POLICY BRIEF

Managing Marine Plastic Debris in Asia and the Pacific

Environment and Development

ESCAP 75
MOVING FORWARD TOGETHER

This policy brief on Managing Plastic Marine Litter in Asia and the Pacific has been issued in January 2022. Preparation of this policy brief is coordinated by the Economic and Social Commission for Asia and the Pacific (ESCAP), through its Environment and Development Division (EDD). The policy brief was authored by Abigail Smith from ESCAP, under the supervision of Curt Garrigan, Chief, Sustainable Urban Development Section, and with support from Solene Le Doze, Janet Salem, Alexander Lee-Emery and Manuel Castillo, from ESCAP. Contributions from Fanny Quertamp from Rethinking Plastics, Jerome Le Borgne from Recycling and Recovery Southeast Asia, Christine Cabasset from the Research Institute on Contemporary Southeast Asia (IRASEC) and Emilie Strady from the French National Research Institute for Sustainable Development (IRD). Financial support by the French Embassy in Thailand is gratefully acknowledged.

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Table of Contents

I. INTRODUCTION 1

A. PLASTIC IN EAST ASIA AND THE PACIFIC 4

II. THE FLOW OF PLASTICS: CITY TO SEA 6

III. CLIMATE CHANGE 13

IV. THE COST OF MARINE PLASTIC POLLUTION 14

V. MICROPLASTICS 16

A. FOOD SECURITY & HUMAN HEALTH 18

VI. SOLUTIONS 19

A. THE CIRCULAR ECONOMY 21

B. EXTENDED PRODUCER RESPONSIBILITY (EPR)] 22

C. EFFICIENT WASTE MANAGEMENT 24

i. MEASURE AND MONITOR 24

ii. INCLUSIVE SYSTEMS 27

iii. FINANCING 28

D. INNOVATION 29

VII. CONCLUSION 31

REFERENCES 32

I. Introduction

Plastics were first developed in 1907 with the discovery of Bakelite, a synthetic polymer that could be easily mass-produced. This invention led to countless innovations and new products as plastics became an essential material of the global economy. In 1989 the world produced about 100 million tonnes (Mt) of plastic every year. By 2015 that number had grown exponentially to 322 Mt (McIlgorm et al., 2020). Since 1907 over 8.3 billion tonnes of virgin plastics have been manufactured. But, as supply and demand continues to grow, global recycling capacity has been unable to keep up. As a result, only 9% of all plastic ever made has been recycled – a small quantity remains in use in society, while the vast majority sits in landfills, has been openly incinerated or now pollutes the land, forests and oceans of our natural environment.

A society without plastic would be unimaginably different. It makes cars safer, extends the life of food with efficient packaging, makes electronics affordable, lowers transportation costs through its lighter weights, reduces the exploitation of biomass by using synthetic materials and is to thank for medical advances that save countless lives every day – just to name a few benefits.

However, the impact of unmanaged plastic waste now presents unprecedented global environmental, economic and social challenges. For example, plastic waste can take hundreds of years to break down naturally, entangling wildlife, economically impacting industries like tourism and fisheries. In addition, because plastics are primarily produced from fossil fuels and involve greenhouse gas emissions in the manufacturing and transport stages of the supply chain, the plastic industry is a key contributor to climate change. Further, plastic being cheap and easy to produce has enabled fast consumerism and driven the supply and demand for single-use plastics (SUPs) as well as cheaply made products that are thrown away and replaced rather than reused or repaired.

Currently, 150 Mts of plastic has accumulated in the ocean (Crepy & Porteron, 2021), and through fragmentation, much of it has broken-down down into harmful and uncontrollable microplastics. With latest predictions that the production of plastics will triple by 2050, the risk that plastic pollution will also triple must be mitigated. Otherwise, by 2050, there will be more plastic in the ocean than there are fish, threatening the global future through food shortages, the loss of the marine economy, increased climate change and worsening disasters.

International policy interventions and recommendations need to be applied immediately and scaled up as soon as possible to avoid this dark future for our oceans. The universal Sustainable Development Goals include target 14.1 "By 2025, prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution" (see **Figure 1** for list of SDGs connected to reducing marine plastic pollution)

The Osaka Blue Ocean Vision, in which G20 countries commit to voluntary "reduce additional pollution by marine plastic litter to zero by 2050 through a comprehensive life-cycle approach", is an example of framework that provides nations with the tools to reach net-zero plastic emissions by 2050. The Osaka Blue Ocean Vision emphasises the need for greater coordination to avoid the common pitfalls of working in silos and accelerate nations capacity to meet global goals.

Ocean being an environmental common good, it is a shared responsibility to protect and sustainably manage the ocean and to ensure it is not polluted by unwanted plastics. The transboundary plastics pollution crisis needs to be addressed by all levels of government, from local to national, regional and global. It will also require active participation from citizens, the private and civil sectors, academia and institutional support to succeed.

FIGURE 1: SUSTAINABLE DEVELOPMENT GOALS & MARINE PLASTIC POLLUTION

By addressing marine plastic pollution, the region will also work towards achieving the following Sustainable Development Goals (SDGs):

1: No Poverty

The productivity, viability, profitability and safety of the fishing and aquaculture industry is highly vulnerable to the impact of marine plastic litter. As plastic pollution threatens catch levels and fishery health, it also threatens employment (Beaumont et al., 2019). Three billion people worldwide depend on the ocean for their livelihood (OECD, n.d.:1).

2: Zero Hunger

Plastic pollution has consequences for human food security. For example, wild seafood populations could decrease over time due to plastic contamination, threatening the future of global food supplies (Barboza et al., 2018).

3: Good Health and Well-being

Microplastics that enter the human body via ingestion/inhalation can be absorbed in various organs and impact human health, damaging cells and inducing inflammatory and immune reactions (Campanale et al., 2020).

11: Sustainable Cities and Communities

Indiscriminate disposal of plastics in areas with inadequate waste management systems places immense pressure on critical urban infrastructure (drains and sewers). This can create multidimensional risks and widespread unsustainable plastic pollution in urban centres (Barboza et al., 2018).

12: Responsible Consumption and Production

The plastic supply chain is primarily linear, make-take-use-dispose, and due to its widespread overuse, particularly of single-use products, waste management services can no longer keep up (Barboza et al., 2018). Therefore, reducing plastics consumption and moving to a circular economy model for this supply chain is critical for the future of the ocean.

13: Climate Action

Plastics are derived from fossil fuels and account for 8% of global oil consumption (production and transport). Thus, plastics and Greenhouse Gas (GHG) emissions are intricately connected with every step of the plastic life cycle (from production to transportation to waste disposal), contributing to climate change (Barboza et al., 2018).

14: Life Below Water

Removing existing plastic pollution and preventing future plastics from entering the ocean is critical to sustaining life below water. This is directly targeted by indicator 14.1.1: Index of coastal eutrophication and floating plastic debris density (United States Gov., n.d.).

17: Partnerships to Achieve the Goal

Marine plastic litter and the health of the ocean is a transboundary issue. It will take countries coming together to fix it. It also involves many sectors, including private industry, informal workers and municipal waste service providers. These sectors need to cooperate to find practical and scalable solutions.

A. PLASTIC IN EAST ASIA AND THE PACIFIC

"Countries in East Asia and the Pacific are at the center of the marine plastics crisis - with some countries in the region representing the biggest contributors and others disproportionately affected by the impacts of marine plastic debris on their shores." (World Bank, 2021)

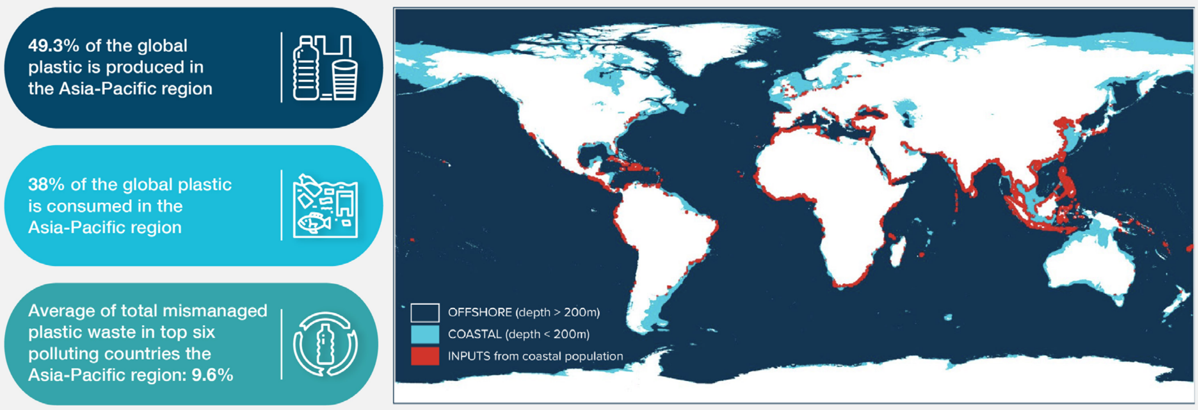
East Asia and the Pacific generates 23% of the world's solid waste at an average of 0.56 kilograms per capita per day – setting global records for the highest waste producers. Just six ASEAN Member States - Indonesia, Thailand, Viet Nam, Philippines, Malaysia and Singapore - generated 243 million tons of waste in 2016 (ASEAN, 2021). And, while the region is quick to consume and dispose of plastic products, the waste collection coverage remains poor, averaging 71% overall and creating ample room for plastic litter to leak into waterways (Kaza et al., 2018).

Source: Closing the Loop, ESCAP

This plastic leakage is a particular problem for Asia and the Pacific, as many emerging nations do not have sufficient waste management systems, capacity, budget or know-how to properly handle the needs of their growing populations and people's plastic lifestyles. Nonetheless, much of the world continues to send their waste to this region to be managed - adding more pressure on already overburdened waste management systems and causing plastic leakage into the environment. Today, plastic released from Asian rivers represents 86% (Lebreton et al., 2017) of the global river plastic inputs into the world's oceans, contributing to disasters like the Great Pacific Garbage Patch (Lebreton et al., 2018) and creating greenhouse gas emissions.

This volume is only on the rise as the region experiences rapid economic growth and growing demand for plastic products. In addition, the current reliance on linear 'take-make-dispose' economic models for plastic consumption is driving a pressing need for the region to come together to provide understandable, scalable and circular solutions to address marine plastic debris.

FIGURE 2: THE PLASTIC PROBLEM IN ASIA AND THE PACIFIC



Source: Map Lebreton, Egger, and Slat (2019); Waste, Jambeck and others (2015); UNEP (2018b); ESCAP (2020).

II. The Flow of Plastics: City to Sea

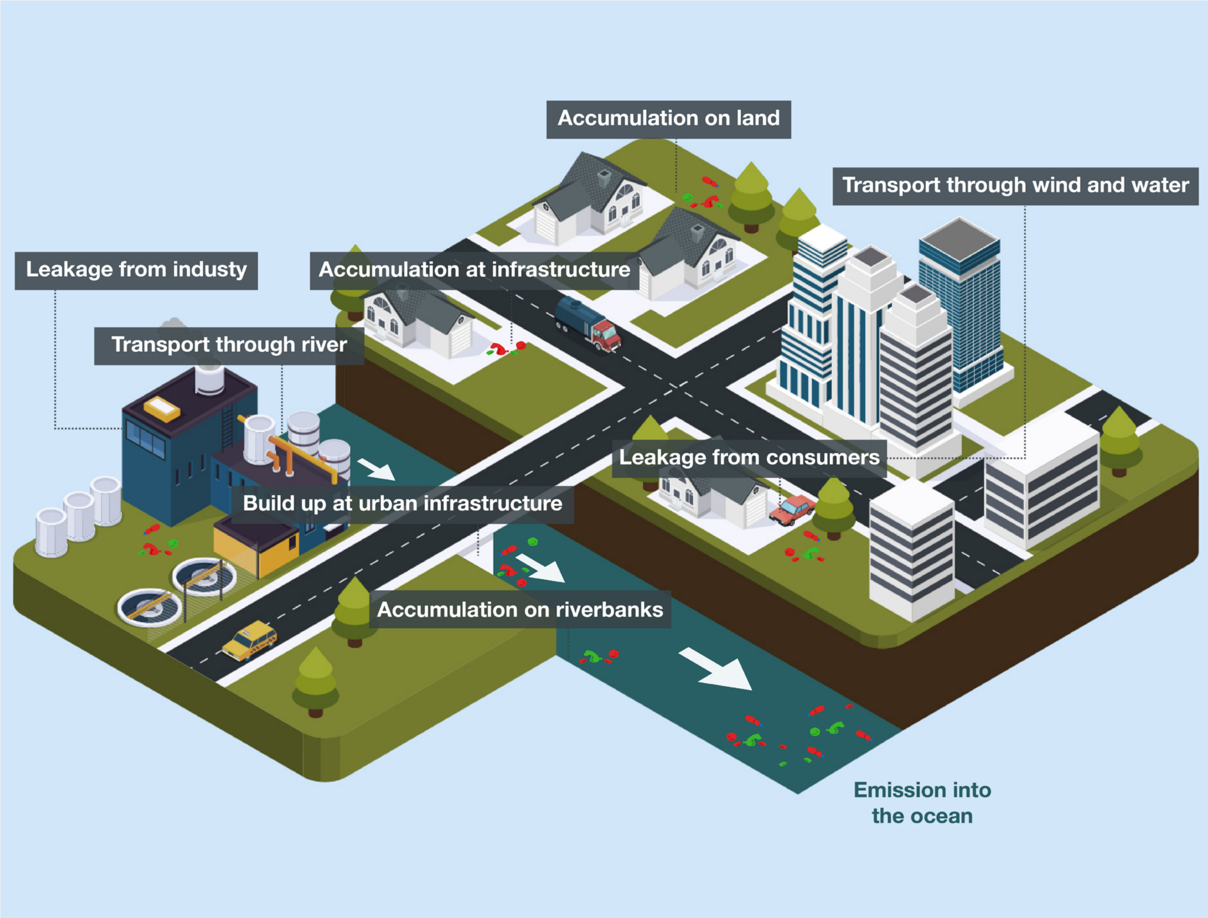
In the subregion of the Association of Southeast Asian Nations (ASEAN), nearly half of all people live in cities. It's projected that by 2025 another 70 million people in the region will move to cities, and by 2030 the consuming class household number will double to 163 million (ASEAN, 2021). As the populations and wealth of cities grow, so will the demands on existing municipal waste management systems, many of which are already overwhelmed.

Cities are key contributors to marine pollution as major centres of plastic production and consumption. Here debris can enter the waterways and environment by direct dumping or leakages within the waste supply chain due to poor management. It is believed that around 32% of plastic packaging escapes the waste collection system, meaning over ⅓ of all packaging plastics disposed of properly by consumers still end up as uncontrolled pollutants (Ellen MacArthur Foundation, 2017). This leakage can mainly be attributed to the fact that nearly 3 billion people do not have controlled waste management facilities today (Wilson et al., 2015). In the ASEAN region alone, a staggering 53% of all waste goes uncollected, leaving the trash unmanaged and often entering waterways (ASEAN, 2021).

About 60% of all plastic in the ocean is directly from fast-growing cities with weak waste management systems in Southeast Asia, South Asia and China (Ocean Conservatory & McKinsey, 2015). With projections forecasting rapid urban growth over the next ten years, Asian and Pacific cities must take immediate action to plug the holes in their municipal waste systems and infrastructure to protect the ocean from being overwhelmed by marine plastic litter.

Mismanaged solid waste is a major issue, not just because it is a significant source of marine plastic debris, but it also causes localised flooding in many cities due to blocked drains, particularly during the monsoon season. These floods bring with them water contamination and disease, further increasing vulnerabilities and reducing the quality of life in urban areas. Therefore, improving local solid waste management can positively impact urban populations and contribute to resilient communities. (ESCAP, 2019).

FIGURE 3: THE FLOW OF UNMANAGED URBAN PLASTIC POLLUTION



Source: Closing the Loop, ESCAP

BOX 1: MEASURING PLASTICS WITH CLOSING THE LOOP'S PLASTIC POLLUTION CALCULATOR

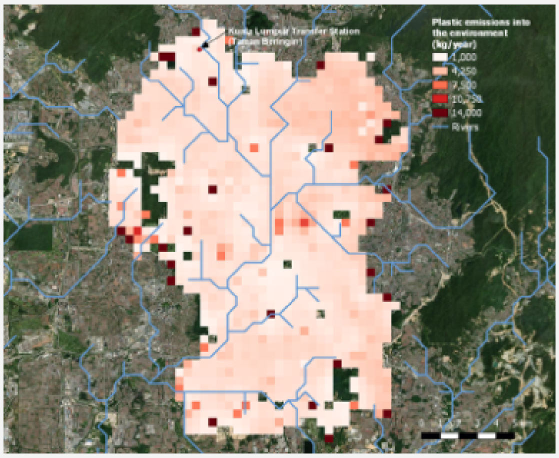
Closing the Loop, a project led by the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and supported by the Government of Japan, addresses the global issue of plastic waste leaking into the marine environment from cities in Asia and the Pacific.

In partnership with the International Solid Waste Association (ISWA) and the University of Leeds (UoL), Closing the Loop applies the Plastic Pollution Calculator model to map plastic waste sources, sinks, hotspots and pathways in four ASEAN cities. This scientific methodology integrates social, environmental and waste governance data to identify the flow of plastics from land into rivers and oceans.

This tool is designed to answer the following:

- What type of plastic products are ending up in our waterways?
- Where in the waste management process does plastic leak into the environment?
- Where are the primary 'hotspots' of leakage and what policy solutions will be most effective? (see example Map of Hotspots **below**)

FIGURE 4: MAP OF PLASTIC LEAKAGE HOTSPOTS IN KUALA LUMPUR, MALAYSIA



Source: Closing the Loop, ESCAP

This information provides a baseline assessment of a city's weaknesses and strengths in its waste supply chain. This is the first step to identifying the measures that need to be taken to stop plastic waste leakage, and its data supports a digital tool that creates a map of the ocean with aquatic plastic flows to better monitor the issue (Discussed in **Box 1**).

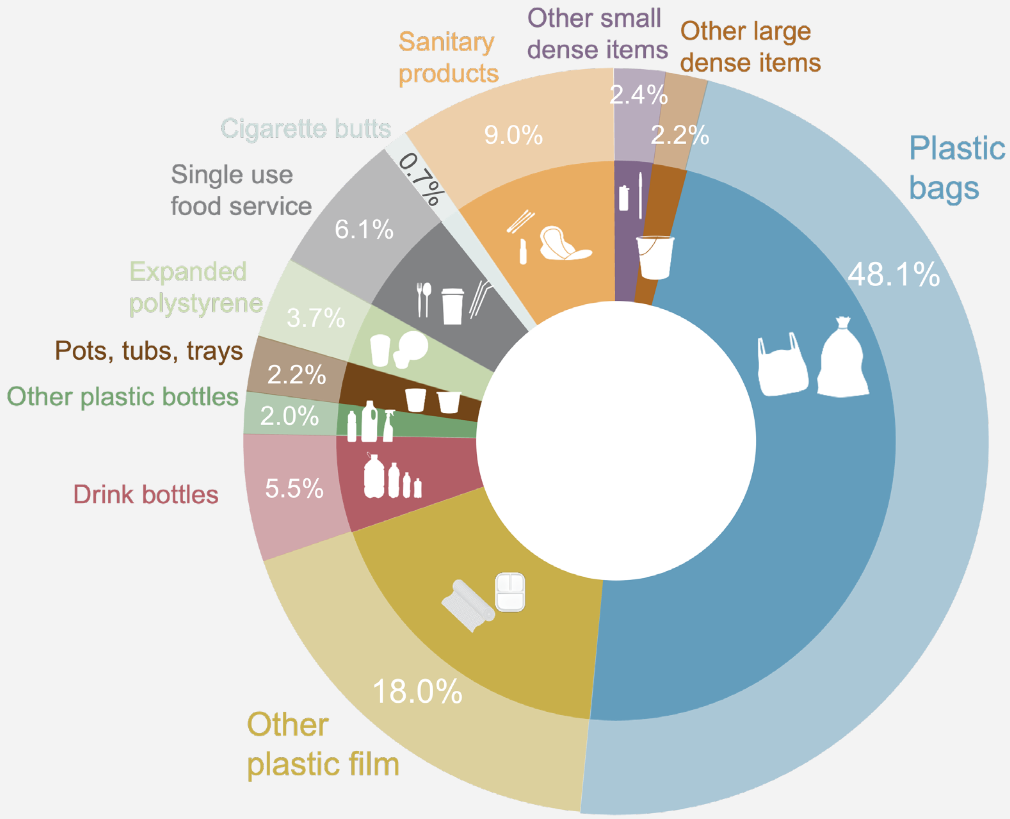
The four baseline reports on the Closing the Loop's pilot cities are forthcoming. Examples from the Plastic Pollution Calculator are on **the following pages.**

KEY RESULTS FROM CLOSING THE LOOP'S PILOT CITIES

Da Nang City, Vietnam

- 83,000 tonnes of plastic waste is generated each year
- 6,752 tonnes /year of plastic is emitted into the environment
- 1,087 tonnes /year of plastic enters waterways
- 48% of plastic waste's mass is from plastic bags (see **Figure 5**)
- 47% of plastic pollution is from littering is the largest source of plastic pollution, followed by uncollected waste (23%), fly tipping / illegal dumping (14%) and leakage while waiting for collection (11%)

FIGURE 5: PLASTIC WASTE ITEM COMPOSITION AT SOURCE PER YEAR IN DA NANG CITY, VIETNAM

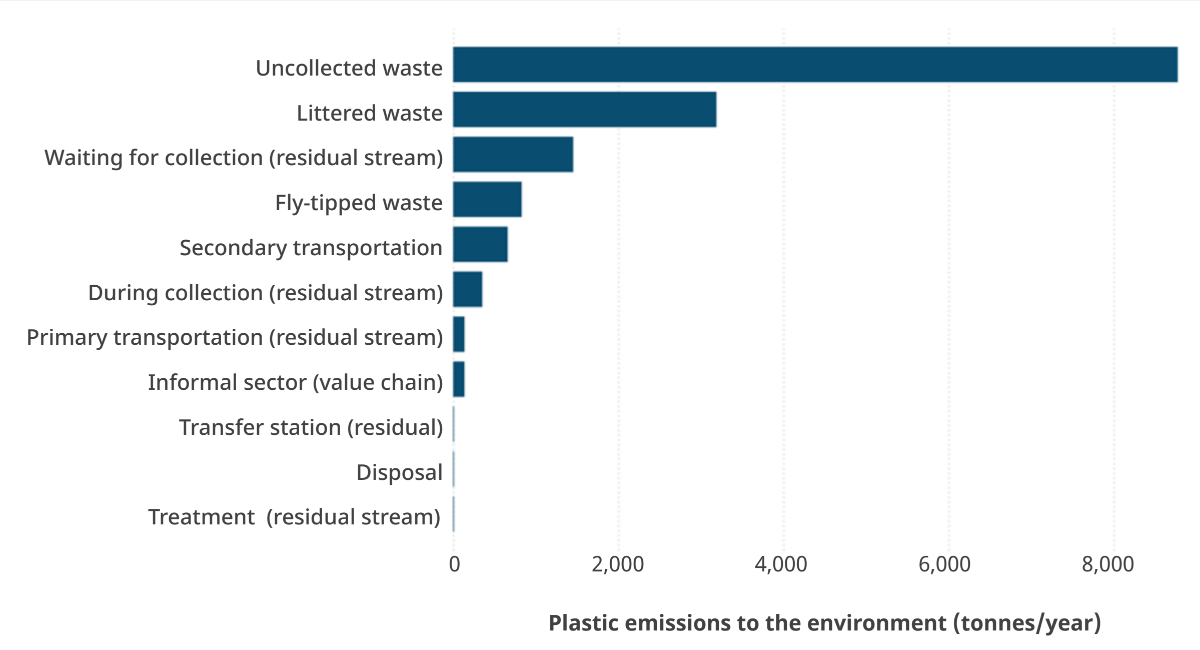


Source: Closing the Loop, ESCAP

Surabaya, Indonesia

- 111,300 tonnes of plastic waste is generated each year
- 16,000 tonnes /year of plastic is emitted into the environment each year
- 2,174 tonnes /year of plastic enters waterways as marine litter
- 27% of plastic waste's mass is from plastic bags
- 55% of plastic emissions are from uncollected waste, followed by littering (20%), leakage while waiting for collection (9%) and fly-tipping (5%) (see **Figure 6**)

FIGURE 6: KEY SOURCE OF PLASTIC POLLUTION IN SURABAYA, INDONESIA

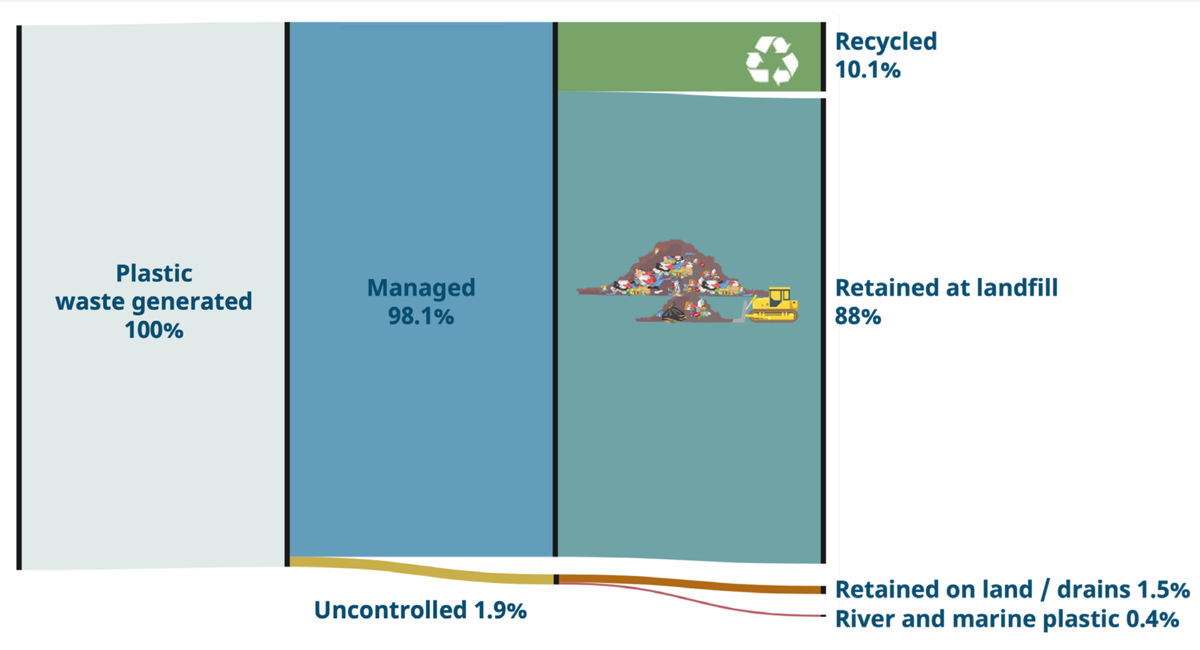


Source: Closing the Loop, ESCAP

Kuala Lumpur, Malaysia

- 161,000 tonnes of plastic waste is generated each year
- 3,000 tonnes /year of plastic is emitted into the environment
- 653 tonnes /year of plastic enters waterways as marine litter (see **Figure 7**)
- 35% of plastic waste's mass is from plastic bags
- 64% of plastic emissions are from littering, followed by fly-tipping (15%) and leakage whilst waiting for collection (15%)

FIGURE 7: SANKEY DIAGRAM OF PLASTIC WASTE FATE IN KUALA LUMPUR, MALAYSIA

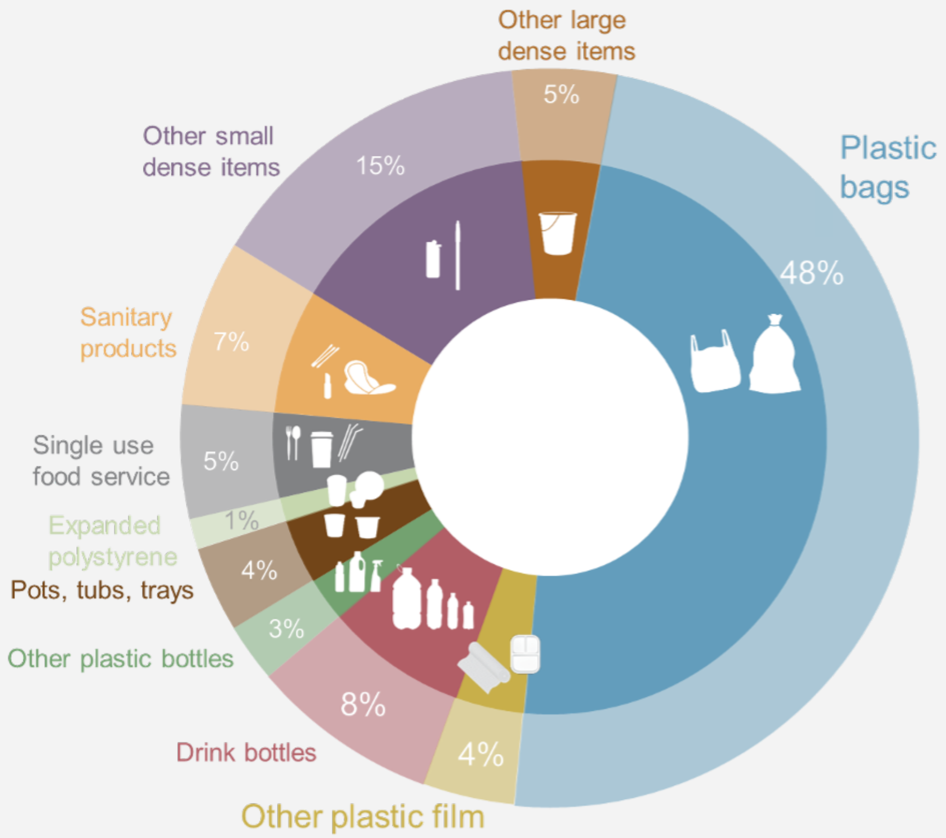


Source: Closing the Loop, ESCAP

Nakhon Si Thammarat, Thailand

- 9,000 tonnes of plastic waste is generated each year
- 448 tonnes /year of plastic is emitted into the environment
- 87 tonnes /year of plastic enters waterways as marine litter
- 48% of plastic waste's mass is from plastic bags (see **Figure 8**)
- 47% of plastic emissions occur while waiting for collection, followed by littering (34%) and emissions from dumpsites (8%)

FIGURE 8: PLASTIC WASTE ITEM COMPOSITION AT SOURCE PER YEAR IN NAKHON SI THAMMARAT, THAILAND



Source: Closing the Loop, ESCAP

III. Climate Change

Plastic emits greenhouse gasses throughout its life cycle. Researchers estimate that the production and incineration of plastics pump more than 850 million tonnes of greenhouse gases (GHGs) into the atmosphere annually. By 2050, without drastic changes, those emissions may rise as high as 2.8 billion tonnes annually (WWF, 2021).

All plastics are fossil fuel-based, requiring extensive oil extracting and refining processes, along with a vast global transportation supply chain, contributing to resource depletion and climate change. Between the crude material and refining process, 8% of the world's total petroleum production is dedicated to plastics alone, and this steep number does not include shipping, recycling or other oil-based activities that bring plastics into daily lives (WWF, 2021). Meaning, the more plastic made, the more fossil fuels are needed, and ultimately, the more plastics contribute to global warming. Similarly, as countries begin to transition away from carbon-intensive energy sources, rising plastic demands may lead petroleum companies to continue their use of fossil fuels.

The ocean's role in mitigating climate change by acting as a carbon sink is vital. It absorbs 30 to 50% of all anthropogenic carbon emissions, delaying a heating planet's disastrous effects (Levine & Doney, 2006). However, as the ocean becomes warmer and more acidic, the question of how much longer the ocean can continue absorbing human-made emissions arises. This is because the oceans' ability to clean this anthropogenic pollution is essentially due to phytoplankton and algae that live in seagrass meadows. These microscopic organisms and their habitat of seagrasses can absorb carbon through photosynthesis and store it. However, laboratory experiments suggest that their ability to sequester carbon is reduced when they ingest microplastics (CIEL, 2019).

IV. The Cost of Marine Plastic Pollution

Three billion people worldwide depend on the ocean for their livelihood (OECD, n.d.:1) and 84% of the global population engaged in the fisheries and aquaculture sector are from Asia. The artisanal and commercial nearshore marine fisheries are a critical component of food security in South and South-East Asian economies. FAO estimates that 50.8 million people were employed in fisheries and aquaculture in Asia and the Pacific (FAO, 2018).

The amount of plastic waste entering the ocean is a threat to all these peoples' livelihoods and food security. However, it does not end there, costs are found throughout the 'blue economy', which includes all economic and coastal resources, and even indirect costs like destruction of biodiversity.

The most significant direst costs from marine plastic debris on the 'blue economy' are fisheries and aquaculture, shipping (transport and shipbuilding) and marine tourism - predicted to cost the Asia-Pacific Economic Cooperation (APEC) community nearly $11 billion USD in damages in 2015 alone (McIlgorm et al., 2020). Some of the main ways plastic pollution affects these sectors are through loss of production, depleted aquatic life, damages to boats and ships (commercial and leisure), costs of beach cleanings and lost tourism due to degradation of resources.

Once plastic pollution makes its way into the ocean, it becomes extremely difficult to control or remove. Pollution distribution and breakdown are influenced mainly by environmental factors, such as exposure to sun and salt and its movement through ocean currents. In addition, 60% of all plastics in the world are less dense than seawater (Seadon, 2017); these materials are particularly easy to push around and break down on the water's surface, causing them to rapidly degrade and making them nearly impossible to retrieve.

Another factor with direct costs includes the ephemeral value of single-use plastics. Globally, around US$80 - $120 billion of items that have only been used once and typically only for a brief time are thrown away (The Pew Charitable Trust & SYSTEMIQ, 2020). This linear economy is not sustainable for the producers, waste management systems or the planet's health. Promoting the reintegration of these valuable materials into the economy via circular economy practices and recycling presents a unique policy lever for sustainable economic growth.

BOX 2: ABANDONED, LOST OR OTHERWISE DISCARDED FISHING GEAR (ALDFG)

This fishing industry is both negatively affected by marine plastic pollution and a contributor to the issue. About 10% of all marine plastic pollution, or about 500,000 - 1 million metric tonnes annually, comes from Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG), otherwise known as 'ghost gear,' (WWF, 2020).

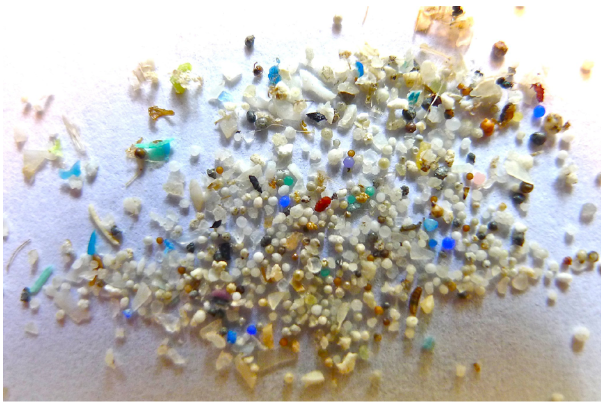
This type of marine plastic litter is designed to catch fish and other marine life, hence representing a great threat to aquatic life through entanglement by discarded nets, lines and ropes that can last intact for up to 10 years after they are 'lost'. This can undermine fisheries' sustainability and cause loss of economic returns as part of their harvest dies in ALDFG, with studies estimating that over 90% of species caught in ghost gear are of commercial value (WWF, 2020). An additional economic burden is saddled to the fishing industry when expensive equipment is lost, as these items need to be re-purchased or gone without.

Supporting preventive measures and working with the fishing industry to reduce 'ghost gear' can have multiple positive co-benefits for the region. Beyond stopping this hazardous type of plastic pollution from entering the ocean, it also supports the livelihoods of fishing communities and the general economic health of the fishing sector.

Source: Hà Nguyễn on Unsplash

V. Microplastics

Microplastics come in all types of polymers and shapes but typically refer to plastic pieces less than 5 millimetres in diameter (under 1-millimetre pieces are sometimes classified as nano plastics) (de Sa et al., 2018). These particles are at most as large as a sesame seed and often so small that they are indistinguishable from a grain of sand (Frias & Nash, 2019). This minuscule size makes them nearly impossible to manage and remove from the environment once they enter.



Source: Oregon State University

Microplastics are split into two main categories, primary and secondary, depending on the source. Secondary microplastics are formed due to the gradual degradation of larger plastics already present in the environment. This fragmentation is due to sun exposure, wave abrasion and biological degradation by microorganisms (de Sa et al., 2018). These secondary microplastics are essentially broken-down marine plastic litter and thereby can be avoided by avoiding this type of pollution in the first place. Primary microplastics are tiny plastic particles released directly into the environment via domestic and industrial liquid waste and sewage discharged directly (e.g. intentional flushing) or indirectly (e.g. run-off) into any body of water (de Sa et al., 2018).

15 to 51 trillion microplastic particles are estimated to exist in the world's ocean, weighing from 93,000 to 236,000 Metric tonnes (Mt), in addition to the estimated 11 Mts of macroplastics in the ocean. With a release rate of 1.5 Mt per year globally entering the ocean, primary microplastics must not be overlooked in the fight against marine plastic litter (Boucher & Friot, 2017). Microplastics are everywhere, from the soil food is grown in, to the air everyone is breathing. Their presence has been found in all waterways tested, including surface and deep water, sediment and atmospheric fallouts. These aquatic microplastics are most alarming due to the high number of species exposed to these polymer chemicals (see list on **following page**), which ultimately threatens marine ecosystems and human health (de Sa et al., 2018).

TYPES OF PLASTIC TO KNOW:

- Polyethylene Terephthalate (PET or PETE or Polyester)
- High-Density Polyethylene (HDPE)
- Polypropylene (PP)
- Polyvinyl Chloride (PVC)
- Low-Density Polyethylene (LDPE)
- Polystyrene (PS)

FIGURE 9: KEY SOURCES OF MARINE MICROPLASTICS

Pellets: Many plastic products begin as pellets as part of the manufacturing and recycling process. Through accidents during production and transport, many of these pellets can escape into the environment.

Synthetic Textiles: Washing synthetic textiles, household or commercially, leads to the shedding of plastic fibres, which are then flushed into waterways. A standard load of 6kg laundry is accountable for 728,000 plastic fibres released to the environment (Napper & Thompson, 2016).

Tyres & Road Markings: Tyres erode through use, shedding microplastics composed of rubber and other chemicals. Road maintenance and infrastructure require many types of plastic, paints, thermoplastics, preformed polymer tape and epoxy, which break down through weathering and vehicle abrasion. All of this road dust is spread by wind and rain, entering the nearby environment and flowing towards the ocean.

Marine Coatings: Boats and ships use coatings made of plastics including epoxy, polyurethane, vinyl and lacquers to protect them from the elements. These plastics get into the ocean as microplastics through surface pre-treatment, coating application and equipment cleaning.

Personal Care Products: Cosmetic and care products use microbeads as ingredients, typically for exfoliation or thickness. Some products contain as much as several thousand microbeads per gram.

City Dust: This is a complex group of sources that typically arise in cities from synthetic abrasions (soles of footwear to building coatings), blasting of abrasives and intentional pouring of detergents.

Source: Boucher & Friot, 2017

A. FOOD SECURITY & HUMAN HEALTH

Only recently has concern begun to grow over microplastics in animal and marine populations and the effects these particles may have on human health when ingested. Research is still only emerging on this topic, but it is vital to consider the health impacts of these toxic particles. Plastic particles may accumulate in the food chain, passing from seafood and fish to humans.

Ingestion of microplastic particles by marine organisms is well known and causes a wide range of ecotoxicological physical effects, including reduced reproduction and mortality (de Sa et al., 2018). The more aquatic life ingests and ultimately dies from microplastics, the more the world's already scarce food sources are depleted, and the livelihoods of fishing communities are threatened.

Marine microplastics also can harm human health through direct consumption (e.g. fish, seafood, land animals that consume fish, water systems). While plastic is predominantly expelled following ingestion, evidence suggests that microplastics can be retained in the gut for much longer than other ingested matter (Barboza et al., 2018). While more evidence is needed to assess the exact health impacts, research shows that plastics smaller than .02 millimetres can penetrate organs, and those with a size of about .01 millimetres can access all organs, including the liver, muscles and brain. In addition, microplastics can cross cell membranes, cross the blood-brain barrier and even enter tissue in the placenta (Campanale et al., 2020).

Source: iStock

VI. Solutions

Reducing the use of plastic, particularly single-use products, is essential to combat marine plastic pollution and the damages it causes. Campaigns against single-use plastics have been strong, and many countries in the Asia Pacific region have already announced plans to phase out certain single use products, even though enforcement is still not widespread.

This can be done in a tiered approach. For example, the island of Bali, Indonesia, first banned plastic bags in their capital city of Denpasar and then spread to the rest of the island over six months. The campaign to ban plastics was supported by grassroots organisations like Bye Bye Plastic Bags in Bali, Indonesia (Bye Bye Plastic Bags, n.d.) to help leverage local support.

Another example of using a tiered approach to ban plastic bags is Bangkok, Thailand. First, starting with public campaigns to sensitise the population, then placing restrictions that force large retailers and convenience to charge for plastic, and future plans to place bans in local markets. This model allows attitudes and habits to change gradually and better adjust to a future free of single-use plastics.

While these types of efforts must continue, consumer reduction of plastic usage is not the only answer. Businesses and governments need to work together and radically redesign the global plastic system, both upstream (pre-consumer interventions, i.e., reduction and substitution) and downstream (post-consumer interventions, i.e., disposal and recycling). This redesign should include applying a Life Cycle Approach that helps decision-makers understand what happens at each stage of the plastic value chain: from raw material acquisition through manufacturing, distribution, product use and disposal. This broader approach is needed to identify and balance trade-offs towards positive impacts for the economy, environment and society (UNEP, 2021).

Furthermore, marine plastic pollution is a transboundary issue. Ocean health is a shared responsibility, especially as rivers running through multiple countries carry and deposit plastics on coasts far from their source. Therefore, the region's nations must come together to strategise and share data and best practices to find tangible solutions. Effective change requires a multi-sectoral and multi-stakeholder approach, including government, consumers, industry (i.e. plastic producers), informal workers (i.e. waste pickers), tourism (i.e. hotels and cruises) and any businesses that rely on plastic or the ocean.

Some existing collaborations and agreements in the Asia Pacific region can help provide the tools and framework for a transboundary and multi-sectoral approach (see list on **following page**). However, these mechanisms require the support and cooperation of the entire region and all acting sectors to be effective.

- **The Coordinating Body on the Seas of East Asia (COBSEA)** who oversee the implementation of the East Asian Seas Action Plan, adopted in April 1981 and revised in 1994
- **SEA circular**, an initiative by the United Nations Environment Programme (UNEP) and COBSEA, aims to solve plastic pollution at the source by supporting market-based solutions, enhancing science, raising awareness and promoting behaviour change towards less plastic wasted in South-East Asia
- **The ASEAN Framework of Action on Marine Debris** comprises four priority areas, namely: (1) Policy Support and Planning; (2) Research, Innovation and Capacity Building; (3) Public Awareness, Education and Outreach; and (4) Private Sector Engagement

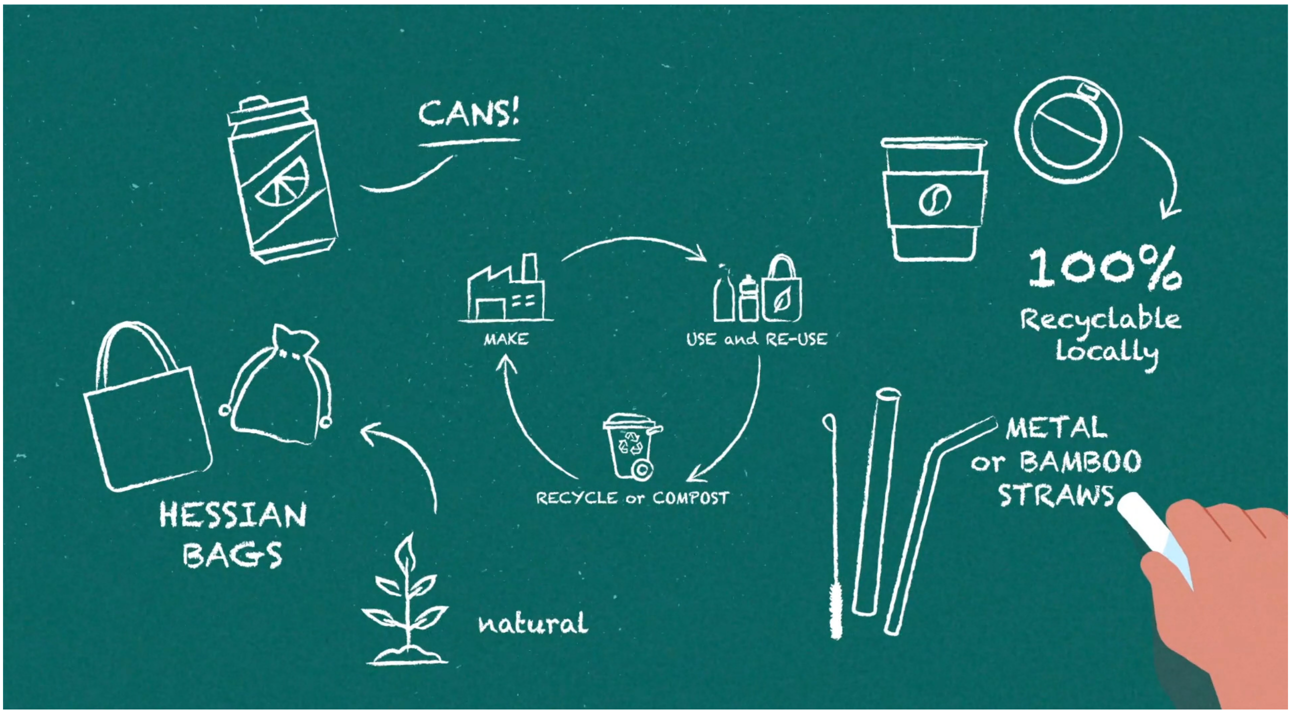
While no single solution exists to save the ocean from flooding with plastics, there is a clear opportunity for regional collaboration and to employ a portfolio of interventions to address marine litter. Immediate action is vital to ensure clean and healthy waterways and environments are passed down to the next generation.

Source: Shutterstock

A. THE CIRCULAR ECONOMY

The standard model currently used in the plastic life-cycle is a linear economy: take-make-dispose. In this model, manufacturing and disposal volumes are unsustainably high for the number of plastics the world uses. It is imperative to shift to a more circular economy model that employs reuse, sharing, repair, refurbishment, remanufacturing and recycling to create a closed-loop system. This aims to minimise the quantities of required resource inputs and reduce waste, pollution and carbon emissions.

To move towards a circular economy, products need to be designed to minimise the consumption of natural resources and waste generation across the product's life-cycle, and to stay within the economy for as long as possible. Dematerialisation, responsible consumption and extended producer responsibility must be promoted and supported by policies. Green products and procurement policies can play a leading role in promoting waste reduction and resource efficiency improvement programmes (Asia WMO). The demand for post-consumer plastic materials will increase with more efficient recycling systems as high-quality materials and innovations expand recyclable manufacturing possibilities.



Source: Closing the Loop, ESCAP

Key circular economy strategies include:

1. Extended product lifespans, multifunctional design, repairability, i.e., extending the use of a product by one or more users.
2. Rental, sharing systems, secondhand, i.e., reuse of less frequently used products by different people.
3. Refurbishing and remanufacturing, e.g., restoring the functionality of a product or upgrading the feature to the new generation of that product.
4. Recycling, upcycling and downcycling, e.g., recycling PET into new clear plastic.
5. Phasing out emissions from the supply chain, e.g., preventing wastewater, air pollution or solid waste.
6. Digitising where possible, e.g., from CDs to music streaming.
7. Switching to bio-based resources within safe ecosystem operation, e.g., using agricultural by products as packaging materials.

Building a circular economy for plastics will require investment. However, the long-term gains will provide payoffs for the environment and the economy. Take, for example, the amount spent annually on disposed of single-use products (US$80 - $120 billion). This cost can be mitigated by establishing circular economies because the plastics are reused instead of thrown away, adding value to their production.

In October 2021, ASEAN adopted the Framework for Circular Economy for the ASEAN Economic Community, which identified three strategic goals: Resilient Economy, Resource Efficiency and Sustainable Growth, along with guiding principles and strategic priorities to enable member States to adopt circular economy approaches. Innovative solutions, such as those deployed in ESCAP's Closing the Loop project can support member States as they identify specific strategies and action plans to accelerate transition to a circular economy.

B. EXTENDED PRODUCER RESPONSIBILITY (EPR)

Extended Producer Responsibility (EPR) is a policy approach where producers (i.e. plastic manufacturers, food and beverage companies) accept significant responsibility, financial and physical, for managing post-consumer plastics. Some EPR schemes are voluntary; however, most are mandatory and based on an established legal framework.

EPR policies can be beneficial when reducing plastic waste by mitigating some of the financial constraints developing countries face for improvements to their waste management systems. Schemes like this also create incentives for plastics industries to find alternative materials and better recycling methods, helping to catalyse innovation throughout the plastic supply chain (OECD, n.d.:2).

BOX 3: EUROPEAN UNION DIRECTIVE ON PLASTIC REDUCTION (EUROPEAN UNION, 2019)

In June of 2019, the European Union (EU) issued a Directive of the European Parliament and of the Council on the reduction of the impact of certain plastic products on the environment. This comprehensive document works as legally binding legislation for all member nations of the EU to combat plastic waste.

Article 8 of the document focuses on Extended Producer Responsibility (EPR) and outlines the actions that member states must take to effectively implement EPR schemes in their countries.

Some of these actions are;

> Establish EPR schemes for all types of single-use plastics

> Ensure that the producers of single-use plastic products cover the following types of costs (varies on types of plastic)

- Awareness-raising measures
- Collection of products that are disposed of in public collection systems (including infrastructure and transport)
- Cleaning up the littering of those products (including transport and treatment)
- Data gathering and reporting per this legislation

> All activities listed above are to be managed cost-effectively and be fully transparent

- Clearly define responsibilities of all actors in the scheme and appoint roles to help manage this process and relationships between the member States
- Schemes are also to be established for fishing gear, including monitoring of 'ghost gear' to develop better targets

Source: Closing the Loop, ESCAP

C. EFFICIENT WASTE MANAGEMENT

Access to essential waste management services is critical to managing plastic litter, particularly for urban areas. Without this, plastic waste will accumulate uncollected and eventually enter the environment.

These services need to be efficient and effective to avoid plastic waste leakage. This requires equipping service providers with a clear understanding of any weaknesses in their waste supply chain through training and education, establishing waste and leakage measurements and monitoring systems and infrastructure investment (i.e. ensuring waste storage bins have properly fitting lids). Additionally, including the informal sector in designing and implementing waste service planning and financing can provide cost-effective, local solutions. Knowing at which steps in the waste management process the plastic is leaking into the environment will help to prioritise where efforts should be focused.

Municipalities should also work to create awareness and incentive recycling. For example, Surabaya, the second-largest city in Indonesia, has been working on better plastic waste management. One mechanism they have used is a plastic waste bus fare scheme, in which anyone can pay bus fare by collecting used plastics. A two-hour bus ticket costs ten plastic cups or five plastic bottles, depending on their size. This program helps the city efficiently collect plastic for recycling and raises public awareness on the issue of single-use plastic litter.

MEASURE AND MONITOR

Measurement and monitoring of plastic pollution are two different steps, serving two different purposes.

1. The measurement of plastic waste pollution is done thoroughly and less frequently to establish a baseline and identify hotspots of plastic pollution that require action. It aims to answer questions such as which products are the priority, where is the plastic pollution leaking into the environment (both in terms of which stage in the plastic pollution value chain and which geographic location), which times of the year might trigger more significant releases (festivals or weather events), and where is the plastic waste coming from (residential, retail, office or public buildings).
2. Monitoring is a dynamic process that aims to track the change in plastic pollution in time and place. This is used to check whether actions to address plastic pollution lead to decreases or increases in plastic pollution, or shifting in location, or even whether new sources of plastic pollution arise, for instance, in new development areas. Monitoring should be part of an action plan.

Measuring, monitoring, and managing plastic pollution are covered in detail through the Closing the Loop eLearning program (ESCAP, 2021), and examples of tools they have developed can be seen in **Box 1** (PPC) and **Box 4** (Digital Map).

Plastic waste measurement requires comprehensive data collection at all levels (national to household), across the value chain (from producers to consumers, including recyclers and waste managers) and across sectors (government, private sector and informal). This allows for the quantities of plastic entering the economy to be accurately determined and decision-makers to clearly understand just how much is recycled, reused or ends up in landfills.

This data allows governments and service providers to design effective waste systems, including the provision of the appropriate number of vehicles, establishing efficient collection routes, setting targets for the diversion of waste, progress tracking, the realistic allocation of finance and land, assess to relevant technologies and best identify strategic partners to support services (Kaza et al., 2018).

In addition, proper monitoring will help identify pollution hotspots where plastic escaping the waste supply chain accumulates in the environment. This monitoring can be done in three steps:

1. **Data Collection**
   This involves collecting visual data in pre-determined areas of interest through various remote sensing techniques, such as satellites, cameras, drones and citizen science.
2. **Data Processing**
   This step involves detecting plastic pollution in the images collected using manual or automated techniques such as machine learning and combining the data from various sources into harmonised information.
3. **Data Visualisation**
   This step converts the information into insights through a hotspot map that visualises the pollution hotspots on a map.

Governments must be transparent with this data and share it with other countries to help replicate best practices and learn from experience. It can also be used to increase public awareness. By publishing this kind of information, citizens will more quickly understand the need and benefit of avoiding non-essential plastics, changing our economies and encouraging recycling (ESCAP, 2019).

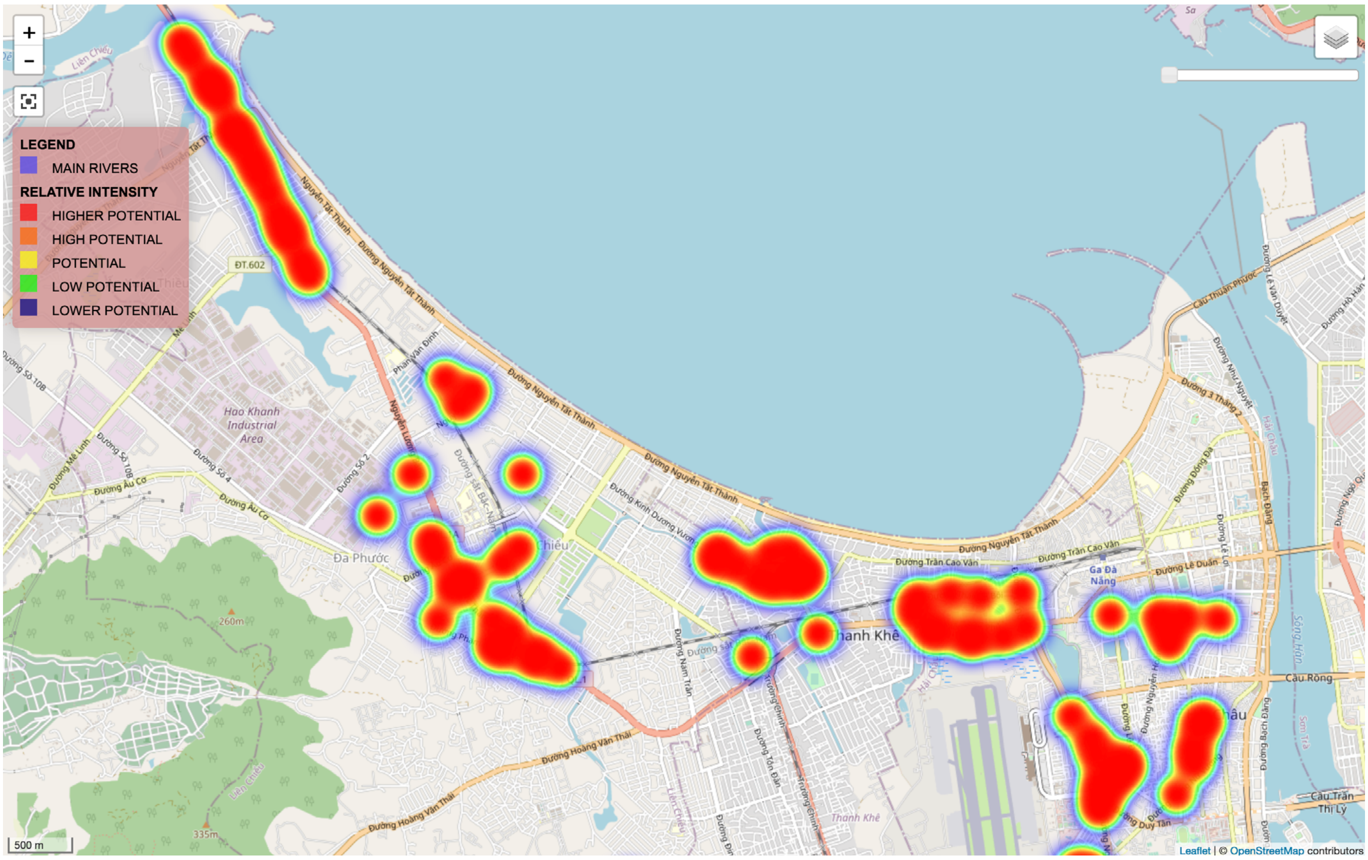
BOX 4: MONITORING PLASTICS WITH CLOSING THE LOOP'S DIGITAL MAPPING TOOL

Using results from the Pollution Control Calculator (PPC) (Discussed in **Box 1**) and other data sources, UN ESCAP and Japan Space Systems (JSS) project, *Closing the Loop,* developed an innovative virtual mapping tool to support city governments in monitoring and managing their plastic waste. Using powerful algorithms trained by artificial intelligence, the tool will scan images from a range of data sources and detect ocean-bound plastic pollution – similar to facial recognition but for plastic waste.

This tool answers questions such as:

- Where is the plastic pollution entering into rivers?
- How much is there?
- How does it move once in the rivers?

Combining the data from many sources builds a virtual twin of the ocean, giving a full scope of the problem for the region, and providing needed information for the region to come together and find solutions to end ocean marine litter.



Source: JSS

INCLUSIVE SYSTEMS

Scaling engagement between policymakers and the informal waste sector can help to economically support local communities and reduce plastic pollution.

In developing countries with inadequate infrastructure to manage waste separation and collection, informal waste workers sometimes referred to as 'waste-pickers', often fill key service gaps. In the Asia-Pacific region, these informal workers are responsible for over half of all plastics that get recycled (ESCAP, 2021). However, even though these workers provide significant contributions to preventing marine plastic litter, they are often overlooked in policymaking, and general attitudes towards them can be negative.

Including the informal sector in plans and leveraging this workforce to implement change in waste management systems provides a unique opportunity to support local communities by providing secure jobs, particularly in urban areas.

Source: Closing the Loop, ESCAP

Some tools policymakers can use to build inclusive waste management systems:

- **Help organise**: Waste pickers in some locations have organised into cooperatives or unions. These can help promote greater economic opportunity, to improve working conditions and elevate their social status.
- **De-stigmatise**: Support wastes pickers' work with formal contracts that include advocacy and community outreach.
- **Build capacity**: Training at all levels and between the formal and informal sectors is key in developing a shared understanding, exchanging ideas, and identifying roles for improved efficiency.
- **Adopt pro-poor initiatives**: Support and improve existing practices by embracing and providing low-technology solutions for workers, like manual tools and pushcarts.
- **Decentralise systems**: Centralised waste systems often run through private contractors who typically take all waste to landfills, as it is cheaper than sorting and recycling. The informal sector can be included by making smaller-scale operations accessible, ensuring more plastic enters a circular economy.

FINANCING

Waste management is expensive. It can be the single highest budget item for municipalities in low-income countries, where nearly 20% of municipal budgets go to waste management services. The sector is also constantly competing for funding with other municipal demands, including essential basic services – like clean water and education (Kaza et al., 2018).

Some common practices to finance better waste management are:

- Collection pick-up fees for households and businesses;
- Fines for illegal dumping and fly-tipping; and
- Fees for purchasing single-use plastic bags.

However, this is not enough, and multiple funding streams are needed for improvements. A primary challenge in financing availability for better waste management infrastructure is that the inherent value of the waste does not cover the cost of collection and disposal (Moss et al., 2017). There are opportunities to generate revenue throughout the plastic waste value chain, particularly with a shift to a circular economy, by recycling and upcycling post-consumer plastics into new products.

D. INNOVATION

To meet the scale of the marine plastic litter crisis, it is important to constantly mobilise large-scale and 'moonshot' innovations focused on practical action. This will involve bringing together small, medium and large businesses, academics and governments to identify and select the solutions most likely to succeed, then finance, develop and implement.

Areas of innovation to consider:

- Plastic product alternatives that are sustainable and meet consumer needs;
- Product redesign for circularity and multilayer reprocessing to ensure they have post-consumer value (IRP, 2021);
- Continue the search for a 'super-polymer' with the functionality of today's polymers and with superior recyclability (Ellen MacArthur Foundation, 2017);
- Reduce the diversity of plastics in usage to make sorting and recycling more accessible and more efficient (IRP, 2021);
- Enhance and develop data collection tools for measuring and monitoring plastics that leak into the environment;
- Explore chemical recycling techniques that can overcome the economic and environmental challenges of mechanical recycling methods (IRP, 2021);
- Develop ocean and river plastic recovery to capture and recycle existing marine litter (IRP, 2021);
- Explore policy interventions based on ‘behavioral science’ to identify nudges and boosts to private and company behavior (Rankine and Khosravi, 2021).

Solving the issue of primary microplastics also requires innovation. While bans on microbeads from products is one small step, it does not fix the problems of synthetic textiles and tyres. Redesign of these products is required (See **Figure 10**). An eco-design approach requires a systemic life-cycle management approach and dialogue with all stakeholders from product design to urban infrastructure planning, both from private and public sectors (UNEP/SETAC, 2009).

FIGURE 10: INNOVATIONS TO MANAGE PRIMARY MICROPLASTICS

Synthetic Textiles	Tyres
• Plastic transformation and product manufacturing (chemist/designer): design textiles/textiles fibres to reduce the shedding of fibres • Product manufacturing (designer): pre-wash textiles to reduce heavy loads from first wash Product maintenance (designer of washing machines): install filtering devices on washing machines • Water infrastructure: understand and increase treatment efficiency.	• Plastic transformation and product manufacturing (chemist/designer): eco-design of rubber polymers and tyres to reduce abrasion • Product use (road/asphalt designer): design road pavement to reduce abrasion • Product use (water infrastructure designer): ensure water run-off collection and appropriate separation of plastics • Water infrastructure: understand and increase treatment efficiency

Source: Boucher & Friot, 2017

Source: A R on Unsplash

VII. Conclusion

Asia and the Pacific is the region that contributes the most to plastic waste leaking into the ocean. As the region's cities and populations grow, so does the amount of waste they generate.

But the region also holds the power to combat plastic pollution. The key entry point for tackling the plastic waste issue is the transition away from the current linear economic model for plastics and to, instead, embrace a circular economy. Creative solutions are needed to close the loop on the plastic life cycle and reduce the amount of plastic, particularly single-use plastics. Waste management systems, including the local level, must be improved to avoid leakage and up-scale recycling opportunities. Entities, including local waste management departments and local and national environmental agencies need capacity building to develop and deploy innovative solutions and monitor the flow of plastics.

Further alignment of waste management strategies with the Sustainable Development Goals will ensure that local actions contribute to the global ambitions of the 2030 Agenda for Sustainable Development.

To meet these ends, it is critical for cities and local municipalities to enact changes such as reducing single-use plastics use and improvements in waste management systems. By including the civil and informal sectors in discussions on their plans, local authorities can build inclusive systems so the public is aware of the needed behavioural changes. It is also crucial for both the government and private sectors to continue to seek innovations in alternatives to plastic and better recycling models which can support a circular economy for plastics. Investments must be made in technologies to measure and monitor the flow of plastics to ensure science-based policies and practices that are effective are put in place. Policy design based on behavioural science approaches can nudge consumers and companies towards desirable behaviour or boost interventions.

Finally, intergovernmental platforms and regional dialogues, such as the Asia Pacific Day for the Ocean, must be leveraged to highlight plastic pollution's transboundary nature and exchange inclusive, practical and financially feasible solutions to this common regional challenge.

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