Standards and the Regulation of Plastic Wastes in Developing Countries

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Abstract

This study examines standard-based approaches to managing plastic waste in developing countries, against the backdrop of rising global plastic production, trade, and environmental leakage. It begins by mapping global trends and asymmetries in plastic consumption, waste management, and pollution, highlighting how the context of developing countries is marked by disproportionate environmental and social burdens. The study analyzes the roles and objectives of standards in plastic waste governance and categorizes five common types of plastic waste-related standards: recycled content, waste collection, contamination thresholds, alternative plastics, and polluter-pays standards. It examines how such standards emerge, who sets them, and the mechanisms through which they are enforced. Key trade-offs in implementation are explored, including tensions between enforceability, equity, and systemic impact. Two case studies illustrate how standards operate in practice: China's contamination standards under their Operation National Sword policy, and the Philippines' credit-based extended producer responsibility policy. The study concludes with policy recommendations for standards that reflect local capacity, integrate informal workers, and address transboundary environmental and economic dynamics.

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Introduction

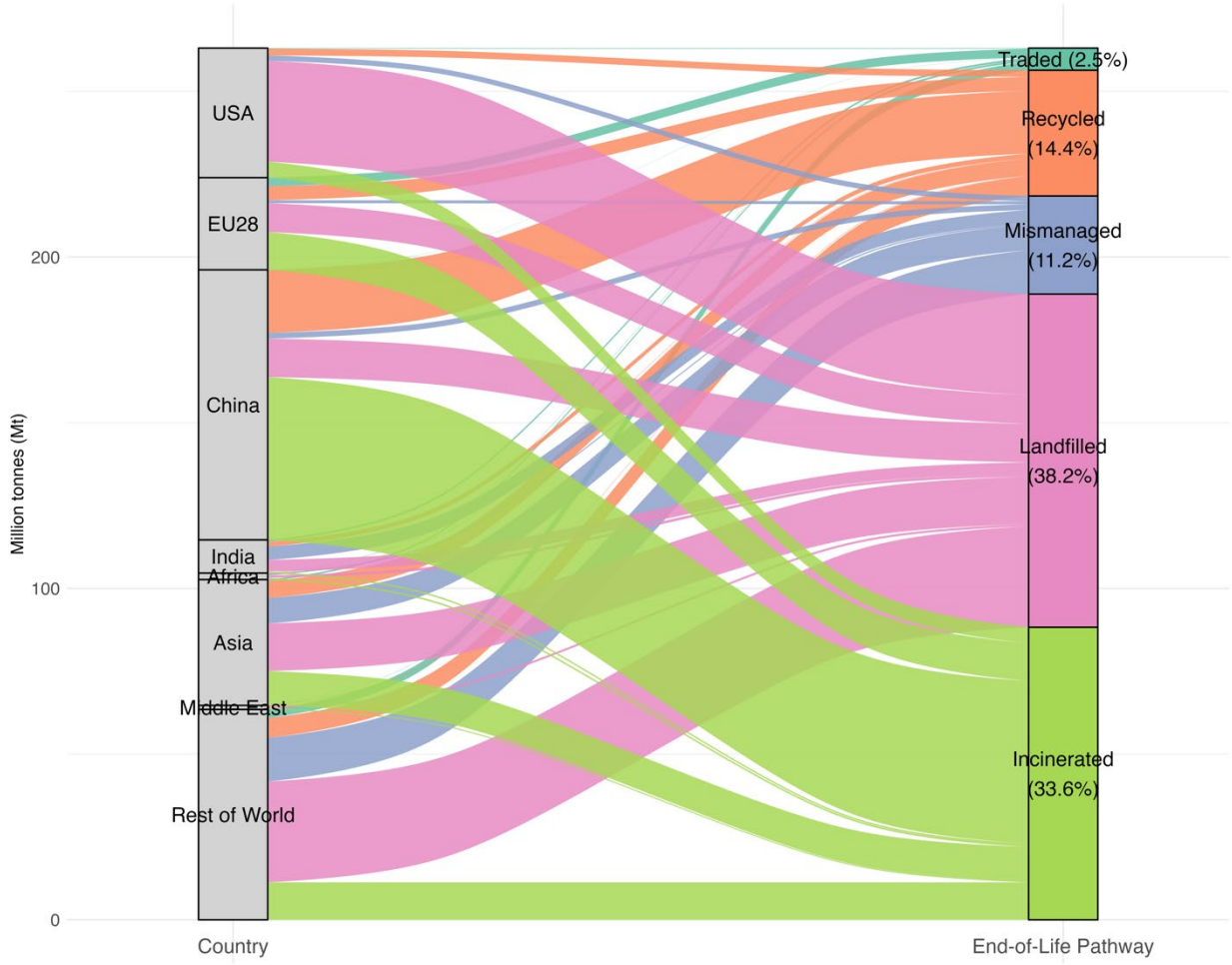
The generation of plastic waste, and indeed wastes more generally, is increasingly recognized worldwide as a serious and intractable problem (Kaza et al. 2018). While global concern has grown, the burdens of this crisis continue to fall disproportionately on developing countries. Among the responses to this challenge, standards-based approaches—covering contamination thresholds, collection systems, recycled content, and extended producer responsibility (EPR)—have emerged as prominent mechanisms for addressing plastic waste and guiding policy. This study examines how such standards are negotiated, designed, implemented, and institutionalized, with a particular focus on developing country contexts. It maps global trends and asymmetries in plastic consumption, waste management, and pollution, showing how environmental and social burdens are unequally distributed. It identifies five key categories of plastic waste standards: recycled content, waste collection, contamination thresholds, alternative plastics, and EPR. The analysis explores how these standards emerge, who sets them, and the mechanisms through which they are enforced—ranging from government regulation to third-party certification and voluntary initiatives. It also highlights critical trade-offs in implementation, including tensions between enforceability, equity, and systemic impact. To ground this discussion, it examines two contrasting case studies: China's contamination-based restrictions under Operation National Sword, and the Philippines' evolving EPR scheme. These cases illustrate how standards can reshape waste flows, labor structures, and regulatory ambition—while also revealing the political and practical challenges of enforcement and inclusion. Ultimately, this study advocates a critical, context-sensitive approach to standard-setting—one that reflects local institutional capacity, integrates informal workers, and addresses transboundary environmental and economic dynamics.

Global Trends in Plastic Waste

Widely recognized as a global crisis, plastic wastes have permeated the ocean, rivers, land, and human bodies, triggering efforts to address the crisis at local, national, and international levels. The facts are stark. Global production of plastic polymers has risen dramatically from 234 million metric tonnes (Mt) in 2000 to 460 Mt in 2019 (OECD 2022a). This output is unevenly distributed, with a growing concentration in developing countries and nonmembers of the Organisation for Economic Co-operation and Development (OECD). As of 2023, China alone accounted for 33 percent of global plastic polymer production, followed by the rest of Asia (19 percent) and other non-OECD countries (16 percent). In contrast, North America and Europe contributed 17 percent and 12 percent, respectively (Plastics Europe 2024). This regional asymmetry is echoed in consumption patterns, where China leads at 20 percent, followed by the United States at 18 percent; the European Union (EU) at 14 percent; and India at 6.4 percent (OECD 2022a).

The production of global plastic waste has increased in tandem, rising from 156 Mt in 2000 to 268 Mt in 2022 (Houssini, Li, and Tan 2025), with some models projecting that this figure could exceed 700 Mt by 2040 (OECD 2023). Of the waste generated in 2022, 38.2 percent was landfilled, 33.6 percent incinerated, 14.4 percent recycled—though only an estimated 10 percent was *actually* recycled (that is, not discarded after entering the recycling process due to contamination or nonrecyclable characteristics). Some 11.2 percent was mismanaged, leaking into the environment through open dumping, burning, or uncontrolled disposal (refer to figure 1), and additional 2.5 percent of global plastic waste was traded across borders for treatment or disposal.

Figure 1. Global plastic waste: Country origins and end-of-life destinations, 2022

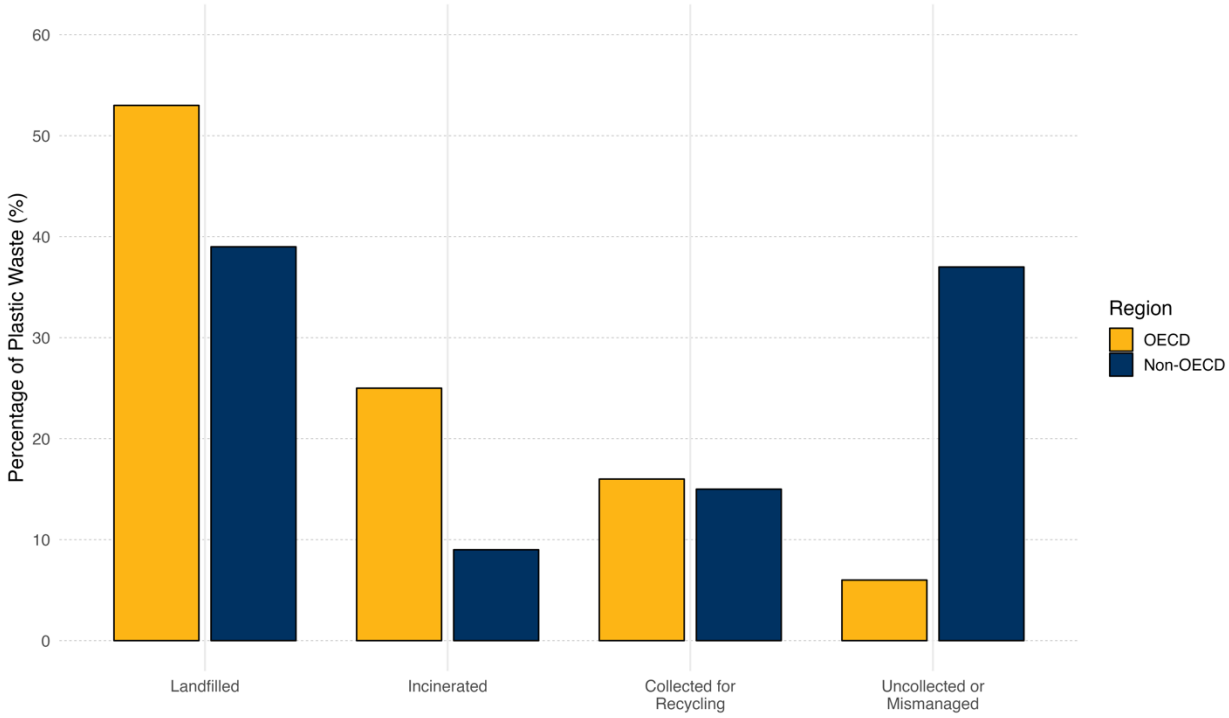


Sources: Data compiled and adapted from Houssini, Li, and Tan 2025; Global Plastics Outlook (OECD 2022a), and the UC Comtrade database.
Note: Asia refers to all Asian countries other than China and India, which are shown separately in the figure. EU = European Union.

Among the plastics that were recycled, only about 10 percent were reprocessed more than once (Geyer, Jambeck, and Law 2017). Plastics can persist in the environment for centuries, and the climate impacts of their production are significant. In 2019 alone, global plastic production was responsible for 2.24 gigatons of carbon dioxide warming equivalent ($GtCO_2e$)—equivalent to 5.3 percent of total global greenhouse gas emissions, excluding land use and agriculture. This amount surpasses emissions from the global aviation sector (Karali, Khanna, and Shah 2023).

Plastic waste management shows clear trends across OECD and non-OECD countries (refer to figure 2). On average in 2019, OECD countries landfilled 53 percent of their plastic waste, incinerated 25 percent, collected 16 percent for recycling, and had 6 percent uncollected or mismanaged. In contrast, non-OECD countries landfilled 39 percent, incinerated only 9 percent, collected 15 percent for recycling, and had a substantially higher rate of uncollected or mismanaged plastic waste—37 percent (OECD 2022b).

Figure 2. Plastic waste management by region (OECD versus non-OECD), 2019 average

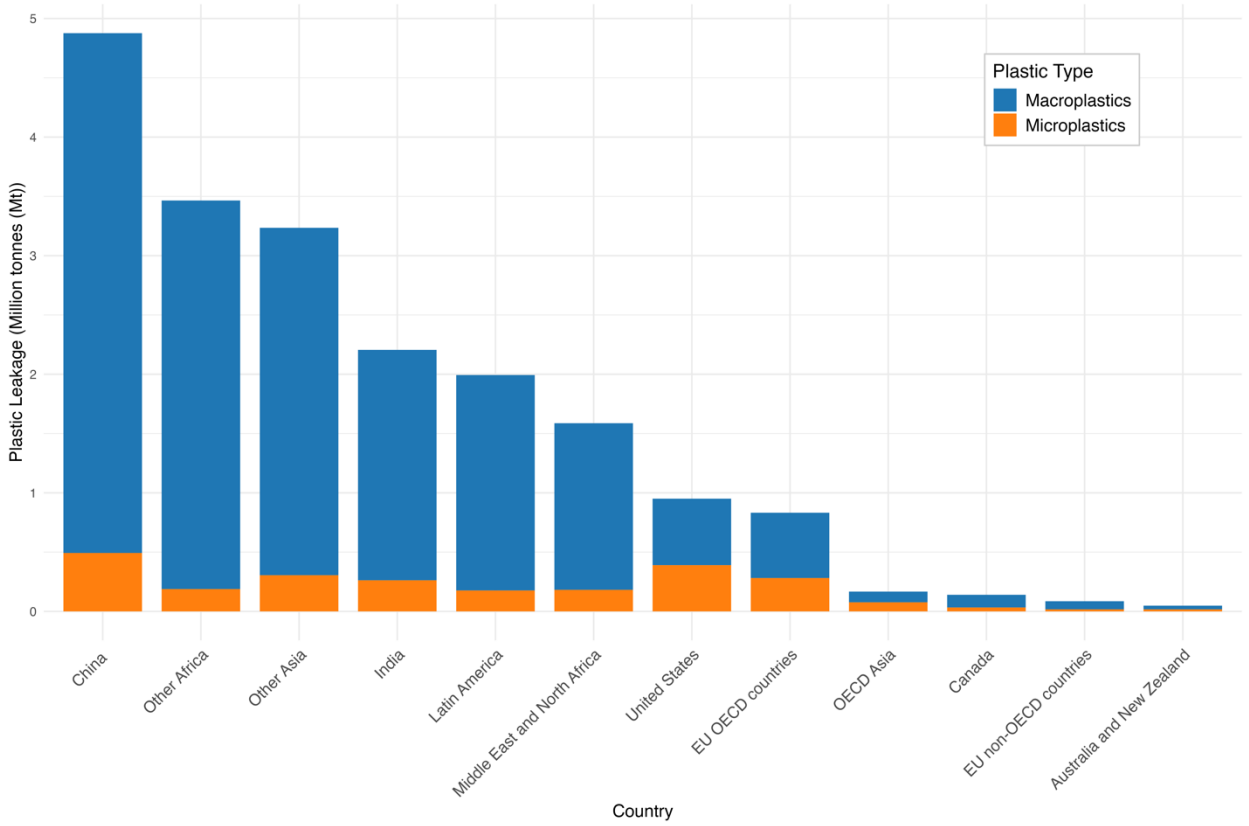


Source: Global Plastics Outlook: Policy Scenarios to 2060 (OECD 2022b).
Note: OECD = Organisation for Economic Co-operation and Development.

Notably, the rates of plastic waste collected for recycling across OECD and non-OECD countries are not significantly different (OECD 2022b). However, there is less clarity as to what this means in practice. For example, some countries include downcycling and plastic waste-to-energy processing into their recycling statistics, while others do not.

The largest difference between developed and developing countries lies in the extent of mismanaged waste. Figure 3 illustrates regional disparities in macro- and microplastic waste leakage into the environment between OECD and non-OECD regions, demonstrating one of the ways in which developing countries bear a higher burden in terms of dealing with plastic waste.

Figure 3. Plastics leakage into the environment by country and region, 2019

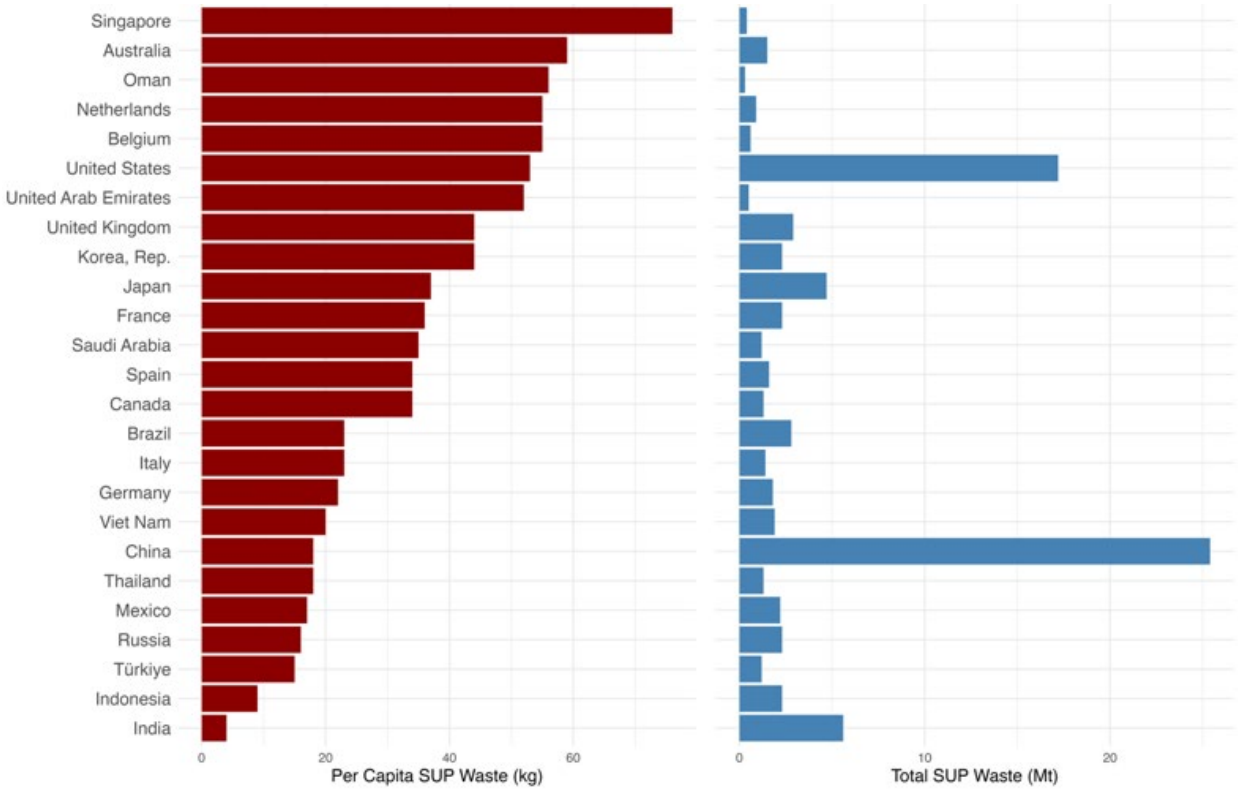


Source: OECD Data Explorer, https://www.oecd.org/en/data/datasets/oecd-DE.html.
Note: EU = European Union; OECD = Organisation for Economic Co-operation and Development.

Figure 4 further illustrates the contrasting patterns between developed and developing countries in terms of single-use plastic (SUP) waste generation. Per capita SUP waste is highest in high-income countries, including several OECD countries and fossil-fuel–exporting Gulf countries, reflecting greater consumption levels and wider availability of disposable plastic products. In contrast, the largest absolute generators of SUP waste include populous countries such as China, the United States, and India. While per capita figures emphasize the intensity of consumption in wealthier and fossil-fuel–rich countries, total volumes reflect the demographic and economic scale of large economies—each posing distinct challenges for global plastics governance.

Figure 4. Single use plastic waste, per capita and absolute, 2019

a. Per capital SUP waste (Mt) *b. Total SUP waste (Mt)*



Source: Minderoo Foundation 2021.
Note: Mt = million tonnes; SUP = single use plastic.

To add to the uneven burdens on developing countries, they have also been recipients of plastic waste and scrap shipped from developed countries (O'Neill 2019). While the proportion of discarded plastics shipped across national borders is very small compared with plastic waste generated (about 2 percent), it has a disproportionate impact on countries less able to deal with waste plastics in an environmentally and socially sound manner. The discussion that follows describes in depth the case of China, which long accepted plastic waste from the United States and other wealthier countries. As China stopped importing such scrap, shippers altered routes to countries such as Türkiye, Malaysia, and Viet Nam. These inequities have reinforced calls for global controls on the plastic waste trade.

Finally, a critical difference between developing and developed countries has to do with waste work and workers. In most developing countries, most of the work of collecting, sorting, and processing or disposing of plastic waste is carried out by informal workers. The informal waste sector is estimated to employ 15 million to 20 million people globally, with informal waste workers comprising about 1 percent of the urban workforce in developing countries (Harfadli et al. 2024). These workers play a critical role in recovering recyclable materials, reducing landfill volumes, and delivering environmental services that are often left unmet by formal systems in many developing countries. Yet while performing this essential work, waste pickers face daily exposure to pollutants, lack labor protections, and remain highly vulnerable to shifting markets for their products (Gutberlet 2023). Despite their vital contribution to waste management and circular economy practices more broadly—through recovering, reusing, and reintegrating materials—they are frequently excluded from national and international policy making (Tucker and Anantharaman 2020).

Given this, the design of standards in developing countries should take into account the impacts on—and potential inclusion of— these workers if their implementation and impacts are to be considered equitable or effective. India's EPR policy offers one such example: it institutionalizes a state-led, standards-based certificate system that allows registered informal waste processors to participate in national plastic waste recovery compliance, thereby creating formal channels for their recognition and inclusion.

Standards-Based Approaches for Plastic Waste Management: Role and Objectives

The primary objectives of plastic waste management and policy are to minimize (and ideally to end) generation and mismanagement of plastic waste and, for more ambitious policy frameworks, to reduce reliance on virgin plastics. These objectives can be pursued through various means, including more robust waste management infrastructure, increasing actual recycling rates, or implementing usage restrictions such as bans on single use plastics. Increasingly, these interventions are guided and structured by standard-based approaches, which are playing a growing role in shaping how plastics are governed across global plastics value chains.

Because of this trend toward standards in developing countries, it is important to consider what is meant by "standards" in the first place. There is no single, universally adopted definition of standards—a fact that reflects both the conceptual elasticity of the term and the diverse institutional, disciplinary, and political arenas in which it operates. From the World Trade Organization (WTO) to the International Organization for Standardization (ISO), definitions of standards vary depending on whether the emphasis lies on voluntary consensus, technical specification, legal authority, or normative alignment (Lambin and Thorlokson 2018; Timmermans and Epstein 2010; Weissinger 2021). In the context of plastics governance, standards typically refer to codified rules or requirements—issued by governments, international bodies, industry alliances, nongovernmental organizations (NGOs), or multistakeholder initiatives—that stipulate how plastics should be designed, produced, handled, and processed across their life cycle. At the end-of-life phase, in particular—where regulatory gaps are most pronounced and normative consensus is often weakest—standards are mobilized to impose a degree of uniformity amid otherwise fragmented practices. They establish benchmarks for recovery, recycling, and disposal that help define what kinds of end-of-life treatments are deemed acceptable, desirable, or compliant across jurisdictions and sectors. These may include criteria for recyclability, thresholds for acceptable contamination, procedures for specific end-of-life treatments, and definitions of eligible waste categories. Yet, standards do more than just coordinate practice—they construct boundaries around what is considered appropriate intervention, who is authorized to participate, and which solutions are seen as credible. In this way, they operate as both instruments of uniformity and sites of negotiation, embedding specific institutional, economic, and political interests in seemingly technical formulations.

Standards serve as a bridge to meet the above-mentioned objectives of plastic waste management and policy. They can incentivize or mandate plastics recycling by establishing requirements for recycled content, minimizing contamination, and promoting more consistent material recovery. They can influence waste collection by specifying criteria for material quality, labeling, or traceability, thereby facilitating the implementation of systems such as take-back schemes. In addition, they can influence production of plastics further up the supply chain: for example, by incentivizing the development and use of alternative plastics, such as bioplastics.

Standards, as steering mechanisms, have their own proximate objectives, which distinguish them from more conventional policy tools. One such objective is economic—for instance, ensuring revenue generation and cost-effectiveness for entities such as local governments that collect plastics for recycling,

by shifting the burden of paying for collection and/or treatment to corporations. Second, standards are often designed to maintain recycling and processing markets for secondary plastics, which can also serve as a source of revenue. Third, standardization itself is another important objective: harmonization of policies and expectations across sectors or regions to facilitate not only global regulation but also the development of global markets. Finally, a standards-based regime—whether voluntary or mandatory—tend to comply with WTO rules, including those around technological barriers to trade. These objectives, centered on market creation and maintenance, are often not compatible with regulatory frameworks, especially those that aim to phase out plastic waste.

Common Types of Plastics Standards

Many types of standards have emerged to govern the life cycle of plastics, targeting different nodes in the value chain and aiming to shape both material outcomes and market behavior. These standards vary in scope, target actors, governance structures, and intended effects. Table 1 outlines five common types, along with examples and the rationales behind them, followed by key examples from developing countries.

Table 1. Select types of plastic-related standards and their governance functions

Standard type	Key functions
Recycled content standards	● Stimulate demand for recycled material ● Set technical requirements for minimum quality ● Prevent greenwashing
Plastic waste collection standards	● Define requirements for collection, sorting, and documentation ● Facilitate flow into recovery systems and reduce mismanagement ● Engage informal sector actors
Contamination standards	● Define acceptable materials for material recovery facilities ● Set technical thresholds for contamination ● Regulate access to domestic and transboundary recycling markets
Standards for alternative plastics	● Set biodegradability or compostability criteria ● Guide facility operation and composting procedures ● Support labeling and claims verification
Polluter pays standards (national EPR)	● Assign producers' and waste processors' responsibility ● Enable credit-based compliance mechanisms ● Link compliance to verified recovery outcomes

Source: Original table for *World Development Report 2025*.
Note: EPR = extended producer responsibility.

Recycled content standards aim to increase demand for post-consumer recycled (PCR) materials by setting minimum thresholds or quality benchmarks for recycled inputs in new products. These standards help stabilize secondary markets, improve recyclate quality, and reduce dependence on virgin plastics. At the international level, ISO 14021:2016 provides definitions and documentation requirements for claims of recycled content to reduce greenwashing. The Global Commitment initiative, developed by the Ellen MacArthur Foundation and United Nations Environment Programme (UNEP), similarly encourages brands to report and increase their use of recycled content. Regionally, the African Organization for Standardization (ARSO) is advancing a harmonized recycled polyethylene terephthalate plastic (PET) (rPET) standard to support trade within Africa and reduce contamination risks. At the national level, countries such as Nigeria and South Africa have developed national standards to set technical specifications for rPET, supporting product safety and market demand.

Plastic waste collection standards specify how plastic waste should be sorted, handled, traced, and measured. These standards aim to improve recovery rates, enable high-quality recycling, and sometimes seek to engage with informal sector workers. India's IS 16557:2016 outlines procedures for decentralized waste segregation and supports integration of community-level systems. Voluntary programs such as the Plastic Waste Collection Methodology of private certification organization Verra, under their Plastic Waste Reduction Standard (PWRS), provide detailed protocols for measuring and verifying plastic collection and enable actors to earn credits tied to verified diversion of plastic waste from the environment.

Contamination standards define the maximum allowable levels of impurities in plastic waste. By setting technical thresholds for nontarget materials, they not only define acceptable input qualities for material recovery facilities (MRFs) but also regulate access to both domestic and international recycling markets. This type of standard, along with concrete examples, is further examined in a dedicated case studies in the sixth section of this study.

Standards for alternative plastics—such as compostable or biodegradable plastics—typically address product performance criteria, labeling requirements, and compatibility with existing waste management infrastructure. They help shape how these materials and products are used, processed, and classified, both by consumers and waste facility operators. Among the most widely adopted are ISO 17088 and ASTM D6400, which set out technical criteria for industrial compostability. These international benchmarks have been incorporated into national standards—such as South Africa's SANS 17088, Malaysia's SIRIM ECO 001:2016, and IS/ISO 17088:2021—in efforts to align with globally recognized definitions and testing methods.

Lastly, *polluter pays standards* encompass regulatory and voluntary measures that assign financial or operational responsibility to producers for the environmental impacts of their products. One of the most widely institutionalized forms of this approach is extended producer responsibility (EPR), which requires producers—often defined as brands that use plastic packaging—to manage the collection, recycling, or environmentally sound disposal of postconsumer plastics. While some EPR policies rely on mandatory fee-based mechanisms (such as eco-modulated EPR fees in South Africa), others incorporate market-based crediting mechanisms that operate without formal fee collection (as in Brazil, India, and the Philippines,). In such cases, producers fulfill their EPR obligations by purchasing tradable certificates or plastic credits tied to verified waste collection or processing activities. The Philippine case is examined in more detail in the case study section.

The discussion that follows examines cases of plastics standards—contamination and EPR—in developing countries that are national in origin or scope (albeit with global implications). However, standards are also emerging in international law. In 2019, parties to the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal adopted an amendment concerning

trade in discarded plastics. While this measure includes a ban on trade in plastic wastes that have specific hazardous content, its core approach is primarily standards-based. It allows for trade in plastic wastes given prior informed consent by the importing country and adequate management standards in that country. This in effect sets a standard for plastics shipped from OECD to non-OECD countries. Following the amendment, the Basel Convention Secretariat has developed technical guidelines for environmentally sound management and inventory reporting of plastic wastes (UNEP 2023a). This document sets out expected practices for plastic waste management, including minimum requirements for treatment and disposal facilities, as well as operational procedures for sorting, shredding, washing, extrusion, and pelletizing of plastic waste. These requirements also address occupational health and safety standards, transport protocols, and disposal pathways, effectively serving as de facto standards by harmonizing national practices with expected norms under the Basel framework (Deere Birkbeck et al. 2023). With respect to the international plastics treaty under negotiation, the rise of plastic credit markets adds to the demand for standards and standardization to facilitate measurement and fungibility that market-based mechanisms require across diverse national systems (Moon et al. 2025).

The Emergence and Enforcement of Plastic Waste Standards

The landscape of plastic waste standards has grown increasingly complex, marked by the proliferation of diverse end-of-life standards and a widening array of signatories and implementing bodies. Yet despite this growth, comprehensive and comparable data on their implementation and impacts—particularly across developing countries—remain scarce. This is in part because these standards are evolving and diffusing rapidly, often spurred by global governance efforts such as the global plastics treaty currently under negotiation or the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. As these standards continue to spread and diversify, questions concerning who sets them, how they are enforced, and how they interact with national and local contexts have become central to understanding their role and impact in plastic waste governance.

Who sets standards at the national and international levels?

End-of-life plastics standards can be set by governments, standard-setting bodies, NGOs, industry coalitions, and individual corporations. Government-led standards often provide legally binding frameworks, such as EPR schemes in the European Union, which require companies to take financial and operational responsibility for postconsumer waste. These are often developed by national or regional standard bodies such as the British Standards Institutions (BSI), the European Committee for Standardization (CEN), and the African Organization for Standardization (ARSO).

International technical standard-setting bodies such as the International Organization for Standardization (ISO) and ASTM International have published globally recognized voluntary standards relevant to plastics and waste management. Notable ISO standards include ISO 15270, which provides guidelines for the recovery and recycling of plastic waste, and ISO 17422, which outlines general principles for the environmentally conscious design of plastic products (ISO 2023).

NGO-led certification standards, such as the Ocean Bound Plastic (OBP) Certification, define criteria for plastic waste management and circular economy practices, often involving third-party verification (Zero Plastic Oceans 2021). The OBP Certification, developed by Zero Plastic Oceans, sets requirements for collecting and recycling plastic waste near coastal and waterway regions. NGOs also partner with other types of actors to create multistakeholder partnerships. For example, the Ellen MacArthur Foundation works closely with the UN Environment Programme on Global Commitment.

A growing number of private, nongovernmental standard-setting organizations—such as Verra and Plastic Credit Exchange (PCX)—have developed plastic credit standards that aim to quantify and verify plastic collection and recovery activities, particularly in regions with underdeveloped waste infrastructure. Verra's Plastic Waste Reduction Standard (or Plastic Standard), for instance, sets out methodologies to credit the recovery and recycling of plastic waste, serving as a market-based mechanism to fund plastic waste management.

Finally, company-led standards, such as Unilever's Circular Economy for Plastics initiative, set internal targets and guidelines for plastic packaging, including commitments to making all plastic packaging reusable, recyclable, or compostable by specified target years (Unilever 2024, 258–62). These corporate initiatives vary in scope and implementation, with some aligning with external standards and others functioning as independent, separate commitments within business operations.

Although often associated with voluntary (nonstate) governance, such standards can be integrated into existing legal and policy frameworks or serve as foundational basis for new ones (especially where no such regulations exist in the first place). More often than not, these standards are developed by international bodies, offering technical expertise and resources that can support implementation in developing countries. However, some caution is warranted, as no single policy model is universally applicable. The case studies that follow demonstrate how standards can be adapted by adopting countries to suit their specific contexts.

Who enforces these standards?

Enforcement means ensuring relevant actors across the plastics value chain—such as producers, waste collectors, and consumers—comply with the requirements and targets set out in a given standard. Among various enforcement mechanisms, regulatory enforcement by governments and government-mandated agencies is generally considered the most effective. When a standard is embedded in legally binding instruments such as EPR schemes or other mandatory policy instruments, it is backed by legal authority and subject to formal compliance requirements (Heiges and O'Neill 2021). For example, India's Plastic Waste Management Rules (2021) integrate the IS 14534:2016 standard, which outlines national guidelines for the recovery and recycling of plastics waste. Developed by the Bureau of Indian Standards (BIS), this standard defines safety, quality, and process norms and is used as a reference in policy implementation and compliance monitoring (Deere Birkbeck et al. 2023).

Such standards may originate as voluntary guidance documents or industry norms but can later be incorporated into binding legislation, thus gaining legal enforceability. This process of institutionalizing standards into national law marks a significant shift from voluntary practices to legally mandated requirements.

In contrast, many plastic-related standards implemented in developing countries operate outside formal regulation and rely on softer forms of enforcement. These include third-party auditing, certification, and the threat of revocation of participation or labeling rights (Deere Birkbeck et al. 2023). For instance, ISO standards—such as ISO 15270:2008 on plastic waste recovery—are not legally binding but are often voluntarily adopted by companies seeking to demonstrate alignment with industry norms or best practices. Compliance is typically assessed through third-party certifiers such as SGS (Société Générale de Surveillance) and Control Union Certifications, which conduct audits to verify conformity with voluntary standards. Similarly, plastic credit standards—such as the Plastic Waste Reduction Standard (PWRS) developed by Verra—often require participating projects to undergo third-party verification to validate claims about additional collection or recycling of plastic waste. Many of these projects are audited by certification bodies such as Control Union Certifications, which assess conformity with the credit standards' methodologies (Moon et al. 2025). While such private enforcement measures may work for

participating companies, they lack the broader jurisdictional authority of public regulation. As a result, they are often criticized for enabling selective or symbolic compliance, relying heavily on market incentives or reputational pressure rather on legal mandates—a pattern observed across other sectors such as carbon, chemicals, and agriculture (Dietz and Grabs 2022; Haya et al. 2023; Vidovic, Delgado, and Khanna 2019).

The Governance Utility of Standards: Advantages, Limits, Trade-offs

General advantages of a standards-based approach

First, standards can provide clear goals for stakeholders along the supply chain and the processes by which to meet them, particularly for collectors, recycling facilities, producers of plastic products, brokers, and export agents, not just consumers or at the point-of-sale (such as a store or food business).

Second, they can provide the basis for the development of regulations and laws regarding plastic wastes, especially for governments lacking strong capacity. For example, many plastic standards are developed by international organizations and bodies, such as ISO, based on expertise and technological knowledge not so easily available for developing country governments.

Third, unlike bans or fees, standards can facilitate the creation and stabilization of markets for secondary plastics, especially across national borders, through harmonization (i.e., a level playing field) as well as assurances regarding plastic quality, such as polymer types or acceptable contamination levels. Such standardized market conditions also align with international trade rules, including provisions under the WTO's Agreement on Technical Barriers to Trade.

In some developing countries, standards are regarded as an engine for economic growth. For example, Kenya Bureau of Standards (KEBS) aspires to be a global leader in standards-based solutions for trade and sustainable development. KEBS's mandate is providing Standardization and Conformity Assessment Services, and Information Services in order to facilitate trade through standards (KEBS 2023).

Fourth, voluntary standards are often more attractive to industry actors (in this case, plastic product manufacturers and brands) and more likely to garner support from this powerful constituency. Industry actors—especially large, consumer-facing companies such as fast-moving consumer goods (FMCG) firms—often favor voluntary standards because they allow for a differentiated competitive edge in the marketplace and help manage reputational risks (Lambin and Thorlakson 2018). For example, plastics-related standards (such as the Ellen MacArthur Foundation's Global Commitment), plastic credit standards (such as Verra's Plastic Waste Reduction Standard), and recycled content standards (such as the Global Recycled Standard [GRS] or those aligned with the ISO 14021 labeling standard) offer flexible pathways to demonstrate progress toward plastic-related sustainability goals. Firms adopt voluntary standards not only to enhance internal practices but also to gain access to key markets and signal compliance to regulators and consumers (Murphy and Yates 2010). Compared to regulatory instruments such as bans or fees, these voluntary standards enable firms to incrementally adjust packaging design, material sourcing, and recovery strategies in ways that are more likely to secure industry buy-in.

Potential limits of standards-based approaches

Despite their advantages, standards-based approaches are often subject to significant limitations "on the ground," particularly in the context of developing countries. First, standards are complex, technical instruments that require considerable institutional capacity and specialized knowledge to design, implement, verify, and assess for their on-the-ground, system-level effectiveness. This complexity is magnified when multiple standards proliferate within the same sector or phase in the life cycle, leading to fragmentation, duplication, and confusion among stakeholders. Many producers face a complicated

array of overlapping standards, which can increase compliance costs without necessarily improving environmental or social outcomes.

Second, voluntary standards are difficult to enforce in practice unless they are formally adopted into national law or supported through strong government oversight. Without legal backing or robust third-party audits, voluntary standards risk functioning more as reputational risk management tools than as effective governance mechanisms. The implementation gaps between standards on paper and outcomes on the ground can be significant, especially when producers lack the resources or incentives to change practices.

Third, many standards-based approaches have a relatively narrow scope, often focusing on downstream activities such as collection, sorting, or recycling. From a supply chain perspective, this means they may not capture the entire plastics supply chain and may fall short of creating meaningful disincentives for the production and use of virgin plastics.

Finally, standards-based approaches are not typically designed to reduce plastic waste emissions to zero, especially if they are connected to markets or economic incentives. Instead of eliminating problematic plastics outright, they often work within existing production systems to set minimum criteria—such as contamination thresholds or recyclability standards. These standards often operate at the project or facility level, emphasizing compliance at specific points in the value chain. While this approach can improve localized practices, it does not necessarily translate into system-wide changes. From a policy design or intervention perspective, this makes them fundamentally different from more prohibitive tools like outright bans. When connected to market mechanisms, these standards can normalize ongoing plastic production and use, so long as technical benchmarks are met.

Trade-offs in the choice and implementation of plastic waste standards

Beyond general considerations of effectiveness or feasibility, plastics-related standards vary significantly in where they intervene in the plastics life cycle, which actors they target or implicate, and local capacities and ability to implement new (types of) standards. These differences can also be framed in terms of trade-offs—between enforceability and systemic transformation, or between efficiency and inclusiveness—and are especially important to evaluate their appropriateness in developing country contexts.

For example, voluntary international standards may catalyze rapid industry uptake across national borders and enable reputational signaling by large firms. However, they can prioritize corporate reporting and third-party certification, potentially excluding smaller domestic firms, informal actors, or local governments that lack the technical or financial means to participate. National mandatory standards, on the other hand, carry the strongest enforcement power and can be designed to reflect local contexts, yet their practical effectiveness depends on the capacity of public agencies to monitor and enforce compliance consistently. This highlights a trade-off between formal regulatory authority and operational flexibility, especially in resource-constrained settings.

A related trade-off exists between product-based and process-based standards. *Product-based standards* tend to intervene at the end-product stages of the plastics value chain, primarily targeting manufacturers, importers, and retailers. These standards—such as minimum recycled content or contamination standards—are typically easier to standardize for testing, labeling, or certification. They are technically precise and relatively straightforward to audit, making them appealing from a compliance and enforcement standpoint. However, they only address downstream material characteristics and do not engage with upstream drivers of waste, such as the overall scale of plastic production or continued reliance on fossil fuel–based feedstocks, nor downstream collection and sorting challenges.

By contrast, *process-based standards* focus on how plastics are collected, handled, or recovered, intervening at the operational and labor practices within the value chain. They assign responsibility to

waste management companies, local governments, producer responsibility organizations, or even informal sector actors. These standards may require documentation, role assignment, and monitoring of activities related to labor practices, facility operational conditions, or social safeguards, making them harder to uniformly implement but potentially more effective in driving deeper systemic changes.

This analytical framing helps interpret the standard types summarized in table 1. Recycled content and contamination standards are largely product-based, targeting measurable material attributes, and thus are easier to audit or certify. Collection standards and polluter-pays standards (that is, EPR) are more process-based, emphasizing governance mechanisms to assign responsibility and hold actors accountable across the waste system. Standards for alternative plastics can span both approaches: some define product specifications (such as biodegradability thresholds), while others are more process-based, outlining operational conditions for composting facilities or testing methodologies to verify compostability. Each of the standards summarized in table 1 intervenes at different points—from product design to waste recovery—and brings different actors into focus as targets of governance. Recognizing this variation helps clarify when different standards may be most feasible or impactful, depending on the intended points of intervention in the plastics life cycle.

Other key trade-offs include cost-effectiveness and equity. Standards that align closely with material specifications or traceability protocols may reduce mismanaged waste at lower cost and attract industry participation, but they often exclude actors lacking access to formal infrastructure, digital systems, or advanced processing technologies. More socially oriented or participatory standards—for example, those requiring community consultation or labor protections—may better reflect local priorities but face implementation hurdles or limited uptake in highly fragmented waste systems.

As explored, trade-offs arise between technical precision and administrative feasibility, rapid uptake and local inclusiveness, and short-term compliance and long-term impact. These tensions are especially pronounced in developing country contexts, where infrastructure, enforcement capacity, and stakeholder dynamics vary widely. These are not merely technical decisions based on cost, efficiency, or available technologies, but governance design choices that reflect assumptions about which interventions are most feasible and which actors are most accountable. It is therefore essential to consider not only under what conditions a given type of standard is appropriate, but also where it seeks to intervene in the plastics system, and the ultimate distribution of costs and benefits across stakeholders. These considerations are further discussed in the final section of this study.

Two Case Studies: Contamination Standards (China) and Plastic Credit Standards (Philippines)

The two case studies that follow engage in deeper discussion of the principles and challenges outlined above, from the perspective of two developing countries: China and the Philippines. In China, extremely strict contamination standards placed on the import of plastic and other low-grade scrap overturned global recycling markets, overwhelmed domestic recycling structures in developed countries, and led to cascading impacts, including new restrictions on imports from neighboring countries. However, the domestic impact of the standards on recycling in China was mitigated by other factors. The case of EPR credit standards in the Philippines demonstrates how voluntary credit standards are incorporated into and enforced within national EPR policy. It also illustrates how credit-based compliance can facilitate early implementation while raising concerns about whether such "regulatory flexibility" encourages meaningful change (regulatory objectives) or accommodating producers to meet obligations without adjusting unsustainable practices. Overall, while each set of standards fulfilled (or is fulfilling) political or economic goals, it is unclear as to their aggregate impact on plastic waste mismanagement.

Case 1. Contamination standards in China: Controlling imports of plastic waste

Contamination standards—both regulatory (such as government-imposed contamination thresholds) and voluntary (such as industry grading systems)—are increasingly recognized as mechanisms that mediate not only the material flows and environmental performance of recycling systems, but also the governance of waste trade and the exercise of regulatory authority. China's deployment of stringent contamination thresholds for end-of-life plastics exemplifies how states can use contamination standards to shape transboundary flows through technical standards rather than through explicit protectionism—a form of regulatory realism that asserts environmental authority while avoiding direct geopolitical confrontation (O'Neill 2017).

Contamination standards refer to the maximum allowable proportion of non-target materials—such as food residue, incompatible polymers, or moisture—within plastic waste, whether in the form of individual items or mixed bales of plastics (ISRI 2022). These technical thresholds play a defining role in determining whether plastic waste can be accepted into material recovery systems, either domestically or across borders. Within national systems, while often framed as quality control measures, contamination standards also function as material and regulatory filters that shape what waste is considered recyclable, who gains access to recycling markets, and what environmental and health risks are deemed acceptable (O'Neill 2017). Beyond national borders, these standards—alongside other technical and procedural specifications—increasingly operate as non-tariff measures in the global trade of plastic waste, shaping the terms under which waste materials cross borders (Lambin and Thorlakson 2018). Rather than imposing outright bans, governments use stringent contamination thresholds to regulate what enters and circulates within their jurisdictions—redefining access to international markets through technical criteria.

At the domestic level, contamination thresholds have been embedded in municipal recycling programs and material recovery facilities (MRFs) as technical standards to define acceptable input quality, particularly in developed countries. In the United States, several cities have adopted limits as low as 3 percent to 5 percent, often enforced through contracts with MRFs (Heiges and O'Neill 2022). These thresholds often determine whether a collected batch of plastic is processed for recycling or rejected for landfill or incineration. Industry specifications, such as the Scrap Specifications Circular published by the Institute of Scrap Recycling Industries (ISRI), also serve as de facto standards, grading plastic bales by contamination level and influencing their tradability (ISRI 2022).

By contrast, enforceable quantified contamination standards at the point of collection remain limited in many developing countries, although source segregation is often encouraged under broader waste management policies. However, developing countries are increasingly considering contamination thresholds to regulate imports of plastic scrap. The most prominent example of this is China's Operation National Sword (ONS), implemented in 2018.

Taking effect on March 1 of that year, the policy marked one of the most globally consequential shifts in plastic waste governance. While often described as an import ban, ONS in fact introduced exceptionally stringent contamination standards—reportedly as low as 0.5 percent for many categories of post-consumer plastic waste—which effectively disqualified most shipments from major exporters such as the United States, Europe, and Japan (Brooks, Wang, and Jambeck 2018; O'Neill 2017).

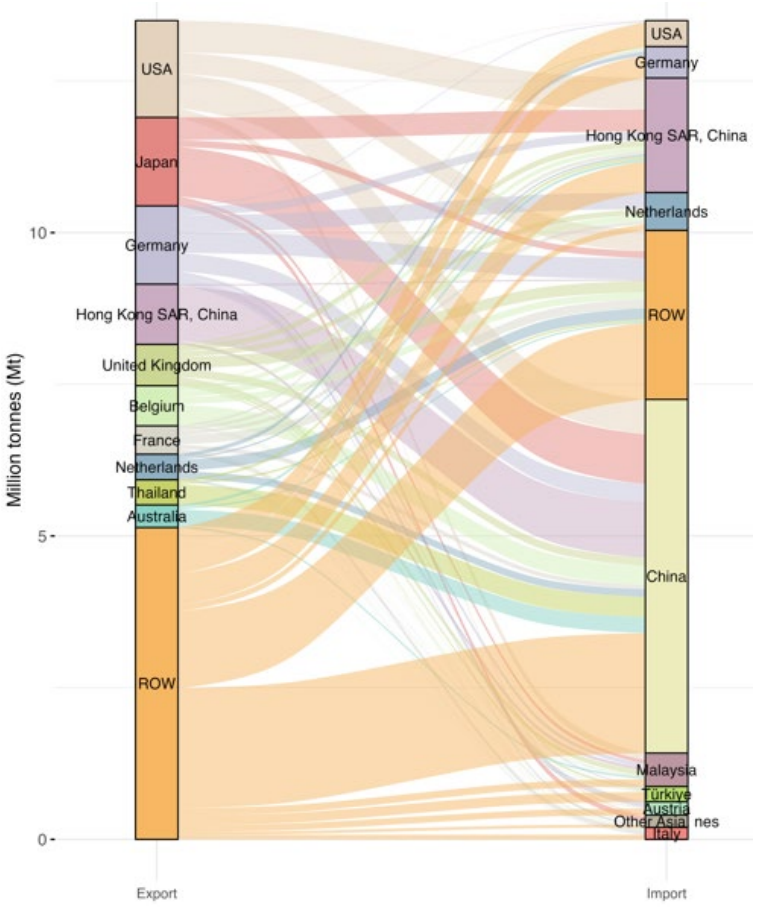
Key features of the contamination standard in ONS: Rationale, enforcement, and supply chain realignment

As the world's largest importer of plastic waste for decades, China had long absorbed the externalities of a fragmented global plastic scrap economy. Before 2018, mainland China alone accounted for more than 55 percent of global plastic waste imports, receiving more than 7 Mt annually (refer to figure 5, panel a). When combined with Hong Kong SAR, China, China's share exceeded 72 percent of the world's traded plastic waste (Brooks, Wang, and Jambeck 2018; Wen et al. 2021). However, years of poorly regulated imports—often contaminated with food residues, hazardous substances, or non-recyclable materials—overwhelmed local recycling infrastructure, particularly in small workshops and informal processing communities. Implemented by the General Administration of Customs, ONS signaled a fundamental redefinition of China's role in the global plastic waste trade: not only to curb the inflow of highly contaminated, poorly sorted plastic waste, but also to reduce domestic environmental harms and advance the country's "ecological civilization" agenda, which includes formalizing, modernizing, and regulating waste systems (Liu and Liu 2023).

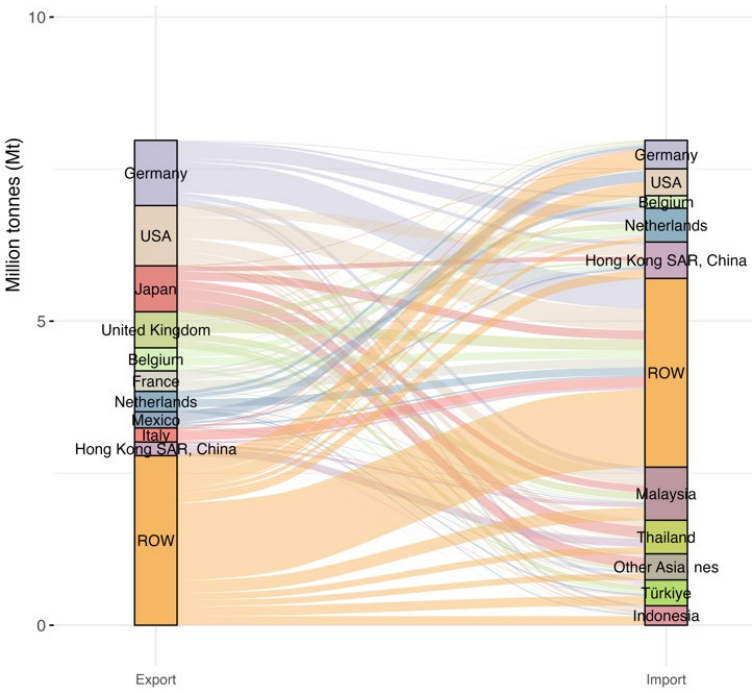
What distinguishes ONS from earlier regulatory efforts such as China's 2013 "Green Fence" campaign is its depth of enforcement and scope of systemic overhaul. While Green Fence was an effort to enforce existing regulations. ONS did not merely increase inspections; it redefined what materials could legitimately be traded as recyclable resources. The policy effectively banned 24 categories of contaminated solid waste, intensified customs scrutiny, and tightened licensing requirements for importers. The 0.5 percent contamination threshold was widely seen as unachievable for most exporting countries using mixed collection systems. ONS forced exporters to reckon with the reality that what was often labeled "recyclable" was, in practice, a costly burden for recipient countries (Heiges and O'Neill 2022; Tan et al. 2025).

Figure 5. Global plastic waste trade flows, 2017–23

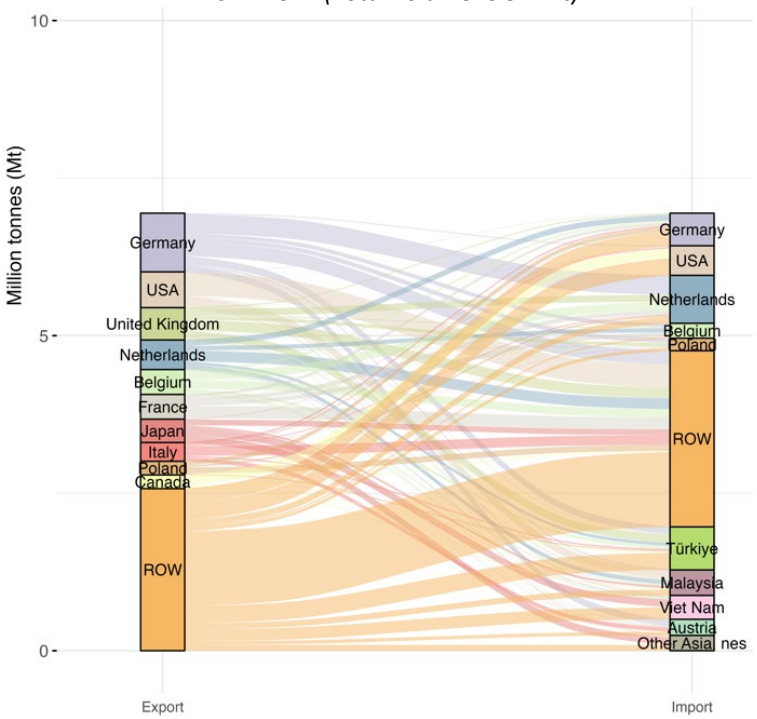
a. 2017 (Total volume: 13.5 Mt)



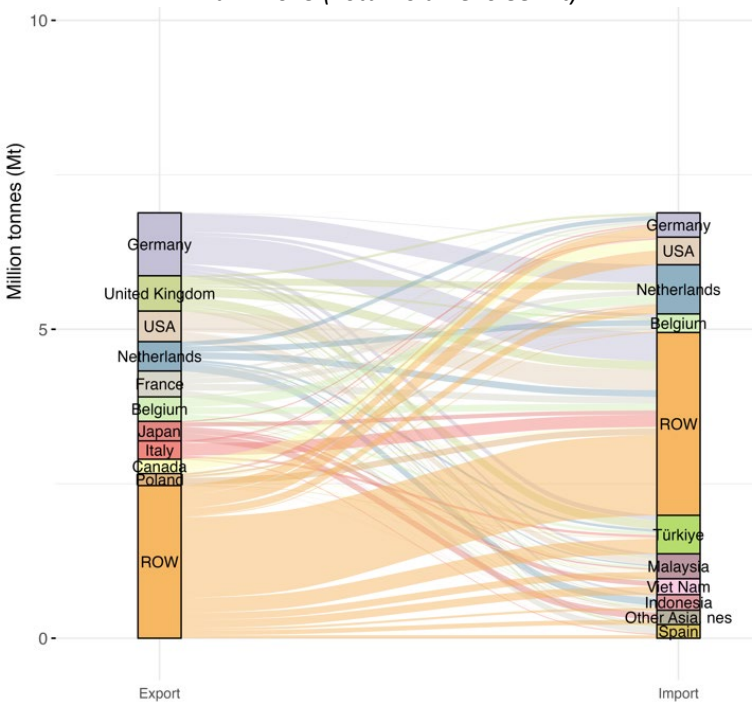
b. 2018 (Total volume: 7.97 Mt)



c. 2021 (Total volume: 6.94 Mt)



d. 2023 (Total volume: 6.88 Mt)



Source: UN Comtrade.
Note: Mt = million tonnes; ROW = rest of world.

International impacts: Contraction, redistribution, and leakage

The implementation of China's contamination standard under Operation National Sword (ONS) triggered immediate and far-reaching effects on the global plastic waste trade. Most visibly, it led to a sharp contraction in overall trade volume, as global exporters—particularly the United States, Japan, and several EU countries—lost access to their largest end market. Between 2017 and 2018 alone, global trade in plastic waste dropped by more than 40 percent, with sustained decline through 2023 (refer to figure 5). This contraction was not simply a reduction in quantity; it signaled a fundamental disruption in the geography of waste disposal and the political economy of waste trading (Brooks, Wang, and Jambeck 2018; Heiges and O'Neill 2022).

Alongside the overall contraction, flows of waste plastics were redistributed. Most immediately, the trade switched to other countries in Southeast Asia and beyond. Countries such as Malaysia, Indonesia, and Türkiye saw rapid increases in imported plastic waste volumes, leading to significant stress on local waste management infrastructure (Brooks, Wang, and Jambeck 2018; Bourtsalas, Yepes and Tian 2023; Uhm 2021). For instance, Malaysia's plastic waste imports ballooned from around 176,000 tonnes in 2012 to nearly 900,000 tonnes in 2018.[1] Türkiye also became a leading importer, leaping from 65,000 tonnes in 2013 to ten times that in 2024.[2] In response to these pressures, several countries introduced import restrictions or outright bans. Thailand, for example, formally implemented a full ban on plastic waste imports in January 2025, following phased restrictions announced in 2018. Framed as a response to the post-ONS surge in plastic waste imports, the measure—which restricts imports to only clean, high-grade plastic waste for industrial use—closely mirrors China's ONS policy in both rationale and structure, emphasizing contamination thresholds as a tool to reassert regulatory control over transboundary waste flows (Laville 2025).

Yet, even as several developing countries moved to strictly control plastic waste inflows, new dynamics emerged. Notably, developed countries, though already involved in plastic waste trade before ONS, expanded their role as importers, reabsorbing a growing share of global plastic scrap trade. By 2022 the EU28 had become the world's largest net importer of plastic waste, accounting for more than 52 percent of global import volumes (3.48 Mt) (Houssini, Li, and Tan 2025). This shift can be understood as part of the broader realignment catalyzed by China's withdrawal from the plastic waste trade (Uhm 2021). ONS intensified global scrutiny of plastic waste trade, contributing to a regulatory shift that culminated in the 2021 Basel Convention Plastic Waste Amendments.[3] These amendments expanded the scope of controlled plastic waste—particularly for mixed and contaminated categories and required pretreatment to meet quality standards and Prior Informed Consent (PIC) procedure before export. As a result, they not only reduced the volume of lower-quality exports but also contributed to shifting trade flows toward countries with robust infrastructure and regulatory alignment, such as members of the EU28.

As trade flows adjusted to new regulatory conditions and enforcement patterns, new trading strategies also emerged to circumvent uneven national and international controls. In particular, some exporters have exploited ambiguities in the Harmonized System (HS) coding system—especially broad or underspecified categories such as "other plastics" (for example, HS 391590) and the lack of distinct codes for widely traded plastic waste streams like PET and polypropylene (PP)—to reclassify contaminated or mixed plastic waste as recyclable materials. These classification practices complicate enforcement and highlight the limitations of current customs protocols in distinguishing waste from resource (Brooks, Wang, and Jambeck 2018; Wen et al. 2021).

Beyond reshaping trade flows, the disruption caused by ONS also had significant implications for climate outcomes. As developed countries faced increased volumes of plastic waste for domestic management, many turned to incineration, which is more carbon-intensive than landfill disposal or recycling. As a result, the net effect in the immediate aftermath of the ban was an increase in greenhouse gas (GHG) emissions associated with plastic waste treatment. Wen et al. (2021) estimate that this shift led to a measurable rise in global warming potential (GWP), driven by the substantially higher incineration rates in OECD countries compared to China. This outcome highlights that leakage from national standards like ONS is not only geographic—through the redirection of waste to other jurisdictions—but also environmental, as the burdens of pollution are transferred or transformed rather than resolved.

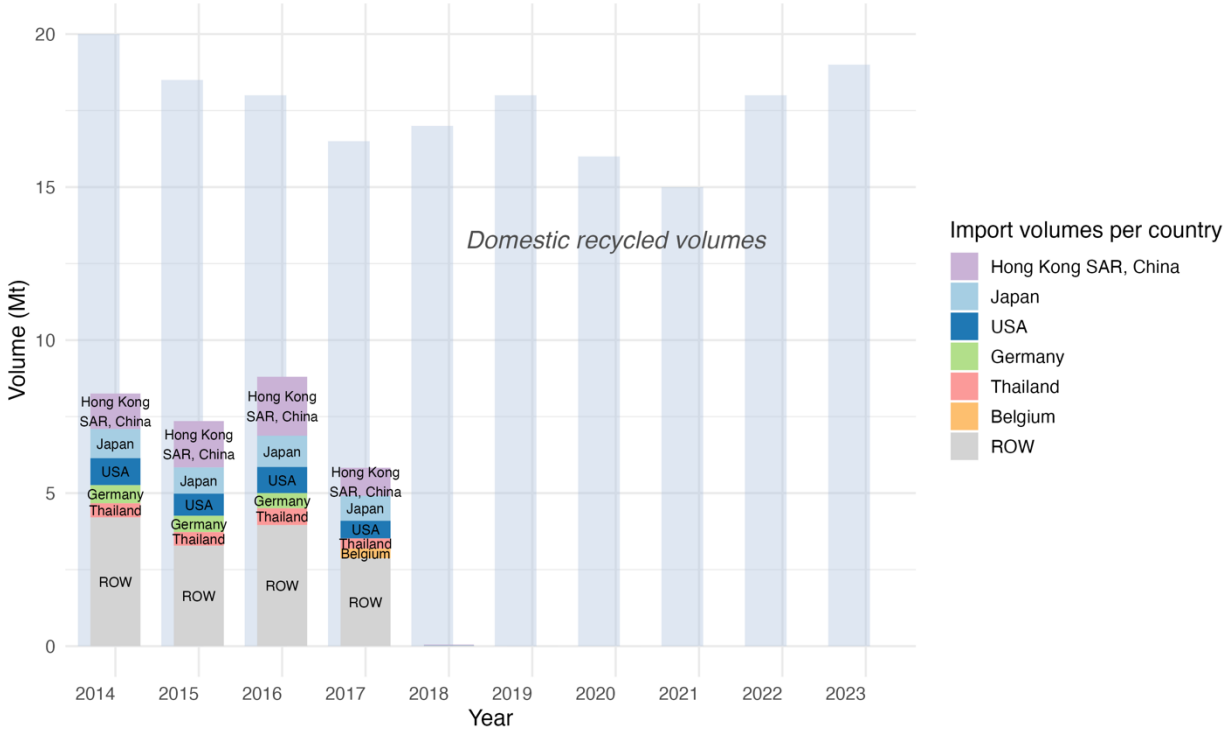
Together, these changes suggest that contamination standards like ONS that are implemented unilaterally, while successful in closing off a major outlet for externalized plastic waste, may contribute to cascading leakage effects when not accompanied by systemic coordination. Rather than addressing root causes, such standards may simply redistribute environmental risks to countries with weaker enforcement or less regulatory capacity (Ley, Macauley, and Salant 2010). Mitigating both geographic and environmental leakage will require harmonized international governance—through instruments like the Basel Convention's plastic amendments and the ongoing global plastics treaty negotiations—to align contamination standards, tracking protocols, and market access conditions. These efforts must go beyond piecemeal restrictions and focus on aligning standards and procedures to prevent regulatory fragmentation and unintended displacement of environmental harms.

Domestic impacts in China: A sector in flux

While the immediate halt in plastic waste imports following ONS might have suggested an inevitable contraction of recycling activity in China, the outcome did not follow a straightforward collapse. Instead, it revealed a more complex recalibration of domestic recovery pathways amid the sudden disappearance of imported feedstock. As shown in figure 6, plastic waste imports dropped precipitously—from more than 7 Mt in 2016 to virtually zero by 2018. Yet the total volume of recycled plastic did not collapse in tandem. Rather, it remained relatively stable in the years immediately following the implementation of ONS, with a gradual increase observable from around 2020 onward—rising from approximately 15 Mt in 2021 to 19 Mt by 2023 (China National Resources Recycling Association 2024; Ma, Niu, and Lu 2022).

This trajectory indicates a certain degree of decoupling of domestic recycling performance from external waste streams and an increasing reliance on internal plastic scrap supply. The relative stability in recycled volume can be attributed in part to domestic policy realignments under China's 13th Five-Year Plan for National Economic and Social Development (2016–2020) and the 14th Five-Year Plan (2021–2025). The 13th Plan emphasized municipal solid waste classification and encouraged the recovery of low-value recyclables—including plastics—by integrating sorting systems into urban infrastructure. The 14th Plan expanded these efforts by supporting the development of standardized household waste treatment systems and investing in city-level collection and sorting of plastic waste. These policy directions were reinforced by the 14th Five-Year Plastic Pollution Control Action Plan (2021–2025), which introduced targeted measures to reduce plastic leakage and enhance plastic recycling capacity (ADB 2023; Liu and Liu 2023; Wen et al. 2021). At the same time, part of the gap left by imported recyclables was absorbed through increased reliance on virgin plastics. Between 2016 and 2020, China's primary plastic production rose from 82.1 Mt to 103.6 Mt, reflecting an increased reliance on virgin plastic inputs in the absence of imported recyclables (Tan et al. 2025). This trend raises important questions about the environmental trade-offs and long-term circularity implications of China's transition following the imposition of ONS.

Figure 6. Plastic waste imports and recycled volumes in China, 2014–23



Source: UN Comtrade; China National Resources Recycling Association; Liu and Liu 2024.
Note: Mt = million tonnes; ROW = rest of world.

Yet this overall system-level stability obscured a more uneven and exclusionary transformation on the ground, where small-scale recyclers and informal actors bore the brunt of the transition. The restructuring of the sector disproportionately favored larger, well-capitalized firms capable of complying with new standards and investing in automation, optical sorting, and modern recycling infrastructure (Li and Mu 2024). Provinces like Guangdong and Shandong began to emerge as hubs for formalized recycling clusters, supported by local government incentives for industrial upgrading (China National Resources Recycling Association 2024). Meanwhile, the abrupt loss of import supply destabilized local recycling economies in provinces such as Guangdong, Zhejiang, and Jiangsu—regions that had long depended on steady inflows of plastic scrap from overseas (Tan et al. 2025). Lacking access to sufficient high-quality domestic feedstock or the capital required to upgrade facilities in line with stricter environmental regulations, many operators were forced to shut down, shift to grey-market activities, or relocate to Southeast Asia, where oversight was weaker and compliance costs lower (Tan et al. 2025; Yu et al. 2023). Thousands of small workshops closed without compensation or clear transition pathways, and the role of waste pickers diminished as collection networks became more centralized and privatized.

Taken together, these domestic shifts suggest that it was not the contamination standard itself, but a wider constellation of domestic policies and public investments that sustained recycling capacity in the post-ONS period—though it simultaneously reconfigured sectoral dynamics in ways that privileged scale, capital, and regulatory alignment over historical participation.

Case 2. Plastic credit standard as a "polluter pays" mechanism: EPR in the Philippines

Regulatory and voluntary standards that assign financial or operational responsibility to producers are grounded in the "polluter pays" principle, which holds producers accountable for the environmental impacts of their products. One of its most institutionalized manifestations is EPR, which requires producers—often defined as brands or plastic packaging manufacturers in the context of plastics—to ensure the collection, recycling, or environmentally sound disposal of post-consumer plastics. While EPR policy designs vary, conventional EPR typically mandate structured fees to fund waste management. These fees—flat-rate or eco-modulated based on recyclability, weight, or toxicity—aim to internalize environmental costs and incentivize sustainable product design (Laubinger et al. 2021).

Several developing countries have adopted government-mandated fee schemes in national regulations. In Colombia, Resolution 1407 of 2018 requires producers to pay mandatory EPR fees through approved Environmental Management Plans—formal documents that producers must submit to the government as part of their EPR obligations (G20 Marine Plastic Litter 2023). República Bolivariana de Venezuela and Costa Rica likewise mandate that producers contribute fees based on the volume of plastic placed on the market (Serra Gonzalez 2021). South Africa's EPR regulations set eco-modulated fees on a rand-per-kilogram basis, with rates differentiated by material type and recyclability (Republic of South Africa 2024).

However, some EPR policies depart from this government-mandated fee model by incorporating standards-based compliance mechanisms. Instead of upfront government-mandated fee payments, producers may fulfill obligations through plastic credit mechanisms that quantify and certify post-consumer waste recovery. The Philippines offers a distinctive case of how national EPR regulation can incorporate voluntary plastic crediting standards into formal compliance structures, effectively institutionalizing transnational standards within domestic policy.

Key features of the credit standard in the Philippines' EPR: Rationale and enforcement

The Philippines' Extended Producer Responsibility Act of 2022 (Republic Act No. 11898) mandates that large enterprises—defined as businesses with total assets exceeding 100 million pesos—that introduce plastic packaging into the domestic market must recover a specified percentage of their plastic packaging footprint. Recovery targets begin at 20 percent by the end of 2023 and increase incrementally to 80 percent by 2028 (Republic of the Philippines 2022). To meet these obligations, enterprises may adopt various strategies, including the purchase of plastic credits.

The incorporation of a credit-based compliance mechanism reflects both regulatory pragmatism and structural limitations in the country's waste management system. At the time the law was passed, many producers lacked direct access to reliable post-consumer collection and recycling infrastructure. By recognizing third-party verified plastic recovery through diversion certificates, the government sought to expand compliance pathways, reduce transaction costs for firms, and incentivize the growth of recovery ecosystems beyond traditional municipal waste channels (Aberilla et al. 2024). Plastic credits are also purported to mobilize private funding for waste recovery, including integration of informal actors and investment in end-of-life processing infrastructure (PARMS 2023; PCX Markets 2025). These credits, issued by accredited Producer Responsibility Organizations (PROs) such as PCX under the Plastic Pollution Reduction Standard (PPRS), represent the verified diversion of one metric ton of post-consumer plastic waste.

The Department of Environment and Natural Resources (DENR) is responsible for the implementation and enforcement of the EPR Act. Obligated enterprises are required to register their EPR programs with the National Ecology Center (NEC) and submit an annual EPR Compliance Audit Report (ECAR), which includes

both a compliance summary and a third-party audit (Philippines, DENR 2024). These reports must adhere to uniform reporting standards established by the DENR and be submitted by the deadlines set annually, with the first report due by July 1, 2024, covering the 2023 reporting year (Fernandez-Guisa 2024). To enforce compliance, the EPR Act stipulates substantial penalties for noncompliance: fines range from PHP 5 million to PHP 20 million, depending on the severity and frequency of violations.

PROs play a central role in operationalizing the EPR Act. They assist obligated enterprises in developing and executing EPR programs, calculating plastic footprints, issuing diversion certificates, and coordinating third-party audits. As of 2024, DENR has accredited seven PROs to carry out these functions (Reyes and Beitien 2024). Among them is PCX, a transnational organization that administers the PPRS and provides globally recognized crediting standards and registries (PCX Markets 2025). In the Philippines, PCX facilitates EPR compliance by managing credit transactions and verifying waste recovery outcomes (Reyes and Beitien 2024). Credits issued by PCX under the PPRS are recognized as valid instruments for fulfilling recovery obligations under the EPR Act.

Impact of the credit standard

The incorporation of plastic credit mechanisms into the Philippines' EPR framework has reshaped how compliance is conceptualized and made operational. By the end of 2023, 947 companies had registered under the EPR scheme, and 163,000 tonnes of post-consumer plastic packaging had reportedly been recovered and diverted—surpassing the initial 20 percent compliance target based on estimated national baselines (Reyes and Beitien 2024). While these figures suggest a degree of institutional uptake, they warrant more cautious interpretation. The reported recovery volume represents only about 6 percent of the 2.7 Mt of plastic waste generated annually in the Philippines (Schachter and Karasik 2022). This discrepancy points to a broader challenge: although the EPR mechanism has facilitated early participation from obligated enterprises, a substantial share of plastic waste remains beyond the reach of formal recovery systems.

Still, in a national context marked by fiscal constraints, limited infrastructure, and a significant reliance on informal waste economies, embedding plastic credit standards into the national EPR system has offered a pragmatic pathway for early implementation and compliance. The credit-based compliance mechanism—recognized under the law as "plastic waste diversion certificates"—served as a widely adopted compliance option, particularly in a context of limited formal collection and recycling infrastructure. It has enabled producers—particularly large firms with global reporting commitments—to demonstrate initial progress while the institutional infrastructure for EPR is still being built. Available data from PCX, one of the country's largest PROs, further suggests that a small number of large, obligated enterprises accounted for a disproportionate share of both the footprint and recovery volumes, indicating that compliance momentum is being driven by a subset of high-capacity actors (Reyes and Beitien 2024).[4]

However, upstream measures—such as packaging redesign, refilling systems, and the use of recycled content—were notably less prominent in the first year, which suggest the need for stronger incentives and guidance to balance waste recovery with production strategies. The first-year implementation experience thus highlights both the feasibility of rapid policy rollout in a developing country context and the ongoing need for policy refinement, infrastructure investment, and strong incentive to ensure long-term policy effectiveness.

Several technical and structural challenges remain. First, while plastic credits are claimed to internalize the environmental costs of packaging waste, their pricing mechanisms remain largely unregulated and market-driven—thus volatile and opaque—with limited public oversight over how credit values are determined and no eco-modulation to reflect material-specific externalities (Eunomia 2024; Moon et al.

2025). Furthermore, integrating material-based crediting standards into a product- or sector-based EPR system introduces fundamental mismatches in scope and accountability. While EPR regulations target specific product categories—primarily post-consumer plastic packaging, in the context of plastics—plastic credit standards cover a broader array of plastic items and waste sources beyond packaging. This scope mismatch can blur the boundaries of regulatory goals and producer responsibility, opening loopholes through which recovery claims may be derived from outside the intended scope of producer obligations (Moon et al. 2025).

The Philippines case demonstrates that while incorporation of credit standards into EPR compliance mechanisms has facilitated early compliance, it has also introduced additional uncertainties around accountability, environmental integrity, and alignment with long-term policy goals—incentivizing product redesign and the reduction of packaging waste. Credit systems may function less as instruments of structural transformation and more as tools of regulatory flexibility, enabling participation without necessarily prompting shifts in production practices and waste management practices.

Key Lessons and Policy Recommendations

Standards are strong tools for addressing complex and challenging environmental (and economic) problems that often transcend national borders. A representative example is the issue of plastic waste and end-of-life plastics. The relevant questions are less about whether standards are effective or not, but more about "under what conditions" standards or alternative policy choices make the most sense, and what their consequences are—especially for developing countries, notably those operating at low capacity and with weak information systems. This section outlines the main lessons and policy implications arising from the data presented in this study, and discusses the experiences of China and the Philippines, which demonstrate that standards can shape material flows and compliance behavior, but their effectiveness depends on institutional capacity, enforcement structures, and sociopolitical contexts.

In China, a highly specific contamination standard was enforced at the border with strong state capacity. This standard had significant international impact, contributing to a sharp contraction in global plastic waste trade volumes, and in near term, increased emissions due to a shift toward incineration in exporting countries. Domestically, the contamination standard coincided with a broader set of waste management policy reforms that aimed at modernizing the country's waste infrastructure. While these policy shifts occurred in parallel, the impacts on domestic plastic waste management performance were largely driven by internal planning and investment, rather than the contamination standard. In the Philippines, by contrast, the introduction of plastic credit standards into a national EPR scheme enabled a measurable increase in reported plastic waste collection and participation among large producers. While the credit mechanism allowed obligated enterprises to comply despite infrastructure limitations, its reliance on diversion certificates—without corresponding incentives for product design change or waste reduction—and the absence of eco-modulation suggest that the standard has thus far supported compliance more than achieving core EPR policy goals.

This section outlines the main lessons observed through the case studies that are relevant for domestic and international stakeholders and policy makers. These lessons—which revolve around the complexities of implementing standards in different national and local contexts—underpin the policy recommendations (priorities for action) advocated in this study.

Lessons (to be) learned

Standards for managing end-of-life plastics are complex: there are many types of standards and initiatives—technical, labeling, accounting, certification, and credits standards—across national and international policy layers. This evolving landscape presents both promise and challenges. On one hand, standards can help codify shared expectations, channel investment, and shape market behavior. On the other hand, the sheer diversity and complexity of standards make decisions around adoption, implementation, enforcement, and impact highly dependent on the context. This is particularly relevant in developing countries, where capacities for regulatory design, implementation, and monitoring are limited and uneven—and often shaped by international actors, as illustrated by the Philippines' incorporation of transnational plastic credit standards into national policy.

At the same time, the landscape of plastic-related standards is a patchwork of overlapping and uneven standards spanning product design, recycled content, labeling, and waste collection and recovery, creating gaps and fragmentation across voluntary, regulatory, and private-sector efforts (Deere Birkbeck et al. 2023; ISO 2023). This fragmented landscape reflects divergent stakeholder priorities, resulting in gaps, duplications, and inconsistencies that complicate alignment with national strategies and pose operational challenges for implementing agencies and private actors alike. Governance gaps are especially evident in critical areas such as reuse and refill systems, environmental labeling, and the regulation of plastic substitutes, which remain subject to few standards or are unevenly addressed (Deere Birkbeck et al. 2023). While some degree of competition among standards may spur innovation or a race to the top, it can also generate confusion regarding compliance requirements and weaken coherence across public and private governance efforts.

These levels of fragmentation contribute to often unintended transboundary impacts. China's contamination standard under Operation National Sword (ONS) highlights how a state-led regulatory system can use technical standards to exert control over transboundary waste flows. Rather than banning plastic imports outright, the policy established an extremely stringent contamination standard, rendering most shipments effectively noncompliant and triggering far-reaching international effects, including diversion of plastic wastes to other developing countries (a pattern of cascading leakages). This outcome was made possible through strong state enforcement capacity on the part of China and clearly defined institutional mandates, which enabled both the reconfiguration of global trade patterns and the advancement of domestic waste policy reform.

Another set of consequences that the cases reveal and is highlighted in other studies of standards is that the social and distributive consequences of implementing standards schemes are far from trivial. For example, the recovery and recycling work of informal laborers, which is often invisible to policy makers (or seen as a negative), can be erased in the creation of technical standards and nonphysical credits.

In sum, standards are increasingly used to manage the environmental and economic impacts of plastic waste and end-of-life plastics. Compared to alternative policy instruments such as outright bans on single use plastics, or eco-taxes, standards offer a politically palatable and institutionally adaptable tool. They can be developed and implemented incrementally and voluntarily, and adopted by a range of actors—from national governments to private companies and NGOs. Yet their effectiveness is highly contingent—not only on how they are designed and implemented, but also on how they are embedded within a broader policy context capable of delivering long-term policy objectives. Their adaptability can also dilute accountability, especially when standards substitute for more harmonized, binding forms of regulation, and create uncertainties, particularly because secondary plastics markets fluctuate and transparency is hard to maintain. Empirical evidence from the case studies suggests that while standards can influence material flows, signal regulatory expectations, and enable quantifiable compliance, their impact on reducing waste and preventing leakage is far more uncertain.

Priorities for action

Based on these insights and the discussion in preceding sections, this study proposes four priority areas for developing countries considering standards-based approaches to plastic waste management. These are organized around four interrelated dimensions: enabling conditions, institutional anchoring, transboundary effects, and social equity.

1. Enabling conditions

Standards need to align with a country's specific institutional capacity, infrastructure, and market realities. What works in one national context may be ineffective or counterproductive in another. This may be particularly problematic in developing standardized international markets, and in establishing mechanisms to assess and adapt policies moving forward. "Enabling conditions" refers to the work that has to be done to ensure standards-based systems work effectively in different national and local contexts.

For instance, governments and supporting agencies need to invest in capacity and knowledge. Designing, implementing, and monitoring of standards require significant technical expertise and sustained resource investments. Institutional learning, technical training, and stakeholder coordination are essential to building enforcement capacity, enabling coordination across the plastic value chain, and fostering institutional accountability. Given lack of capacity in many developing country governments, outside or third-party scaffolding and expertise can play a critical role. For example, the International Organization for Standardization plays a key role in strengthening national capacity by equipping national standardization bureaus with tools to align international standards with domestic regulatory goals and policy implementation processes. In countries such as Kenya, ISO engages directly with national standardization bureaus—advising on how to reference standards in legislation, develop conformity assessment systems, and position standards as practical instruments for achieving environmental policy goals, as well as facilitating international trade through regulatory coherence (ISO 2023, 2024).

2. Institutional anchoring

Embedding standards within national legal frameworks can significantly enhance enforceability, accountability, and transparency. In India, for example, compliance with IS/ISO 17088 is mandated for compostable plastics under the Plastic Waste Management Rules (2021), with producers required to obtain certification from the Central Pollution Control Board (CPCB) prior to sale. Similarly, in Malaysia, products marketed as biodegradable must comply with SIRIM ECO 001:2018 standard. This requirement is reinforced by directives at the local level, such as those issued by Kuala Lumpur City, furthering enforcement within local jurisdictions. However, effective implementation also requires an ongoing commitment to policy maintenance and capacity building, which can be challenging for many developing country governments and development agencies (Sagar 2000).

3. Transboundary leakage and spillover effects

Domestic plastic standards can inadvertently shift environmental burdens across borders through waste displacement or market disruption. Policy makers should anticipate and mitigate these effects by coordinating regionally and aligning with international agreements such as the Basel Convention and the forthcoming plastics treaty. The WTO Dialogue on Plastic Pollution (DPP) provides a relevant example of how international institutions are engaging with the transboundary dimensions of plastics governance by examining the trade implications of domestic measures such as standards, labeling, and disclosure requirements. The DPP seeks to share policy experiences and explore how trade rules can accommodate diverse national approaches without exacerbating leakage or creating unintended trade barriers (WTO 2025).

4. Equity and inclusion

While some standards claim to incorporate informal and marginalized actors, such inclusion often lacks meaningful protections, leading to exploitative incorporation without formal rights or meaningful safeguards. Standards-based approaches must go beyond symbolic recognition to actively safeguard labor rights, provide access to social protections, and ensure informal waste workers and small-scale recyclers have a voice in standard-setting and monitoring processes. India's IS 16557:2016 is one example of how this can be done. The recognition and involvement of waste-pickers in the international plastics treaty negotiations is another (Hillsdon 2023; O'Hare and Nøklebye 2024). The potential for boosting informal waste workers and economies is also now recognized by leading international finance and development organizations, including the World Bank and the UN Environment Programme (Georgieva et al. 2023; UNEP 2023b).

Conclusion

As plastic-related standards gain traction in developing countries, the challenge now is not whether to adopt them, but how to design, implement, and coordinate them effectively. This study has presented actionable recommendations grounded in the study's findings, with particular attention to feasibility, equity, and global coherence, and the challenges articulated in the fifth section of this study. Can standards in developing countries significantly shift the needle on reducing plastic waste mismanagement—and under what conditions? The case studies presented here suggest that standards can influence outcomes, but their effectiveness hinges on political will, enforcement structures, and institutional capacity. Standards offer a politically and economically viable tool for taking on global problems of plastic waste, by enabling flexible compliance mechanisms while also promoting harmonization across jurisdictions. They also support cross-border trade, reduce regulatory friction, and open pathways for global cooperation.

One final consideration is the evolving role of global governance. Whether and how plastics-related standards gain formal enforceability will depend in part on how the global plastics treaty defines their role as an overarching governance architecture. The treaty's institutional design—whether it establishes binding mechanisms, reporting obligations, or structured pathways for aligning national standards with global objectives—will shape the extent to which national and voluntary standards are legitimized, harmonized, or incentivized across borders.

Developing countries, especially as the international community moves toward a legally binding global plastics treaty (in some shape or form), have a critical opportunity to shape not only how standards are adopted and implemented domestically but also to influence how global frameworks define fair responsibility, recognize diverse sociopolitical and legal contexts, and allocate financial and technical resources. Crucially, this also includes engaging with what kinds of practices are standardized and managed, which in turn determine what kinds of data are collected and valued—including contamination rates, informal sector contributions, and rates of mismanaged waste. As shown in our analysis, particularly in the first section on global trends in plastic waste, patterns across regional disparities in plastic waste management, transboundary waste flows, and mismanagement rates suggest that current standards-based approaches may face limitations in delivering consistent and system-wide improvements. These limitations can undermine the effectiveness of standards in advancing primary objectives of plastic waste management policy—minimizing mismanagement, reducing reliance on virgin plastics, and ultimately ending plastic pollution. Improving how standards function across diverse implementation contexts will require governance systems that are more responsive to practical constraints and limitations—and this will depend, in part, on the engagement of developing countries in shaping systems that reflect context-sensitive and equitable approaches to standardization.

Notes

[1] United Nations Comtrade Database, https://comtrade.un.org/.
[2] United Nations Comtrade Database, https://comtrade.un.org/.
[3] Text of the Basel Convention and Amendments, Secretariat of the Basel Convention, https://www.basel.int/theconvention/overview/textoftheconvention/tabid/1275/.
[4] Plastic footprint volumes refer to the total weight of plastic packaging introduced into the domestic market by an obligated enterprise, as defined under the Philippines' Extended Producer Responsibility (EPR) Act. Plastic waste recovery volumes represent the quantity of post-consumer plastic waste collected, diverted, or otherwise recovered through activities such as recycling or co-processing, in accordance with recovery obligations under the same law.

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