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« Plastic : a consequence and a problem of globalisation »

Both a consequence and a driver of the economic growth and globalization that followed the Second World War, plastics are an inherent part of our daily lives. Multifunctional, practical, and cheap, they have gradually invaded our everyday environment. Stemming first from carbochemistry and later from petrochemistry, the main plastic materials were invented between 1850 and 1950. While around a hundred families of plastics exist with various properties, for many of them, enhancements through toxic additives make recycling difficult or impossible. Plastics thus encompass a set of synthetic materials manufactured from hydrocarbons, absorbing 14% of global crude oil and 8% of global gas. Maritime transport sits at the very heart of plastic's life cycle: hydrocarbons, basic chemical products, pellets, finished goods, and final waste. This last point raises numerous economic and environmental questions regarding the place of plastic in the contemporary world and its pollution of the oceans.

Plastic: contextual éléments

Each year, 400 Mt of plastics are produced worldwide, and by 2025, annual production is estimated to reach 600 Mt. Today, China accounts for 50% of total global production, followed by Europe (19%)¹ and the United States, Canada, and Mexico combined (18%). Plastics are present across all sectors. Within the European Union, more than a third of the plastic produced is used for packaging, 20% for building and construction, 10% for the automotive industry, followed by electrical and electronic components (6%), the household, sports, and leisure sector (4%), and agriculture (3%). The remaining portion, roughly 16%, concerns household appliances, mechanical engineering, furniture, and medical equipment.

The question of plastic's role in consumer products has become a societal and political issue, bringing with it the necessity for a progressive eradication of single-use products. Part of the economic model of the consumer society relies on the practical and affordable nature of plastic products first in Western countries and Japan, and subsequently worldwide. While the fragility of plastics is responsible for the discarding of manufactured objects, a major part of the problem stems from single-use applications. This has allowed manufacturers to escape the logistical constraints of returnable packaging systems (deemed too costly and complex), while adapting to and encouraging new practices (mass retail, the democratization of household appliances, takeout food, individual portions, e-commerce, etc.) to increase profitability. The volume of packaging used by the agrifood industry continuously rises, alongside domestic or outdoor eating habits that accommodate or even encourage plastic.

The majority of plastic waste is not recycled, but rather incinerated or discarded into the environment. On a global scale, it is estimated that only 14% of plastic packaging is recycled, keeping in mind that this cycle is not infinite and that plastic ultimately becomes unrecoverable. Each type of plastic requires a different recycling process, as plastics are manufactured from thousands of distinct formulas. It is estimated that 40% goes to landfills, 14% is burned in incinerators, and 32% ends up in nature; through the effect of runoff, terrestrial waste finds its way into the ocean. According to a 2017 study published in *Nature*, fifteen of the twenty rivers that carry the most plastic materials are located in Asia, including six in China. Though sometimes quickly dismissed as a problem unique to developing nations, scientific findings show the true extent of this issue within European rivers and shorelines.

¹ The European plastics industry recorded an annual turnover of €350 billion in 2018, employing 1.5 million people across 60,000 companies.

The plastic waste trade: the "new plastic routes"

The North-South disparity in plastic consumption must be recalled. According to the *Plastic Atlas*, an African consumes an average of 16 kg of plastic per year, a Southeast Asian 40 kg, and a European 136 kg! The global average stands at 45 kg. This raises the question of plastic waste, with the obvious conclusion that developed States have partly exported the problem. The United States, Japan, Germany, and the United Kingdom are the largest global exporters of plastic waste in the world. Concurrently, it is these very same States that maintain the strictest environmental standards and which will tend to export their waste to countries where regulations (both environmental and social) are almost nonexistent.

The marginal cost of exporting waste is lower than the cost of constructing waste management facilities². Developed nations thus shift their negative externalities of "waste processing" onto other countries. These waste flows end up in non-compliant waste recovery facilities, or even in open-air dumps, posing significant health and environmental risks.

Waste is subject to cross-border trade that grows steadily in volume and at an accelerated pace in value. The market price of virgin material is a determining factor here. Plastics are intrinsically linked to fluctuations in oil prices. Recycling appears all the less attractive when the price of virgin raw material is low. Prospective studies on material price trends generally agree that, over a long-term horizon, the scarcity of raw materials and the depletion of our natural resources should drive up the price of raw materials and energy—and ultimately make recycling more valuable.

Importing recyclable waste can allow countries to recover low-cost raw materials that can be reinjected directly into the national production process. However, the importing State must possess an ecologically and socially satisfactory regulatory framework and be equipped with adequate receiving and processing infrastructure. The fact that a large portion of waste exports is sent from developed countries to developing countries raises questions about the actual effectiveness of this waste reprocessing. "Southern States" are sometimes all the more reluctant to regulate this market because it allows marginalized populations to earn a living from informal recycling activities.

For exporting nations, shipping processed plastic waste to China and neighboring countries provided an outlet for plastic waste management, keeping it out of landfills or preventing it from being incinerated in the countries of origin (which causes a direct release of GHG emissions). This does not account for the informal flows (illegally traded and undocumented) of exported plastic waste, the proportions of which remain unknown.

The export of plastic waste produced by so-called "Northern" countries to those of the "South" is fully integrated into maritime trade. Along with paper, components, textiles, metals, and scrap iron, plastic is part of the end-of-life products exported by developed nations. In 2016, this represented roughly 5 million TEUs across all product categories combined, including 1 million TEUs for the United States alone. Transport costs are relatively low because this involves containerized backhaul traffic. These reduced freight rates incentivize the offshoring of recycling on a global scale. Container carriers, for their part, find a relatively substantial market for routes heading toward China and Southeast Asia.

China used to be the world's leading importer of plastic, absorbing 45% of the total plastic waste generated globally since 1992. In order to preserve the environment and public health, China implemented a new policy as of January 1, 2018, banning the import of several waste categories, including plastics. Eight types of plastic waste originating from consumer goods are now prohibited, notably plastic polymer waste made of PE, PS, PVC, PET, and others (such as PP), as well as bales of PET plastic bottles, aluminum plastic films, and compact discs/digital video discs. Industrial plastic waste that complies with the Chinese environmental control standard GB 16487.12 is still accepted under specific conditions. This shift highlighted our dependency on China in this field and profoundly impacted the global trade of plastic waste. Consequently, tonnes of waste accumulated in California, the United Kingdom, Australia, and elsewhere.

EU countries were not left out. According to a report by the European Environment Agency's European Topic Centre on Waste and Materials in a Green Economy³, which studies plastic waste exports from the 27 Member States (+UK) to other nations, the Chinese restrictions triggered a "downward trend in plastic waste exports [which] is expected to lead to an increase in incineration and landfilling in the short

² In some cases, residents of developed countries benefit through reduced local taxes. In the United States, the return to local management has caused them to rise in many counties.

³ <https://www.eionet.europa.eu/etcs/etc-wmge/products/etcreports/plastics-waste-trade-and-the-environment>

term, due to the current lack of capacity to scale up recycling and reuse within the EU." This report estimated that EU plastic waste exports to non-EU countries stood at approximately 150,000 tonnes per month in early 2019.

Across Southeast Asia, recyclers operating in Indonesia, Thailand, Vietnam, and Malaysia, as well as in Turkey, stepped in to fill the void left by the Chinese bans. Waste containers still fill the holds of ships. However, these States were subsequently overwhelmed by waste (+70% in waste imports per year), bypassed by the sheer volume that China used to absorb easily. Numerous illegal recycling factories set up operations, discharging their toxic wastewater directly into the environment. Exasperated by this avalanche of waste, some of these countries plan to ban these imports. The Philippines, Malaysia, and Indonesia had declared the return of several waste containers to their shipping countries of origin, namely Canada, Australia, the United States, Germany, the United Kingdom, and France. It is estimated that 111 million tonnes of plastic waste will be displaced by the new Chinese policy by 2030.

The legal framework of the global plastic trade

Waste flows⁴ are monitored by customs and governed by international conventions, such as the Basel Convention⁵, which prohibits the export of hazardous waste to developing nations. Plastic used to be categorized under the "green list" (waste subject to a simple declaration). In April 2019, during the Conference of the State Parties to the Convention, an amendment was submitted by Norway to reclassify plastics under the "orange list," thereby subjecting them to prior notification and authorization before being shipped to non-OCDE countries.

This amendment was accepted by a majority vote⁶. This allows for greater traceability of global plastic waste flows. It will enter into force on January 1, 2021. From this date, all shipments of plastic waste unsuitable for recycling will be subject to the Convention's prior informed consent procedure. Countries unable to process this waste will therefore be allowed to refuse it. In parallel with international conventions, individual States are also taking measures to limit these influxes of non-recyclable waste. Malaysia, Vietnam, Thailand, India, and Indonesia have imposed a series of restrictions on imported non-recyclable plastics, notably bans, inspections, freezes on new licenses, new taxes and fees, and raids to determine the legality of imports. In Malaysia, the Ministry of Environment succeeded in shutting down around thirty factories that were illegally importing plastic waste. The objective is to permanently ban non-recyclable plastics and only authorize the import of recyclable plastics. By 2030, single-use plastic is expected to be banned nationwide.

These increasingly stringent restrictions must compel exporting States to rethink their relationship with the "disposable culture." The circular economy and plastic reuse are half-hearted solutions that sometimes allow exporting States and manufacturers to evade their responsibilities. Some advocate for the implementation of strict liability, holding waste producers and exporters responsible for ensuring that the material they ship is properly managed by any receiving entity. In certain developed and developing nations, the introduction of Extended Producer Responsibility (EPR) and deposit-refund systems has reduced waste from PET bottles and stimulated the recycling sector. Germany, Japan, and South Africa are among the countries that have successfully established manufacturers' responsibility for recycling used PET bottles.

More than 60% of all plastic manufactured (since 1950) is found in landfills or in nature, including the oceans. The remainder has been incinerated or remains unaccounted for. Manufacturers must reduce overall plastic reliance and offer alternatives to consumers, and if this is not done, they must manage this waste safely and transparently. It is impossible to completely remove certain plastics from the market, such as single-use medical applications, but if we truly want to combat this 21st-century scourge, it will be achieved through measures of prohibition, sanction, and banishment whenever the use of a substitute material is possible⁷. Limiting plastic production at the source will be the most effective

⁴ Wastes' means substances or objects which are disposed of, are intended to be disposed of, or are required to be disposed of by the provisions of national law.

⁵ The [Basel Convention](#) on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, which entered into force on May 5, 1992, and to which 187 States are parties.

⁶ It is worth noting that only Haiti and the United States have signed the Basel Convention but have still not ratified it—bearing in mind that the United States is the world's largest exporter of plastic waste.

⁷ These alternatives to plastic fall into three broad categories: natural polymers, synthetic biopolymers made from compostable biomass, and reusable, durable non-plastic materials.

measure, but it will require true political will. In France, the anti-waste law (Law No. 2020-105 of February 10, 2020) aims to strengthen producer responsibility, clarify consumer information, simplify sorting actions, and reduce waste by optimizing recycling. Thus, by following European directives, France is implementing bans on certain plastic objects. Bioplastics made from biopolymers—a new generation of plastic that is just as impactful on the ocean—have also been prohibited.

In reality, the majority of biodegradable plastics only degrade at very high temperatures. Incineration plants meet these conditions, but this is not the case in the natural environment. Even bioplastics derived from renewable sources such as corn starch, cassava roots, sugar cane, or the bacterial fermentation of sugar or lipids (PHAs) do not automatically degrade in the environment, and certainly not in the ocean. Governments must ensure that a clear distinction is made between home-compostable and industrially compostable plastics. The diversion of arable land for the manufacturing of this type of plastic is also to be questioned, along with the accompanying use of water and pesticides.

Consumer information has been reinforced with the obligation to provide information on proper sorting gestures and to indicate the presence of recycled content, hazardous substances, or plastic, for example. Extended Producer Responsibility (EPR) is expanded with the obligation, for instance, to open new specialized collection and treatment channels for specific waste, such as cigarette butts. However, some regret that this law is not stringent enough (failing to prevent material diversity, or to ban superfluous items and substances that are complicated to eliminate), such as the target of a global ban on single-use plastics by 2040. This is despite the increasingly extensive and alarming body of knowledge regarding the impacts of plastics on the environment, and particularly the marine ecosystem...

The impact of plastic in the oceans

Each year, between 8 and 10 Mt of plastic waste are discharged into the oceans. It is estimated that 80% (by weight) of solid marine debris originates from land-based sources, while 20% results from maritime activities (fishing, aquaculture, shipping, etc.). Plastic residues have recently been found off the coast of Antarctica and in the Mariana Trench. Floating debris on the ocean surface accounts for only 1% of the cumulative mass of all plastic waste. Consequently, "ocean cleanup" campaigns appear quite trivial. The remaining 99% rests on the seabed. They aggregate within several gyres (North and South Pacific, North and South Atlantic, Indian Ocean), forming a "plastic soup," and ultimately sink to the bottom of the oceans. Addressing coastal and marine pollution will be one of the key innovation challenges of the decade.

Once on the ocean floor, deep-sea currents transport these plastic fragments and fibers, gathering them into microplastic hotspots. Among these microplastics, fibers originating from textiles and clothing are predominantly found. The bulk of this waste is carried by waterways. The decomposition of plastic under mechanical and biological actions (heat, UV, oxygen) is extremely slow in the environment. Although plastic fragments into tiny pieces, uncertainties remain regarding their persistence in the environment and their impacts on both nature and public health. Bacteria cannot fully degrade this material. Fish and birds are the primary victims of floating plastics, which they can ingest, thereby integrating them into the food chain. According to the 2018 UN report, *"Single-Use Plastics: A Roadmap for Sustainability,"* cleaning up coasts and beaches to remove plastic waste in Europe costs approximately €630 million per year. Studies suggest that the total economic damage caused by plastic to the global marine ecosystem amounts to at least \$13 billion per year. These economic, health, and environmental risks must compel us to take action. Tackling one of the greatest environmental scourges of our time will require governments to opt for strong, comprehensive regulations, businesses to reform and innovate, and enlightened consumers to act.

Camille VALERO

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