

Plastic Mismanagement in Africa

Subjects: Polymer Science

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Plastic waste pollution is one of the main items on international agendas. It leads to more and more leakages and constitutes a dangerous threat to living beings and the ecosystem (toxic substances). Globally, only 9% of plastic waste is recycled, while 22% of it is mismanaged. A large part of this waste ends up legally or illegally in Africa.

Keywords: plastic footprint ; plastic/textile waste ; plastic recycling ; toxic substances

1. Statement of the Problem

1.1. Plastic Production in the World and by Region

Africa produces 5% and consumes 4% of the world's plastic ^{[1][2]}. Plastics are used daily for various purposes, e.g., for packaging goods, beverages, and food for easier transport; shoes; clothing; telecommunications; transport; etc. ^[3]. In 2021 ^[4], the regions with the lowest yearly plastic production were the Middle East, Japan, and the Commonwealth of Independent States (CIS), with an average of 11,721 kilotonnes (kt), followed by Latin America and Africa, with 15,628 and 19,535 kt; the EU-27+3 (current EU, Norway, Switzerland, and the United Kingdom), with 58,605 kt; the rest of Asia, with 66,419 kt; North America (the USA and Canada), with 70,326 kt; and China, with 125,024 kt, as the largest producer, as shown in **Figure 1**. In 2017, the share of plastic production in Africa and the Middle East was 7% and increased to 8% (5% for Africa) by 2021 ^[4]. According to the same source, it decreased by 4% in the EU-27+3 and by 1% in Japan, while it increased by 3% in China and by 1% in the Commonwealth of Independent States (CIS), and stagnated in all other countries during this period.

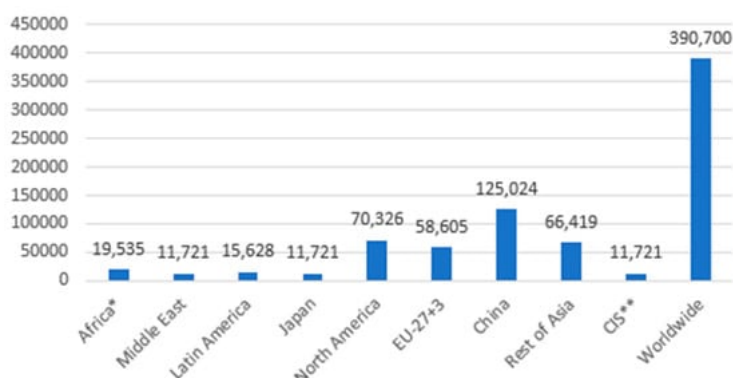


Figure 1. Annual plastic production worldwide and by region in kilotonnes (kt) in 2021 ^[4]; * Africa and the Middle East together produced 8% (the portion for Africa is estimated at 5%); ** Commonwealth of Independent States: Azerbaijan, Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan, and Ukraine.

1.2. Plastic Production in Africa

Figure 2 presents some of the plastic producers in Africa. The choice of African countries is guided alone by the data availability (even if some are old) and confirms the data scarcity ^[5]. In 2020 ^[6], Egypt (2329 kt), South Africa (1410 kt), and Nigeria (513 kt) were among the biggest African plastic producers. Ethiopia's estimated production in 2022 was 386 kt ^[6], Ghana's was 205 kt in 2019 ^[7], and Kenya's was 130 kt in 2018 ^[8]. In 2018, Kenya produced around 30% ^[9] of the country's 433 kt of primary plastic material.

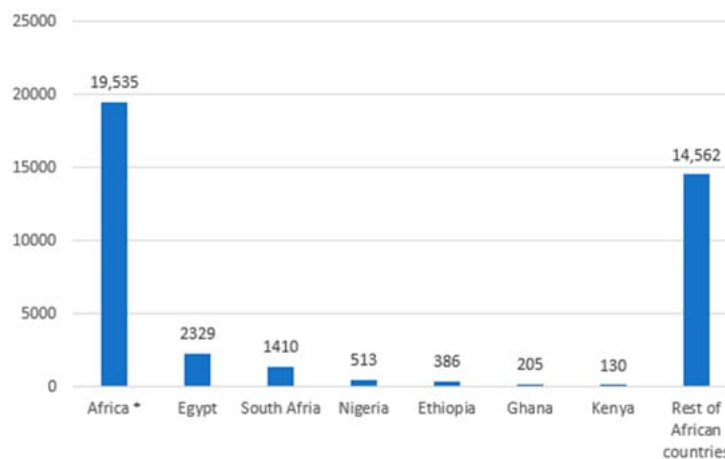


Figure 2. Plastic production in some African countries in kt per year ^{[4][5][6][7][8]}. * Africa and the Middle East together produced 8% (the portion for Africa is estimated at 5%).

Egypt is one of the largest polymer markets in Africa, accounting for over 20% of demand in 2017 and the country's polymer consumption is estimated at 2 million tonnes, with a per capita consumption of 21.8 kg/capita (investments in the plastics industry in Egypt amounted to USD 7.8 billion in 2016) ^[10]. In Rabat (Morocco's capital), the plastics manufacturer "Erum" completed an expansion of its plant in Tangier and inaugurated a new facility on 11 May 2023 ^[11]. The new plant (with a production capacity of 202 million product units) specializes in manufacturing plastic products for the clothing sector, such as plastic hangers ^[11]. The countries mentioned in this section are the most relevant African plastic producers and for which data are available. Countries from North, South, East, and West Africa are represented.

1.3. Imports of Unprocessed and Processed Plastics for Products

Imports of plastic raw materials from some African countries have increased significantly in recent years. It is not easy to find information concerning all African countries for the same year, so researchers used different references for different years. For example, from 2007 to 2020, imports for Algeria increased from 304 to 931 kt (+108%), Morocco from 374 to 659 kt (+76%), Tunisia from 209 to 326 kt (+56%), Nigeria from 513 to 848 kt (65%), and Ethiopia from 54 to 224 kt (+315%) ^[12]. Egypt and South Africa imported 896 kt and 539 kt of plastic raw material in 2020 ^[12]. In these 27 years (from 1990 to 2017), Africa imported 230 million tonnes (Mt) of plastic product components. The largest share of plastic components went to Egypt (43 Mt, 18.7%), Nigeria (39 Mt, 17.0%), South Africa (27 Mt, 11.7%), Algeria (26 Mt, 11.3%), Morocco (22 Mt, 9.6%), and Tunisia (16 Mt, 7.0%) ^[13]. Adding the 46 million tonnes of imported plastic products mentioned in Section 1, researchers can conclude that $((230,000 + 46,000)/27 = 10,222)$ kilotonnes of plastic products have been imported by the 33 countries on average per year in this period. Assuming that the percentage of countries mentioned above will roughly stay the same, the import quantity of each of these countries can be calculated. According to references, with data from 2018 for Kenya; 2020 for Ethiopia; 2018 and 2020 for South Africa; 2019 and annual estimations for Ghana; 2020 and the average value across 27 years for Nigeria, Egypt, Algeria, Morocco, and Tunisia, South Africa, Algeria, Nigeria, and Egypt imported the most unprocessed plastics, while Ethiopia, Ghana, Algeria, Egypt, and Nigeria imported the most processed plastics. **Figure 3** presents the yearly average imports of unprocessed and processed (products) plastics of some African countries in kt.

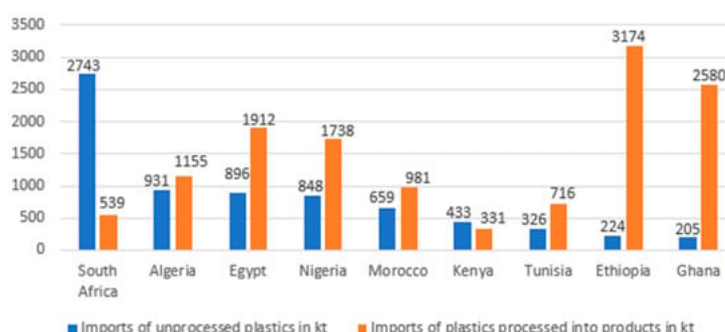


Figure 3. Average African imports of unprocessed plastics and processed plastics for products in kt per year ^{[8][13][14][15][16]}.

1.4. Import of Finished Products or Packaging Made from Plastics

Many developing countries, including important producers of plastic, are net importers of plastic packaging. Africa's dependence on imports widely varies, ranging from 70% of plastic consumed in primary form as a product in Egypt and Nigeria to only 27% of primary plastics in South Africa ^[17]. Globally, according to the same source, 14 Mt of commercialized plastic packaging is significantly smaller than, for example, 196 million tonnes of primary plastic but has a high value in terms of exports, estimated at USD 53 billion in 2018. In addition, packaging products are typically single-

use ^[17] or have a very short “in-use” lifespan (6 months typically or less) ^[18]. Lightweight, elasticity, and cheapness are properties that make plastic more attractive in the design of useful products. Most of the packaging used in Africa is poor single-use plastic bags (those intended to be used only once before being discarded) ^[19] for fresh vegetables and short-lived products for daily purchases. Egypt, Nigeria, and South Africa are the largest producers and importers of plastic polymers and products (including imported packaging). In addition, Ethiopia, Ghana, Kenya, and Mozambique are seeing growing production and imports of plastic goods ^[20]. The increase in imports of plastic products and packaging into African countries is a fact (many countries have formal retail outlets) ^[20]. According to a WWF ^[20] report, the COVID-19 pandemic enhanced e-commerce in various African countries and led to a rising consumption of plastic packaging, which is higher in comparison to the packaging consumed in physical stores. Data about the import of finished products or packaging made from plastic for individual African countries were rare, but the increasing tendency of its quantity has been documented.

1.5. Import of Plastic Waste or “Pseudo-Products” That Are De Facto Wastes

In general, waste management remains a major concern for many African countries ^{[21][22]}. The number of inhabitants, income of the population, and urbanization also have an impact on people’s consumption patterns and the amount of waste produced, such as plastic waste, which continues to increase. In 2018, South Africa and Kenya imported, respectively, 18 kt ^[12] and 3 kt ^[16] of plastic waste. In 2018, the ban on plastic waste import in China showed serious consequences for exporters of plastic waste from developed countries, including the USA, the EU, and some other European countries, who were then forced to find new legal or illegal export possibilities in developing countries, mainly in Southeast Asia and African countries such as Ethiopia and Senegal ^[20]. The USA exported more than 1 million tonnes of plastic waste to Senegal in 2019 ^[23].

Plastic is also contained in electrical and electronic products. Moyon Massa and Archodoulaki ^[24] reported that Ghana and Nigeria in Africa are among the biggest recipients of e-waste from developed countries. According to them, approximately 400,000 used computers are imported every month, of which only about 50% are still working. Europe and the USA are among the largest exporters of electronic and electrical equipment to Africa. The authors mentioned that about 300 containers of used and/or discarded electrical and electronic equipment arrive at the ports of Tema in Ghana every month. An average of 75–80% of this imported equipment is already at the end of its life.

Every African consumes 5 kg of textiles per year ^[25], and due to the increasing exports of used clothing from industrialised countries to developing countries, clothing waste in Africa is on the rise. In general, a considerable amount of used clothing shipped in Africa is already unusable. Greenpeace ^[26] reported that 30–40% of imported SHCs in Kenya are of such poor quality that they can no longer be sold.

2. Waste Management in Africa Compared to Europe (EU-27+3)

2.1. Recycling Rate

In terms of increasing waste generation, a direct correlation exists between the volume of generated plastic waste, the population growth ^[27], and the Gross Domestic Product (GDP) ^[13]. Plastic is not inherently bad and contributes multiple benefits to society, and it has become an essential element of modern life and plays a key role in global progress toward sustainability ^[20]. Plastic products are helpful in daily human life and only need to become sustainable. The approach of a circular plastic economy (CPE) will be the best in this context. This approach is a system applying the principles of circular economy to the plastic value chain, including the design, manufacture, use, and end-of-life phases. A CPE will promote innovative design, encourage recycling, and incentivize the reuse of materials. The intention is to foster a move toward more sustainable interventions for the plastic challenge through innovation ^[28]. Due to lax regulations and improvements to its economy, Africa is also contributing to the rise in plastic pollution ^[29]. Poor management of plastic waste can be observed in almost all African countries: in most sub-Saharan African countries, it is over 80% ^[30], except South Africa (54%). In Mauritania, the rate is 82%; in Egypt, 67%; in Morocco, 66%; in Tunisia, 60%; in Algeria, 58%; and in Libya, the lowest, at 23% ^[10]. In general, short-life products (plastic packaging) and medium/long-life products (agriculture, electronics, automotive, construction, and others) generate more than 80% and less than 35% of waste, respectively (with a product consumption of 100% in both cases) ^[31]. According to Embrandiri A. et al. ^[32], 49.2% of plastic waste in Africa has plastic packaging as a source. In 2015, Africa generated 19 million tonnes of plastic waste, of which 17 million tonnes were mismanaged ^{[20][33]}, compared to 60–99 million tonnes (15.8–26.1%) of globally mismanaged plastic waste in the same year. In addition, more than 380 million tonnes of such waste were generated worldwide (including in Africa), and it is projected to triple by 2060 ^[19]. **Figure 4** presents the plastic waste data for some African countries (in kt). This figure shows that Egypt, Nigeria, South Africa, Algeria, the Republic Democratic of Congo (DR Congo), and Tanzania are the largest producers of plastic waste in Africa, with an average of more than 1000 kt. Ghana, Kenya, Angola, Cameroon, Côte d'Ivoire, Morocco, and Uganda generate over 500 kt on average, while Mozambique, Ethiopia, and Zambia over 300 kt.

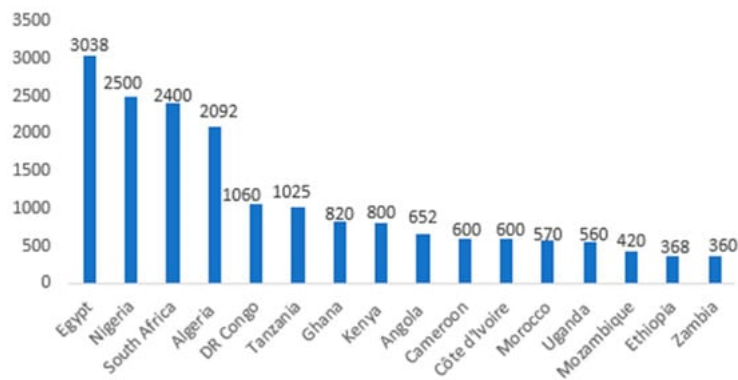


Figure 4. Average data on plastic waste for some African countries per annum in kt [18][34].

In 2019, Klynveld Peat Marwick Goerdeler (KPMG) International [35] forecasted an estimated 12.3 Mt of plastic waste to be sent to recycling facilities in Europe in 2020, while in Africa, small-scale plastic recycling plants existed only in some countries, namely [36] Tunisia with a processing capacity of 30,000 tonnes/year, South Africa 19,200 tonnes/year, Morocco 15,200 tonnes/year, Algeria 7200 tonnes/year, Zimbabwe 4380 tonnes/year, Côte d'Ivoire 1800 tonnes/year, and Ghana 1200 tonnes/year. In the EU-27+3, there are recycling plants with a capacity of over ten million tonnes per year, whereas in the African countries mentioned above, there are only 78,980 tonnes per year. These data confirm the lack of recycling plants with sufficient capacity on the continent.

The incineration of plastic waste produces tonnes of toxic air pollutants if it is not carried out properly. In addition, the post-treatment of incinerators requires a large amount of land and funding [37]. Open-field incineration of plastic waste, as practiced in many African countries, is one of the main sources of pollution [38]. Municipal solid waste (MSW) contains about 12% plastics, which can release toxic gases into the atmosphere when incinerated [39]. Although the incineration of solid plastic waste results in a 90–99% volume reduction [39] (i.e., a reliable reduction in landfill), it is often carried out in an open field in most African countries, with all the associated negative environmental impacts (e.g., CO₂ emissions and some infectious diseases). Therefore, this is not a suitable solution [40], although the associated energy would be useful in the cement industry for example (a “clean” incinerator with suitable filters) or using suitable filters for plastic waste burning in a vacuum chamber in anaerobic conditions to produce steam which will help to generate electrical energy effectively because such power plants produce on average more CO₂ than the gas-fired equivalents. The presence of toxic substances in recycled plastic waste has been confirmed [41][42]. Some concentrations of PAHs and polychlorinated biphenyls (PCBs) have been detected in sediment cores of the Lagos (Nigeria) lagoonal system, which may pose a significant ecotoxicological risk to estuarine organisms [43].

2.2. Energy Recovery in Large Plants and on a Small Scale (Use of Used Textiles as Substitute Fuel in the Domestic Sector)

In 2017, the first conversion of plastic waste into synthetic fuel oil was developed in Kenya and a waste-to-energy plant was commissioned in Ethiopia [32]. The recycling rate for the EU-27+3 in 2021 (42% [4]), provides accurate data on energy recovery through plastic incineration plants and confirms that this process is more developed in Western countries. The incineration of plastics purely for volume reduction is not sustainable and is contrary to the goal of the circular economy, which includes the reduction, reuse, and recycling of plastic waste. Material or energy recovery is the best approach as it offers the best environmental outcome [44]. Bassay et al. [44] propose incineration, conventional pyrolysis, conventional gasification, and catalytic gasification as recycling methods for the thermal treatment of plastic waste in Africa. In 2017, Nunes, L.J.R. et al. [45] presented a study on the use of waste from the textile industry (more specifically, cotton waste) as a renewable resource for the production of thermal energy (production of cotton briquettes in Portugal). The construction of large and small plants to convert textile waste into energy for the domestic sector may be more attractive for African countries. Studies on the conversion of used textiles into fuels in Africa were not found in this survey.

2.3. Orderly and Irregular Landfilling

South Africa is the 32nd largest producer of plastics globally, and the plastic industry plays a significant role in the country's economy [46]. In 2018, South Africa properly disposed of 44% [12] of its plastic waste. In most developing countries (including in the African continent), plastic waste is not properly landfilled [18]. There exist more open dumpsites of mixed waste (irregular landfilling), like in **Figure 5**. Plastic waste is often openly incinerated in such landfills.



Figure 5. Unofficial mixed landfill waste near Mokolo coal market (Yaounde—Cameroon).

In South Africa, 10% of plastic waste is openly incinerated, 17% in Ghana, and 56% in Kenya, with all the negative consequences for the environment and living creatures. The biggest problem in landfilling waste is its degradation without any appropriate expert control (negative impacts on human health and the environment). Plastic waste is even more hazardous due to its long lifetime ^[38], as it can undergo several negative transformations during this time due to the presence of toxic substances and/or additives and become a source of pollution for groundwater. Landfilling, as shown in **Figure 5**, is not a long-term solution ^[40] as it contributes to water crises in the affected countries, especially in African drought areas ^[47].

3. Initiatives to Solve the Problem

To fight against plastic waste leakage, some African countries including Senegal, Côte d'Ivoire, Mali, Ghana, Kenya, Ethiopia, Malawi, Mauritius, Tanzania, Uganda, Eritrea, and Congo ^{[18][48]} have banned single-use plastic bags, but the enforcement and execution of this measure are quite challenging ^[18].

In South Africa, the preferred waste management method is recycling. Due to collection difficulties, as mentioned above (mostly driven by the informal sector), only 40.3% of short-lived plastics and 17.7% of all converted plastic are taken from recycled-content landfills and recycled at recycling plants ^[46].

In Rwanda, the combination of a strict legal regime, enforcement, and arguably successful policy has been implemented to substantially reduce plastic pollution ^[5]. After a study conducted by the Rwanda Environment Management Authority (REMA) in 2003 ^[49], which provided some evidence of local discussions for anti-plastic action, the Rwandan government responded by initiating nationwide campaigns to increase awareness about the issues in 2004. In 2005 ^[49], Rwanda banned the import and use of plastics that are less than 100 microns thick. In 2008 ^[49], Rwanda's anti-plastic bag legislation, which banned the importation and use of non-biodegradable packaging bags, became one of the strictest laws. However, a person who intends to manufacture, import, export, or use plastic carry bags and single-use plastic items for exceptional reasons can apply for authorization ^[50]. A competent authority establishes the guidelines for the procedures and conditions for the issue of exceptional authorization. Imported products packaged in plastic material or single-use items are subject to an environmental levy following relevant laws ^[50]. In addition, every manufacturer, wholesaler, or retailer of those products must put in place mechanisms to collect and segregate used plastic carry bags and single-use plastic items and hand them to the recycling plants ^[50]. Every person/entity recycling this waste must do it in a way that protects the environment. Any person/stakeholder who violates the legislation pays up to a FRW 10,000,000 administrative fine, depending on the law that was violated (USD 1 = FRW 1237). A lack of monitoring and data management systems limits the government's ability to quantitatively measure and assess the impacts and effectiveness of plastics policies needed to design, improve, and implement plastics policies for the effective management of plastic waste ^[51]. According to the same source, Rwanda needs to invest in establishing data collection and management systems for plastics and plastic waste. However, some qualitative improvements have been achieved through this legislation in Rwanda.

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