WHO PAYS FOR PLASTIC POLLUTION?

ENABLING GLOBAL EQUITY IN THE PLASTIC VALUE CHAIN

TOWARDS A TREATY TO END PLASTIC POLLUTION

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CALL TO ACTION

DESPITE WHAT WE'VE BEEN TOLD, PLASTIC IS NOT CHEAP. ITS PRODUCTION AND DISPOSAL - AND THE POLLUTION IT CAUSES COME WITH HIGH SOCIAL, ENVIRONMENTAL AND ECONOMIC COSTS, BORNE PRIMARILY BY COMMUNITIES AND GOVERNMENTS.

Moreover, there are disparities in the distribution of these costs within and between countries. This report reveals for the first time the scale of these disparities. It estimates that the true full lifetime cost of plastic is 8 times higher in low- and middle-income countries than in high-income countries. For low-income countries in particular, the full lifetime cost of plastic rises to 10 times that of high income countries.

In the absence of global regulation and standards, communities across low- and middle-income countries are being exposed to the most harmful effects of plastic production and pollution, including air pollution, increased risk of flooding, the spread of infectious diseases, threats to livelihoods and unsafe working conditions.

These exposures and risks at a local and global level reflect important structural inequities across the entire plastic value chain. Despite national and voluntary efforts, plastic pollution has only got worse and it's set to triple by 2040 unless urgent action is taken. A comprehensive approach featuring jointly developed global rules, accompanied by effective means of implementation, would empower low- and middle-income countries with more control over the plastics in their markets, increase the value of end-of-use plastics and remove the most harmful and problematic plastics that are most costly to manage and which damage human health and pollute the environment. The negotiations of a global treaty to end plastic pollution which commenced in March 2022 present a once-in-a-generation opportunity to address the plastic pollution crisis once and for all.

WWF CALLS ON ALL GOVERNMENTS TO ESTABLISH A GLOBAL TREATY TO END PLASTIC POLLUTION THAT:

- Includes binding and equitable global rules to regulate plastic production and consumption, including:
  - Global bans, phaseouts and phasedowns of high-risk and avoidable plastic products, uses, polymers and chemicals of concern.
  - Global requirements for product design and systems, securing a safe and non-toxic circular economy, prioritizing reuse, improving recycling, and securing the safe and environmentally sound management of plastic waste.
- Establishes measures that provide a credible solution across the entire lifecycle of plastics for stopping their leakage into the environment, ensuring reduced consumption and production, scaling reuse and creating a safe circular economy, as well as business opportunities in environmentally sound alternative materials, products or services.
- Establishes robust implementation support measures, including sufficient financial support and alignment of public and private financial flows, particularly for low- and middle- income countries and, where relevant, differentiated timelines for implementation.
- Accelerates a just transition by taking into account the perspectives of the communities most vulnerable to plastic pollution and change and ensuring transparency and inclusivity in decision-making.
- Creates a global regulatory framework where countries experiencing the most severe impacts of plastic pollution can participate in global decision-making for the entire global plastics lifecycle in a democratic way, without the possibility of being blocked or vetoed by individual countries or vested interests.
- Creates common and harmonized rules that would lower enforcement and implementation costs, strengthen governments' joint bargaining power and close opportunities for avoiding regulations and exploiting vulnerability.

EXECUTIVE SUMMARY:

In the absence of global rules, regulations and coordinated action, the transboundary plastic pollution crisis is worsening. The global plastic value chain is unregulated and there are record levels of plastic production, consumption and pollution. In 2019 alone, 2 million garbage truckloads of plastic pollution leaked into the global ocean.* In the absence of clear and specific rules for what countries must do to eliminate plastic pollution, the level of mismanaged plastic waste is expected to increase by almost 90% by 2040.[1] High-risk and avoidable single-use plastic products continue to be produced and circulated in record numbers, despite clear evidence of the risks to the environment and society alike.

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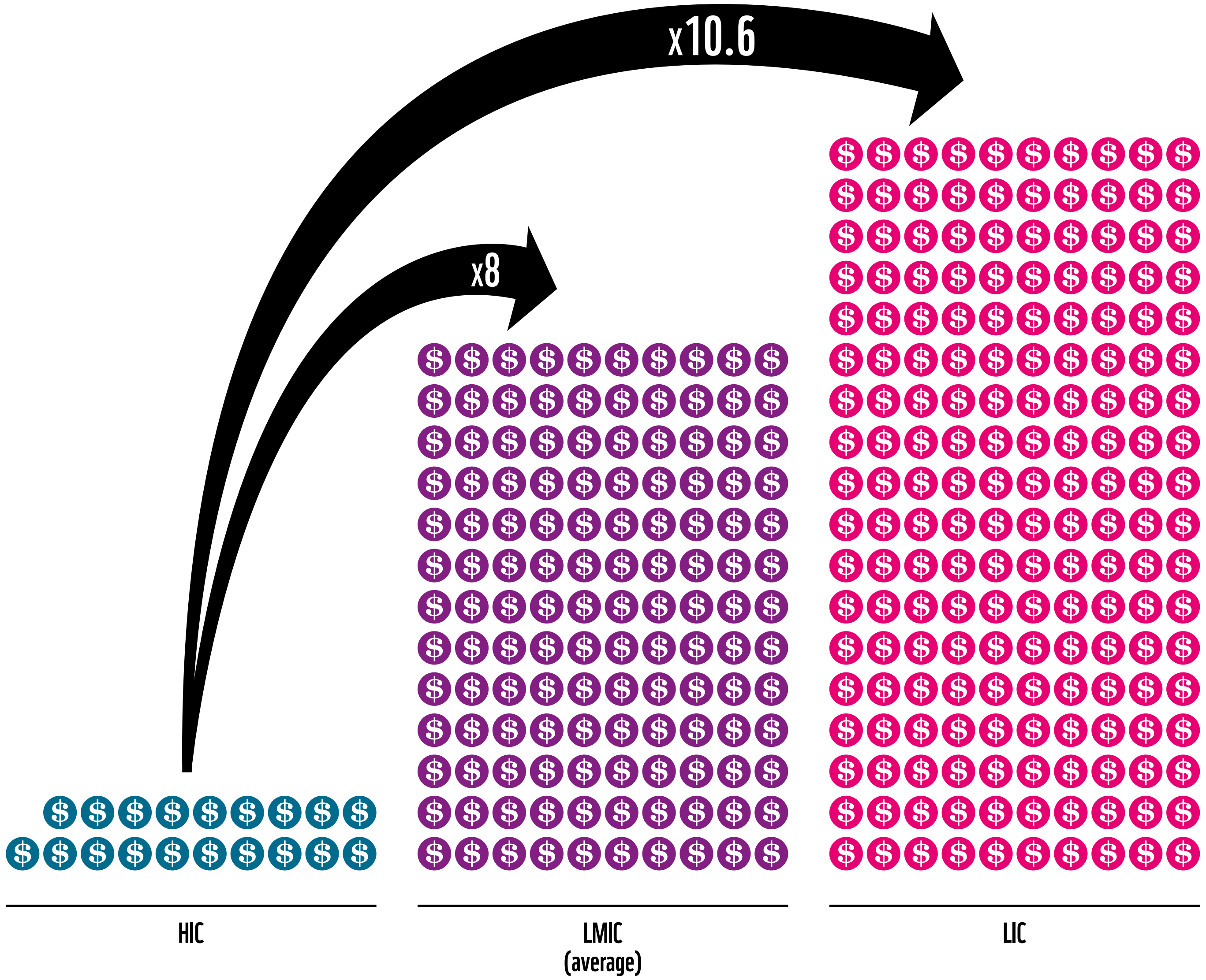
A lack of rules across the value chain has generated inequities for low- and middle-income countries (LMICs). Despite a number of national and voluntary measures, the absence of common global rules to combat plastic pollution impacts all countries. However, it is LMICs, especially low-income countries (LICs) and small island developing states (SIDS) that are bearing the brunt of the problem. The distinct challenges faced by many of these countries are a symptom of three key structural inequities in the plastic value chain:

Structural Inequity #1:
Non-plastic producing low- and middle-income countries and small island developing states have little-to-no influence on international plastic production. In the absence of global rules governing plastic production, most plastic products which contribute to plastic pollution in LMICs, such as single-use plastics, fishing gear, and products releasing microplastics, are designed without regard for how these countries can safely deal with them. Even the avoidable and most problematic products, of which several have been banned by national governments, continue to be produced, sold and traded globally.

Structural Inequity #2:
Low- and middle-income countries have limited capacity to manage growing volumes of plastic waste. As the volume of plastic produced and consumed globally continues to grow exponentially, it is outpacing countries' waste management systems. This is disproportionately harming LMICs which often lack the capacity and infrastructure to safely manage existing levels of plastic waste. These countries face prohibitive costs to developing and upgrading waste management infrastructure which are estimated at US$ 26 billion annually[2]. Without coordinated global efforts to reduce the amount of waste generated, LMICs will continue to be exposed to the worst effects of plastic pollution.

* This assumes that a garbage truckload has a maximum capacity of 15 tonnes and a plastic waste leakage mass of 28 Mt into land and water environments.[1,91]

Comparison of the total lifetime cost of a single 1 kg block of plastic in HICs, all LMICs, and LICs.



Structural Inequity #3:
There is no mechanism to share accountability for the costs of plastic pollution. LMICs and SIDS are most affected by the consequences of global plastic production decisions, yet they're not compensated for these impacts by the companies and countries that produce the plastics. Further, they're unable to influence production decision-making processes in the face of asymmetric power structures and the absence of accountability mechanisms, such as Extended Producer Responsibility (EPR) schemes in many countries.

As a result of these inequities, the burden of plastic pollution is unevenly distributed across countries around the world. Higher-income countries, which typically have more influence on the production and design of high-risk plastic products, have more capacity to manage or export their plastic waste and mitigate the impacts of plastic pollution within their own national borders. Conversely, LMICs are grappling with an ever-growing volume of plastic waste, most of which is too difficult to recycle - yet they are poorly placed to influence upstream global production and consumption structures to combat this. As a result, they shoulder a disproportionate share of the costs of plastic pollution.

This report estimates that while LMICs consume almost 3 times less plastic per capita than high income countries on average, over its lifecycle, the true costs of plastic are 8 times higher for low- and middle-income countries than high-income countries under present global conditions.[12,13] These costs are due to the following challenges:

93%

STUDIES HAVE SHOWN THAT 93% OF RECORDED DEATHS THAT ARE DIRECTLY ASSOCIATED WITH PLASTIC PRODUCTION OCCUR IN LMICs

x8

THE TRUE COSTS OF PLASTIC ARE 8 TIMES HIGHER FOR LOW- AND MIDDLE-INCOME COUNTRIES THAN HIGH-INCOME COUNTRIES

- **Plastic production and conversion disproportionately burdens low- and middle-income countries.** As the fossil-fuel industry increases investments, the production of primary plastic from oil and gas extraction is increasing. While activities at the beginning of the plastic value chain are dispersed globally, including the production of primary plastic and its conversion into intermediate and manufactured goods, LMICs bear some of the worst environmental and socio-economic impacts associated with plastic production. With lower capacities to regulate and enforce production, and health and safety standards, they face growing consequences of air pollution and poor working conditions, as well as threats from hazardous material spills associated with the production process. Studies have shown that 93% of recorded deaths that are directly associated with plastic production occur in LMICs.[3,4]
- **Low- and middle-income countries face disproportionately large challenges in plastic circulation and waste management.** With only limited technical and financial resources, their infrastructure has quickly been overwhelmed by a tide of plastics that were designed with no thought of how they would be reused or recycled or of their end-of-life impacts. Given the limited infrastructure for collection, sorting and recycling, the staggering volume of plastic products that enter circulation in LMICs are more prone to leak into the environment, including rivers, oceans and on land.

Plastic pollution leads to severe environmental consequences for low- and middle-income countries, with growing threats to human health. There is now so much plastic in the ocean that almost every marine species group has encountered plastic pollution, with adverse impacts observed in almost 90% of those assessed.[5] There is also growing recognition of the harmful human consequences LMICs face. The environmental burden of plastic pollution has disproportionate socio-economic consequences for these countries, including (but not limited to) livelihood impacts from environmental degradation, toxic pollution from open burning, unsafe working conditions harming waste disposal workers, and broader human health risks to communities from flooding and disease.[6] It has been estimated that the impacts of plastic pollution cost up to 1 million lives each year in LMICs.[6]

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Given the magnitude of the plastic pollution crisis, relying on national action and voluntary global measures will do little to end it or to remove inequities in the plastic value chain. Across high-, middle- and low-income countries alike, national measures such as regulatory bans on the import, sale, and use of plastics at different stages in the lifecycle are the most frequently used policy response. However, it is increasingly clear that national approaches will only have limited effectiveness in the absence of global harmonization and coordination, especially for small market jurisdictions. In part, this reflects the transboundary nature of plastic pollution, which, by definition, is best addressed using a global solution to shift the burden off individual countries and help to address global challenges more efficiently. It also reflects the complexity of the crisis, and the need to share financial and technical resources to find common solutions, from the design of safe and circular plastic alternatives, through to enforcing bans and coordinating phase-out measures. Without global harmonization and coordination, a solely bottom-up approach that relies on LMICs to implement national measures would simply increase the pressure without lowering the barriers.

1 MILLION

IT HAS BEEN ESTIMATED THAT THE IMPACTS OF PLASTIC POLLUTION COST UP TO 1 MILLION LIVES EACH YEAR IN LMICs

To effectively address plastic pollution, global rules and regulations must tackle the global inequities that are both exacerbating and being exacerbated by it. Crucially, this must target plastic at its source – through product-specific bans and phase-outs – to minimize high-risk plastic production, eliminating the possibility of it ever becoming pollution. In cases where an immediate ban is not practical, the treaty should take measures to reduce and eventually eliminate all harmful plastic products. For products that cannot practically be banned, the treaty should establish binding global measures, including design requirements, standards, targets and incentives to promote reduction, reuse, recycling, and circularity. To complement these reduction policies, global efforts must also support enhancements to waste management systems.

Negotiations to develop a global treaty as part of the International Negotiating Committee (INC) on plastic pollution must target the most ambitious options. As countries and actors come together to end plastic pollution, these negotiations represent a pivotal opportunity to catalyse systemic change and promote equity across the entire plastic value chain. By doing so, there is potential to unlock global innovation and opportunity by unleashing a coordinated and safe circular economy. There is also potential to empower all governments to regulate global markets more effectively, in particular those that have no power over them today. However, there is a risk of compromise. Many of the options included in the treaty's first draft are weakly phrased and contain few specific obligations, which rather than creating common global regulations, would place the burden of solving the plastic pollution crisis on individual governments. In this scenario, the international community will lose out on the benefits of harmonized global rules, and LMICs will lose out on the benefits of being able to share their burdens. Attempts to spell out in minute detail how governments should achieve their individual goals individually through national action plans, rulebooks and implementation guidelines represent an overly prescriptive and fundamentally flawed model of multilateral environmental governance: the risk is that it will create a new layer of conditions for developing countries' implementation efforts without creating a true joint global effort. Achieving equity in the plastic value chain requires, instead, a commitment to common binding obligations and control measures, while giving countries flexibility in determining how to implement these obligations and control measures at a national level. Global measures cannot be watered down such that they neglect the urgency and importance of the issue at hand. It is time for all countries and negotiators to dial up their ambition and finalize a plastics treaty that reflects this.

CHAPTER 1

STRUCTURAL INEQUITIES IN THE GLOBAL PLASTIC VALUE CHAIN

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The absence of common global measures across the plastic value chain has generated structural inequities that penalize LMICs

Across the value chain, plastic pollution is a transboundary problem that affects all countries with increasing severity. From local beaches to the remote Arctic, the consequences of plastic pollution in our lands, rivers and ocean are far-reaching and universal. The cumulative mass of all produced plastics now surpasses the combined mass of all land and sea animals alive today.[7] As the equivalent of 2 million garbage truckloads of plastic are dumped into the environment every year,[8] it's no surprise that plastic has been found in all of Earth's ecosystems. Despite growing awareness and attention to plastic pollution, the problem has been worsening, with global plastic production surging over the past two decades – the amount of plastic manufactured between 2003 and 2016 exceeds the entire production output of the 20th century.[5] If no action is taken, primary plastic production is expected to increase by 66% by 2040, resulting in an increase in waste mismanagement of up to 90%.[1]

The growing plastic crisis reflects the absence of global rules and regulations. Plastic's versatility, durability, and affordability have made it a major component of daily life worldwide. However, with plastic pollution in the global ocean at record levels[8], the extent of the associated human and environmental impacts is yet to be fully realized. This worsening problem reflects the absence of a dedicated global governance structure, and the resulting accountability gap in global management across the plastic value chain. Current policies comprise a fragmented patchwork of national and non-binding regulations that have failed to effectively address the issue.[9,10] As a result, the global plastic value chain faces a range of system failures, including a lack of common obligations to prohibit avoidable harmful products and materials across all markets; an absence of accountability mechanisms for producers across the transboundary plastic value chain; a lack of global standards for sustainability, safety and circularity in product design; and a general lack of technical capacity, knowledge sharing and collaboration among actors. In the absence of a comprehensive global system, with binding obligations targeting the most high-risk products, plastic production and consumption is increasing at an unrestrained rate. Notably, policies that incentivize plastic production, including subsidies for oil exploration,[11] have caused a significant surge in plastic production and consumption while neglecting the social and environmental costs of plastic pollution. As the crisis continues to worsen, the impacts of plastic pollution on people and environments in all countries will become more severe.

Regulatory fragmentation across the plastic value chain gives rise to structural inequities that disproportionately burden low- and medium-income countries. From the production of primary forms of plastic such as granules and powders, to the management of plastic waste, the plastic value chain creates a range of harmful environmental impacts that also cause severe human impacts. This is driven by the absence of governance and control structures across the plastic value chain, but it also reflects the highly globalized nature of the plastic products produced, consumed and disposed of. As a result, plastic pollution negatively impacts all states, from high-income countries (HICs) to LMICs. However, it is LMICs – especially the lowest income countries (LICs), SIDS, and marginalized groups and communities – that are the most impacted. While LMICs consume almost 3 times less plastic per capita than HICs on average,[12,13] they suffer some of the most acute environmental and socioeconomic consequences of plastic pollution – and there's little sign of improvement. For example, African countries, most of which are LMICs, produce and consume less than 5% of global plastic volumes, yet they are severely and disproportionately impacted.[14] This uneven burden of plastic waste can be traced to **three key structural inequities** in the plastic value chain:

STRUCTURAL INEQUITY #1:

Non-plastic-producing LMICs and SIDS have little to no influence on international plastic production. In the absence of a global system governing plastic production, the overproduction and excessive consumption of virgin plastic is likely to continue unabated. As of 2019, only 9% of global plastic waste was recycled, and as fossil fuel industries increase investments into plastic production, the price of primary plastic will become competitive with the price of recycled plastic.[13,15] Consequently, increasing volumes of plastic waste will continue to be generated – and this cannot be effectively addressed under the current fragmented plastics governance structure. Production decisions are largely concentrated in the hands of countries with extensive plastic production and manufacturing industries, which can mostly be traced to multinational industrial actors headquartered in HICs. Typically, these countries have the technical and financial capacities to dispose of plastic in environmentally sound ways, or simply export it to other countries. As such, they're less burdened by the environmental and human consequences of plastic pollution than non-producing LMICs and SIDS. Without any rules in place globally, LMIC governments can neither predict nor control the design and production of plastic items that arrive in their markets and can do nothing to make businesses outside of their borders or jurisdictions responsible for upstream solutions. Even the avoidable and most problematic products – from single-use packaging to those containing intentionally added primary microplastics – continue to be sold and imported by LMICs, despite efforts to ban them by some national governments. As a result, high-risk and problematic plastics continue to arrive in LMICs, without consideration for how these nations can manage them. Specifically, the design and composition of many of these plastics make them particularly difficult to manage, as incineration or recycling can release harmful chemicals such as halogens, dioxins and furans.[16]

AS OF 2019, ONLY

9% OF GLOBAL PLASTIC WASTE WAS RECYCLED

BY 2040, IF NO ACTION IS TAKEN, PRIMARY PLASTIC PRODUCTION IS EXPECTED TO INCREASE BY

66%

RESULTING IN AN INCREASE IN WASTE MISMANAGEMENT OF UP TO

90%

STRUCTURAL INEQUITY #2:

LMICs and SIDS have limited capacity to manage growing volumes of plastic waste. As global plastic production and consumption accelerates, LMICs face the impossible task of handling a volume of plastic waste that far exceeds their ability to safely handle it. Many of the waste management approaches common in HICs, such as incineration or exporting waste to other countries, are simply not viable long-term solutions for LMICs. Limited waste management infrastructures mean that LMICs suffer from high rates of plastic waste leakage and are heavily reliant on unsafe practices such as open burning and dumping. Although waste management is often the highest single budget item for local municipalities in LMICs, rates of waste mismanagement are nearly double the global average.[17] This is compounded by the fact that many LMICs, especially SIDS, are further impacted by transnational waste that washes up on their shores, in addition to waste generated locally or from international imports – this is explored in more detail in the example of Fiji below. The investments required to expand waste management infrastructure to meet the growing tide of plastic waste facing LMICs are prohibitive, estimated by the OECD to be around US$26 billion annually.[10] While the struggles LMICs face to manage plastic waste reflect their limited resources, it's clear that the unequitable burden of pollution they face can only be addressed through reducing the amount of waste generated, rather than focusing solely on increasing their waste management capacity.

STRUCTURAL INEQUITY #3:

There is no mechanism to share accountability for the costs of plastic pollution. Despite the visible harm that plastic pollution inflicts on the environment around the world, and particularly on its most vulnerable groups and communities, there is no accountability during production, and no clear shared vision for a circular and non-toxic plastic value chain. There is no compensation mechanism for the damage that the production and trade in harmful plastic goods does to the environment and society: this disproportionately harms LMICs and SIDS, who are faced with far higher costs relative to their capacities to respond to plastic pollution.

STRUCTURAL BARRIERS IN WASTE MANAGEMENT IN LMICS: A FOCUS ON FIJI

Fiji, like many other SIDS, is being hit hard by the impact of transnational plastic waste. Fiji is an archipelago with a combined coastline of 1,129km, where the coastal towns and cities of its two main islands, Vanua Levu and Viti Levu, are home to around half of Fiji's population.[18] Geographically, Fiji's location in the Pacific Ocean places it at the intersection of several major ocean currents. While this positioning makes Fiji a popular tourist destination due to its rich biodiversity,[19] the currents also bring in a great deal of marine plastic debris. The accumulation of plastic in the ocean surrounding Fiji is posing a growing threat to its precious physical environment, from the ingestion of microplastics by fish through to the entanglement of plastic waste in marine ecosystems. Studies have shown that corals entangled in plastics, for example, have almost a 90% likelihood of suffering from disease, which is 20 times higher than corals without plastic contamination.[20,21] This immense waste management challenge, with limited resources for coastal cleanup and disposal, poses a long-term threat to Fiji's tourism industry – which the country is relying on to restore its economy to pre-pandemic levels by 2024.[22]

While Fiji is heavily dependent on tourism for its economy, the growing number of visitors is adding pressure on its ability to manage waste. Tourism contributes up to 40% of Fiji's GDP, and provides more than 100,000 jobs – as much as 45% of the labour force.[23] However, tourists also generate seven times more plastic waste per person per day than Fiji's residents.[24] With the number of tourists arriving in Fiji reaching pre-pandemic levels,[25] this is generating vast quantities of plastic waste. The growing consumption and disposal of single-use plastic products, such as bottles, bags, nappies and sanitary products, are overburdening Fiji's waste management capacities, resulting in higher levels of plastic pollution.[24] These impacts are increasingly recognized, with nearly 80% of local respondents to a recent survey saying they see plastic as a direct threat to the island's tourism industry.[24]

The influx of plastic is compounding Fiji's waste management challenges. Recognizing the environmental and socioeconomic harm that plastic pollution poses, Fiji has developed environmental legislation, regulation and strategies for solid waste management. However, its relatively small population and economic scale restrict its ability to invest in and maintain large-scale recycling and waste management facilities. Capacity constraints mean that only one of Fiji's eight disposal sites entirely satisfies current environmental standards, meaning that the island suffers a plastic leakage rate of 25%.[26] Faced with rapidly growing levels of plastic waste, this equates to nearly 4,000 tonnes of plastic pollution each year[27] – the equivalent of 80 swimming pools filled with 500ml plastic water bottles.[b] Furthermore, Fiji has struggled to establish viable recycling markets due to its remote location, limited scale and a lack of investment, constraining its ability to process recyclable materials and increasing its reliance on landfilling and burning of waste.[26]

SIDS consume less plastic than other countries, yet they end up flooded with tides of waste from other jurisdictions – and their geographical, infrastructural and economic limitations mean they face unique and disproportionate challenges in managing it.[28] Addressing these structural barriers requires international collaboration for a global treaty on plastic pollution. By focusing on upstream and downstream drivers, a global treaty can help address the burden of plastic pollution in SIDS like Fiji, including through imposing global bans on harmful single-use plastics that wash up on beaches, building recycling capacity and finance from extended producer responsibility (EPR) schemes, and introducing reuse requirements (e.g. refill container deposit schemes) that reduce plastic waste.

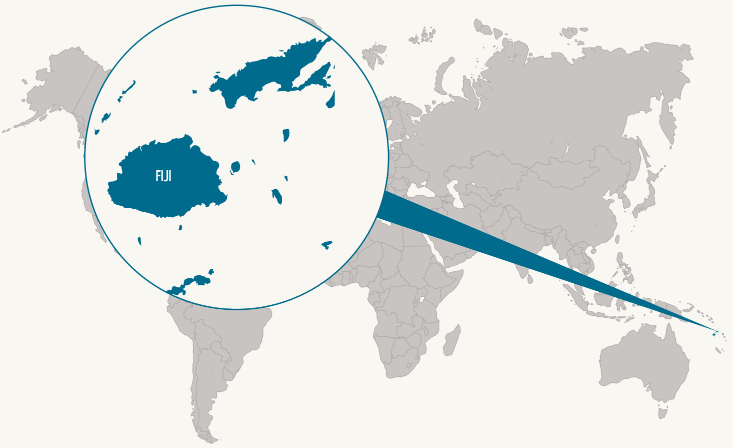
TOURISM CONTRIBUTES UP TO

40%

OF FIJI'S GDP, AND PROVIDES OVER

100,000

JOBS - AS MUCH AS 45% OF THE LABOR FORCE.



TOURISTS GENERATE

7 TIMES

MORE PLASTIC WASTE PER PERSON PER DAY THAN A FIJIAN RESIDENT DOES.

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CHAPTER 2

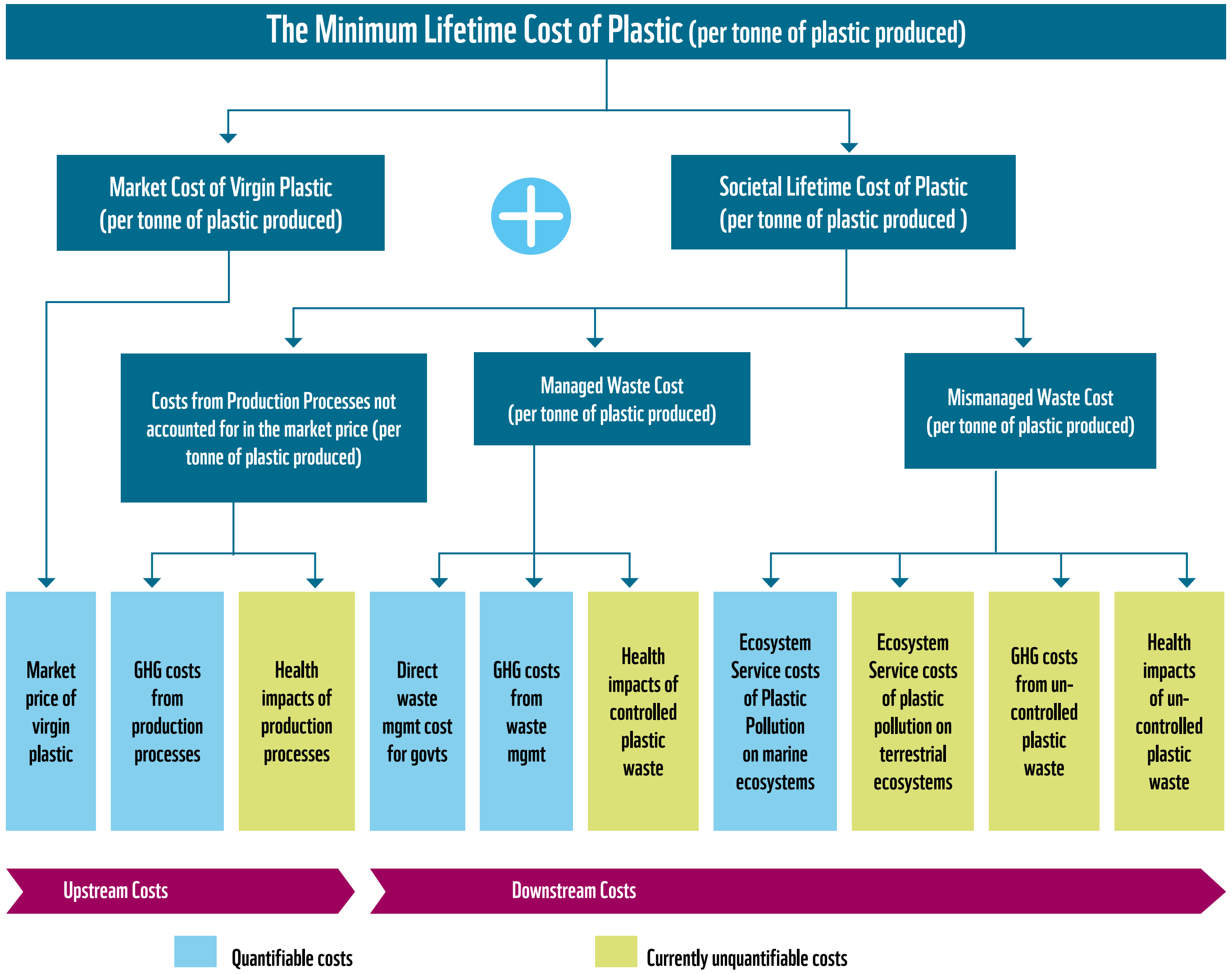
THE TRUE COST OF PLASTIC

These inequities make it 8 times more expensive for LMICs to deal with plastic pollution than for HICs

As a result of the structural inequities in the plastics value chain, LMICs incur a disproportionate burden from plastic pollution. Without an ability to regulate global production and ensure accountability, LMICs, especially SIDS and LICs, are faced with a growing volume of plastic waste that exceeds their technical, technological and financial capacity to manage it. This means that the current global plastics value chain has disproportionate impacts on LMICs, such that the same plastic products will have costs that are far greater for LMICs than for HICs. While many of these costs cannot be quantified, reflecting gaps in available data and current understanding of the full impact of plastic pollution, Dalberg has nevertheless developed a model to illustrate these disproportionate impacts in which some of the costs are quantifiable. Considering the lifecycle of a standardized kilogram of plastic, in no specific composition or form, this model compares how costs upstream during production, and downstream as waste management, accrue to HICs and LMICs respectively. A summary of the model is shown below in **Figure 1**.

LMICs incur 8 times more cost than HICs from 1 kilogram of plastic across its lifetime, reflecting a stark difference in the impacts this plastic has on marine ecosystem services. Across the value chain, plastic gives rise to a range of human and environmental costs in the countries in which it is produced, consumed and disposed of. The key differences in costs between HICs and LMICs are downstream, as presented in **Figure 2**, reflecting the higher risks of plastic being mismanaged and the subsequent costs this has for marine environments.

Figure 1: Quantifiable and unquantized costs used in the 1 kg plastic model



Differences in quantifiable upstream costs are minimal:

- **Market price:** The market price of a kilogram of plastic, weighted across the most common plastics by production share, is estimated to be US$1 in both HICs and LMICs.
- **Greenhouse gas (GHG) emissions costs:** While the production of primary plastics and their conversion into products may give rise to a range of human and social costs in host countries, the only quantifiable upstream cost is the greenhouse gas (GHG) emissions associated with plastic production, estimated to be US$0.4 per kilogram of plastic for HICs and LMICs alike.

LMICs face significantly higher downstream costs, reflecting high rates of plastic leakage and corresponding marine ecosystem impacts:

Quantifiable downstream costs are split between managed plastic waste and mismanaged plastic waste.

- **Managed plastic waste:** GHG costs, and national income-adjusted running costs of end-of-life activities are similar for HICs and LMICs, at US$0.5 and US$0.3 respectively, with the slightly higher cost in HICs reflecting the higher proportion of waste that is successfully managed.
- **Mismanaged plastic waste:** The 8x cost multiplier in LMICs arises from the costs of mismanaged waste: there are significantly higher waste mismanagement rates in LMICs. This results in a cost of US$149 for LMICs calculated in terms of lifetime damage to marine ecosystem services, compared to US$17 for HICs.

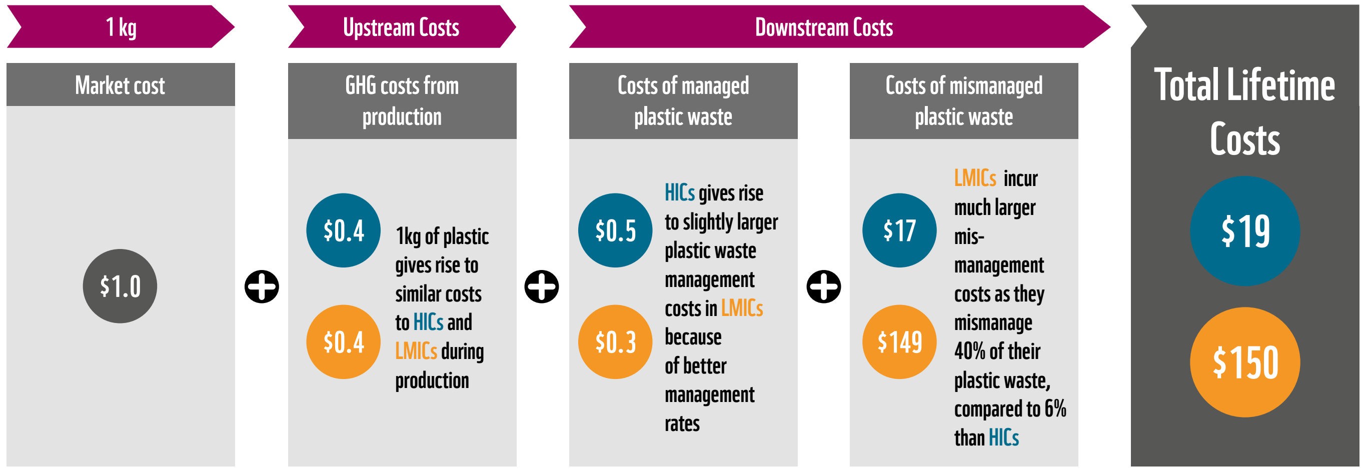
On the basis of these quantifiable figures, the total lifetime cost of a kilogram of plastic in LMICs is around US$150 – as summarized below in **Figure 3**, this is eight times higher than the US$19 incurred by HICs. In LICs these costs are more than 10 times higher, reflecting their even lower capacities to manage plastic waste, and the consequently greater reduction of marine ecosystem services.[c]

Although unquantifiable, the burden of plastic pollution on LMICs spans multiple environmental and socioeconomic dimensions, and the full extent of the impact borne by LMICs compared to HICs is likely to be far greater. This reflects the fact that other costs – both upstream and downstream – are currently unquantifiable and have not been used in the calculation.[d] Crucially, these include many of the human health and economic costs that LMICs face, which are rapidly emerging as pressing issues. The full range of upstream and downstream costs is explored in more detail below.

The upstream processes of plastic production and conversion, while widely dispersed, disproportionately impact LMICs. A complex interdependency exists between HICs and LMICs at various stages of the plastic value chain. The production of primary forms of plastic from fossil fuels, stemming from oil and gas refining processes, tends to be concentrated in oil and gas producing nations – primarily HICs such as the USA and Saudi Arabia.[29] Further down the value chain, conversion of primary forms of plastic (e.g. granules) into intermediate plastics and manufactured goods (e.g. single-use plastics and fishing gear) is more dispersed globally. Large LMICs such as India, Indonesia and Thailand are among the main exporters of intermediate manufactured goods, while HICs like Germany, the USA and Japan lead in exporting final manufactured plastic goods.[29] China is the largest exporter of both intermediate and manufactured goods. Although policymakers, including in some LMICs, have often regarded plastic production and product conversion as attractive industries in national development strategies, the severe environmental and socioeconomic consequences that arise from this are increasingly being recognized. Although these consequences – notably from air pollution and material leakages – are experienced by countries and communities all around the world, it is LMICs that are bearing the worst human and environmental impacts.

Communities in LMICs suffer greater exposure to air pollution from plastic product conversion and manufacturing. In LMICs, where regulation and enforcement of environmental safety standards in production are often less stringent, and where technologies to mitigate the effects of harmful chemicals (e.g. scrubbing or filtration of waste production gasses) are less common, the negative consequences on human health are disproportionately high. According to one study, 93% of recorded deaths that are directly associated with plastic conversion and disposal are in LMICs.[3,4] It's often the most vulnerable groups and communities, particularly in LMICs, that suffer the most. Frequently, these communities have limited access to healthcare, making them particularly susceptible to the health impacts of air pollution – especially since they're likely to be employed in or live near sites of plastic production or product manufacturing, placing them on the frontlines of exposure to harmful chemicals and contaminants in their surrounding environments. In addition, at the global level, the contributions of plastic processes to global carbon emissions are also well recognized, generating 1.8 billion tonnes in 2019 – with 90% of this resulting from production processes.[13]

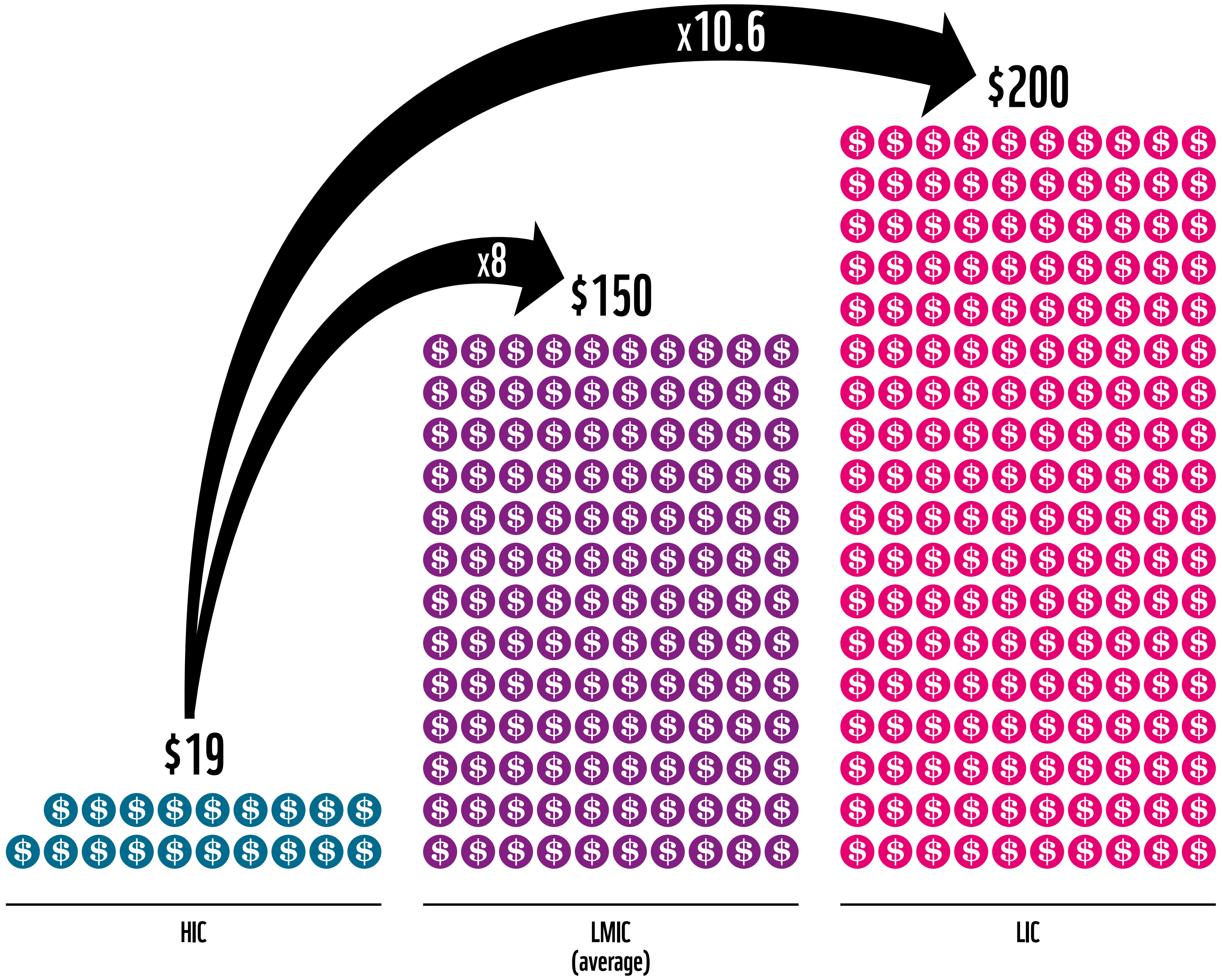
Figure 2. Breakdown of the lifecycle costs for a kilogram of plastic in HICs and LMICs.



LMICs are also particularly vulnerable to leakages of pre-production materials. During the production of primary plastic forms, several risks are borne by local communities. A particularly harmful pollutant is pre-production plastic pellets, also known as "nurdles", that are transported regionally or globally to manufacturers or compounders who produce a finished plastic article. Plastic nurdles are prone to spillage, with an estimated 230,000 tonnes leaking into the ocean annually.[30] Once leaked into the environment these primary microplastics are unlikely to be recovered, and they're known to cause impacts from leaching into terrestrial and marine ecosystems through to ingestion and bioaccumulation in the food chain. Plastic nurdles are transported globally, so both HICs and LMICs are vulnerable to these hazards; however, these incidents have a disproportionate impact on LMICs and coastal communities, who are often highly reliant on marine ecosystem services. This was evidenced by the recent X-Press Pearl incident in Sri Lanka: as hundreds of tonnes of oil and plastic leached into the ocean, there were devastating consequences for the nearby marine and coastal environments.[31] The effects were acutely felt at the human level, as local communities that depended on fishing and other marine industries were faced with severe disruptions to their livelihoods.

Plastic waste management brings a significant burden for LMICs. As global plastic production and consumption has increased relentlessly over the past two decades, so has the level of waste generated. Global plastic waste generation more than doubled from 2000 to 2019, to 353 million tonnes.[13] Waste management processes – from collection, sorting, and disposal through landfilling to incineration – are prone to a range of system vulnerabilities that enable plastic to leak into nearby coastal, terrestrial or marine environments. Globally, around 20% of plastic waste evades waste management systems entirely, and goes into uncontrolled dumpsites, is burned in open pits, or ends up polluting terrestrial or aquatic environments.[13] The struggle

Figure 3. Comparison of the total lifetime cost of a single 1 kg block of plastic in HICs, all LMICs, and LICs.



to manage plastic waste is heightened for LMICs. Although local municipalities in LMICs spend up to 20% of their budgets on waste management, over 90% of their waste is still openly dumped or burned.[13,32] With waste management systems strained by an influx of plastic products that were designed without consideration for safe management, LMIC governments are faced with difficult financial decisions, with more waste management funding hindering their capacity to invest in other development areas such as education and healthcare.

Plastic pollution has severe environmental consequences, especially in the most vulnerable SIDS and LICs. Ocean plastic leakage is a large and growing problem, driven by the combined effects of direct dumping and leakage from rivers and terrestrial sources. There is now so much plastic in the ocean that almost every marine species group has encountered it, with adverse impacts observed in almost 90% of assessed species.[5] Marine plastic pollution is a particular problem for LMICs: two rivers in Southeast Asia alone are responsible for almost 8% of global marine plastic pollution.[27] LMICs are particularly exposed to the adverse effects of plastic pollution, given the volume of plastic that leaks into the surrounding ocean, and given that they're home to much of the planet's most precious maritime biodiversity.[5] This pollution threatens marine wildlife as a consequence of direct entanglement, ingestion or smothering, but also through toxic chemicals leaching into the ocean as plastic degrades.[5] As highlighted in the case study of **Brazil**, the release of secondary microplastics poses a high threat to natural ecosystems and the populations that depend on them.

FROM BASIN TO COAST: A CASE STUDY ON PLASTIC POLLUTION'S IMPACT ON BRAZIL

Growing plastic consumption in Brazil is overwhelming limited waste management infrastructure.

Brazil's contribution to global plastic production is minimal, with the Latin America and Caribbean region as a whole accounting for less than 5% of the total.[33] Yet plastic consumption in Brazil is increasing, with 10.33 million tonnes of plastic entering the Brazilian domestic market each year. On top of this, Brazil is importing plastic waste from other countries at an increasing rate: it's estimated that Brazil imports 12,000 tonnes of plastic waste each year, growing at a rate of over 7% annually.[34] As domestic and internationally generated waste increases, so too does the amount of plastic waste that is mismanaged.[35] According to a new study, Brazil could be the fourth largest generator of plastic pollution in the world,[36] with over a third of its plastic mismanaged each year – the equivalent of each inhabitant littering more than 1,500 plastic bottles into the environment annually.[36]

The rising burden of plastic pollution in Brazil reflects several system gaps, notably the limited infrastructure coverage and capacity for collection and sorting in populous coastal communities and capital cities (e.g. São Paulo and Rio de Janeiro).[35] Brazil, like many other LMICs, faces high costs for upgrading infrastructure and capacity for collection, sorting and recycling. Currently only 22% of Brazilian cities selectively collect waste for recycling,[37] and most of this is done by some 281,000 informal waste pickers who live in poverty and are highly susceptible to health issues as a result of their day-to-day work.[38]

Brazil's precious coastal ecosystems bear the brunt of this plastic pollution.

Brazil's extensive coastlines encompass diverse marine habitats, sustaining livelihoods and biodiversity. These ecosystems are intertwined with the lives of local communities, who rely on healthy marine ecosystems for resources and cultural heritage. As more plastic waste leaks into the ocean, both the people and the wildlife native to Brazil's coasts are suffering the consequences.

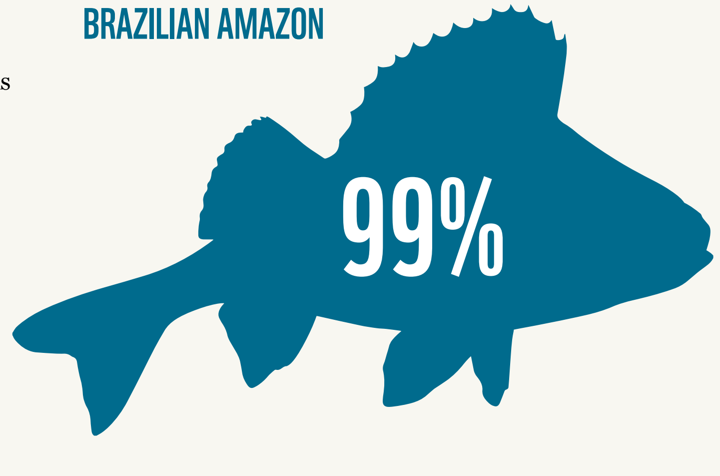
As plastic products degrade and leach into Brazil's rivers and waterways toward the coast, primary and secondary microplastics are threatening precious coastal ecosystems. A study which examined six distinct Brazilian mangrove soils revealed extensive microplastic pollution, averaging 10,000 occurrences per kilogram of soil. This level is notably elevated compared to global studies, where values rarely surpass 2,000 occurrences per kilogram, even in heavily impacted estuarine environments. Alarmingly, high levels of microplastics have been found in remote mangroves on Brazil's coast, underlining the ubiquity of these pollutants.[39] At the same time, on islands off Brazil's coast such as Trindade Island, ocean currents have been washing up plastic litter and discarded fishing gear from the mainland. These plastic particles have been incorporated into the natural rocks to resemble igneous rock (so called "plastistones")[40] – this is a stark indication of the human-induced disruption to Earth's natural processes.

Brazil's Amazon Basin, one of the most biodiverse places on Earth, is also threatened by plastic pollution.

The Amazon Basin encompasses almost 60% of Brazil (Amazônia Legal),[41] hosting unparalleled biodiversity and serving as a critical global carbon sink. While research on plastic pollution in the Amazon Basin is scarce compared to coastal ecosystems, there's increasing evidence of a growing threat. Recently, scientists have found evidence of microplastics ingestion in almost 99% of 14 freshwater fish species in the eastern Brazilian Amazon.[42] This threatens the future of native species in the Amazon, as well as the fishery that more than 3.5 million people rely on.[43] Since fish is a vital food source, the risks of microplastic contamination have serious long-term implications for human health.[44]

And this isn't the only way plastic is harming marine wildlife in Brazil. Abandoned, lost or discarded fishing equipment – known as "ghost gear" – is having profound adverse effects. A study in the western Brazilian Amazon showed that at least 40% of recorded dolphin-fishing interactions involved entanglement with ghost gear previously used for commercial fishing.[45] Without the introduction of global policies to control plastic use and a full lifecycle approach to managing fishing gear, the environmental impacts of plastic pollution in Amazonian rivers will continue to get worse.

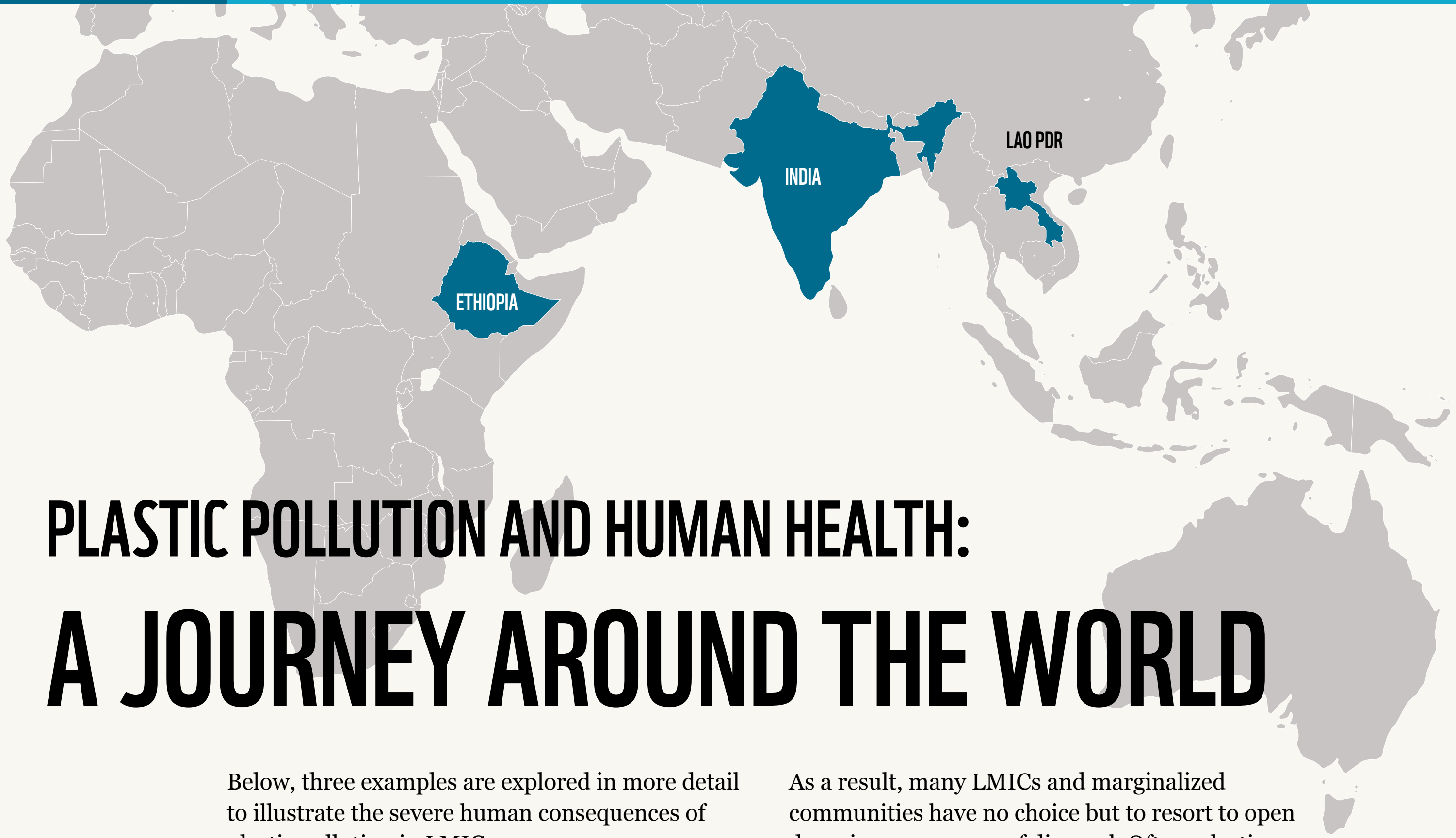
SCIENTISTS HAVE FOUND EVIDENCE OF MICROPLASTICS INGESTION IN ALMOST 99% OF 14 FRESHWATER FISH SPECIES IN THE EASTERN BRAZILIAN AMAZON



Brazil's commitments to end plastic pollution will have significance in Brazil and beyond and can be supported by a treaty that contains binding upstream measures.

In a recent demonstration of regional cooperation, Brazil took a significant step toward tackling plastic pollution by signing the Belém Declaration, along with other state leaders in the Amazon Treaty Cooperation Organization (ATCO).[46] The primary focus of this regional commitment is to confront the pressing challenges that the Amazon rainforest faces and highlight its crucial role in addressing the climate crisis. Specifically, the signatories commit to implementing immediate actions aimed at eliminating plastic pollution in soil and water, with a particular emphasis on Amazonian rivers.

To realize this ambitious commitment, it's clear that action needs to be taken at the source to limit the flow of domestically produced and imported plastic products, alongside efforts to enhance waste management infrastructure. Brazil can greatly benefit from a well-coordinated global response, in the form of a global treaty on plastic pollution that combines effective upstream regulations, including bans on the highest-risk products and global standards for circular product design, alongside mechanisms for sharing technical and financial resources for waste management. In line with Brazil's commitments to climate and biodiversity, the treaty presents a pivotal opportunity for Brazil to take decisive action and assume a leading role in the effort to end plastic pollution.

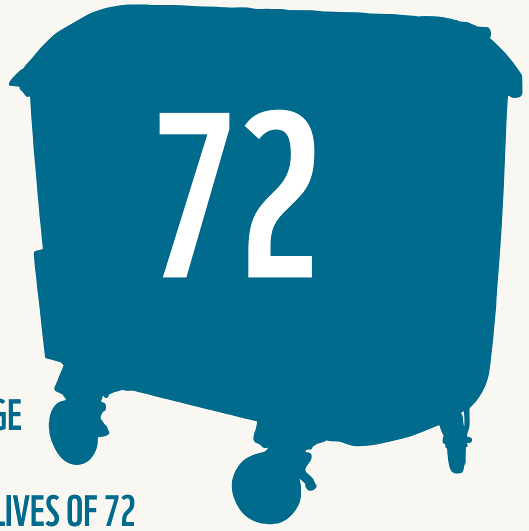


PLASTIC POLLUTION AND HUMAN HEALTH:
A JOURNEY AROUND THE WORLD

Below, three examples are explored in more detail to illustrate the severe human consequences of plastic pollution in LMICs:

Informal garbage dumps and garbage landslides (Ethiopia, Africa)

The increasing quantity of single-use, problematic and unnecessary plastic products, designed and produced with little regard for the capacity of LMICs to collect and sort them, are challenging the ability of LMICs to manage them through safe, formal channels. Many of these products are designed with mixed materials, which make them difficult to sort and reuse or recycle.



KOSHE GARBAGE LANDSLIDE
CLAIMED THE LIVES OF 72
INDIVIDUALS FROM MARGINALIZED GROUPS AND COMMUNITIES LIVING IN SETTLEMENTS ON THE OUTSKIRTS OF ADDIS ABABA

As a result, many LMICs and marginalized communities have no choice but to resort to open dumping as a means of disposal. Often, plastic waste is mixed with other types of household and municipal waste, further hindering the possibility of recycling and reusing it. In the absence of proper regulation and enforcement, these garbage mounds become unstable and dangerous for the informal workers who work on them, and communities who live nearby. Frequently, these hazards are exacerbated by businesses taking advantage of lax law enforcement to avoid landfill fees and regulations.

The prevalence of unstable mounds of plastic and other waste in informal dumps poses a direct threat to human health. A severe example of this is the Koshe garbage landslide that struck Ethiopia in 2017. The landslide claimed the lives of 72 people from marginalized groups and communities living in settlements on the outskirts of Addis Ababa, displacing nearly 300 to temporary shelters.[96]

This incident underscores the perilous living conditions faced by those residing near such hazardous sites. While rehabilitation projects led by UN-Habitat and the government of Japan have attempted to combat this risk at the Koshe dumpsite through the utilization of semi-aerobic landfill disposal technology, the dumpsite is still expanding from the outskirts into the inner city. With over 3,600 tonnes of mixed waste added every day the risk of landslides continues; alongside additional human health risks including airborne and waterborne exposure to toxic chemicals, infectious diseases and respiratory ailments, perpetuating a cycle of poor health and vulnerability.[50]

EVERY YEAR IN LAOS THERE ARE

4,400

DEATHS ATTRIBUTED TO HOUSEHOLD AIR POLLUTION - THESE ACCOUNT TO ALMOST 10% OF ANNUAL DEATHS IN THE COUNTRY.

Open air burning and health implications (Lao PDR, Southeast Asia)

As with open dumping, open burning is common in many LMICs whose formal waste management services are overwhelmed by plastics. In fact, this practice extends beyond plastics, and is also common in e-waste dumps, where informal workers burn cables to recover valuable copper wires for sale in the scrap metal sector. Additionally, impoverished communities living without access to electricity or alternative energy sources often resort to burning plastic waste and other materials like tires for heating and cooking purposes.

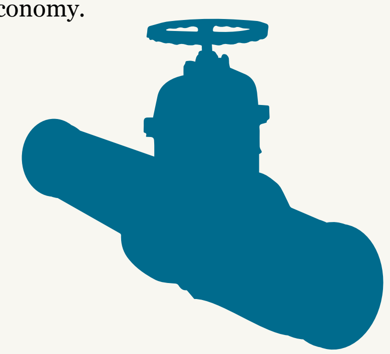
The prevalence of open burning is highest in LMICs such as Lao PDR, where approximately one-third of the citizens burn their waste.[51] This reflects two critical structural gaps: i) there's a lack of global regulation underpinning the sustainable production of plastic products, particularly with safe disposal in mind; and ii) there are not enough global behaviour change programmes to educate and mobilize communities in sustainable waste management practices. Due to these global system failures, the prevalence of open burning contributes significantly to the release of harmful pollutants into the atmosphere. According to a 2020 World Bank report, every year in Lao PDR there are 4,400 deaths attributed to household air pollution, accounting for almost 10% of all deaths in the country.[52] The impact of air pollution on human health extends beyond mortality, with respiratory diseases and cardiovascular complications driving a decline in public health and well-being.

Plastic blockages, flooding and disease (India, South Asia)

Beyond the threats they pose to wildlife and ecosystems, single-use products such as plastic bags can increase the likelihood of flooding. LMICs bear the brunt of this, given that they face high seasonal flood risks and battle against higher levels of plastic leakage – especially from plastic bags, which are susceptible to leakage from unsecured dump sites due to their light weight and tendency to disperse in wind and rain.

Plastic waste obstructs waterways and drainage systems. This increases the severity of flooding and its associated hazards, particularly during monsoon seasons. Beyond the direct threat of rising flood water and risks of drowning, flooding worsens the spread of disease, as stagnant floodwater creates an ideal breeding ground for waterborne diseases such as cholera and diarrhoea, endangering the health of countless individuals.

In July 2005, a flood in Mumbai, the capital city of Maharashtra, claimed the lives of more than 1,000 people[53]. The severity of this flood was, in part, due to the amount of plastic waste that was obstructing the city's drainage systems. And it's only gotten worse. In 2018, research showed that Mumbai was dumping 80 - 110 metric tonnes of plastic waste into drainage systems and water channels. Since then, the State of Maharashtra has joined the World Economic Forum's Global Plastic Action Partnership to help raise awareness among citizens and businesses. Building on this global commitment, a binding global treaty will help tackle the problem of plastic at the source, reduce the severity of natural disasters and the harm they cause to people in LMICs and support a thriving healthcare system and economy.



IN 2018, RESEARCH SHOWED THAT MUMBAI WAS DUMPING

80 - 110 METRIC TONNES

OF PLASTIC WASTE INTO DRAINAGE SYSTEMS AND WATER CHANNELS.

Plastic pollution is increasingly threatening the health of terrestrial ecosystems. As waste management systems have struggled to keep pace with the increase in plastic waste, many LMIC groups and communities have no alternative but to dispose of plastic waste through open dumping or open burning. This threatens the health of terrestrial ecosystems, as plastic waste that is burnt or dumped is prone to degrading and dispersing over large distances, increasing the risk of ingestion by wildlife. These plastics degrade very slowly and can release hazardous toxic chemicals into the soil (e.g. phthalates) which damage habitats, affect soil fertility and fauna, and can reduce agricultural productivity.[47,48]

The environmental burden of plastic pollution has disproportionate human consequences in LMICs. The accumulation of plastic within both aquatic and terrestrial ecosystems in LMICs inevitably has serious implications for human health, especially in marginalized groups, communities and countries. Mismanaged municipal waste, specifically high-risk plastics, is creating a growing public health emergency for LMICs. Research suggests that diseases related to mismanaged waste cause up to 1 million deaths annually in LMICs.[6] In addition, and as outlined below, LMICs are vulnerable to a range of health hazards relating to mismanaged waste, such as air pollution from open burning, flooding from plastic waste blocking waterways, and landslides from uncontrolled dumpsites. Beyond human health, plastic pollution can have wider human consequences – plastic pollution in natural environments can impact Indigenous communities' spiritual practices. This growing threat to human health and well-being exists beyond a local scale, also having broader implications for national and regional sustainable economic development.[49]

Plastic pollution is threatening the livelihoods of vulnerable groups and communities in LMICs. As well as its direct impacts on human health, the accumulation of plastic pollution in LMICs is leading to a range of longer-term socioeconomic impacts that LMICs are disproportionately affected by. While waste management, especially through informal channels, is a large source of employment among certain community groups, the rising levels of plastic pollution in LMICs is threatening other vital sources of livelihoods. In rural LMIC communities, where populations have few alternative ways of disposing of plastic goods, open burning and dumping in fields and inland waterways is building long-term threats to the viability of agricultural livelihoods that communities depend on. The leaching of hazardous chemicals from plastic pollution, as well as the breakdown of plastic into smaller microplastics, can cause changes in the physio-chemical properties of soil with impacts such as reduced root growth and nutrient uptake. Stunted plant growth and reduced crop yields threaten the viability of surrounding communities' livelihoods, especially those that operate around the subsistence line. If unaddressed, terrestrial plastic pollution can lead to longer-term socioeconomic fallout from reduced food security and lower incomes.

Marine plastic pollution poses an elevated threat to marine industries that LMICs depend on. Estimates suggest that a year's worth of marine plastic pollution causes a lifetime loss of up to US$4.2 trillion in marine ecosystem services,[54] directly threatening the employment of the 31 million people globally whose jobs depend on marine ecosystems.[55] In LMICs, especially within coastal communities, the increasing presence of plastic waste has profound repercussions for fishing, tourism and aquaculture. Pollution caused by fishing itself (e.g ghost gear) makes up 10-50% of marine plastic pollutants by mass.[56] This plastic pollution harms tourism, as people are less likely to visit areas marred by litter. Consequently, beaches and tourist destinations strewn with litter incur higher cleanup costs and suffer diminished revenues from tourism. Plastic pollution has significant consequences for fisheries, as evidenced in **Mozambique**, where disruptions to coastal livelihoods are threatening job and food security.

CASE STUDY

PLASTIC POLLUTION IN FISHERY INDUSTRIES IN COASTAL COMMUNITIES OF MOZAMBIQUE

Mozambique's marine industries are increasingly threatened by plastic pollution. The escalating issue has raised global concerns, particularly in LMICs with coastal communities which rely on valuable marine ecosystems for their employment and livelihoods. Mozambique, a nation in southeastern Africa with a coastline of 2,770 km, is one of the countries that suffers the detrimental impacts of plastic pollution on marine industries, most notably fisheries.[57] Mozambique is not a major producer of plastic, and remains primarily dependent on imported plastic products, from single-use plastics through to plastic fishing gear. Plastic waste is almost entirely disposed of in unsanitary, unsafe dumps, with less than 1% being recycled.[58] With limited options for managed waste disposal, Mozambique has one of the highest plastic leakage rates in Africa – nearly 10% of plastic waste generated finds its way into the marine environment.[59]

The impacts of plastic pollution on Mozambique's fisheries, particularly small-scale artisans, are causing job and food security risks. The coasts are home to 66% of Mozambique's population, many of whom rely on fishing as a primary livelihood.[60] On a national level, marine plastic pollution is costly to fisheries, with estimated damages of MZN 347 million in 2017 (US$5.5 million).[59] These damages arise from costs to repair fishing gear, the overall costs of fouling incidents, and lost earnings from reduced fishing time due to clearing litter from nets. Despite the fishery sector only contributing around 4% of GDP, it provides considerable social value.[61] Fisheries are an important source of income for many households, with 90% of fish being caught by small-scale fishers for their own consumption or local markets.[60] However, growing levels of marine plastic pollution are impacting the health and abundance of local fish populations, through ingestion, entanglement and habitat degradation. This in turn reduces the quantity and quality of the catch, threatening the 20% of Mozambique's population who depend on fishing for their income.[61] Losses in fish supply also pose a food security problem in a country where 80% of the population cannot afford a nutritious diet,[62] and where during certain seasons fish is the only accessible source of protein for coastal communities.[63]

Mozambique's growing marine tourism sector is also suffering, as tourists are deterred by polluted marine ecosystems. Tourism contributed MZN 5 billion in revenue in 2022, employing more than 350,000 people, yet plastic pollution on beaches and in marine ecosystem is threatening the long-term sustainability of the sector. Coastal and marine ecosystems, and the wildlife they support, provide valuable services for tourism, notably by supporting recreational activities, but also through their educational, cultural, culinary and climate regulation roles. Plastic pollution can reduce the quality and quantity of these services, both deterring visitors and burdening local tourism operators with the need to spend money on clean-up activities.[64,65]

MARINE PLASTIC POLLUTION IS COSTLY TO FISHERIES, WITH ESTIMATED DAMAGES OF $5.5 MILLION IN 2017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CHAPTER 3

EQUITABLE SOLUTIONS TO THE PLASTIC CRISIS

Global and binding rules are needed to address plastic pollution equitably and effectively

Without global rules, national efforts are not enough to tackle the escalating plastic pollution crisis – although there is a clear upward trajectory in the number of national policy initiatives, including regulatory, information, and economic-based instruments.[9,66] Policymakers in HICs and LMICs alike are increasingly encouraged to develop national action plans, including ambitious goals and targets for addressing the problem through plastic cleanups and improvement in waste management and collection systems. For many LICs and SIDS, these measures have been promoted as the primary levers to combat plastic pollution and ease pressure on waste management systems that cannot cope with the volume of plastic waste generated. However, it's more and more evident that national initiatives have inherent limitations and are less efficient and effective without global coordination.

Despite a 60% increase in national and subnational policies between 2017 and 2022, the total volume of plastic in the ocean has increased by more than 50%.[10] In part, this reflects the transboundary nature of plastic pollution: reducing it in one country does not prevent it in others. Many of the plastic items that wash up on beaches around the world originate from thousands of miles away, and national action plans will not prevent this from happening. A notable example of this is Seychelles, which implemented bans on single-use plastic bags and straws in 2017.[67] Despite reducing national plastic consumption, a growing burden of plastic from other countries is polluting its beaches and marine ecosystems. A recent study led by the University of Oxford found that most plastic debris on Seychelles beaches comes from far-off sources, meaning Seychelles bears the burden of pollution for which it is not responsible.[68]

Many LMICs cannot effectively enforce national product regulations without global coordination. Like Seychelles, **Kenya** is another example of a country that turned to national product bans in response to the unprecedented growth in single-use plastics. However, as highlighted in the example below, without regional and global coordination, Kenya has faced challenges enforcing this ban as it battles illegal plastic inflows.[69] The transboundary plastic trade, as seen along Kenya's borders, requires coordinated international efforts to establish harmonized regulations for plastic production, use and sale, ensuring that illegal trade does not undermine national bans. By fostering a sense of shared responsibility among nations, a global treaty would promote accountability throughout the entire plastic value chain. Stemming from this, the illegal flow of plastic products can be eliminated, with national policies uniformly respected and enforced.

CASE STUDY

KENYA'S STRUGGLE TO ENFORCE PLASTIC POLLUTION REDUCTION POLICIES IN THE ABSENCE OF A GLOBAL TREATY

In 2017, Kenya took a bold step in the fight against plastic pollution by banning single-use plastic bags. This move involved stringent penalties, including significant fines and imprisonment, for consumers and businesses caught using or manufacturing plastic bags. While Kenya's ban was initially largely effective, with highways once littered with plastic bags becoming clean,[69] a transboundary challenge emerged due to illegal waste moving through its borders with neighboring countries such as Uganda and Tanzania.

Despite the ban on single-use plastic bags within Kenya, illicit trade remained rampant along its borders. Traders found ways to smuggle single-use plastic bags into the country, often hiding them within shipments of other plastic materials exempt from the ban, like packaging products.[70] Kenya's porous borders revealed the true transboundary nature of plastic pollution. As these bags infiltrated local markets, perpetuating their use and undermining Kenya's commitment to environmental sustainability, the people and ecosystems continued to suffer the effects of plastic pollution. Six years after the ban, colorful single-use plastic bags are piling up in the Dadach Boshe dump, with strong winds sending them flying into ecosystems and farms. Locals have reported the loss of goats from the ingestion of plastic bags, which has led to swollen stomachs and fatal health issues.[70] The situation was exacerbated by manufacturers of plastic bags who, although relocating to other countries, maintained connections with Kenya and continued to smuggle their products across the borders to boost their businesses. In addition, a reluctance to enforce the ban at the borders further complicated the situation, highlighting the need for broader awareness of the environmental impacts of single-use plastic bags.

LOCALS HAVE REPORTED THE LOSS OF GOATS FROM INGESTION OF PLASTIC BAGS WHICH LEAD TO SWOLLEN STOMACHS AND FATAL HEALTH ISSUES

Action at the global level has been limited, largely focused on voluntary targets. Plastic pollution has long been recognized as a global threat. Global action can be traced back several decades to landmark agreements such as the London Convention on the Prevention of Marine Pollution, or the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. While these conventions gained substantial international attention and contained mechanisms to review compliance, more recent policy efforts have tended to operate on a nationally determined or voluntary basis, lacking clear, measurable targets and legal enforcement mechanisms. According to the Plastic Pollution Policy Inventory,[66] a global database consisting of government documents targeting plastic pollution, the 28 international policies created since 2000 to address plastic pollution have predominantly used voluntary, non-binding agreements.[9] Consequently, signatories are not obligated to implement any agreed-upon actions, with no mechanisms in place to ensure accountability for their commitments.

There is clear potential for binding international action to balance the asymmetries that lead to inequities across the plastic value chain in LMICs. Recent international environmental treaties have shown that coordinated, binding global action is possible. Key examples include the **Montreal Protocol** on Substances that Deplete the Ozone Layer (signed in 1987), the **Basel Convention** on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (signed in 1989), and the Stockholm Convention on Persistent Organic Pollutants (signed in 2001). Following global commitments to ban or significantly limit the use of persistent organic pollutants (POPs) through the Stockholm Convention, monitoring indicates that POP concentrations in humans and the environment have declined since it was initiated, and continue to decline.[71] Similarly, the Basel Convention and its 2019 Plastic Waste Amendment has been instrumental in providing LMICs such as **Malaysia** with a framework to refuse hazardous imports of plastic waste.

However, the absence of binding global obligations with actionable control measures across the whole value chain is undermining this fight.[9,74] Efforts to address plastic pollution remain fragmented, and lack effective coordination across the value chain. While international agreements such as the Basel and Stockholm treaty showcase the potential for international action to promote sound waste management practices, by definition they do not address the root of the plastic crisis, which lies upstream in production and consumption. Consequently, global upstream actions such as product bans and phase-outs on high-risk plastics, such as single-use items and fishing gear, are the only way to reduce the amount of plastic that ends up mismanaged – conclusively addressing plastic pollution at the source.

A comprehensive global treaty is essential to address the structural inequities in the plastic value chain and level the playing field for LMICs and SIDS. Binding global measures with actionable targets, that include banning avoidable high-risk plastic products, harmonizing product design rules worldwide and mandatory implementation of EPR schemes in all countries around the world hold the most promise to address plastic pollution equitably and effectively at the source. In the face of a worsening global problem, collaborative global solutions are required to alleviate the inequities faced by LMICs and SIDS. A harmonized framework would not only alleviate the complexity and inconsistency often associated with diverse national policies and regulations, but it would also promote the international cooperation which is essential to ensure successful worldwide implementation and enforcement. The examples below explain how a new lifecycle approach in global action can conclusively end these inequities:

Structural Inequity	Proposed Solution
i. Non-plastic-producing LMICs and SIDS have little to no influence on international plastic product production. High levels of demand and excessive consumption of virgin plastic products globally has spurred record production of plastic products that are designed without consideration for the needs of LMICs and SIDS.	This inequity can only be addressed through a global treaty with binding obligations that enforce global design regulations aimed at incentivizing circularity through design and product standards which protect vulnerable communities and ecosystems from severe impacts of plastic production. Where possible, production and consumption of problematic plastics should be significantly reduced. For these global rules to truly be effective, LMICs, especially LDCs and SIDS, must have a voice in the decision-making processes. Therefore, the treaty must establish a multilateral platform with full global representation to ensure the most effective and equitable outcomes.
ii. LMICs have limited capacity to manage growing volumes of plastic waste. LMICs face prohibitive costs to expand waste management infrastructure to cope with current and future flows of plastic waste.	While improving waste management systems globally is essential to reduce leakage, it does not conclusively tackle plastic pollution. Insufficient environmentally sound waste management infrastructure and capacity should only be seen as part of a larger global problem, with more pressing root causes in the production and consumption stages. Without coordinated global action, as well as the means to influence waste management decisions of actors outside of national jurisdictions, LMICs' actions risk being undermined. Upstream action that limits the level of plastic production and promotes the design of products that can be easily recycled is essential to alleviate the pressure borne by LMICs. This should include global bans and phase-outs of high-risk problematic plastics such as single-use items, fishing gear and microplastics. Measures should be enforced through binding commitments that apply to all countries, collectively shouldering the responsibility to prevent plastic pollution, while supporting LMICs and SIDS with their inequitable burdens. At the same time, globally coordinated upstream actions must be matched with accelerated efforts in infrastructure and capacity building, allowing LMICs to leverage the financial and technical resources available on a global level, and thereby mitigate plastic leakage at a faster pace and expedite a just transition. Given that many LMICs, especially SIDS, suffer from transboundary plastic pollution, a global treaty with common measures is essential to ensure that all countries are able to collaboratively develop their waste management infrastructure to meet globally determined standards, leveling the playing field for LMICs, and reducing their plastic mismanagement rates.
iii. There is no mechanism to share accountability for the costs of plastic pollution. LMICs are disproportionately affected by the human and environmental costs of plastic pollution, which are not accounted for by those responsible for its production.	The global treaty must enforce accountability on the responsible actors and provide compensation for the environmental and societal harm caused. This accountability can be enforced in the form of waste trade levies that disincentivize waste exports to LMICs, as well as EPR fees that mandate financial or physical responsibility for end-of-life treatment or disposal. This ensures that the costs of managing plastic waste are equitably borne by those who produce and profit from it, rather than being shouldered by non-producing LMICs and SIDS. While EPR fees are already implemented in many HICs including the USA, EU and Japan, they are typically not at full functionality in plastic-producing LMICs such as China, and even less so in LICs.[75] Finally, when imposing taxes or EPR fees, it's crucial to consider their potential economic implications – especially increased commodity prices. To mitigate this, fees must be specific to the most harmful plastic products. This targeted approach ensures that the responsibility is appropriately distributed and does not disproportionately impact consumers, especially those with lower incomes.

TACKLING PLASTIC POLLUTION: A CASE STUDY OF INDONESIA'S CIRCULAR ECONOMY INITIATIVES

Indonesia is at the forefront of the battle against plastic pollution and mismanaged waste. The rapid growth of Indonesia's population, along with rising income levels, has contributed to a significant increase in plastic consumption. Much of this has been met with domestic production, with Indonesia mandating that 70% of plastic products must be produced domestically.[78] At the same time, however, its waste management infrastructure has not been able to keep pace with the higher levels of plastic products that are disposed of as waste. And without a cohesive waste management system as well as policy and financial support, landfills have exceeded their capacity, leading to cases where they catch fire, causing public concern. As a result, Indonesia has the world's second-highest marine plastic waste emission rates from rivers.[79] And while there is a high level of community engagement and participation, they are generally local in scope and lack focus more on managing waste rather than reducing it.

In response to this crisis, Indonesia has embarked on an ambitious national action plan. In 2020, Indonesia made a commitment to cut marine plastic leakage by 70% by 2025, and to eliminate plastic pollution entirely by 2040.[80] The national action plan laid out a System Change Scenario aimed at reducing the consumption of avoidable plastics by more than 1 million tonnes per year and doubling current recycling capacity. The delivery of this ambitious action plan is governed by the Indonesia National Plastic Action Partnership (NPAP), a multistakeholder platform dedicated to tackling plastic pollution and waste. The NPAP unites regional governments, government ministries, leading companies, embassies and other organizations – for example, in early 2023, Coca-Cola Europacific Partners, Dynapack Asia, and its non-profit foundation Mahija Parahita Nusantara, opened *Amandina Bumi Nusantara*: Indonesia's first food-grade plastic recycling facility.[81,82]

In addition to large multistakeholder projects, small-scale circularity initiatives also provide valuable employment and economic outcomes, alongside environmental protection. One inspiring example is Tridi Oasis, a female-led Indonesian recycling company specializing in the transformation of PET bottles into recycled PET flakes.[83] Its innovative approach enables the creation of products like food-grade packaging and textiles from mixed plastic products that are traditionally difficult to recycle. Through collaborative efforts with local and international partners, as well as direct engagement with local communities, Tridi Oasis has made significant strides in advancing the local circular economy. Its work has not only created more than 120 stable jobs for Indonesians, but it has also had a profoundly positive impact on the environment, recycling 250 million plastic bottles in 2021 alone and reducing the need for primary plastic production.[84]


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The case of Tridi Oasis exemplifies the positive transformations that are achievable through the collective efforts of policy measures and circular economy initiatives in Indonesia. While the production of plastic in Indonesia may be seen as an important pillar of economic development, small-scale schemes offer significant potential for job creation, especially among vulnerable communities and population cohorts. Tridi Oasis is just one of many examples that highlight the potential of greater circularity while simultaneously improving livelihoods, reducing plastic pollution, and promoting economic growth. As Indonesia and its partners strive to meet their ambitious targets, such success stories serve as beacons of hope and inspiration for other countries in their fight against plastic pollution.

Unlocking the wider benefits of a circular economy requires global and coordination. National action to promote circularity has shown promise, enabling Indonesia to drive its journey toward sustainable economic development in the face of a pressing plastic problem.

INDONESIA MADE A RESOLUTE COMMITMENT TO CUT MARINE PLASTIC LEAKAGE BY 70% BY 2025 AND TO ELIMINATE PLASTIC POLLUTION ENTIRELY BY 2040

Recognizing that plastic pollution contributes to carbon emissions and greenhouse gasses, improving the quality of waste management has become an important strategy in climate change mitigation. Further, the National Development Planning Agency is focusing on developing a circular economy policy in a low-carbon framework to achieve national development goals. Collectively, these measures are expected to prevent 16 million tonnes of plastic from leaking into Indonesia's oceans and, notably, create more than 150,000 jobs by 2024. Between 2018 and 2021, national plastic waste generation already decreased by 28.5%.[85] So far, more than 75 cities and provinces have implemented regulations to reduce or ban the use of plastic bags and packaging in shopping centers and traditional markets. And between 2018 - 2022, Indonesia reduced plastic waste leakage into the sea by approximately 36%. However, while progress has been made, the NPAP only represents one facet of a broader, transboundary issue. Global action is vital not only to address plastic pollution at its source but also to provide a collaborative platform where nations worldwide can support one another in achieving sustainable economic growth while safeguarding the environment. Going forward, the global treaty must create the conditions for LMICs to work with other countries and corporations to capitalize on the opportunities in circularity, leveraging harmonized design regulations and shared knowledge and technologies.

A clearly defined set of global rules can give each country the flexibility to decide how to implement its obligations, according to its national circumstances and capacities. It's increasingly clear that a treaty based on national action and voluntary options will only increase inequity by putting all the burden of implementation on national measures. National action plans, while useful to coordinate and align national measures, cannot be the focus of global action. The purpose of the global treaty is not to detail how states should implement their obligations, but rather, to define global obligations that act as the foundation upon which national action can be built.

These global measures will deliver benefits to the people and environment in LMICs and HICs alike.

i. **Plastic pollution is transnational – a shared response benefits all countries.** Regardless of who is polluting, plastic that leaks into the ocean from one country will enter global circulation and may end up damaging coastal and marine ecosystems in other parts of the world. A recent study estimated that a plastic bottle discarded into the Mediterranean Sea travels 200km a year.[76] Therefore common, coordinated action that eliminates a race to the bottom is essential. Drawing a parallel with global action to protect Earth's ozone layer through the 1987 Montreal Protocol, a similar international framework is urgently needed to combat global plastic pollution with a common, comprehensive set of regulations that are adhered to by all.

ii. **Protecting the environment through global rules will not come at the cost of economic development.** As articulated in the Rio Declaration on Environment and Development, sustainable development and environmental protection are deeply intertwined: one cannot exist without the other.[77] A global binding treaty can play a pivotal role in enabling sustainable economic development across all countries, ensuring that economic sacrifices are not a necessary consequence. For instance, the global treaty can serve as a catalyst for unlocking new growth opportunities, propelling businesses toward a circular economy model. Expanding a product's use phase through reuse models, recyclable materials and durable designs not only prevents plastic waste generation, but also promotes the development of new products and opportunities. This enables companies to access new markets; for example, by developing alternative materials or exporting recycling/reuse technology to LMICs and SIDS. This collective commitment to circularity will create a vibrant ecosystem of economic opportunities, where businesses thrive while contributing to a healthier, more sustainable world for all. One country that has implemented a portfolio of circular economy initiatives is **Indonesia**, where local businesses and partnerships have created new jobs, spurred innovation and improved social equity, all while addressing plastic pollution.

Negotiations on the global treaty to end plastic pollution must therefore progress towards common binding rules that target the root causes of plastic pollution. WWF calls for targeted global rules to address the fundamental drivers of inequity across the plastic value chain. A truly global approach is vital to minimize the potential for loopholes, foster a sense of collective responsibility among nations, and level the playing field. HICs must play by the same rules as LMICs, with measures applied universally, encompassing every facet of plastic across the value chain from its production and distribution to its consumption and eventual end-of-life management. Crucially, the treaty must give each country flexibility in deciding how to implement these rules at a national level so that actions can be tailored to suit specific national needs. This, along with generous technical and financial support, is especially important. Actions must include:

i. **Global bans, phase-outs and strict regulations for high-risk plastics:** Immediately banning, significantly phasing down, and imposing strict regulations on high-risk products – particularly single-use plastics, fishing equipment and microplastics – is a critical step toward addressing the plastic pollution crisis. While stringent and immediate bans are appropriately reserved for the most harmful plastics, it's equally vital to consider a broader approach. All non-essential plastics and plastic products, unless proven to be unproblematic, should be systematically phased out or replaced by alternatives with demonstrably reduced environmental impacts. A sense of urgency surrounding the elimination of high-risk plastics at the source is crucial, as these materials are not only highly prone to becoming pollutants but also have the potential to inflict severe harm on both people and the environment. Encouragingly, there are already numerous more sustainable alternatives to many of these single-use items that are readily available in some markets. Development of these alternatives will not only benefit new and existing industries, particularly in LMICs, but will also drive further technological innovation. Moreover, transitioning to lower impact, circular alternatives would alleviate the burden on plastic waste management systems in LMICs while also championing a more responsible and sustainable approach to consumption.

ii. **Global product design requirements:** It is vital that all plastic products remaining in circulation are subject to stringent rules promoting reusability and recyclability. These rules will ensure that they maintain value in the economy for as long as possible without needing to be disposed of, preventing them from being mismanaged and ultimately leaking into the environment. To achieve this ambitious goal, a harmonized set of general and sector-specific global design standards is needed. These standards should be created collaboratively, with particular input from LMICs, to ensure that plastic products are designed with circularity and environmentally sound end-of-life management in mind. This means going beyond traditional product design and considering the entire lifecycle of these items. The standards should encompass all aspects of product design, from mandating minimum recycled content inputs and setting ambitious reuse targets to restricting the use of specific polymers and materials that hinder plastic circularity. Establishing these guidelines will ensure that the production of necessary plastic items does not exacerbate the plastic crisis, while also leveling the playing field for LMICs, who currently bear the brunt of the impacts.


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iii. **A fully accountable lifecycle approach:** The scope of the global treaty must encompass the full plastics lifecycle, from production to waste management. It should target the most pressing sources of plastic pollution, which include single-use plastics, fishing gear and microplastics. For each of these, the global treaty must hold the relevant stakeholders accountable for their environmental and socioeconomic impacts of the products that they produce. This accountability should extend to producers through the establishment of global requirements and minimum criteria for national EPR schemes in all countries, ensuring that those who create and profit from plastic products bear the responsibility for their end-of-life management. Furthermore, global rules on end-of-life management cost accountability will serve as a powerful incentive for plastic waste collection and reduce reliance on environmentally harmful practices like informal landfilling and dumping. Different measures will need to be taken for different plastic product groups. For example, accountability for discarded fishing gear – or ghost gear – can be ensured through global commitments to mandate appropriate marking of all fishing gear, so that if these items are lost, neglected or intentionally discarded, their origins can be traced and responsibility assigned. At the same time, action against ghost gear can include the establishment of deposit return schemes. Concerning microplastics, the global treaty must also focus on preventing their leakage into the environment. This involves global bans and phaseouts of leakage-prone products, uses and material compositions, product design requirements, and material composition standards to minimize leakage through practices such as the elimination of microplastics in outdoor paint, the installation of appropriate filters on washing machines, the development of new tire materials that reduce abrasion, and the implementation of best practices for managing storm drains. This shift in responsibility is crucial to alleviate the burden on non-producing LMICs. At the same time, changes in the production and consumption of plastic products need to be appropriately managed as part of a just and equitable transition, to ensure the benefits are not undone by any resulting socioeconomic costs borne by LMICs. Alongside ensuring gradual transitions, financial and technical support is vital to support the most vulnerable countries in realizing these changes.

iv. **Robust technical and financial mechanisms:** To ensure implementation of the global rules across the whole lifecycle, financial support for LMICs is critical. Such support will underpin the ability of these countries to effectively implement the provisions outlined in the treaty, as well as aid the communities most severely affected by plastic pollution or the treaty's measures. To establish a sustainable financial framework, the treaty should serve as a vehicle for the creation of funds or financing mechanisms. Funding from corporations can also be raised through EPR fees and taxes. These funds can then be strategically allocated to support countries in implementing binding measures under the treaty. Beyond the financial aspect, technical experts, government bodies and private sector actors can leverage the global platform provided by the treaty to offer valuable technical assistance and capacity-building programmes.

Most of the world recognizes the urgency of an ambitious treaty that includes these actions – but a democratic decision-making process is still needed. A historic step was taken toward this reality in March 2022 when United Nations member states embarked on the development of a global treaty, through the Intergovernmental Negotiating Committee (INC), aimed at ending plastic pollution. This represents a pivotal opportunity to catalyze systemic change and promote equity across the entire plastic value chain. The fact that nations are coming together to negotiate and draft a treaty of this nature is a positive indication of the global commitment to addressing the plastic pollution crisis, serving as a beacon of hope and a clear indication that a treaty with significant, positive global impact is indeed feasible. As the international community's discussions have continued, 140 states have already agreed that high-risk plastics should be

THE GLOBAL TREATY MUST TARGET THE MOST PRESSING SOURCES OF PLASTIC POLLUTION, WHICH INCLUDE SINGLE-USE PLASTICS, FISHING GEAR, AND MICROPLASTICS.

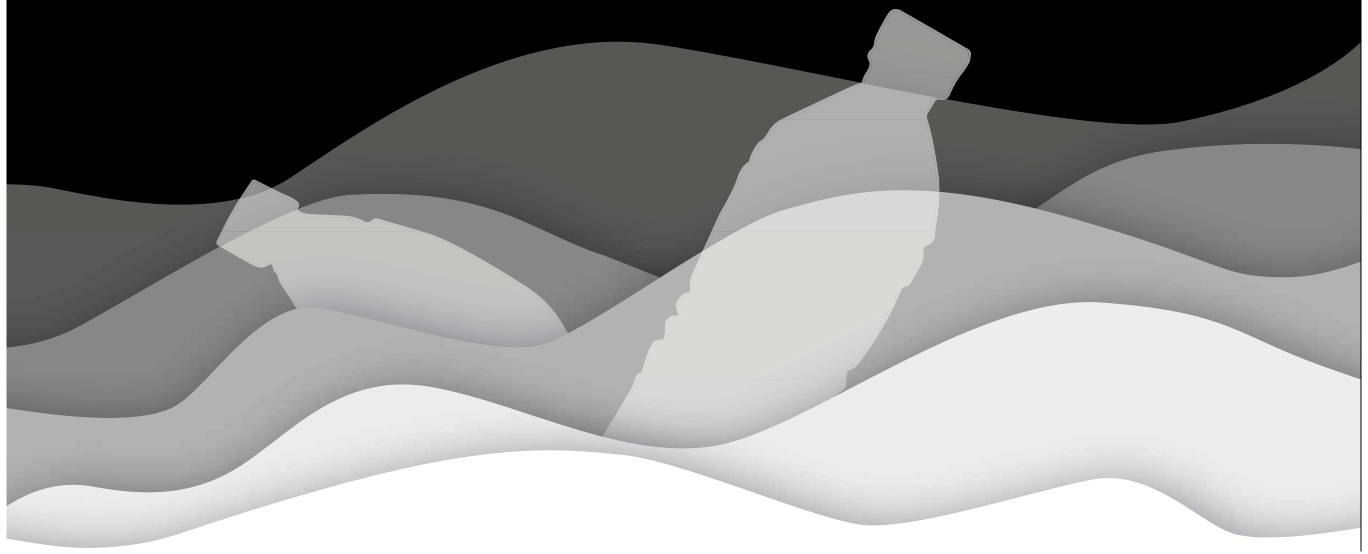
banned or phased out, and 145 states have supported global requirements to ensure circularity.[86] Support extends to the public too. In a 2022 survey, 70% of people in 34 countries supported global rules to stop plastic pollution, of which 70% expressed the need for accountability and consequences for rule-breaking.[87] However, even with a global majority and key plastic producing and consuming economies in favor, there is a looming risk that specific interest groups could disrupt negotiations, potentially leading to delays or interference in the effort to establish global rules. Therefore, prioritizing the common precedent of a democratic decision-making process over introducing a consensus-based approach is essential to prevent the creation of a *de facto* veto situation, where a single country could obstruct decisions. WWF calls for negotiators to push for an ambitious treaty with a critical mass of states on board rather than to accept a weak treaty by consensus.

Now is the time for all countries and negotiators to dial up their ambition and finalize a global treaty on plastic pollution that is binding in both form and content. The Zero Draft released by the Chair of the Intergovernmental Negotiating Committee represents the transition from general discussions to concrete text negotiations and reflects the widespread desire for a robust treaty with global rules. It also includes many binding obligations that are fundamental in addressing the plastic crisis. However, despite these promising developments, there is a risk that these global ambitions will be watered down toward voluntary and nationally determined actions. This is evident in the inclusion of options within the Draft that employ substantially weaker language and propose fewer specific obligations. Such approaches put all the burden on individual states, without addressing the global barriers to action and implementation. While voluntary actions can undoubtedly complement binding global rules, relying on them as the key global measures will substantially limit the effectiveness of the treaty. Thus, all negotiators must advocate for the strongest and most effective measures to ensure the global treaty is ambitious and impactful. A treaty with the strongest options would cut annual mismanaged plastics by an estimated 90% and primary plastic production by 30% by 2040 – significantly reducing pollution, while promoting equity and circularity.[88] In contrast, without a global treaty, the business-as-usual scenario results in almost a 90% increase in annual plastic waste mismanagement and a 66% increase in primary plastic production by 2040.[88]

Ensuring equity for all in the long term requires a regime that can gradually strengthen over time. Plastic pollution is undeniably a complex issue to regulate, reflecting its transboundary nature and the deep interdependencies in the plastic value chain. This is illustrated by the fact that no single country on the planet has managed to eliminate it entirely. In the face of this uncertainty, a gradual, start-then-strengthen approach is required. In practical terms, this entails beginning with a framework that can be progressively reinforced over time, in terms of continuously developing the control measures, expanding the lists of products and materials subject to each measure, and gradually expanding participation by onboarding new members. To ensure the success of this approach, global measures must incorporate mechanisms for monitoring progress and evaluating efforts, as well as specific procedures to enable the original treaty and annexes to be amended and protocols added as needed to respond to emerging challenges. Equally important is the establishment of an inclusive future decision-making system that incorporates the perspectives of marginalized communities, civil society and rights-holders, empowers all member countries to have equal decision-making rights, and prevents vetoing of important decisions by special interests. This is vital to overcome the core structural inequities that LMICs face, to ensure that global measures are enforced and continue to reflect their needs. Therefore, the institutional setups of the treaty, including its governing body and subsidiary bodies, should reflect this commitment. Overall, it's vital to consider the procedures related to the treaty's entry into force, compliance, and potential future amendments. As well as containing a strong structure for promoting, supporting and incentivizing implementation and compliance, the regime should enable parties to proactively develop and share new knowledge, as well as ensuring long-term participation and accountability.

28 INTERNATIONAL POLICIES CREATED SINCE 2000 TO ADDRESS THE PLASTICS PROBLEM HAVE TENDED TO USE VOLUNTARY, NON-BINDING AGREEMENTS. CONSEQUENTLY, SIGNATORIES ARE NOT OBLIGATED TO IMPLEMENT AGREED-UPON ACTIONS, WITH NO MECHANISMS IN PLACE TO ENSURE ACCOUNTABILITY FOR THEIR COMMITMENTS.

DESPITE A
60% INCREASE
IN NATIONAL AND SUBNATIONAL POLICIES BETWEEN 2017 AND 2022, THE TOTAL VOLUME OF PLASTIC IN THE OCEAN HAS
INCREASED BY MORE THAN 50%



ANNEX: METHODOLOGY

This annex describes the methodology used by the authors to estimate the total lifetime cost that 1 kilogram of plastic has for HICs and LMICs. This model builds upon WWF's previous work to estimate the minimum lifecycle cost of plastic in the *Plastics: The Costs to Society, the Environment, and the Economy* report (henceforth referred to as the WWF Plastic Cost report).[54] As such, the model only includes the components of the plastic lifecycle that were quantifiable in that report. Quantifiable components in this context refer to the impacts of the plastic lifecycle for which there are peer-reviewed publications and sufficient data to enable a "best-guess" estimate. The report also provides an overview of the unquantified costs that are not incorporated into this model.

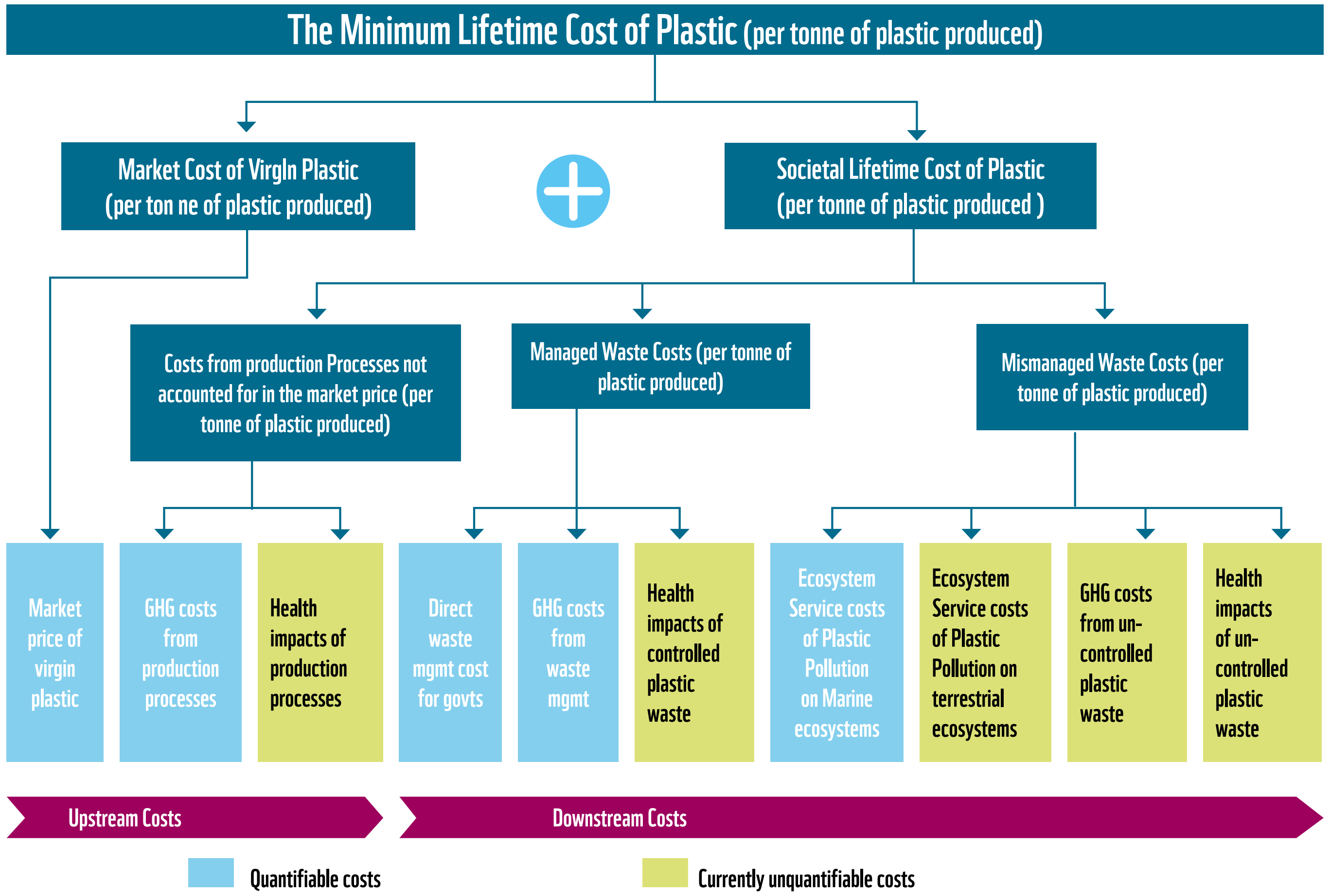
MODEL OVERVIEW

This model aims to offer a more comprehensive understanding of how the cost of plastic varies among HICs, upper-middle-income countries (UMICs), lower-middle-income countries (LMICs, not to be confused with the umbrella group low *and* middle income countries used in the main report), and low-income countries (LICs). While the model outputs are presented as the "monetary costs" of 1 generic kilogram of plastic in different countries, these costs are not physical, i.e. these countries do not physically pay these costs per kilogram of plastic produced and managed. Instead, these costs are an indication of the disproportionate burdens that plastic imposes on countries with different national incomes.

Encompassing various cost dimensions that have been adequately documented, the model only incorporates cost estimates that are "quantifiable". Dimensions lacking sufficient data to generate a cost estimate, referred to as "currently unquantifiable costs", have been excluded from the model. The sources used for quantifiable cost dimensions rely on the best available data relating to different impacts of the plastic crisis. They often provide monetary estimations based on existing data, albeit with the understanding that these estimates are "best-guess" approximations.

Given that many impacts of the plastic lifecycle remain inadequately documented, the estimate presented by this model represents the **minimum lifetime cost imposed by plastic produced in 2019 in both HICs and LMICs**. This encompasses everything from upstream production and manufacturing to the downstream total degradation of the plastic. The model's approach is outlined in **Figure 3** (this is a copy of **Figure 3** in Chapter 2) below.

Figure 3. Overview of the quantifiable and unquantified costs considered to estimate the minimum lifecycle cost of plastic.



MODEL CALCULATIONS

1. Market cost of 1 kilogram of primary plastic

The following inputs were used to estimate the unit kilogram market cost of primary plastic produced in 2019:

a. Average cost of primary plastic per tonne, as estimated in the WWF Plastic Cost report by calculating a weighted average cost per tonne based on production share.[54,e]

The following steps were taken estimate the unit kilogram market cost of primary plastic produced in 2019:

b. To convert the cost per tonne into cost per kilogram, the average market cost of primary plastic per tonne is divided by 1000.

2. Unit kilogram cost of lifecycle GHG emissions[f]

The following inputs were used to estimate the unit kilogram cost of lifecycle GHG emissions (production and end-of-life) from the plastic produced in 2019:

a. Total GHG emissions from across the plastic lifecycle in 2015 is provided by Zheng et al.[89,g]

b. Cost of 1 tonne of carbon is taken in line with the average price from IPCC based on IAMs used in the IPCC SR15 report.[90]

c. Tonnes of CO_2 emissions from production per tonne of plastic produced is estimated from the WWF Plastic Cost report.[54]

d. Tonnes of CO2 emissions from end-of-life per tonne of plastic produced is estimated from the WWF Plastic Cost report.[54,h]

The following steps were taken to estimate the unit kilogram cost of lifecycle GHG emissions from the plastic produced in 2019:

a. To obtain an estimate of the total amount of CO_2e released per tonnes of plastic produced across production and end-of-life, the respective emissions per tonne were summed.

b. To calculate the overall estimated cost of GHG emissions from the lifecycle of the plastic produced in 2019 per kilogram of plastic, the mass of CO_2e per tonne is multiplied by the cost of 1 tonne of carbon.

3. Unit kilogram cost of direct waste management

The following inputs were used to estimate the unit kilogram waste management cost of the plastic produced in 2019:

a. Data on municipal solid plastic waste management stages is provided by the Pew Charitable Trusts, collected for their *Breaking the Plastic Wave* report.[8] This includes formal collection and sorting,[i] informal collection and sorting,[j] disposal mass and cost,[k] and recycling (open and closed loop) mass and cost.[l] Mass and cost data for these dimensions were categorized into eight different geographic archetypes: high-income countries (HICs); upper-middle income countries (UMICs); lower-middle income countries (LMICs, not to be confused with the umbrella group low *and* middle income countries); and low-income countries (LICs); with each split into urban and rural classifications.[m]

b. Proportion of managed (landfilled, incinerated, recycled) waste per OECD and non-OECD group is provided by the OECD Global Plastics Outlook database.[13,n]

The following steps were used to estimate the unit kilogram waste management cost of the plastic produced in 2019:

a. For this model, the respective costs were calculated for the 4 income groups: HICs, UMICs, LMICs, and LICs.

b. To calculate the municipal plastic waste management costs per tonne in 2016 for each income group, the unit kilogram cost of the different waste management stages using the data provided by PEW was summed. A weighted average for the landfill, incineration, and recycling costs was constructed based on the average proportion of waste in each income group that undergoes each of these processes.

c. To obtain the unit kilogram cost in 2019, the costs are inflated from 2018 US$ to 2019 US$ using the US consumer price index.

d. To estimate the cost of the portion of a kilogram of plastic that is managed, the cost per tonne is multiplied by the proportion of plastic waste that is managed in each respective income group.

4. Unit kilogram lifetime cost of mismanaged plastic waste on marine ecosystem serviceso

The following inputs were used to estimate the unit kilogram marine ecosystem service lifetime cost of the plastic produced in 2019:

a. Upper and lower bounds for the lifetime cost per tonne of plastic entering the ocean are estimated from the WWF Plastic Cost report.[54,p]

b. Proportion of mismanaged waste per OECD and non-OECD group is provided by the OECD Global Plastics Outlook database.[13,q]

The following steps were used estimate the unit kilogram marine ecosystem service lifetime cost of the plastic produced in 2019:

a. To obtain a single lifetime cost per tonne of mismanaged plastic waste on marine ecosystem services, the mean of the upper and lower bounds is taken.

b. To estimate the lifetime cost of the portion of a kilogram of plastic that is mismanaged, the cost per tonne is multiplied by the proportion of plastic waste that is mismanaged in each respective income group.

MODEL OUTPUT

The lifetime cost breakdown of a kilogram of plastic for the 4 income groups is shown below. To obtain the average cost for all low- and middle-income countries, a weighted average is applied using the proportion of plastic waste that is mismanaged in UMICs, LMICs and LICs as a proxy.

MODEL LIMITATIONS

- Calculations yield a lower-bound minimum estimate as many "currently unquantifiable costs" highlighted in the report have insufficient data (e.g. human health impacts, land ecosystem service impacts) which have been omitted from the model.
- The 1 kilogram of plastic used in the model is a generalization, assumed to be a formless bulk mass that is averaged over various common types of plastic.
- Marine ecosystem cost is the only significant differentiator of costs between HICs and LMICs because the other significant costs are unquantifiable. Inclusion of these other costs would likely increase the cost difference between LMICs and HICs for the same reason that marine ecosystem costs are higher in LMICs: their waste mismanagement rates are higher.
- The model does not account for the capacity of waste management, so it does not include sunk costs such as investments already made in waste management infrastructure.

Table SEQ Table * ARABIC 1. Lifetime costs associated with one kilogram of plastic in HICs and LMICs (low and middle income), with a breakdown of LMICs, into UMICs, LMICs (lower-middle income), and LICs

	High-income	Low- and middle-income (average)	Upper middle-income	Lower-middle income	Low-income
Mass of plastic mismanaged (kg)	0.05	0.50	0.25	0.43	0.64
Mass of plastic managed (kg)	0.95	0.50	0.75	0.57	0.36
Market cost (US$)	1.01	1.01	1.01	1.01	1.01
GHG emissions from production (US$)	0.40	0.40	0.40	0.40	0.40
Managed waste cost ($)	0.49	0.30	0.31	0.29	0.30
Mismanaged waste cost (US$)	16.90	149.00	76.60	131.69	196.10
Total cost (US$)	**18.80**	**150.71**	**78.32**	**132.71**	**198.81**
HIC multiplier[r]	1.00	8.41	4.34	7.40	11.06

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ENDNOTES: ADDITIONAL NOTES

a This assumes that a garbage truckload has a maximum capacity of 15 tonnes and a plastic waste leakage mass of 28 Mt into land and water environments.[1,91]

b This assumes that a 500ml PET plastic water bottle has a mass of 10 g and an overall bottle volume of 500 ml, and that an Olympic- sized swimming pool has a volume of 2.5 million liters.

c Cost calculations are rounded to 2 significant figures for visual representation purposes and, as such, the multipliers differ from those detailed in the annex.

d Cost calculations are rounded to 2 significant figures for visual representation purposes and, as such, the multipliers differ from those detailed in the annex.

e Primary plastic market costs are assumed to be globally equivalent. Average market cost of general primary plastic is obtained by weighting across PET, HDPE, PP, PS, PVC, and 'other' plastics based on production share.

f GHG costs are approximated to be equivalent in all countries due to a lack of quantifiable data for each country group. Variations in costs are acknowledged but have been deemed insignificant compared to other costs, hence this approximation has been used. GHG costs also do not account for plastic trade and assumes that the plastic is produced and managed within the same country.

g While these figures do not provide estimates for the use phase of the plastic lifecycle or from mismanaged plastic waste, they are taken as a conservative estimate for GHG emissions from the plastic lifecycle as the data on these missing components are currently not comprehensive enough to provide robust estimates. These figures also do not include the displacement of carbon intensive primary polymer production by recyclates.

h This assumes that 70% of the 368 million tonnes of plastic produced in 2019 became waste, based on estimates by Geyer *et al.* and PlasticsEurope Market Research Group (PEMRG) and Conversio Market & Strategy GmbH.[92,93]

i PEW assumed that all imported waste was formally sorted. Import data was provided only for trade among archetypes with no data provided for intra archetype trade and was based on United Nations Comtrade database for 2018. The sorting costs were prorated for plastics such that the sorting costs account for only the costs attributable to plastic waste and are therefore higher than the sorting of other waste streams, such as organic waste. Allocation was done to reflect the relatively higher volume-to-weight ratio that plastic occupies in a collection truck.

j PEW assumed no informal collection or dumpsite collection in rural archetypes. This was based on input from the expert panel which said there wasn't enough value/density in the rural waste stream for waste pickers to profit from collection.

k Disposal includes incineration and landfilling. Net cost per tonne of incineration was calculated using incineration revenues that account for the sale price of the energy generated, based on[94]; and expert panel consensus and incineration costs based on expert panel consensus on data from actual plants. The costs reflect the same operating, safety, and environment standards across all archetypes. Total landfill costs were calculated based on World Bank data and Eunomia data. The costs reflect the capital expenditures and annualized operating expenditures of engineered landfills.

l Net cost per tonne of recycling was calculated using recyclate sale prices for different recyclates based on a composition of high-value plastics (PET, HDPE, and PP) and costs that represent the sum of the capital expenditure and the operating expenditure of both closed- and open-loop recycling processes. Both capital and operating expenditures for recycling plants were based on the experience and knowledge of an expert panel and confirmed through interviews. The cost of the recyclate sale process was assumed to be a wash and all recycled waste was assumed to be sold. Furthermore, for simplicity, only the cost of the first waste management stage is included (i.e. does not account for costs that recycled plastic incurs after it is used and becomes waste again).

m Income classifications are defined by the World Bank. Urban-rural classifications are defined by the UN. All cost data is reported in 2018 US$, so calculated involved inflating to 2019 USD using the U.S. Labor Department's Bureau of Labor Statistics' data on the US consumer price index that is 1.018.

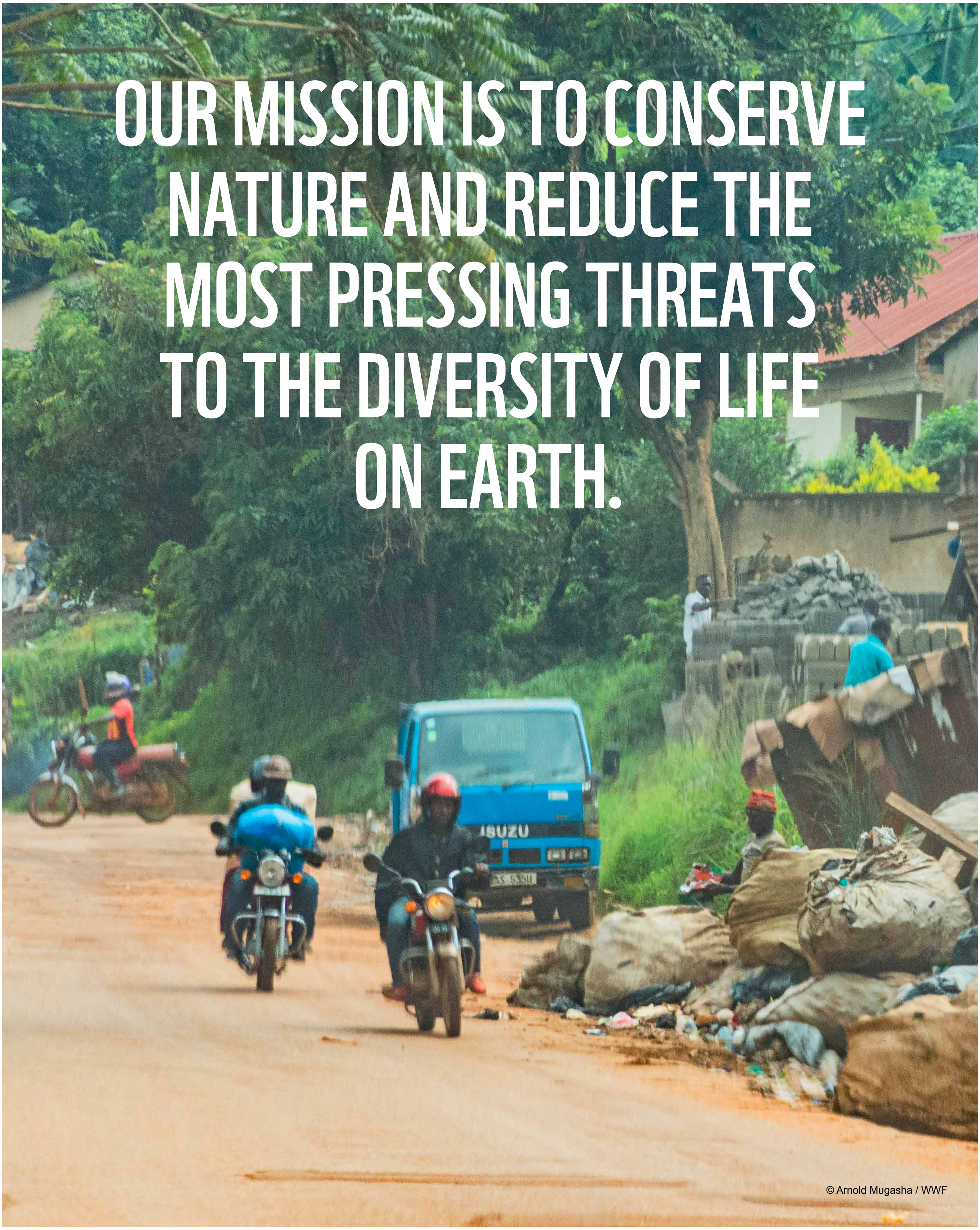
n It is approximated that OECD countries correlate to HICs and non-OECD countries corelate to LMICs.

o This assumes that the marine pollution remains within the jurisdiction of each country and does not account for its transboundary nature. Therefore, it is taken to be a minimum value.

p Since plastic can take several centuries to degrade in the ocean and can remain there for thousands of years, plastic waste will generate costs for societies and governments for at least this much time. Therefore, lifetime cost is extrapolated from the 2011 annual cost using an NPV formula with a time horizon of infinity and a discount rate of 2%. This estimate assumes that the yearly cost flows remain constant over time even as the plastic degrades into microplastics – this is felt to be a reasonable and conservative assumption by the marine ecosystem expert. This also assumes that the lifetime cost is equivalent to both HICs and LMICs.

q It is approximated that OECD countries correlate to HICs and non-OECD countries corelate to LMICs.

r The graphic in Figure 2 uses rounded total cost figures (to 2 significant figures) and, as such, the multiplier differs from the values presented in this table.



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