlooked, particularly in the Asia Pacific region.

5.6 10 Steps for Inclusive Waste Management

- Sharing experiences of inclusive waste management around the world has revealed some key approaches that have consistently worked to integrate vulnerable informal workers while also closing gaps in waste management systems. Here WIEGO have outlined 10 steps for inclusive waste management:

1. *"Nothing for us without us:" inclusive waste management should be defined and strategized through participatory multi-stakeholder platforms.*

   One of the most important strategies for inclusive waste management is to include informal workers in **planning processes**, especially through broad **multi-stakeholder platforms.** These platforms should include informal workers and also other stakeholders including NGOs and researchers. Multi-stakeholder platforms are useful spaces for **planning inclusive waste management interventions**, **identifying research and policy needs**, **capacitating stakeholders**, and **sharing best practises.** Examples include: Belo Horizonte's now 18 years old Waste and Citizenship Forum and India's Solid Waste Management Round Tables.

2. *Research and build from what already exists.*

   A focus on **building** and **improving existing systems** and **infrastructures** presents a **localized** and **cost-effective** approach for informal inclusion that doesn't displace existing workers. This requires a thorough mapping of the existing formal and informal aspects of a waste system. Research and knowledge sharing is fundamental to better understanding waste systems and should pay particular attention to commonly overlooked stakeholders like street and dumpsite pickers. Platforms and events such as the **Territorial Dynamic of Waste Collecting and Recycling Conference**, are useful to bring together researchers and civil society organizations to investigate waste collection, in this case in Vietnam. This work can help illuminate challenges and opportunities for the informal sector, and identify possible actions to improve and support their work. The Global Alliance on Waste Pickers have catalogued the main national and international wastepicker organizations at https://globalrec.org/waw/list/.

3. *Intersectional and gender-sensitive approaches should be taken to ensure that the most marginalized actors are included.*

   With growing awareness about the detrimental impacts of excluding the informal waste sector, NGOs, government and the private sector are under increasing pressure to target informal waste workers with formal waste interventions. Often these efforts reach only workers who may be easier to find due to **higher levels of literacy** or **technological aptitude**, or because they belong to social or occupational groups that are more **acceptable to mainstream society**. However the informal waste sector is often the occupation of overlooked people with intersectional disadvantages in **gender**, **race**, **ethnicity**, **poverty**. To promote a truly inclusive waste management system, it is important to ensure that at least some interventions are able to find and integrate the **most marginalized workers** in the system. For example, in Indonesia it is common to engage informal waste collectors working in semi-formalized doorstep collection and waste sorting, while women waste pickers who work in dumpsites and in the streets are almost never targeted for interventions that would improve their livelihoods.

SWaCH Waste Picker Cooperative, India.
Photo by Brodie Cass Talbott

4. *Integration should support self-organized waste pickers.*

   Many waste pickers throughout history have found their way into formal roles, normally by being hired by waste management companies. However, rather than inclusion, this form of integration can often look more like absorption - waste pickers enter formal work streams but lack any **power to influence** the wider waste management system or provide **sustainable, long-term roles** for marginalized workers. This can often lead to poor working conditions and a lack of social protections. An inclusive system should reserve at least some portion of low-barrier work that is oriented for marginalized workers. Successful inclusive waste systems count on the participation of waste worker organizations. These organizations tend to promote **internal democratic representation**, **social protection**, **profit distribution**, and **solidarity with workers** who are not included in their organization or the formal system.

5. *De-stigmatization of workers is key to their inclusion.*

   Intersecting stigma associated with **waste, poverty** and **socio-cultural factors** can drive **exclusionary waste management systems** and **policies**. Often political action to hide the symptoms of poverty can lead to the expulsion of informal waste workers from the public eye and from formal opportunity. **Campaigns to de-stigmatize informal workers** are critical for both ensuring more inclusive systems but also for encouraging residents to care about waste reduction and management. **WIEGO's Essential Workers' Campaign** advocates for the realities of informal waste work during the COVID-19 pandemic, and demands support to help workers generate the funds and resources to protect themselves.

6. *Capacity development at all levels (Waste Pickers, Govt, Private Sector, NGOs, Researchers).*

   When strategizing the inclusion of the informal sector, it is recommended to provide capacity-building for **waste pickers** and their **organizations**. Yet other stakeholders including **government**, **the private sector**, **NGOs** and **researchers** also need greater support on best practises for engaging the informal sector, especially women. This is often best delivered by **established waste picker organizations.** For example, India-based waste picker organization Hasiru Dala has trained more than 102 local government officials on solid waste management and

Figure 28. *Capacity building workshop with Kpone Landfill waste pickers. Photo by Dean Saffron.*

the informal waste sector in the past two years. In regions like South-East Asia and the Asia Pacific, where waste pickers are less organized, NGOs and other stakeholders that support waste management at the community or municipal levels are best suited to deliver training.

7. *Essential protections for essential workers.*

   Waste pickers are **essential workers.** The collection of household and recyclable waste is a **basic sanitation service** and waste pickers play a **fundamental role in the value chain** by redirecting materials to recycling and reuse providers thereby expanding the lifespan of city landfills. Waste pickers, organized or not, should therefore be recognized and supported by **government** and **society**. In the context of COVID-19 this includes provision of **personal protection equipment**, **adequate infrastructure** in sorting centres, **collective equipment for decontamination** of materials, **capacity building** for occupational health and safety, and **social protection** measures such as cash grants to enable vulnerable workers, such as the elderly, sick workers and pregnant women, to take leave to protect themselves.

Figure 29. *Waste workers with personal protective equipment (PPE). Source: WIEGO, 2020*

8. *Locally appropriate technologies: pro-poor modernization instead of capital-intensive technologies.*

   As waste management systems are modernized, they often introduce **new external actors** and **technologies** that can be challenging for informal workers to adapt to. This is especially true for **women** for whom the introduction of technology in waste management is often the first step to exclusion. For example, women in South Asia are 28% less likely than men to own a mobile phone and 58% less likely to use mobile internet. Inclusive waste management systems like those in India make specific efforts to accommodate some **manual** and **locally appropriate technologies** to maintain the low-barrier participation of waste pickers. Across the Asia Pacific region informal waste workers use a combination manual equipment, like **pushcarts** and **bicycle carts**, and mechanical options, like **trucks** and **tricycles.**

9. *Payment for service provision and for environmental service.*

   Waste pickers and other informal waste workers typically earn their living through the **sale of recyclable material**. However, decent work in waste management should also include a **payment for providing essential services**. This helps protect waste pickers from **price fluctuations in the recycling market** and acknowledges the **time** and **expense** associated with collection, sorting and processing waste. These payments can be made by households, government or the private sector. In Pune, India, the SWaCH waste picker cooperative collects these service payments directly from residents and the government subsidizes coverage for slum communities.

10. *Plan for sustainable livelihoods*

    Waste management is a dynamic sector that faces increasing disruption due to the **instability of recycling markets**, the **growth of non-recyclable plastics** and **hazardous waste**, growing **privatization**, and increased **awareness** about the **environmental problems** caused by material production and disposal. It's critical that waste systems be crafted strategically so that vulnerable actors do not become dependent on toxic or declining practices. The future of sustainable waste management should instead emphasize **reuse**, **waste prevention** and **safe recycling practices**. Informal waste workers can play a stronger role in achieving long-term sustainable waste management by **identifying and addressing gaps in waste management and waste prevention** systems. Government and waste workers can then develop targeted interventions to improve waste sector performance. The **low overheads and large labour force** of waste picker organizations mean they tend to be **highly adaptive** and so capable of finding **creative waste solutions**. For example, the SWaCH waste picker cooperative in India recognized that the immersion of offerings in rivers during their city's annual Ganpati festival was causing river pollution. In an effort to keep rivers clean, they began providing services to recover religious idols and offerings for reuse, recycling and composting. They now have funding to provide this service every year.

- WIEGO has developed 10 key questions for urban practitioners to help identify opportunities for informal engagement:
  1. *What are the existing formal and informal features of your local waste system?*
  2. *Who are the most informal and precarious workers in your system?*
  3. *Where are women present as workers within the waste system?*
  4. *Where are there gaps in the waste management system that are leading to marine waste leakage?*
  5. *What interventions would you propose to fill those gaps to reduce marine waste in your community?*
  6. *What impact would such interventions have on women and precarious workers?*
  7. *How can informal workers be included in sustainable paid waste work?*

8. *How do you propose to fund these interventions?*
9. *What local resources and actors exist to strategize inclusive waste management?*
10. *What steps can be taken to engage these stakeholders over the long term to implement inclusive waste management?*

Figure 30. *An informal waste picker in Da Nang city, Viet Nam.*

5.7 Module Summary

Key Takeaways

- **Informal waste workers and waste pickers** are an **essential component** of modern waste management and the circular economy that have been **overlooked** and **undervalued** for far too long.
- The informal sector provides an **essential urban sanitation service**, **subsidizes formal municipal waste collection**, and **reduces the amount of environmental pollution** and **marine plastic leakage**.
- **Inadequate waste management** is a **key driver** of **ocean plastic pollution** and underserved communities in the Asia Pacific region are a **key source**. The informal sector can be leveraged with support from **government**, **NGO** and **private stakeholders** to tackle this type of leakage. However, because in many cases the waste produced in these communities is of low value it is often difficult to finance based on the sale of recyclable materials alone. Therefore creating a **formalising working relationship** between **waste pickers** and **local government** is key to enabling inclusive and sustainable waste management systems.
- There is an intrinsic connection between **public health**, the **economy** and the **environment** which demands a complex set of **sanitation control**, **economic** and **social protection measures** to ensure decent working conditions for waste pickers.
- Informal waste sector workers are increasingly forming **organizations** to secure better **working conditions** and **representation.** These groups have been successful in engaging with the formal

sector and local governments to create **inclusive waste management systems** across the world. **Knowledge sharing** and **capacity building** between formal and informal stakeholders is increasing at city, national and international scales. Working with waste picker organizations presents an opportunity for city governments to improve **quality of life** for residents and utilize **low-cost**, **effective** and **local solutions** to support existing waste systems.

Learning Outcomes

- **Recognize the value and urgent need for action to include the informal waste economy**, the key issues regarding integrating waste pickers, and to recognize how to make action towards this.
- **Identify partners to help build the capacity** of both the informal waste picker associations through integration with municipal waste management systems
- **Understand the role and examples of participatory planning and budgeting processes** for inclusive waste management systems to maximize marine waste prevention.

5.8 Module 5 Quiz

Question	Options
1. The informal sector is a ___ component of city waste management systems. *(select two)*	A) New B) Established C) Ineffective D) Valuable
2. Which benefits do informal waste pickers provide to cities? *(select all that apply)*	A) Subsidized collection and improved coverage B) Improved transport infrastructure C) Cleaner environments and public spaces D) Livelihoods for vulnerable groups
3. Waste picker livelihoods are under threat from ___ *(select all that apply)*	A) Containerization and restricted waste access B) Exclusive waste solutions *(waste to energy infrastructure)* C) Greater inclusion in planning processes D) Health risks from hazardous materials
4. Creating inclusive informal solutions are often ___ compared to private service providers or heavy infrastructure	A) Less expensive B) About the same cost C) More Expensive D) Free
5. Which waste picker groups are particularly vulnerable?	A) Women B) Young C) Migrants D) All of the above

6. The informal waste sector is a key component of which Sustainable Development Goals? *(Select two)*	A) SDG1 (No Poverty) B) SDG7 (Affordable and clean energy) C) SDG12 (Responsible Consumption and Production) D) SDG16 (Peace, Justice and Strong Institutions)
7. Multiparticipatory planning platforms include which stakeholders: *(select all that apply)*	A) Civil society organizations B) Private sector waste providers C) Local government D) Waste pickers and organizations
8. Waste picker organizations tend to____ *(select two)*	A) Promote democratic representation B) Reduce waste system effectiveness C) Reduce social stigma and barriers to work D) Have no impact on wastepicker livelihoods
9. Informal waste picker activity _____ marine plastic leakage	A) Increases B) Decreases C) Has no effect on D) Eliminates
10. Developing inclusive waste management systems can provide benefits for ___	A) City Government B) Waste Pickers C) Urban Residents D) All of the Above

5.9 Key Resources

Videos

Just Recycling: The Social Economic and Environmental Benefits of Working with Waste Pickers: WIEGO (7:12)
https://www.youtube.com/watch?v=SfHUWA5dTZ4&feature=emb_title

Beaten or Broken? Informality and COVID-19 in South Asia: World Bank (1:18)
https://www.youtube.com/watch?v=MsFEHFD4rhA

WIEGO Reducing Waste in Coastal Cities Case Studies. Taylor Cass Talbott (12:02)
https://www.wiego.org/rwcc

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Quiz Answers

Q1 – B,D, Q2 – A,C,D, Q3 – A,B,D, Q4 – A, Q5 – D, Q6 – A,C, Q7 – A,B,C,D, Q8 – A,C, Q9 – B, Q10 - D

Module 6: Engaging Stakeholders to Reduce Plastic Pollution

6.1 Module Introduction

Welcome to Module 6 - 'Engaging Stakeholders to address Plastic Waste'. This module will provide an introduction to the type of stakeholders you may encounter along the plastic value chain as a foundation for participatory planning and policy making to reduce plastic waste.

Learning Objectives:

- **To identify and understand the key stakeholders** in the plastic value chain.
- **To understand the roles and possible perspectives** of different stakeholders.
- **To increase awareness of a human rights-based approach** to participatory planning.

Developers:

- United Nations Environment Programme (UNEP) and Coordinating Body on the Seas of East Asia (COBSEA)
- This module is based partially on content of the Massive Open Online Course on Marine Litter developed by UNEP and the Open Universiteit of the Netherlands, as a key activity of the Global Partnership on Marine Litter (GPML), with support through the UNEP-COBSEA SEA circular project (www.sea-circular.org) and UNEP CounterMEASURE and CounterMEASURE II projects (https://countermeasure.asia).

Expected Completion Time: 1hr

6.2 Engaging Stakeholders

- Plastic pollution is a complex challenge with a range of **sources**, **drivers**, **pressures** and **responses.** Preventing and reducing waste leakage into the environment requires understanding the **diversity of actors** involved, their role in **causing** and **tackling** plastic pollution, their **motivations** and **interests**, and the multitude of formal and informal rules through which they coordinate **transactions**, **interactions** and **decision-making**.
- Effectively addressing the problem of marine litter requires involvement and action by **public**, **private** and **civil society** actors. This can range from: changing consumer behaviour; adopting new technologies; designing and enforcing policies; incentivizing sustainable production practices and product design; conducting research; improving waste management systems; or recovering

litter from the environment. This requires active involvement of **consumers**, **producers**, **retailers**, **policy makers**, **scientists**, **civil society**, and many others.

- The importance of participation is widely recognized in global development frameworks. This includes the **2030 Agenda for Sustainable Development** which highlights "*a spirit of strengthened global solidarity, focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries, all stakeholders and all people*."
- Similarly the United Nations Environment Assembly (UNEA) has adopted several resolutions[1] on marine litter, plastic pollution and the protection of the marine environment. For example, UNEA resolution 4/6 "*calls upon Member States and other actors at the local, national, regional and international levels, including in the private sector, civil society and academia, to address the problem of marine litter and microplastics, prioritizing a whole life-cycle approach and resource efficiency, building on existing initiatives and instruments, and supported by and grounded in science, international cooperation and multi-stakeholder engagement*."

Characterizing Actors and Approaches

- Plastic pollution can be addressed by many actors and in many ways. A simple model that differentiates between **state**, **market** and **civil society** can help to better understand the position of certain stakeholders and their interrelationships.
- Although state, market and civil society are often considered to be separate entities, it is important to acknowledge that many organizations and governance structures have **overlapping characteristics**. State, market and civil society are strongly related and **exert influence** on each other. Therefore the role and performance of one cannot be understood without taking into account its relation to other stakeholders.
- This simple model can be used to analyse the various **responsibilities** of actors, the **performance** of particular interventions, and to identify **gaps** and **shortcomings** to inform future development.

Stakeholder Analysis

- Completing a thorough **stakeholder analysis process** helps to identify which policies and strategies are likely to be most effective. Each plastic waste context includes a unique diversity of actors with their own **understanding** of the pollution challenge, own **perspective** on the environment, own **opinion** about what should happen, and own **interests** at stake.
- To understand the **role** and **position** of these actors it is important to understand the local **institutional** and **policy frameworks** that govern and influence the actions and interactions of different stakeholders. This defines which organizations are responsible for different aspects of the plastic value chain.

[1] In its fourth session (2019), the UNEA adopted four resolutions of direct relevance to plastics: (1) UNEP/EA.4/Res. 6, Marine plastic litter and microplastics; (2) UNEP/EA.4/Res.7, Environmentally sound management of waste; (3) UNEP/EA.4/Res. 9, Addressing single-use plastic products pollution; (4) UNEP/EA.4/Res. 11, Protection of the marine environment from land-based activities.

- Some key actors to consider include:
    - Consumers and Civil Society
    - Plastic Manufacturers
    - Retail Businesses
    - Local and national authorities
    - Environmental and Social Non-Government Organizations (NGOs)
    - International organizations and donors
    - Academic researchers and universities
    - Local and regional media
    - Disadvantaged groups
- To this end, it can be helpful to identify stakeholders using a **Plastic Value Chain** framework (see Module 2).
- Various approaches and methods have been developed to map and analyse actors or stakeholders. They typically consider stakeholder:
    - Roles, services and responsibilities in relation to plastic waste
    - Motivations and goals
    - Organization structure and capacity to enact change
    - Interrelations and influence between actors and on the overall decision-making process.
- The best-known stakeholder analysis approach draws a **grid** with **two axis** in which actors are positioned in relation to their **(1) influence or power** and **(2) their interest in or their perspective on the action/project**. This allows a simple **prioritization** of the specific stakeholders to inform the level of appropriate involvement.

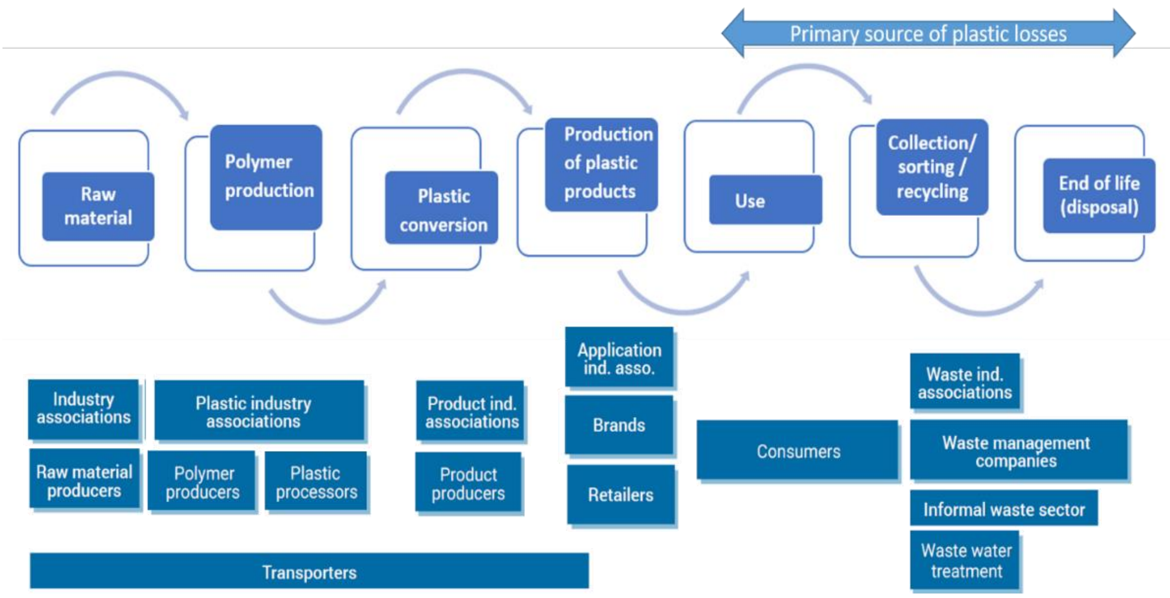

Figure 31. *Overview of key plastic value chain stages and their assocated stakeholders/interest groups. Source: UNEP, 2018.*

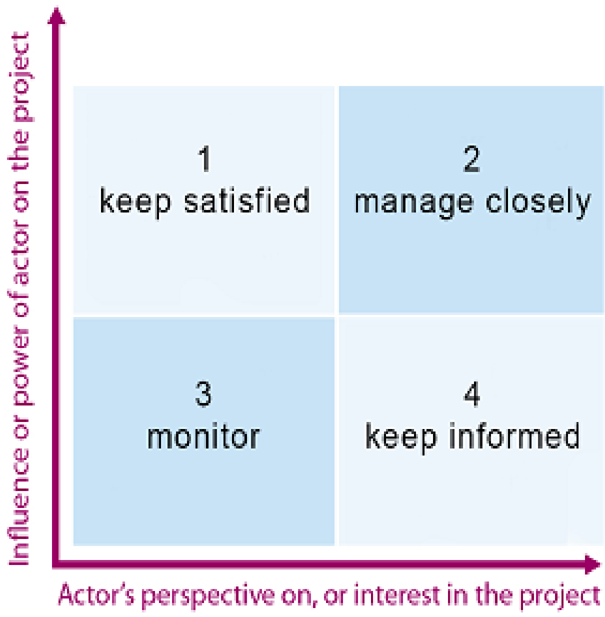

Figure 32. *Typical stakeholder analysis framework. Source: UNEP, 2015*

Major Groups and other Stakeholders in Intergovernmental Processes

Major Groups and other Stakeholders (MGoS) were integral to the development and adoption of the **2030 Agenda for Sustainable Development**. Since its adoption, MGoS have been actively working towards implementation, through projects, initiatives, advocacy, knowledge-sharing, and monitoring. MGoS often work in **partnership** with other sectors, including governments.

Since the first United Nations Conference on Environment and Development in 1992 - known as the Earth Summit, it was recognized that achieving sustainable development would require the active participation of all sectors of society and all types of people. Agenda 21, adopted at the Earth Summit, drew upon this sentiment and formalized **nine sectors of society** as the main channels through which broad participation would be facilitated in UN activities related to sustainable development.

These are officially called "Major Groups" and include the following:

- Women
- Children and Youth
- Indigenous Peoples
- Non-Governmental Organizations
- Local Authorities
- Workers and Trade Unions
- Business and Industry
- Scientific and Technological Community
- Farmers

Over two decades later these major groups are just as important for sustainable and equitable development. MGoS continue to demonstrate a high level of engagement with intergovernmental processes at the UN.

- A **Perception Survey** is a useful tool to collect **comparable data** from a wide spectrum of stakeholders. Surveys present a strong first step to obtaining qualitative and quantitative data and identify which stakeholders may be most open to engagement.
- The perception survey is developed in four stages – (1) drafting of the survey questionnaire and identifying the survey tools and respondents; (2) piloting / testing the survey questionnaire; (3) conducting the survey; and (4) drawing inferences.

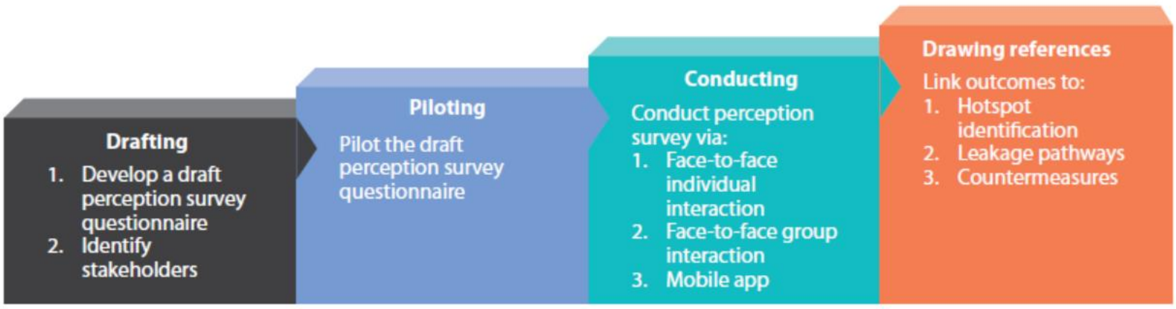

Figure 33. *Perception survey process. Source: UNEP CounterMEASURE, 2019.*

6.3 A Human Rights-based Approach (HRBA)

- A **Human Rights-based Approach** is a conceptual framework for development that is aligned with international human rights standards and operationally directed to promoting and protecting human rights. It seeks to analyse the inequalities which lie at the heart of development problems and redress the discriminatory practices and unjust distributions of power that impede development progress.
- Human rights protect **all people's basic needs** free of discrimination, to ensure no one is treated differently in accessing those needs, irrespective of their gender, wealth, age, or ethnicity. A human rights-based approach is guided by the principles of **equality**, **participation**, and **inclusion** to protect the interests of **right holders** and hold accountable **duty bearers** (governments, businesses, and people of power). By focussing on the needs and capacities of social groups and addressing underlying socio-economic injustices, a rights-based approach enables targeted intervention to meet the needs of vulnerable or marginalized groups.
- The protection of our environment and ecosystems is key to human well-being and the enjoyment of human rights, including the **rights to life**, **health**, **adequate standard of living**, and access to **adequate food** and **safe drinking water**. Conversely, the unsustainable management of natural resources and waste and the resulting decline in services provided by ecosystems threatens the effective enjoyment of all human rights.
- A human rights-based approach recognizes and addresses the **underlying causes** of the **discriminate impacts** of pollution and of environmental degradation on **vulnerable groups.** It places emphasis on initiatives that aim to empower and engage these groups through

participatory processes; and that help to **build the capacity** of governments, plastic producers and other **duty bearers** to act and protect human rights.

- **Environmental rights** entail: the right to a clean and safe environment free from direct and indirect threats to livelihoods, life and health; the right to information and participation in environmental decision-making; and access to justice in environmental matters. These rights are embodied in a range of frameworks and mandates that guide sustainable development and environmental action.
- The following actions are necessary and specific to human rights-based approaches:
  a) Assess and identify the **human rights claims** and **obligations** of all stakeholders. In each case determine the **rights holders** and **duty bearers**.
  b) Analyse the **immediate**, **underlying**, and **structural causes** where human rights are not being realized.
  c) Assess the **capacity** of rights holders to claim their rights, and of duty bearers to fulfil their obligations. Then develop strategies to build these capacities.
  d) **Monitor** and **evaluate** outcomes and processes guided by human rights standards and principles.
  e) Ensure alignment with the recommendations of **international human rights bodies** and mechanisms.
- Other key principles and practices include:
  1. People are recognized as **key actors** in their own development, **rather than passive recipients** of commodities and services.
  2. **Participation** is both a **means** and a **goal**.
  3. Strategies are **empowering**, not disempowering.
  4. Both **outcomes** and **processes** are **monitored** and **evaluated**.
  5. Analysis includes **all stakeholders**.
  6. Programmes focus on **marginalized, disadvantaged**, and **excluded** groups.
  7. The development process is **locally owned**.
  8. Programmes aim to **reduce inequalities**.
  9. Both **top-down** and **bottom-up** approaches are used in synergy.
  10. In-depth **situational analysis** is used to identify causes of development problems.
  11. **Measurable goals** and **targets** are important in programming.
  12. **Strategic partnerships** are developed and sustained.
  13. Programmes support **accountability** of all stakeholders
- In short, taking a human rights-based approach to project or programme planning and implementation ensures a **fair**, **equitable** and **ethically-sound** course of action and also leads to more **effective**, **appropriate**, and **sustainable** outcomes in the longer term.

6.4 Public Sector Engagement

- The **public sector** is critical to engage when addressing plastic waste. The sector is vast, covering actors as diverse as **local and national governments**; **finance institutions**; **intergovernmental institutions**; as well as **public research and development institutions.** All actors have varying mandates and roles at different stages of the plastic value chain. In one way or another, all provide incentives for behaviour change.

Local and National Governments

- Government entities at different levels play an important role in **minimizing plastic waste.** They are **duty bearers** with the authority to make decisions that control and shape the plastic value chain. For example, formulating and implementing **policies**, **frameworks** and **legislations** typically falls under the responsibility of the government as well as **ensuring compliance**. They can set further **standards**, **targets** and decide upon **bans**.
- Common government bodies included in the plastic value chain are: **environmental protection agencies**; various ministries including for **agriculture**, **trade**, **tourism**, **infrastructure**, **energy**, and **coastal protection**; and **national statistics offices**.
- The **importance** and **roles** of public stakeholders varies **between countries** and **among sectors** within a particular country. For instance, implementing waste management usually falls within the mandate of local or municipal governments but may be centrally managed or privately operated.
- Government actions are **highly interlinked** with the actions of other sectors. They set the **institutional framework** and **policies** through which all stakeholders operate and interact. They can provide incentives for applying extended producer responsibility (EPR) in the private sector; create and enforce better labour policies in the civil society sector; and often contribute the main funding and support for plastic waste reduction projects.
- It is important to account for government stakeholders when making interventions at different stages of the plastic value chain. A **strong political will** can be imperative in creating and maintaining **momentum** for tackling plastic pollution.

Finance Institutions

- Finance institutions are important as **sources of funding** and for their role in **shaping plastic markets**. They may or may not be part of national governments.
- Financial institutions ensure **financial flows** between **key institutions/donors** and **recipients** at regional and national level.
- They can also devise and enforce the **institutional context** in which markets are created and function. These institutions can establish **economic incentives** such as deposit refund schemes and plastic bag charges to influence consumer choice and habits. They can **direct investments** and as such ensure funding for waste management infrastructure and wastewater treatment facilities.

Intergovernmental Institutions

- Intergovernmental institutions, including United Nations (UN) entities and multilateral environment agreements, provide important platforms for **transboundary cooperation**, **knowledge exchange** and the negotiation of **regional and international agreements** and **frameworks**.
- As with other public sector stakeholders, these entities can play an important role at **every step of the plastic value chain**, from agreeing international targets, standards and regulations related to plastic production, labelling, trade and disposal; to leveraging funding for collaborative research and pollution reduction projects.

Public Education and Research Institutions

- Education bodies such as **universities** and **public research institutes** can provide reliable and up-to-date information to enable **science-based decision-making**.
- The sector can contribute to the development of **data, tools** and **technologies**, and enable effective and efficient **monitoring** and **tracking** of plastic pollution sources, flows and impacts. Research and development can improve **product design** as well as the **efficiency** of recycling and resource use.

Case Study**: Regional Seas Conventions and Action Plans**

The Regional Seas Programme, is the world's only legal framework for protection of oceans and the seas at regional scale. It aims to address the accelerating degradation of the world's oceans and coastal areas by engaging neighbouring countries in comprehensive and specific action to protect their common marine environment. More than 145 countries have joined 18 Regional Seas Conventions and Action Plans (RSCAPs) for the sustainable management and use of the marine and coastal resources.

A number of the RSCAPs have produced **Regional Action Plans on Marine Litter**. The Coordinating Body on the Seas of East Asia (COBSEA), one of the seven UNEP-administered RSCAPs, revised and adopted the **COBSEA Regional Action Plan** (RAP MALI) in 2019. The overall goal of the RAP MALI is to consolidate, coordinate and facilitate cooperation, and implement necessary policies and strategies to tackle marine litter. The RAP MALI guides regionally coherent action to reduce and prevent land- and sea-based sources of marine litter, developing science-based monitoring and assessment programmes and improving regional cooperation, knowledge sharing and awareness raising to enable progress.

Other relevant subregional frameworks guiding action toward reducing marine litter include the ASEAN Framework of Action on Marine Debris and the APEC Roadmap on Marine Debris agreed in 2019. Developing targeted regional policy frameworks, such as these, bring together participating countries to agree on and work towards regionally coherent goals on both regional and national level.

For more information about the Regional Seas Programme: https://www.unep.org/explore-topics/oceans-seas/what-we-do/working-regional-seas

- It is important to develop platforms and mechanisms that make research findings **accessible** to decision makers to enhance the science-policy interface. It is worth noting that education and research bodies may be public or private institutions in different country settings.

6.5 Private Sector Engagement

- The **private sector** is the sole **producer** of plastics for two main types of application – as **plastic products** and as **plastic packaging** for other products. The majority of the plastic value chain is attributed to private-sector activities.
- As concern over marine litter and plastic pollution has grown in recent years, the role of the private sector, which produces plastic but does not contribute to the much-needed waste management, has come under increasing scrutiny. These businesses are the key suppliers at the **top of the plastic value chain** and therefore changes in these practices will have implications for consumers, waste management workers, businesses, and public sector actors further down the chain.

Goals for Engaging the Private Sector

1. Circularity

- The **Circular Economy** presents an **alternative** to the dominant **extract-use-dispose linear economic model**. In contrast, a Circular Economy considers waste as a v**aluable resource.** It focuses on **minimizing consumption** and **maximising the productive life** and **value** of existing products. This reduces pressure on finite natural resources and the environment.
- There are a highly diverse range of actions that businesses can take to move toward circularity. Some may pose **fundamental changes** to how businesses operate while others may be smaller **operational** or **product design** changes. Improving the value of plastic products and reducing the amount of waste in the long term is a clear and cost-effective target for businesses.

2. Plastic Neutrality

- **Plastic neutrality**, akin to carbon neutrality, is the state of consuming as much plastic as is being collected. Ways of achieving plastic neutrality include shifting production to using **100% recycled material**, and **offsetting** by means of supporting waste collection services, local communities, and the informal sector for recovery of plastics for recycling, waste-to-energy or proper disposal. As circularity is deeply rooted in the concept of plastic neutrality, private sector stakeholders often

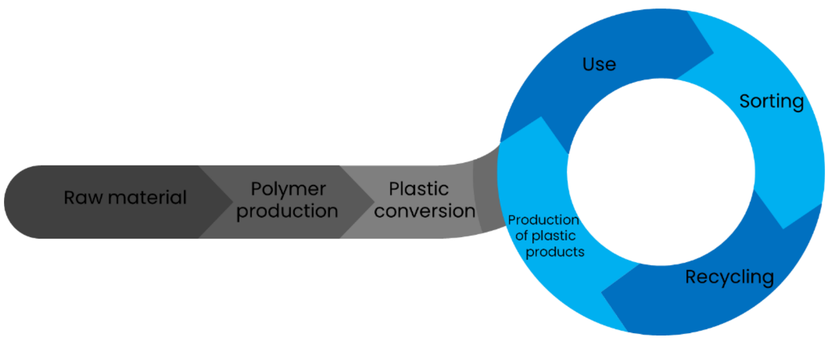

Figure 34. From a linear to a circular plastic economy.

see achieving, to any extent, **increased circularity** as the **first milestone**, while **plastic neutrality** is considered as the **ultimate goal**.

Approaches for Engagement

Alliances

- **Cross-sectoral alliances** involving civil society, academia and the private sector have been a popular modality of engagement with private sector stakeholders. Alliances are usually oriented by **business sector** or by **commodity**. In the case of plastics, there have been a plethora of cross-sectoral international, regional and national alliances that are driven by civil society and private sector alike. Examples include the **Alliance to End Plastic Waste (AEPW)** which brings together over 50 private companies and aims to invest over $1.5bn over 5 years in sustainable plastic solutions.
- Advantages of alliances include the **sharing of best practices** that are highly applicable for other members and the **positive benchmarking** and **peer influence** that members exert on each other.

Case study: **Phuket Hotels Association, Thailand**

The **tourism industry** is a major contributor to plastic waste in Thailand and welcomes over **39 million tourists** per year. This demand has led to the development of over **10,000 hotels** across the country. All of these are reliant of the consumption of a wide variety of **convenience plastic items** such as cups, straws, shampoo bottles, amenity kits and many forms of packaged food and drink.

Launched in 2017 the **Phuket Hotels Association** is a **tourism-sector oriented alliance** of 17 local hotels and businesses. This aimed to not only **reduce the impact** on the environment but also to **strengthen the Phuket brand** as a green tourism destination and **improve capacity and awareness** among the local community for cleaner beaches in the long term.

Activities included: (1) Partnerships with **academic institutions** and experts to develop a **plastic waste management strategy**. (2) The sharing of **best practices** and publication of knowledge products - '**Great Big Green – Hotel Guide**' (3) **Training** and **awareness raising** with local schools and tourists, and (4) the launch of several **international events** to discuss **sustainable tourism** and **development**.

Challenges in the development of this private sector partnership included issues around plastic baseline **confidentiality**, the **availability** of **cost-effective alternative materials**, early **political buy-in**, and **capacity** and **communications** for how best to implement sustainable practises.

Overall the association has been very successful. A 51% reduction in single-use plastic bottle consumption was recorded in the first half of 2019 and one hotel was able to reduce around 660,000 bottles by **switching to glass**, saving approximately **$16,600 per year**. With support from USAID the Phuket Hotels Association also provided **education opportunities** for around 20,000 hotel staff.

Two-way Dialogues

- Through engaging private sector on a one-on-one basis, **two-way dialogues** are more **direct** than alliances. Advantages of two-way dialogues include 1) **confidentiality** of proprietary information regarding progress and issues pertinent to reforming the plastic value chain and 2) greater opportunities for **close and long-term collaboration** between organizations for action on plastic waste reduction.

Case study: **Net-Works, A Multistakeholder Partnership from the Philippines**

Net-Works is an inclusive business model that collects discarded fishing nets through coastal communities and recycles them into carpet tile. This programme was made possible through close partnerships and collaboration between **Interface**, one of the world's largest manufacturers of commercial carpet tile; the **Zoological Society of London** (ZSL), international **conservation charities**, and **Aquafil**, a yarn producer and supplier. Net-Works enables **fishing communities** in developing countries to **sell waste nets** back into a **global supply chain**. Interface receives a **fully recycled source of nylon** for carpet tile production, and the local community receives **long-term incentives** to **protect** their **natural environment**.

So far, the programme has been established in 14 rural coastal areas in the central Philippines, including Danajon Bank and the nearby Bantayan Islands. Each of those areas has its own **community bank**. Net-Works is expanding and has recently started collecting in Northern Iloilo, also in the central Philippines. In addition, since 2015, Net-Works is in the process of replicating its model in other countries. To date, Net-Works has collected **66,860 kgs** of discarded fishing nets across 14 collection sites in the Philippines.

Resources:

Summary Brief: MOOC Case Studies: Net-works

Video: https://www.youtube.com/watch?v=DX6Uidpg3VM

6.6 Civil Society Engagement

- Civil society is the 'third sector' of society, along with government and business. It comprises **civil society organizations** (CSOs), **non-governmental organizations** (NGOs), as well as **social movement organizations**.
- A CSO is a **group of people** that operate in the **community** in a way distinct from both government and private sector. CSOs include **not-for-profit organizations**, **networks**, and **associations** and provide valuable **research**, **expertise** and **advocacy** functions to meet shared needs. CSOs can be involved during all stages of the plastic waste chain depending on their reach and expertise.
- **NGOs** and **not-for-profit organizations** are important partners to ensure **policy compliance**, **lobby stakeholders**, and **raise awareness** of issues or misconduct. NGOs can operate at local, national, or international levels.

The Role of Civil Society in Identifying Pollution and Solutions

- Drivers and responses to plastic pollution are **context** and **location-specific**. CSOs and NGOs often originate in or have close ties with local communities and can collect on-the-ground information about how plastics are used and disposed. Leveraging **local understanding** and **capacities** can **improve implementation** and **ownership** for plastic management interventions.
- Civil society groups, including grassroots and youth movements, are vital to **inform** the prevailing **contextual issues** with localities, to **build awareness**, **mobilize actors**, and **educate communities** that may otherwise be overlooked by large-scale centralized programmes.
- CSOs can also **identify hotspots** where plastic leakage occurs or identify when public or private sector efforts may be falling short of protecting communities. This type of **environmental advocacy** and increased accountability can be essential in driving policy change.
- Overall CSOs are considered important **implementing partners** for pollution reduction projects. They are key to providing technical assistance and expertise on the ground and to represent the needs and interests of different groups of society.

Consumers and Citizens

- **Consumers** and the **public** are the largest drivers of **plastic demand** and **waste production**, including inappropriate waste disposal.
- It is crucial to **inform consumers** to support environmentally-sound choices on what products to purchase and how to dispose of them correctly. This includes **traditional education** in public institutions, as well as **public awareness raising campaigns** aimed at behaviour change. Advertisements and social media campaigns have been used to promote consumers switching to reusables or giving up single-use items using slogans such as *'say no to plastic bags'* or *'say no to straws'*. These campaigns often use **shocking imagery** of the impacts of plastic on wildlife and ecosystems.

Figure 35. *'Don't suck the life from our oceans' public awareness campaign imagery. Source: Greenpeace Canada, 2018.*

- Members of the public are becoming increasingly engaged with plastic pollution issues. In badly affected coastal areas **volunteer beach cleanups** and **citizen science** are a common way to enact local change.
- However, for these short-term measures to be effective a **permanent** shift in **consumer demand** toward sustainable products is needed.

Case study: **Bye Bye Plastic Bags, a Civil Society Organization in Bali, Indonesia**

In Bali 2013, Isabel and Melati Wjisen, two school students in Grades 6 and 7, were disgusted with the amount of plastic waste on beaches around the island. They decided to act and started the biggest **youth action** campaign Bali had ever seen, including a petition to ban the use, sale and production of plastic bags in Bali.

Their organization, **Bye Bye Plastic Bags** (BBPB), **raises awareness** and **educates** about the harmful impact of plastic on our environment, animals and health. This includes outreach to to over 20,000 youth and the development of plastic educational booklets aimed for elementary schools in Indonesia.

BBPB has become a **national** and **international** movement, active in over 25 locations and advocating for change locally and at international events, including the UN Ocean Conference and the World Economic Forum.

Youth stakeholders are increasingly involved with **environmental justice** and **climate** issues. They can be key drivers of change and highly receptive to take action on plastic pollution and help protect ecosystems.

Resources

Website: http://www.byebyeplasticbags.org/bbpbprojects/

Videos: https://www.youtube.com/watch?v=P8GCjrDWWUM

Science and Research Community

- As with public universities and institutions, scientists, think tanks and research institutes play an important **knowledge management** and **networking** role through the value chain.
- They can provide valuable inputs on everything from **product design** and **emerging technologies** to **data collection** on the sources, flows and impacts of plastic pollution.
- They are important partners to identify appropriate and effective measures, and to **verify** and **monitor** results.

Empowering Disadvantaged Groups

- The impacts of plastic pollution and related threats to health, wellbeing and livelihoods are felt most acutely by **disadvantaged groups**. It is important to understand the given context within a country or community and to identify groups who may be socially disadvantaged or disproportionately affected, such as **youth**, the **elderly**, **women**, **ethnic minorities**, **LGBTQ+** persons, persons with **disabilities**, **remote communities** and the **urban poor**.

- In Asia, waste management relies heavily on the unrecognized contributions of **informal waste workers** (see Module 5). Many of these are women and children who are exposed to high levels of pollution and hazardous materials with little access to protective gear, health care or social protections.
- **Inclusive pathways** to improving waste segregation, collection and recycling will need to engage informal waste workers and their representatives, to ensure their needs, rights, and interests are addressed.
- Another group that may be disproportionately impacted by plastic pollution and with little access to safe and effective waste management solutions, includes **coastal communities** and particularly **small-scale or artisanal fishing communities**. These stakeholders can play an important role in recovering and recycling plastic pollution such as fishing gear. Engaging with these groups on plastic waste management can create increased income opportunities and awareness for pollution prevention.
- Addressing plastic in an effective and equitable manner requires **recognizing** the **social** and **economic impacts** of plastic pollution; **identifying vulnerable groups**, their rights, needs and interests; and then **empowering these groups** to participate in decision making. This includes establishing **formal processes** for **consultation** and **open dialogue**, as well as ensuring that resources are accessible to all social groups.

Civil Society in Data Collection and Verification: South and South-East Asia

- **Citizens** especially **youth** in collaboration with **NGOs, academic institutions** and **local authorities** are very effective in collecting important **primary data** through cleanups and waste audits.
- In 2019 **local NGOs** and **universities** collected and sorted over **3,400kg** of waste in **21 cleanups** in the Ganga basin, the Yamuna basin, and in Mumbai in India, as well as in the lower Mekong. Post-

Multistakeholder plastic waste cleanup and data collection. Agra, India Source: UNEP, 2019.

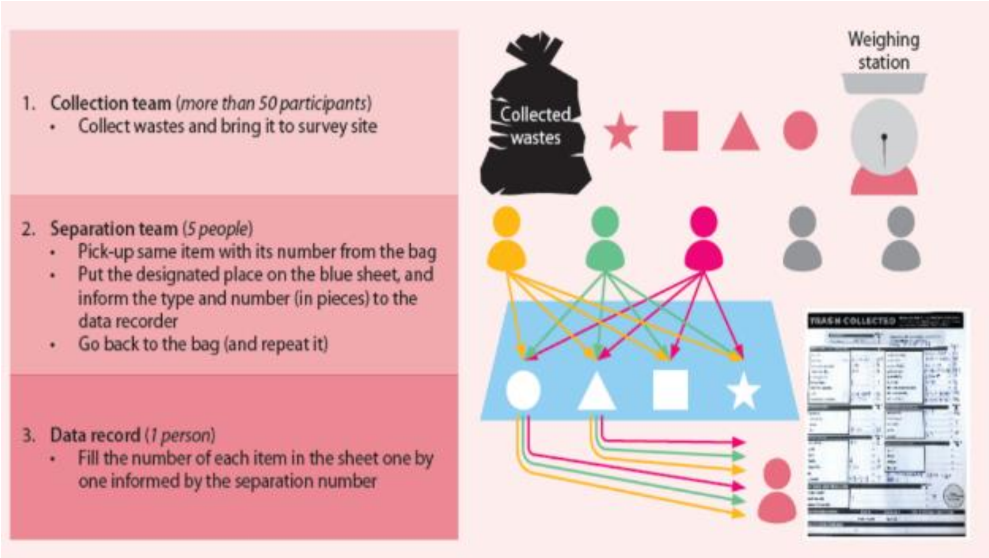

Figure 36. *Cleanup and waste audit process in Ubon Rachathani, Thailand. Source: UNEP, 2019.*

cleanup waste audits found mainly plastic bags and beverage bottles, but also less common items such as disposable cutlery, multilayer food packaging, sachets, fishing gear, and products associated with worship and festivals (e.g. textiles, flowerpots).

- **Students** in Chiang Rai and Ubon Ratchathani in Thailand, carried out cleanups and waste audits in coordination with **local universities** (Mae Fah Luang University and Ubon Ratchathani University), **NGOs** (Trash Hero), and **local authorities** in Thailand. These cleanups were linked to international initiatives such as **World Cleanup Day 2020** led by Ocean Conservancy and, in case of Ubon Ratchathani, with international support under **city-to-city cooperation** between and the Ubon Ratchathani provincial government and the city of Kitakyushu in Japan.
- While plastic bottles and bags are among the most commonly found plastic waste items, waste **composition** varies dependent on **local markets** and **contexts**. For example at collection sites along the Ganges plastic sachets for chewing tobacco and pan masala were highly prevalent. In contrast, in Chiang Rai in Thailand, plastic flowerpots contributed a relatively large portion of the river waste (due to local flower festivals).
- When planned correctly, cleanups with civil society stakeholders can deliver a triple benefit: (1) the **cleaning** of a targeted area, (2) increase **public awareness** on the hazards surrounding plastic waste, and (3) generation of **site-specific plastic waste data** which can be used to identify possible **solutions**.
- Civil society groups can help to build **geospatial databases** of **illegal dumping sites** and **plastic hotspots**. Using a **mobile phone application**, such as the one developed under the CounterMEASURE project, groups and individuals **collected** and **uploaded geo-tagged images** of the problem sites to a centralized GIS platform. (https://survey123.arcgis.com/share/4a5d8ece8e5047969e061c974d372b27)
- Civil society can also **verify** the **effectiveness** of interventions. For example, a cleanup by UNEP of a dense mangrove site at Sagar Vihar in Mumbai, 2019, verified the effectiveness of the state-wide

ban on the use of Styrofoam containers. This cleanup initiative found nearly no Styrofoam or disposable cutlery among the collected waste and was able to compare to previous data.

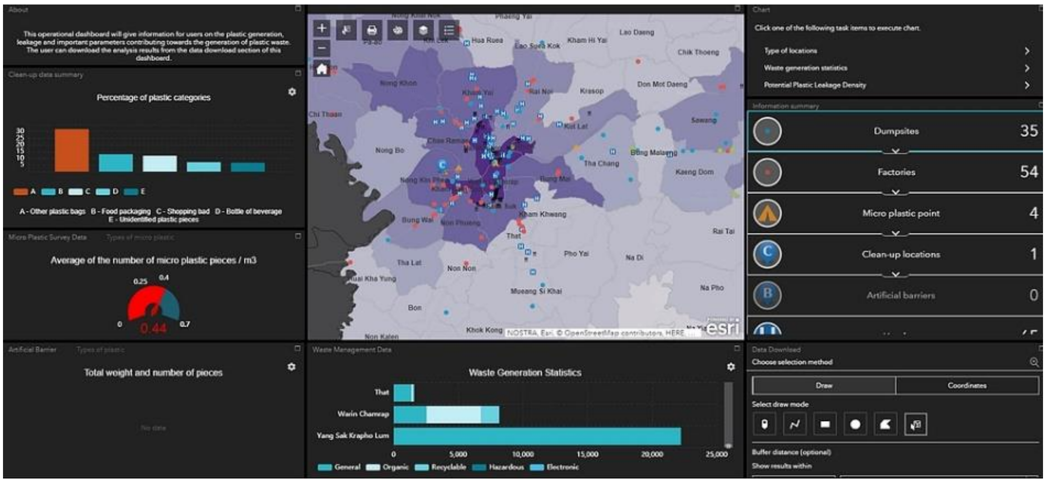

Figure 37. *CounterMEASURE GIS visualization platform for plastic waste. Source: UNEP, 2020.* *https://platform.countermeasure.asia/*

Plastic Leakage in Haridwar, India

- At SIDCUL, a **government enterprise** in the industrial area near Haridwar city, India, **plastic cans** are manufactured from virgin HDPE and PET polymers. These are sold to visitors who use these cans to collect and carry the **holy river water** *(Gangajal)* from the Ganges to their homes. These cans are sold at a cost of around 20 cents ($USD) at the bathing *ghats* (riverbank locations developed to provide visitors with safe access to the water). When used these plastic cans are considered as sacred as their contents and so visitors often choose to dispose of the cans by immersing them directly into the river. During the non-festive season there are about **7,000 daily visitors** to the river. However, during the city's **festivals** such as during the Kanwar Mela pilgrimage and Kumbh Mela pilgrimage this number can increase to **millions** placing extreme pressure on **local services** and the **environment**.
- A **perception survey was** conducted in Haridwar to understand the plastic pollution problem, featuring **focus group discussions** with stakeholders, including the Shri Ganga Sabha **religious organization**. This 100-year-old working committee comprising 49 workers oversees the religious, sanitary, infrastructure maintenance and other activities of the most visited *ghat* at the Ganges river in Haridwar.
- Perception survey results:
  - *Leakage Hotspots:* Ghats are major sources of plastic pollution.
  - *Plastic Application Hotspots:* HDPE and PET cans are main sources of river plastic pollution. Almost all plastic waste collected at the sites were containers used for water collection.
  - *Plastic Accumulation Hotspots:* The volume of waste suggests that there could also be accumulation hotspots downstream. Waste can collect at major barriers like barrages on the main stem of the river or river water diversion structures on downstream river banks.

- *Leakage pathways:* As HDPE and PET cans are transported along riverways, leakage pathways can be identified from the point of purchase to the point of disposal. The flow of the river at the ghat determines the leakage rate.
- *Countermeasures:* Simple measures to prevent leakage could include (i) providing dustbins in the vicinity of ghats and (ii) extensive awareness campaigns to change consumer behaviour toward proper disposal of cans.

Figure 38. *Use of plastic containers to collect Ganges river water at a ghat in Haridwar, India. Source: UNEP, 2019.*

Multistakeholder plastic waste cleanup and data collection in Chiang Rai, Thailand Source: UNEP, 2020.

6.7 Module Summary

Key Takeaways

- Building **relationships** and gaining **commitments** to tackle plastic waste from stakeholders in **every sector** is paramount to efforts to reduce plastic pollution. Each sector has a key role to play in the plastic value chain and can contribute to the protection of marine and coastal **environments** and **livelihoods**.
- There are three main stakeholder groups: **public sector** (*governments, public finance institutions, intergovernmental institutions, public education and research institutions*), **private sector** (*plastic producers, retailers, brands, associations and other businesses*), and civil society (*communities and disadvantaged groups, NGOs, nonprofits, private research organizations, consumers*).
- **Analysis of stakeholder interests and needs** and creating inclusive mechanisms for engagement, with particular emphasis on the **rights of disadvantaged and vulnerable groups**, are key to both **effective** and **equitable action** on plastic pollution.
- The **responsibility** to solve the problem of plastic pollution is never on a single sector, it requires **action from all**. It is also important to note that each stakeholder involved in creating, regulating and managing plastic waste makes decisions that impact others. These impacts propagate across different scales and geographies and both up and down the plastic value chain.
- Solutions that are **most effective** in reducing plastic waste, tracking plastic pollution and creating cultures that are resilient towards plastic pollution are often ones that involve **citizens** and **multiple stakeholder groups**.

Learning Outcomes:

- **Be able to identify relevant stakeholders** at different stages of the plastic value chain to inform stakeholder engagement.
- **Understand the importance of engaging different stakeholders** for inclusive plastic waste action.

6.8 Module 6 Quiz

Question	Options
1. Stakeholder engagement can increase effectiveness and inclusiveness of an intervention.	A) True B) False
2. Plastic pollution and the resulting decline in ecosystem services are a threat to which human rights?	A) Right to life B) Right to health C) Access to adequate food and safe drinking water D) All of the above
3. Businesses are the most important stakeholders to reduce plastic pollution.	A) True B)False
4. Improving plastic circularity is often seen as the first minlestone towards __	A) Plastic Neutrality B) Human Rights C) Increased production D) Increased profits
5. Which of these is not a designated Major Stakeholder Group by the United Nations	A) Women B) Political lobbying groups C) Business and Industry D) Children and Youth
6. Which of these is a civil society stakeholder?	A) Plastic bottle manufacturer B) Ministry of Planning C) Hotel Business Group D) Conservation NGO
7. Which of these is a private sector stakeholder?	A) Ministry of Environment B) Plastic recycling business C) United Nations commission D) Workers rights NGO
8. Which of these is a public sector stakeholder?	A) Local Restaurant B) Environmental Protection NGO C) City Government D) Plastic Manufacturer

9. The negative impacts of plastic pollution are ___ distributed among stakeholders	A) Evenly B) Unevenly
10. Why is completing stakeholder analysis and engagement important? *(select all that apply)*	A) It gives relevant groups the opportunity to present their perspectives and ideas on plastic pollution. B) It means affected groups with little traditional power are not overlooked C) Plastic solutions resulting from a participatory process tend to be more effective in the long term. D) It allows the prioritization and classification of stakeholders for engagement and project outreach.

6.9 Key Resources

Videos

Ted (2016). Our campaign to ban plastic bags in Bali *(11:00)* https://www.youtube.com/watch?v=P8GCjrDWWUM

Interface (2014). Net-Works: turning waste nets into carpets *(4:23)* https://www.youtube.com/watch?v=DX6Uidpg3VM

UNEP, (2018). The Work of the Regional Seas *(6:07)* https://www.youtube.com/watch?v=m6msrSbws-w

References & Further Reading

Coordinating Body on the Seas of East Asia (COBSEA) Website: https://www.unenvironment.org/cobsea

UNEP Regional Seas Programme Website: https://www.unep.org/explore-topics/oceans-seas/what-we-do/working-regional-seas

SEA Circular Website: https://www.sea-circular.org/

CounterMEASURE Project Website: https://countermeasure.asia/

COBSEA (2020) Issue brief: A human rights based approach to preventing plastic pollution https://www.sea-circular.org/wp-content/uploads/2020/03/UNEP-COBSEA-SEA-circular_Issue-Brief-01_A-human-rights-based-approach-to-preventing-plastic-pollution.pdf

MARLISCO (2015). How to communicate with stakeholders about marine litter - Reflections from the MARLISCO project. https://www.marlisco.eu/tl_files/marlisco/Downloadables/WP%202/Annex1_Final_Guide.pdf

Nielson et al., (2019). Plastics and Sustainable Investments - An information brief for investors https://www.mistra.org/wp-content/uploads/2017/10/plastics-and-sustainable-investments_download.pdf

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United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), (2018). Partnering for Sustainable Development: Guidelines for Multi-stakeholder Partnerships to Implement the 2030 Agenda in Asia and the Pacific https://www.unescap.org/sites/default/files/MSP%20Guidelines.pdf

United Nations Environment Programme, (2015). Methods and approaches for actor or stakeholder analysis. https://moocs.ou.nl/assets/courseware/v1/a859a84d0c48873c2ef6f8d8dd987bd3/asset-v1:OUNL+MLMOOCEN+2020+type@asset+block/MOOC_MarineLitter_Reading_document_2.2.3.pdf

United Nations Environment Programme, (2018). The State of Plastics – World Environment Day Outlook https://wedocs.unep.org/bitstream/handle/20.500.11822/25513/state_plastics_WED.pdf?sequence=1&isAllowed=y

United Nations Environment Programme, (2018). Mapping of global plastics value chain and plastics losses to the environment (with a particular focus on marine environment). https://wedocs.unep.org/handle/20.500.11822/26745

United Nations Environment Programme, (2019). CounterMEASURE Project: Promotion of countermeasures against marine plastic litter in Southeast Asia and India. https://countermeasure.asia

United Nations Environment Programme, (2020). Marine litter Massive Open Online Course (MOOC) https://moocs.ou.nl/courses/course-v1:OUNL+MLMOOCEN+2020/course/

Quiz Answers

Q1 – A, Q2 – D, Q3 – B, Q4 – A , Q5 – B, Q6 – D, Q7 – B, Q8 – C, Q9 – B, Q10 – A,B,C,D

Module 7: Local Action Planning to Address Marine Plastic Waste

7.1 Module Introduction

Welcome to the final module in this course – 'Local Action Planning to Address Marine Plastic Waste. This module will bring together the different dimensions of plastic waste management and turn these into practical action plans. It draws upon all of the key learning outcomes of the course and outlines the key stages for developing policies and interventions to tackle plastic pollution. These principles have been developed with city-scale planning in mind but the process of resource mobilization, action plan development, and implementation and monitoring can be applied at all scales. This is the final module and is followed by an end-of-course quiz which must be passed (>80%) to receive the certificate of completion.

Learning Objectives

- Be able to analyse a plastic waste leakage situation in a city, including a municipality's physical & technical capacity, waste operations, financing and governance.
- Recognize the importance of action planning to tackle plastic waste in cities for short, medium and long-term success, and be able to use participatory and systems-based approaches to identify possible solutions.
- Understand the prioritization process for assessing which technical and governance solutions will have the biggest impact and be able to apply best practices for implementation.
- Be able to develop a Local Action Plan proposal for a city that incorporates scientific evidence and relevant global, national and local frameworks and targets related to plastic waste management.

Developers:

- Institute for Global Environmental Strategies
- Ocean Conservancy

Expected Completion Time: 1 hr

7.2 Plastic Pollution Recap

- The volume of plastic waste entering the environment and its impact on **ecosystems**, **human health** and **socioeconomic systems** have significantly increased in recent years. An estimated **11 million tons** of plastic waste enter the ocean every year of which **80%** comes from **land-based sources**.

- South-East Asia is a primary **source** and **recipient** of plastic waste pollution. More than half of land-based plastic pollution enters the oceans from just five countries and four of which are in South-East Asia (Indonesia, Thailand, Philippines and Vietnam) *(Jambeck et al., 2015)*. In addition to the environmental impact, plastic pollution costs about **1.3 billion USD** annually to the **tourism, fishing** and **shipping** industries in the region.
- The **Association of Southeast Asian Nations** (ASEAN) and its member states have already committed to tackling plastic pollution. Following that, some national governments have developed plans and timelines to reduce their plastic waste.

The Need for Local Actions to Address Plastic Pollution

- **Cities** are playing a vital role in responding to global plastic pollution. **Local governments** are typically responsible for managing municipal solid waste (MSW), including plastic waste. Plastic pollution negatively affects many city functions including **waste generation** and **collection**, **recycling**, **storm drain maintenance**, **tourism promotion**, **community health**, **protecting the local environment**, and **public funds**.
- Many cities find it difficult to address plastic pollution due to: a) the **complexity** of the plastics value chain and interactions both upstream and downstream, b) **different uses** and forms of plastics, c) complex **multi-stakeholder** collaboration, and d) the need to **integrate local knowledge** and activities (Boucher, et al., 2020).
- Plastic pollution is a complex and cross-cutting issue that has **no single ready-made solution**. Finding actions appropriate to local context requires an adequate understanding of the **plastics value chain**, **origins** of plastic waste, **leakage** and **hotspots**, as well as **knowledge** on the possible interventions that can bring these impacts most effectively under control using the limited resources available.
- Local governments need to **develop plastic mitigation strategies**, integrate these interventions into **ongoing waste management** and **city development**, and create the **multistakeholder partnerships** necessary for effective implementation.
- The development of a **Local Action Plan** for plastic waste management provides local governments and their partners with **strategic direction**, **new ideas, tools**, and a **community of**

Regional

- ASEAN Framework of Action on Marine Debris, 2017
- G20 Osaka Blue Vision, 2019
- Bangkok Declaration on Combating Marine Debris in ASEAN Region, 2019
- Bangkok 3R Declaration Towards Prevention of Plastic Waste Pollution through 3R and Circular Economy, 2019
- COBSEA Regional Action Plan on Marine Litter, 2019

National

- ***Vietnam:*** National Action Plan for Management of Marine Litter, 2030
- ***Indonesia:*** Plan of Action on Marine Plastic Debris, 2017-2025
- ***Malaysia:*** Roadmap Towards Zero Single Use Plastics, 2018-2030
- ***Thailand:*** Roadmap on Plastic Waste Management, 2018-2030
- ***Philippines:*** National Strategy on Marine Litter, 2019 *(draft)*

Figure 39: *Selected regional and national actions to address plastic pollution in South-East Asia*

practice to address plastic pollution while meeting other long-term goals such as socio-economic development and environmental protection.

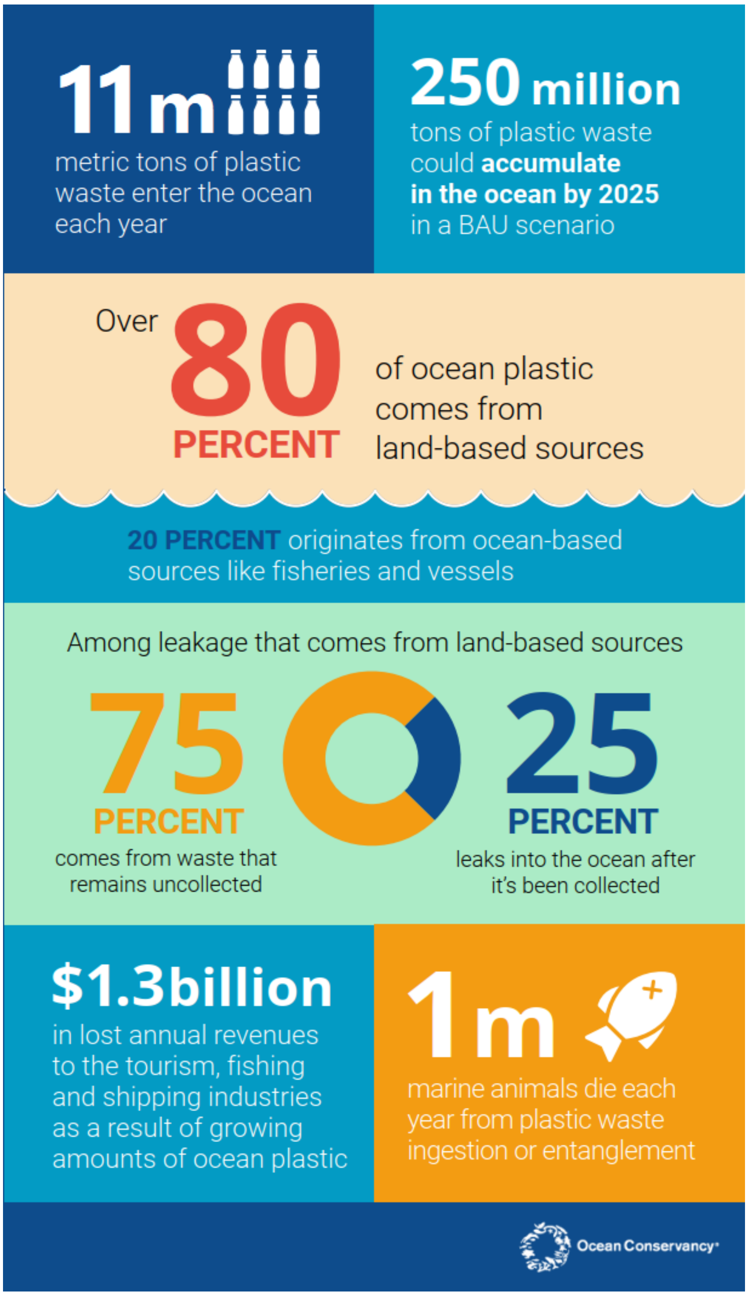

Figure 40. *Marine plastics summary. Source: Ocean Conservancy, 2020*

Guiding Principles

- As identified by the Plastics Policy Playbook (Ocean Conservancy, 2019), local action plans need to adopt some guiding principles as a pre-request for the successful planning of actions. These Guiding Principles intend to be applied flexibly based on local context and judgment.
    - **Combine measures across the value chain:** Real value lies in combining actions along the value chain, by both the public and private sectors in new and innovative ways.

- **Engage and invest in the informal sector:** Measures must support the human rights and livelihoods of those on the front line of collection efforts. Dignified employment with improved working conditions and leveraging the expertise of independent waste collectors can drive improvements in collection quantity and efficiency
  - **Drive consumer awareness and behaviour change:** Consumer buy-in is a critical enabler of a successful plastic waste management framework, and focus countries need targeted awareness campaigns to engage audiences and spark behavioural change
  - **Inspire political will:** Leaders at the national and local levels should be motivated and empowered to support solutions to reduce ocean plastic waste.
  - **Improve enforcement at a national and local level:** Strong national policies require having a clear direction and the rule of law. Those policies, however, have to be enforced at the local level, which requires the improved capacity for action.
- In general, the action planning process includes three main stages: (1) **mobilization**, (2) development of an **action plan** and (3) **implementation** and **monitoring**.

7.3 Action Planning Process Stage 1: Mobilization

Securing Political Commitment and Support

- Securing **political commitment** is vital for the long-term sustainability of a project. This often starts with the identification of a '*plastics champion*'. This is an individual or small group of individuals with influence who will provide political **support** and **elevate** the project among the appropriate stakeholders. This is important from the early stages of development, especially when obtaining necessary approvals/permits, through to implementation. Acting on marine plastic provides clear **political benefits** as plastic pollution remains high in the public and media awareness.
- The exact process of action plan development will vary dependent on the **local political and administrative structures**. In some municipal governments it will be necessary to get a political endorsement on the Action Plan and/or to integrate with existing local policies and priorities. In general, aiming to **build upon existing local policy** or **planning frameworks** presents the best option to support smooth **implementation** and **institutionalization** of marine plastic actions.
- It is also necessary to identify a **lead agency** in charge of coordinating the action planning process. The identification of this agency should be the responsibility of the respective city, but is most likely to be either the department responsible for **Municipal Solid Waste Management** or the **City Planning Agency**. In practice, mobilizing the support of multiple city agencies is often required to help pave the way for innovative and constructive implementing partnerships.
- Plastic pollution is a relatively new challenge for many cities. It requires **sensitizing** and **building the capacity** of the elected and appointed city officials who are selected to champion, prepare, implement, and monitor the local action plans.

- Engaging **local specialists** or **partner agencies** to facilitate the action planning process and develop specific inputs to build capacity and knowledge can also be helpful.
- Joining wider **regional, national**, and **international networks of cities** that promote actions to tackle plastic pollution can help in learning. These promote **peer-to-peer knowledge** and **data sharing**, and provide access to new **tools**, **resources** and **expertise**. Being a network member offers regional solidarity, encourages more ambitious actions, and confers recognition of local achievements.
- Ensuring a firm foundation of **commitment** and **adequate resources** (both human and financial) at the start of the planning process is key to success.

Case Study: **The Urban Ocean Program**

The Urban Ocean Program, led by the Ocean Conservancy, the Resilient Cities Network, The Circulate Initiative and the Trash Free Seas Alliance, is a multistakeholder initiative that works with cities to develop, share and scale solutions to the ocean plastic problem. This initiative, bringing on board their first cohort of 10 cities in June 2020, will bring new actors to the table including, global companies looking to reduce marine waste across their supply chains, waste management and city sustainability experts, financial partners who can support, invest and scale innovate solutions, and educators seeking to reduce waste and improve consumer involvement.

The Urban Ocean Program addresses three priorities: (1) building public-private partnerships between cities, businesses and financing organizations; (2) Encouraging waste reduction and consumer recycling through education; and (3) sharing best practices and developing model policies through peer networking and exchanges.

The programme is unique in its knowledge sharing approach, matching *learning cities*, those committed to improve their waste management and high impact potential, and *mentor cities*, those cities and municipalities leading the way in implementing circular economy approaches.

For more information: https://oceanconservancy.org/trash-free-seas/plastics-in-the-ocean/urban-ocean/

Pre-identification of City Visions and Priorities

- Building an effective relationship with political leaders and senior decision makers requires a **common understanding** of the current plastic waste situation and the need to make changes. These topics can often be **politically sensitive** and so **clear communication** between stakeholders is very important at this stage. Clear and concise messaging around the **economic, environmental** and **public health benefits** of acting to prevent plastic pollution is often a better framing of the problem than focussing exclusively on the impacts and/or the poor management of existing systems.
- Highlighting **synergies** between a city's **existing development vision** and local plans, and **plastic action** can help formulate these communications (especially for policies regarding waste management, urban development, public health, biodiversity, poverty reduction, and local economic development).
- In many cities, promoting these **co-benefits** may be central to **maintaining political support**. The priority needs from the city can be understood through early meetings with local leadership, senior staff and stakeholder organizations.

Case Study: **Early City Engagement Meeting Checklist**

1. What common challenges are faced?
2. What is the overall goal or aim of preparing a plastic action plan?
3. What benefits are expected from the action plan?
4. How will the development of the action plan be funded?
5. What are the available capacities?
6. What is the timeline?
7. How does this action plan relate to the city vision and other relevant plans and policies?
   (Source: UNEP, 2013)

Stakeholder Engagement

- While plastic waste management involves a wide range of stakeholders, a successful Action Plan relies on harnessing the energy and capacities of all citizens and organizations towards a common purpose. Therefore, two questions need to be asked in the beginning of making an action plan:
  - Who should be engaged?
  - How can they best provide their inputs?
- **Stakeholder analysis** can be a useful method of identifying key stakeholders and understanding their **relative influence** and **involvement** in making the action plan (Module 5 and 6). Broad **consensus** and full **ownership** of the action plan is important to ensure its implementation. Thus, the Action Plan should be developed through an **inclusive** and **participatory planning** process, involving political leaders, department officials, specialists, NGOs/community organizations and the private sector.

- In countries with more limited formal waste infrastructure the **informal sector** remains a predominant method of waste collection and recycling. The expertise and active involvement of the informal sector is critical in improving waste management and facilitating **social** and **economic inclusion**.

Strategic Governance

- To move the action planning process forward, coordinate activities and engage stakeholders efficiently, establishing two types of **coordinating committee** are recommended: (1) A high-level steering committee, and (2) a city-level working group.

The Steering Committee or Advisory Committee

- The Steering Committee plays a **high-level advisory function** and provides the **political backing** to develop the Local Action Plan. It will also guide the action planning process, including all stages of preparation, to ensure that the initiative is both **managed effectively** and is providing **maximum benefits.**
- The Steering Committee should include the **authorities** and **institutions** involved in decision-making together with a selection of other important stakeholders. The size of the Steering Committee depends on the city area and its institutional, legal and cultural characteristics, but generally, the group should not exceed **10 to 15 members** to be functional and manageable.
- The Steering Committee should consist of a combination of political authority, planning expertise, MSWM practitioners, private sector representation and community leaders. To formalize a commitment to the planning exercise, the Steering Committee will need to draft and agree a **Terms of Reference** for itself.

Checklist of Potential Members of a MSWM Plan Steering Committee	Typical Terms of Reference for a Steering Committee for MSWM Plan
• A senior political figure (chair) • At least one member of the Working Group • Selected local officials representing government departments • Representatives from affected municipalities • Representative of the regulatory agencies • Selected waste management operators, practitioners and planners • Private sector representative • Representatives of civil society organisations groups • Women leaders in MSWM • Selected specialist experts • Representative of external support agency	• The Committee shall review the proposals, reports and activities prepared by the Working Group • The Committee shall meet at regular intervals • The Committee shall support the Working Group in securing primary data and information • The Committee members shall be responsible for co-ordinating and monitoring relevant activities within their respective agency, organisation or community • Steering Committee will decide on the composition of the Working Group and appoint its members • Steering Committee to assess and endorse the ToR of the Working Group

Figure 41. *A Common Checklist for Establishing Steering Committees. Adapted from: Wilson et al., 2001; Sakurai, 1990.*

Working Group

- The Working Group provides **technical leadership** and is responsible for managing the **operational activities** required for preparation of the Action Plan.
- It is necessary to ensure that the working group comprises **city staff** from **relevant departments**. If several municipalities or districts exist within the metropolitan area, the Working Group needs to include staff from each local administration. In addition, **non-government member**s such as private sector, informal sector or waste pickers associations, academic and community leaders should also be invited based on their **expertise**, **resources** and **availability**.
- Each member of the working group should have clear **roles** and **responsibilities**. The Working Group can be considerably smaller than the Steering Committee. Depending on the local conditions and the expertise available, a team of **5 to 10 experts** is sufficient.
- The Working Group must maintain **close relation** with the Steering Committee to translate the strategic decisions of the Steering Committee into practical actions. Regular meeting of the two groups also ensure **transparency** for reporting progress and emerging issues. In return, the Steering Committee will ensure the necessary policy and advisory support for the effective operation of the Working Group.
- Both the Working Group and Steering Committee should strive for **gender parity** in their composition.

Case Study: **Suggested Working Group Skillsets**

- Team leadership and project management
- Organization and planning in MSWM
- Political, institutional, legal skills
- Technical skills (disposal, landfill design, engineering, collection, traffic & vehicles)
- Socio-economic issues
- Economics and finance
- Data collection and research
- Administrative support

Source: Wilson et. al., (2001)

Case Study: **Plastic Smart Cities Network**

Plastic Smart Cities is a global city initiative of the World Wide Fund for Nature (WWF) working with cities worldwide to keep plastic out of nature. Since 2018, the initiative supports cities and coastal centres that are taking bold action to stop plastic pollution. WWF is working with 25 pilot cities to achieve a 30% reduction in plastic leakage by 2025, through better waste management and advancing circular economy. Together, WWF aims to achieve 1000 plastic-smart cities globally to join this network by 2030.

For more information: https://plasticsmartcities.org

Agreeing a Work Plan and Timeline

- The development and agreement of a Work Plan and the Timeline is another valuable step in the mobilization stage. This helps lay out the key **actions, targets** and **benchmarks** for the action planning process and outlines the next steps for the Steering Committee, Working Group and other stakeholders going forward.
- It may be appropriate to present the Work Plan to the relevant city political leadership and officials to get their consensus before continuing the Action Planning Process.

7.4 Action Planning Process Stage 2: Developing the Action Plan

An action plan establishes specific goals and details what steps must be taken in order to achieve each goal. The process of achieving a robust City Action Plan should answer three basic questions:

1. What is the current situation? (Baseline and Gap Analysis)
2. What can we do about it? (Intervention Planning)
3. How do we implement change? (Action)

What is the current situation? – Baseline and Gap Analysis

- Understanding the current situation – **where** are problems occurring, **why** they are occurring, **who** is responsible for managing the situation, and **what** elements are missing **-** is fundamental to developing an Action Plan that will be practical and useful for the city.
- Baseline assessments can be split into: physical or technical (plastic waste management, leakage and hotspots); and governance (policy, regulatory, institutional and financial) analysis.

Physical Aspects - Understanding plastic waste management, pollution, leakage and hotspots

This usually consists of three interrelated activities:

- ***Data Collection****:* A substantial data collection exercise is required to gather information on the plastic value chain at the **production**, **consumption** and **disposal** stages, as well as to understand the wider plastic waste management system. This will underpin all further policy and management decisions and so it is important to ensure **sufficient resources** are allocated to this stage.
- ***Leakage and Impact Classification:*** It is important to assess the key sources of 'macro' and 'micro' plastic leakage. Plastic hotspots can be classified in different ways dependent on their characteristics. The Plastic Pollution Calculator (PPC) of ISWA and UOL (2019) classifies leakage within five categories:
    - **Polymer Type** (e.g. PP, PET, PS, PVC, HDPE, LDPE, polyester and synthetic rubber)
    - **Application/Item Type** (e.g. straws, grocery bags, beverage bottles, food packaging, lids & caps, cups, household/ hygienic articles, and fishing nets)

- Industrial Activity (e.g. packaging, automotive & transportation, construction, electrical, medical, fishing, agriculture, textile and tourism)
- **Physical Location** (e.g. city districts, industrial areas, specific rivers, dams, beaches)
- **Value Chain Stage** (e.g. leakage during collection, at dumpsites, littering).

Other tools and methods to measure plastic pollution, leakage and hotspots, are not limited to: *National Guideline for Plastic Pollution Hotspotting and Shaping Action – Introduction to the Methodology (UNEP, 2020)*; *The Marine Plastic Footprint – Towards a science-based metric for measuring marine plastic leakage and increasing the materiality and circularity of plastic (IUCN, 2020)*; *Marine Litter Prevention (GIZ, 2018)*; *and Plastic Drawdown (Ocean Seas, 2019).*

- ***Prioritization of Hotspots****:* Once specific hotspots are identified it is useful to prioritize these to ensure the **most efficient use** of intervention resources. This will be based on both the **size** and **impact** of the hotspot, and the available **resources** and **capacities** of local stakeholders for action. Supplementing the scientific-evidence base with local knowledge via engagement with key stakeholders can help inform priorities.
- Each priority hotspot should be fully categorized based on the 5 leakage factors to help pinpoint the key drivers across the waste management system.

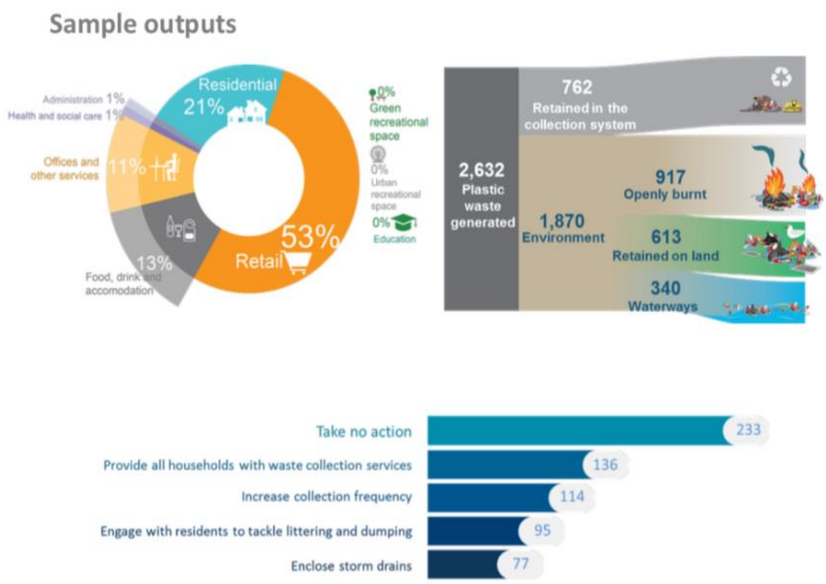

Figure 42. *Sample quantitative analysis from the Plastic Pollution Calculator Assessment methodology. Source: University of Leeds/ISWA, 2020.*

Governance Aspects - Understanding Plastic Policies, Operations, Digital Readiness, Capacity and Stakeholders

- While technical and infrastructure improvements are essential for waste management, **poor governance** is a major contributor to why municipal waste management and other urban systems fail. This is not exceptional for plastic waste management.

- Qualitative analysis of a city's governance needs to focus on: (1) Policy and Regulations, (2) Institutional Capacity, (3) Stakeholder Participation / Inclusivity, (4) Financial Sustainability, (5) Digital Readiness.
    - ***Policies and Regulations:*** Effective plastic management must be built on a foundation of proactive policies and sound institutions. Any baseline assessment requires a full stocktake of relevant policies including their level of success and enforcement. Obtaining a greater understanding of existing national and local policies and legal frameworks can also help when framing the action plan to political stakeholders.
    - ***Institutional Capacity:*** Institutional capacity has a fairly broad assessment criteria. Some key questions to answer include: (1) Is there an institution at national/provincial level responsible for implementing plastic waste management policies? (2) Is there an institution at city level which is responsible for implementing plastic waste management policies? (3) Is there adequately resourcing and enforcement by these institutions? (4) How available is good quality data on solid waste management? (5) To what extent do institutions co-operate at inter-municipality and inter-agency levels?
    - ***Stakeholder Participation / Inclusivity:*** The multi-stakeholder nature of plastic waste drivers and impacts requires a multi-stakeholder response. For this to be inclusive and effective a stakeholder mapping exercise should be completed. See Modules 6 and 7.
    - ***Financial sustainability:*** Securing financial sustainability is a major issue for cities. In developing cities, solid waste management represents a significant proportion of total recurrent city budgets, yet in spite of relatively high costs, collection service coverage is often low and disposal standards remain poor. Thus, it is important to undertake a full review of the waste management budget and allocations.
    - ***Digital readiness:*** The emergence of digital platforms and widespread mobile uptake provides new opportunities to understand plastic leakages and hotspots. Evaluating the digital readiness of respective cities will contribute towards identifying the most feasible technical solutions, for example use of satellites, drones or citizen science data collection.

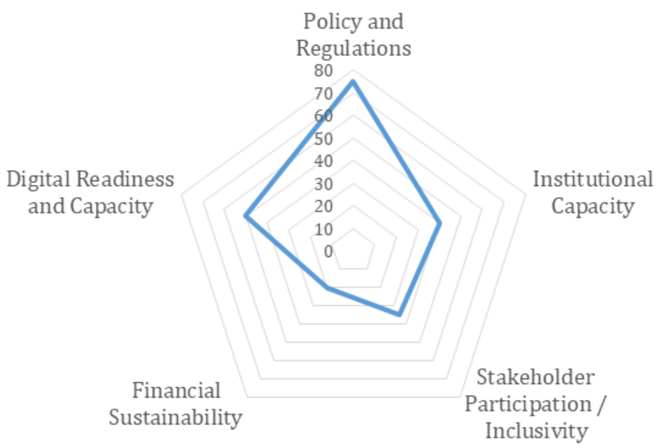

Figure 43: *Example visualization of a plastic governance assessment.*

Case Study: **The Swachhata Mobile App – Civic Engagement**

In 2014, the Indian Ministry of Housing and Urban Affairs launched Swachhata App—a mobile application that allows citizens to report their complaints about city waste management. The app allows users to identify and upload images of waste management problems such as overflowing bins or illegal dumping directly to the local government. This creates a transparent and accountable system of grievence redressal and more efficient action to address local concerns. The app has more than 8 million downloads and is used in over 2,750 cities. In one city, Mysore, up to 90% of consumer waste management complaints through the app are resolved by the city. The widescale data collection also allows national government to rank city performance and understand the key challenges and trends within different municipalities.

Source: Ocean Conservancy, 2019

Case Study: **Closing the Loop – Pune, India**

The experience of the Pune municipal solid waste management model shows that informal waste workers are active and effective in recovering and valorizing resources. A mutual municipality-waste picker partnership can have positive economic, social and environmental impacts. Contracting the informal sector takes advantage of a larger and able local workforce and undertakes recycling activities at a much lower cost than conventional centralized waste management approaches. It can also achieve a significant plastic waste segregation and higher recycling rates. Pune's formal-informal partnership directly contributes to a more circular urban waste management model by recovering valuable materials (including plastic) providing feedstock for local and global recycling industries.

Source: ESCAP, 2019.

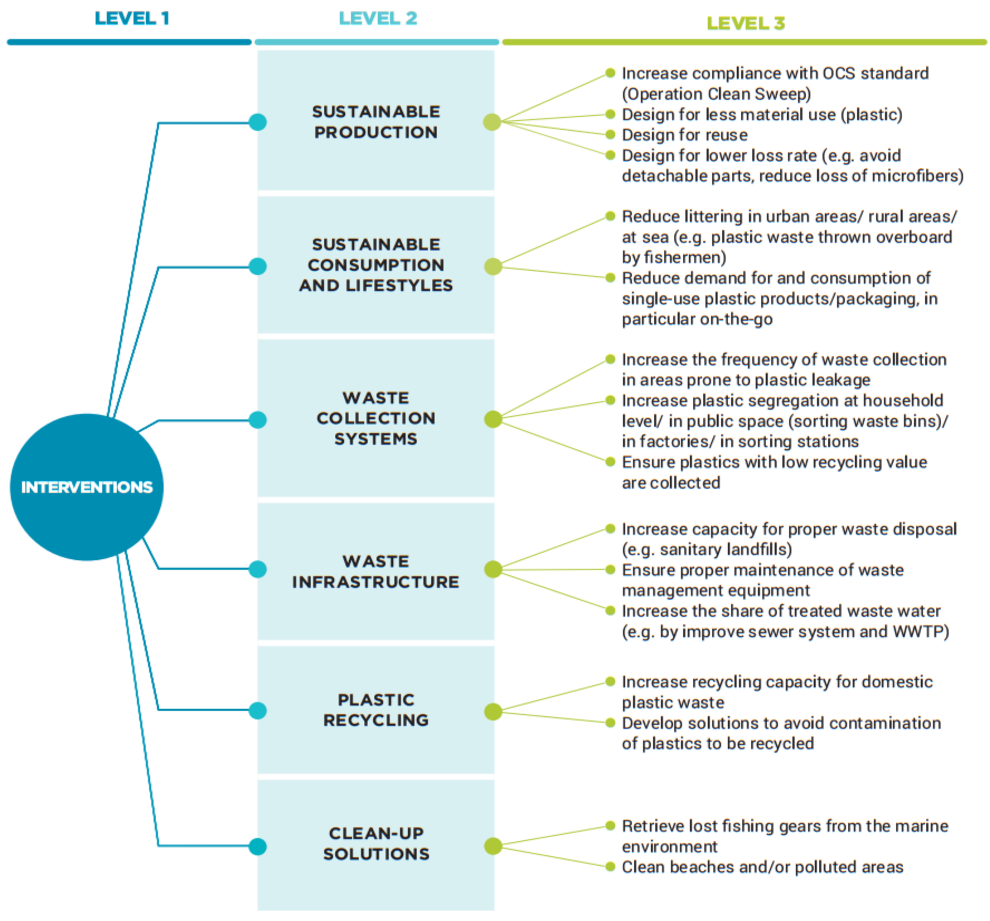

Figure 44: *Non-exhaustive list of plastic waste interventions. Source: Boucher et al., 2020*

What Can We Do About it? Identification and Prioritization of Interventions

- After completing the baseline data collection and analysis it is time to identify some possible solutions to improve plastic waste management.
- This process considers: **interventions** – a specific project designed to reduce/mitigate plastic waste in some way (e.g. a public information campaign); and **actions** – the steps taken to implement and/or monitor an intervention (e.g. completing a stakeholder assessment to guide development of communications).
- Starting more generally it is useful to create a **list of possible interventions** that could work in the chosen city. These interventions should be tangible measures with high potential to reduce plastic leakage or its impacts across the plastic value chain.
- There are three-steps in identifying and prioritizing of specific interventions as below:
    - ***Step 1 - Match Hotspots with Generic Interventions*: The working group in coordination with city stakeholders** identifies a list of common interventions based on experience of previous work, literature review and learnings from the other cities and countries. This preliminary list of interventions helps to facilitate the brainstorming phase of the workshop. Potential interventions need to cover all relevant stages of the value chain and stakeholders: from producer to retailer and consumer; from how products are designed to lifestyle changes among plastic users; and from polymer manufacturing to post-leakage cleanup.
    - ***Step 2 - Specify and Balance the Interventions:*** **C**ities need to assess their existing interventions in the context of this longer list and understand how and where these will be impacted or improved by new action. Though each hotspot requires dedicated action, a single intervention can mitigate multiple hotspots. Indeed, focusing only on technology-driven solutions will often fall short of solving the issue if not followed by systemic and organizational changes. Understanding the longer-term impacts of any intervention on the flows of plastic and stakeholders within the waste management environment is key to action planning.
    - ***Step 3 - Prioritize the interventions:*** Once a list of the potential interventions has been developed, a process of prioritization must be carried out to identify which are most relevant for the city. Extensive investigation and consultations with relevant stakeholders, including at the source, use, and end-of-life stages is needed. Prioritization should be based on two key criteria:
        - ***Criteria 1 - Mitigation potential****:* actions with high mitigation potential are those that create meaningful reductions of plastic leakage and/or its impacts.
        - ***Criteria 2 - Unintended consequences:*** highly consequential actions are those actions most likely to generate unintended environmental or socio-economic trade-offs (e.g., substitution from plastic to another material may generate additional environmental impacts such as GHG emissions).

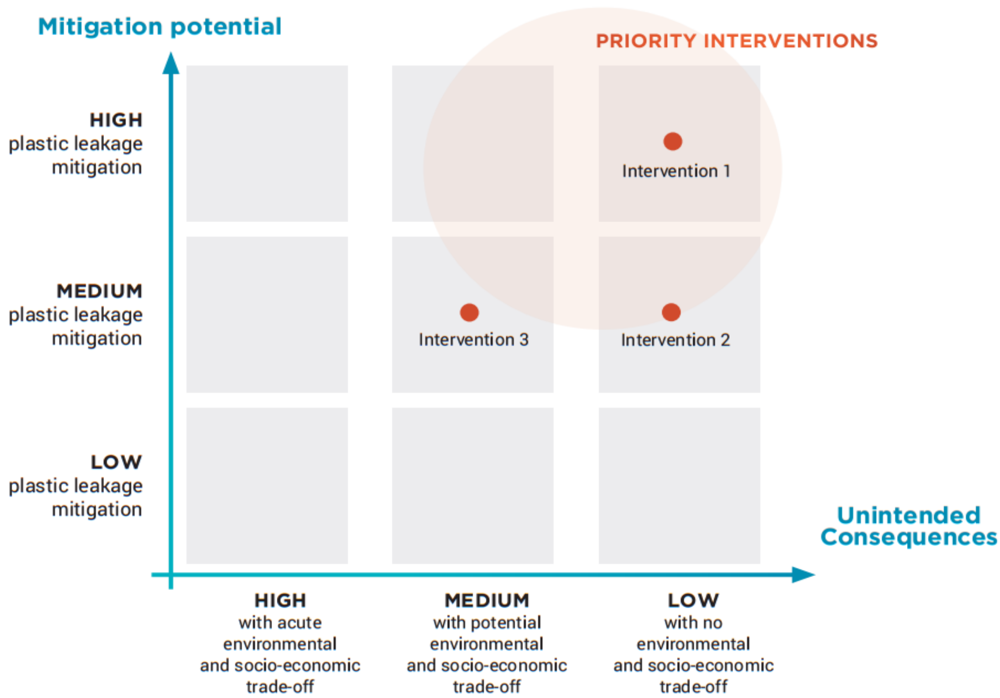

Figure 45. *Framework for the prioritization of interventions. Source: Boucher et al., 2020*

How to Implement Interventions? Identification and Prioritization of Actions

- At this stage the city identifies the most appropriate actions to implement the prioritized interventions. Here, actions are the ways an intervention may be practically implemented through specific regulatory, financial or informative instruments. This takes place in two stages:
- ***Step 1 – Match the interventions with actions***: Once the relevant plastic intervention has been identified cities can begin to plan for implementation. Example Actions: *Field data collection to create knowledge products; creating media about plastic pollution for awareness raising, developing targeted training programs for capacity building; investing in technological solutions to remove plastic waste from the environment; drafting tax policies for specific plastic products; budgeting for enforcement of local plastic bans.*
- ***Step 2 - Prioritize the Actions and Instruments:*** Next a prioritization process is required to identify the most effective steps within a city's time and resource limitations. This should be based on two criteria:
    - ***Criteria 1 - Feasibility****:* technical and socio-economic assessment of each instrument must be performed based on the resources available.
    - ***Criteria 2 - Synergies:*** Instrument and action evaluation should assess the specific hotspots benefitting from any interventions and how these can harmonize with measures already in place.

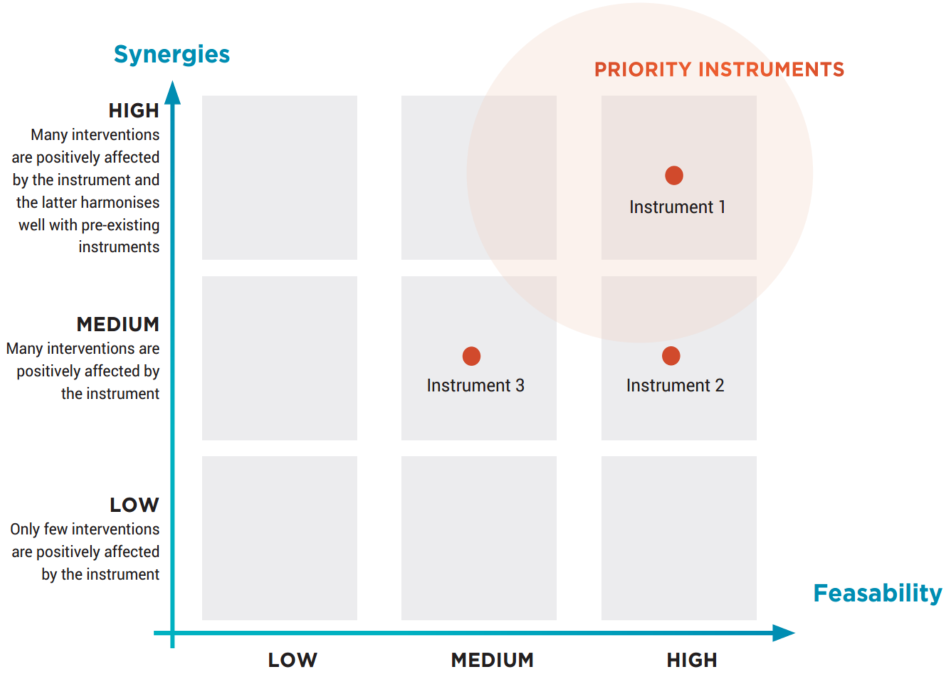

Figure 46. *Framework for the prioritization of actions and instruments. Source: Boucher et al., 2020*

7.5 Action Planning Process Stage 3: Implementation and Monitoring

Obtaining Necessary Approvals and Budgets

- The official process of implementation can begin with the **formal adoption** and **launch** of a plastic waste action plan. **High-level political endorsement** and **commitments** should be obtained at the appropriate stages but it is for each city to judge how and when to get these approvals.
- The Action Plan launch should be accompanied by an appropriate **public relations** and **communications** campaign.
- The action plan can either yield a **standalone policy** for addressing plastic pollution in the city or can **integrate** specific actions into existing plans and planning processes.

Public Awareness and Education

- An essential parallel activity during the early stages of action plan implementation is to set in motion an ongoing **public awareness** and **education programme**. This must both **communicate** the Action Plan to the general public and **mobilize** their **support** and **cooperation**.
- The emergence of **digital platforms** and increasing **digital literacy** with widespread mobile uptake has provided new opportunities to engage the civil society in the context of municipal service provision.

Capacity Building and Financing

- As with the other stages, implementation requires **building capacity** amongst local governments and their partners, as well as mobilization of **financial resources**.
- Municipal solid waste management (MSW) typically represents a **small share** of overall government budgets. While **one-time grants** from national governments, international organizations and donor agencies can help finance local waste management infrastructure, **sustainable financing models** and **investment** is required for long-term service improvements.
- New financing instruments are required to improve **investment opportunities** and provide sustainable financing to cover **operational costs**. The Plastics Policy Playbook (Ocean Conservancy, 2019) identifies ten shortlisted measures that are critical to improving the financing of collection, and they focus on **extended producer responsibility** (EPR), **pay-as-you-throw** (customers pay based on the metered quantity/type of waste they produce), **blended financial instruments** and **enabling measures** that drive operational efficiencies (Figure 47).

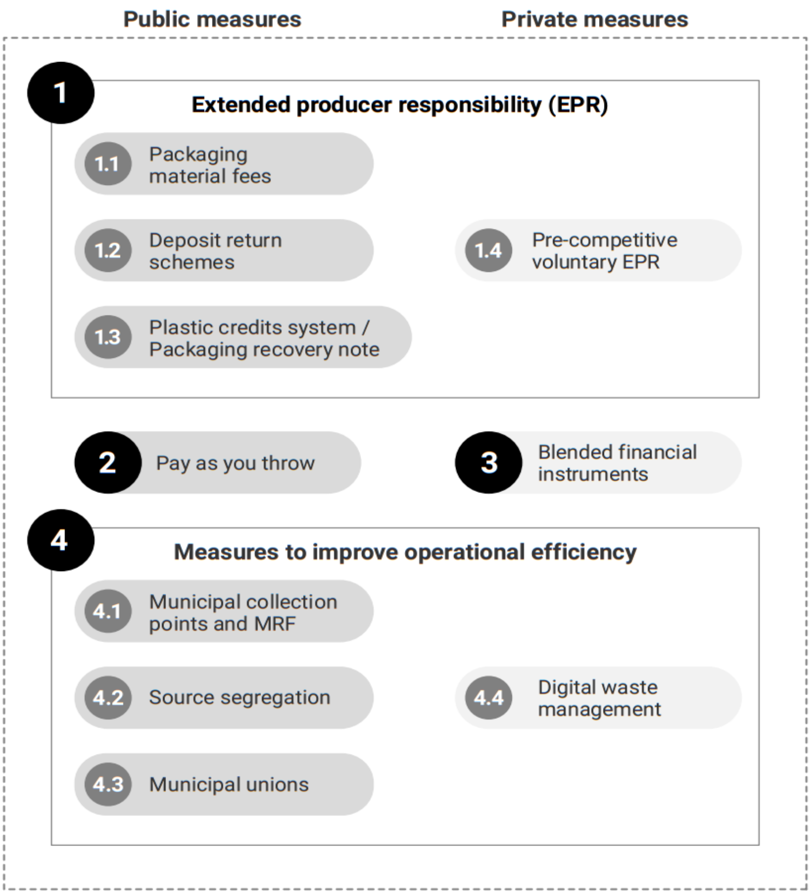

Figure 47. *Shortlisted measures for financing plastic waste management. Source: Ocean Conservancy, 2019*

Monitoring and Evaluation

- The Action Plan is living document and should include several **key milestone targets** and **review points**. Progress must be assessed by key stakeholders at regular intervals, and necessary amendments and adjustments made as appropriate.

- Continuity and alignment with **existing plans** and **policy processes** is desirable, and it is recommended that the Steering Committee should serve not only for the **initial development** of an action plan but also oversee its **implementation.**

Case Study: **Waste Management in India's Cleanest City – Indore**

Indore was recognized as India's cleanest city in the Swachh Surveshkan 2018 survey. Key highlights of Indore's solid waste management system shows how city was successfully get involve the public to its waste segregation programme through comprehensive citizens awareness activities. The city achieved almost 100% segregation levels deploying social media, street plays, wall paintings, radio advertising, community festivals and print media were all used to spread awareness. An independent mobile application (311 App) was set up for service delivery requests, and to register and track complaints.

Source: Ocean Conservancy (2019)

7.6 Module Summary

Key Takeaways

- The volume of plastic waste entering the environment and its impact on **ecosystems**, **human health** and **socioeconomic systems** has significantly increased in the last few decades. Today, over **11 million tons** of plastic waste enters the ocean each year. The Asia Pacific region, in particular South-East Asia, is a primary **source** and **recipient** of plastic waste. In addition to the environmental impact, plastic pollution costs about **1.3 billion USD** annually to **tourism, fishing** and **shipping** industries in the region.
- **Cities** are playing a vital role in responding to global plastic pollution. They are important hotspots of both waste products and innovative solutions. **Local governments** are typically the main stakeholder responsible for managing plastic waste. Plastic pollution negatively affects many city functions including **waste generation** and **collection**, **recycling**, **storm drain maintenance**, **tourism promotion**, **community health**, **local environments**, and **public funds.**
- The development of a **Local Action Plan** for plastic waste management provides local governments and their partners with **strategic direction**, **new ideas, tools**, and a **community of practice** to address plastic pollution while meeting other long-term goals such as socio-economic development and environmental conservation.
- The development of local action plans should be guided by some key principles: (1) **Combine measures** across the **value chain**; (2) **Engage** and **invest** in the **informal sector**; (3) Drive **consumer awareness** and **behaviour change**; (4) Inspire **political will**; and (5) **Improve enforcement** at national and local levels.
- In general, the action planning process includes three main stages: (1) **resource mobilization** and **administrative setup**, (2) development of a **local action plan** and (3) **implementation** and **monitoring**.

- To manage the action planning process establishing two types of coordinating committee is recommended: (1) a **high-level steering committee**, and (2) a **city-level working group**. The steering committee plays an advisory role and provides the political backing to develop the Local Action Plan, while the working group provides the technical expertise and is responsible for managing the day-to-day operations.
- Understanding the current situation **(baseline)** – **where** are problems occurring, **why** they are occurring, **who** is responsible for managing the situation, and **what** elements are missing **-** is fundamental to developing an Action Plan that will be practical and effective.
- Baseline assessments can be split into: **physical/technical assessments -** plastic waste generation, leakage and hotspot analysis; and **governance assessments -** policy, regulatory, institutional and financial analysis.
- A physical baseline assessment includes a period of **primary** and **secondary data collection** followed by **leakage** and **hotspot classification.** This provides the initial data required for hotspot prioritization.
- A governance baseline assessment needs to focus on how effective are a city's existing practises including: (1) **policy** and **regulations**, (2) **institutional capacity**, (3) **stakeholder participation / inclusivity**, (4) **financial sustainability**, (5) **digital readiness**.
- These assessments then **inform the development of plastic interventions** and **solutions**. This typically begins as a **longlist of possible measures** that is refined through a process of **prioritization** in consultation with **key stakeholders**. Several criteria are used to assess the suitability of each possible solution. At a high level this assesses **mitigation potential** (with respect to priority hotspots) and the **risk of unintended consequences**. This is further narrowed through implementation planning which identifies **key instruments** and **actions** based on their **feasibility** (human / financial resources) and their level of **synergy** with other mitigation strategies.
- **Political commitment** is key to the success of any action planning process. The identification of local **'plastics champion'** who can provide support to elevate the project is a key early step in the planning process. Leveraging local knowledge from across the **public**, **private** and **informal sector** is key to ensure an equitable and effective plan. Plastic pollution can be a **politically sensitive** topic and therefore promoting the benefits of taking action is typically a more effective framing for engagement with high level stakeholders than highlighting existing system failures.
- **Monitoring, evaluation** and **reporting** mechanisms are important to ensure effective implementation and an adaptive approach to plastic management. This can be achieved through consistent **data collection** and **regular meetings** between the steering committee and working groups.

Learning Outcomes

- Participants understand the **process** of developing a **plastic action plan** and can identify the **key stakeholders** required for planning and implementation.

- Participants can **identify** and **prioritize** interventions and actions to tackle marine plastic pollution based on the 4-criteria framework – **mitigation potential**, **unintended consequences**, **feasibility** and **synergies**.
- Participants can **integrate learning** from the previous 6 course modules to formulate and combine effective plastic mitigation strategies into a unified action plan.

7.7 Module 7 Quiz

Question	Options
1. How much plastic waste enters the oceans each year?	A) 100,000 Tons B) 1 Million Tons C) 11 Million Tons D) Unknown
2. A baseline assessment must consider	A) Only governance aspects of the waste management system B) Only technical aspects of the waste management system C) Only secondary data from similar cities D) Both technical and governance assessments
3. Plastic waste hotspots are typically characterized by which variables? *(select two)*	A) Polymer type B) Local biodiversity C) Value chain stage D) Economic value of waste
4. Which stakeholders are important to consider when creating a steering committee?	A) Local government officials B) Civil society organizations C) Waste management specialists D) Private sector actors E) All of the above
5. City action plans are often most effective when they ___ *(select two)*	A) Build on existing methods and policies B) Create their own new frameworks and methods C) Are developed top-down by national government D) Use local knowledge and expertise
6. A governance assessment must consider which key factors?	A) Existing policy and effectiveness B) Stakeholder participation C) Financial sustainability D) All of the above
7. The action planning process should be guided by which two groups? *(select two)*	A) A high-level multistakeholder advisory committee B) An informal waste picker organization C) A day-to-day expert working group D) An international infrastructure developer

8. Possible interventions should be prioritized based on which two criteria?	A) Mitigation potential B) Cheapest option C) Risk of unintended consequences D) Quickest to implement
9. Actions and instruments to implement chosen interventions should be prioritized based on which two criteria?	A) Feasibility (time/human/financial resources) B) Action is most favoured by research groups C) Actions work effectively in other countries D) Level of synergies with existing plans/measures
10. In recent years cities, countries, civil society and other actors across the Asia Pacific region have begun to take ___ action to tackle plastic pollution	A) More B) Less

7.8 Key Resources

Videos

Addressing Mandalay's Waste Crisis – A Community in Transition: IGES (14:24)
https://www.youtube.com/watch?v=CBVttYS0R0E

Building Smart Plastic Policies in Your City: Ocean Conservancy (56:60)
https://oceanconservancy.org/trash-free-seas/plastics-in-the-ocean/urban-ocean/

Developing a Waste Management Strategy: Transforming Waste from Problem to Resource: IGES (23:33)
https://www.youtube.com/watch?v=ItPO_Wq6dm8

Fantastic Plastic | Awareness Documentary | Up cycling | Recycling | Zero Waste | Auroras Eye Films: Auroras Eye Films (14:36)
https://www.youtube.com/watch?v=B7vv4-Ief-o

Strategic Municipal Solid Waste Management Plan: EAWAG & EPFL (10:02)
https://www.youtube.com/watch?v=3t0HaMiozN0

Science-based Solutions to Macro- and Micro-Plastic in Municipal Waterways: Ocean Conservancy (54:50)
https://oceanconservancy.org/trash-free-seas/plastics-in-the-ocean/urban-ocean/

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Quiz Answers

Q1 – C, Q2 – D, Q3 – A,C, Q4 – E, Q5 – A,D, Q6 – D, Q7 – A,C, Q8 – A,C, Q9 – A,D, Q10 - A

End-of-Course Quiz

Question	Options
1. How much Plastic Waste enters the oceans each year?	A) 2 million tons B) 4 million tons C) 11 million tons D) 15 million tons
2. Plastic waste is ___ *(select all that apply)*	A) Environmentally Destructive B) Transboundary C) Expensive D) Preventable
3. Most plastic products are derived from __	A) Crude oil and natural gas B) Plant-based Sources C) Recycled materials D) Coal
4. How much plastic waste is derived from urban areas?	A) 20% B) 40% C) 60% D) 90%
5. Ten rivers are responsible for __ of riverine plastic waste and __ of these are in the Asia Pacific Region	A) 40% 4 B) 50% 2 C) 70% 6 D) >90% 8
6. Which industry uses the largest amount of plastic products?	A) Textile B) Packaging C) Construction D) Transportation
7. At which stage in the Plastic Value Chain does most plastic leakage occur?	A) Fossil Fuel Extraction B) Plastic Manufacturing and Transport C) Waste Management and End-of-Life Disposal D) It's the same for each stage
8. What is a Plastic Pollution Pathway?	A) An uncontained landfill site which leaks plastic B) Littering C) The medium (e.g. a river or stream) through which high amounts of plastic waste and transported into the environment D) A local hotspot produced by tourist activity
9. What is a Plastic Pollution Sink?	A) A river which transports high volumes of plastic waste B) A location which leaks plastic waste into the environment C) A location where it is unlikely or impossible for accumulated plastics to be further transported

	D) A city drainage network
10. In which two ways do macroplastics harm animal life? *(select two)*	A) Plastic entangles animals B) Plastic provides new habitats C) Plastic reduces tourism D) Animals consume plastic material
11. Which of these sampling methods requires the highest amount of technical expertise?	A) Visual Counting B) Automated AI Image detection C) Litter trap D) Riverbank waste collection
12. Which of these sampling methods can be used to sample plastics that are suspended in the water column?	A) Satellite detection B) Bridge net sampling C) Visual counting D) Beach waste collection
13. The most effective approach for monitoring plastic pollution uses ___	A) Only riverside sampling B) Only satellite sampling C) A combination of methods D) Only bridge sampling
14. The informal sector is a __ component of city waste management systems. *(select two)*	A) New B) Established C) Ineffective D) Valuable
15. Creating inclusive informal solutions are often __ compared to private service providers or heavy infrastructure	A) Less expensive B) About the same cost C) More Expensive D) Free
16. Informal waste picker activity ____ marine plastic leakage	A) Increases B) Decreases C) Has no effect on D) Eliminates
17. Waste picker organizations tend to___ *(select two)*	A) Promote democratic representation B) Reduce waste system effectiveness C) Reduce social stigma and barriers to work D) Have no impact on waste picker livelihoods
18. Plastic pollution and the resulting decline in ecosystem services are a threat to which human rights?	A) Right to life B) Right to health C) Access to adequate food and safe drinking water D) All of the above
19. Which of these is a civil society stakeholder?	A) Plastic bottle manufacturer B) Ministry of Planning C) Hotel Business Group D) Conservation NGO

20. Which of these is a private sector stakeholder?	A) Ministry of Environment B) Plastic recycling business C) United Nations commission D) Workers rights NGO
21. The negative impacts of plastic pollution are ___ distributed among stakeholders	A) Evenly B) Unevenly
22. Why is completing stakeholder analysis and engagement important? *(select all that apply)*	A) It gives relevant groups the opportunity to present their perspectives and ideas on plastic pollution. B) It means affected groups with little traditional power are not overlooked C) Plastic solutions resulting from a participatory process tend to be more effective in the long term. D) It allows the prioritization and classification of stakeholders for engagement and project outreach.
23. A baseline assessment must consider___	A) Only governance aspects of the waste management system B) Only technical aspects of the waste management system C) Only secondary data from similar cities D) Both technical and governance assessments
24. City action plans are often most effective when they ___ *(select two)*	A) Build on existing methods and policies B) Create their own new frameworks and methods C) Are developed top-down by national government D) Use local knowledge and expertise
25. A governance assessment must consider which key factors?	A) Existing policy and effectiveness B) Stakeholder participation C) Financial sustainability D) All of the above
26. The action planning process should be guided by which two groups? *(select two)*	A) A high-level multistakeholder advisory committee B) An informal waste picker organization C) A day-to-day expert working group D) An international infrastructure developer
27. In recent years cities, countries, civil society and other actors across the Asia Pacific region have begun to take ___ action to tackle plastic pollution	A) More B) Less
28. What are the 3Rs in waste management?	A) Reduce, Reuse, Recycle B) Reduce, Burn, Return C) Repeat, React, Rewind D) Recycle, Return, Sort
29. Which SDGs are related to activities across Plastic Value Chain?	A) SDG 3 (good health and wellbeing) B) SDG 6 (clean water and sanitation) C) SDG 13 (climate action)

	D) SDG 14 (life below water) E) All of the above
30. Which common plastic waste items have high recycling value?	A) Polyester Cups B) LDPE Plastic Films C) PET Plastic Bottles D) None, plastic waste is valueless

Quiz Answers

Q1 – C , Q2 – A, B, C, D, Q3 – A, Q4 – C, Q5 – D,Q6 – B, Q7 – C, Q8 – C, Q9 – C, Q10 – A, D, Q11 - B, Q12 - B, Q13 - C, Q14 – B, D, Q15 - A, Q16 - B, Q17 – A, C, Q18 - D, Q19 - D, Q20 - B, Q21 - B, Q22 – A, B, C, D, Q23 - D, Q24 – A, D, Q25 - D, Q26 – A, C, Q27 - A, Q28 - A, Q29 - E, Q30 - C

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