



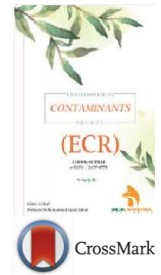
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## REVIEW ARTICLE

# PLASTICS BURDEN - A GLOBAL ENVIRONMENTAL CONCERN AND PROSPECT: A REVIEW

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## ABSTRACT

Plastics are ubiquitous, resulting to one of the greatest environmental challenges globally. The plastics revolt has had an insightful impact on human society, probably because the materials were inexpensive, frivolous and convenient. These potentials led to the successful production and proliferation of plastic all over the world. As the global plastic production increased, it became difficult to cope with the amount of plastic wastes generated. Plastic garbage clogs sewers in numerous cities throughout the world, resulting in floods and the spread of illness. When consumed by both wild and domestic animals it leads to their death. Hence new strategies are needed to address manufacturing, usage and managing the plastics. Several steps are required to reduce the damaging effects of plastic pollution in the environment. Among these are effective methods of waste management such as recycling, and using fewer plastics. The use of biodegradable plastics, public awareness of the issue, education, and the establishment of sensible environmental sanitation regulations are all crucial. However, policies and inventions are being developed worldwide to allow plastic pollution to be transformed into valuable items, which will help to eliminate plastic pollution from the environment and create jobs for youth. This contemporary review paper highlights the production, types and consumption of plastics, plastics regional, national and local trends, plastics pollution and climate change, effects of plastics in the environments, plastics waste management practices, plastics global policies and innovations, finally a growing concern of plastics proliferation in Kano metropolitan city of Nigeria. The bibliography searches focused on keywords related to Plastics pollution, proliferation and its effects in the environments globally.

### KEYWORDS

Biodegradable, Environment, Innovation, Plastics, Pollution, Public awareness.

## 1. INTRODUCTION

"Exhausted Plastic Pollution", the theme of World Environment Day, 'WED' 2018, is a campaign to combat one of the greatest environmental challenges of the globe (Michelle, 2018). Effortlessly, key elements have been found to tackle this worldwide problem, including a grassroots initiative to encourage the establishment of an international framework to control plastic pollution. Teach, unite, and inspire people everywhere to demand that corporations and governments take action to reduce and eliminate plastic pollution. Urge individuals to choose to reject, minimize, reuse, and recycle plastics in order to help people everywhere develop a sense of personal responsibility. Encourage local government regulations and further initiatives aimed at addressing plastic pollution (World Environmental Day, 2018). If present production, consumption, and waste management methods don't change, the amount of plastics in the environment which is already a global problem will rise. If nothing is done, 12,000 million tons of plastic wastes are predicted to build up in landfills and the environment by 2050 (Geyer et al., 2017). A growing concern related to Plastic production, types, additives consumption, sources of plastics waste are hereby raised. National and local trends, environmental impact of plastics, waste management practices as well as some of the global policies are discussed, in addition proliferation and prospect of plastics waste in Kano province, Nigeria are also overviews.

## 2. PLASTICS OVERVIEW

### 2.1 Production of Plastic Materials

Since 1950s, the plastics production has increased significantly. With a global shift from the manufacturing of durable plastics to single-use plastics (particularly packaging), the growth in plastics production has largely exceeded that of any other material. In 2015, the amount of plastic produced and distributed in both industrialized and developing nations increased by about 200 times, from 1.5 million to over 300 million tons (Van Cauwenberghe et al., 2015; Pinheiro et al., 2017; Wright and Kelly, 2017). Fossil hydrocarbons, which are non-renewable resources, are mostly used in production. The current rate of plastic production growth continues and the plastics industry could contribute 20% of global oil consumption by 2050. Northeast Asian manufacturers provide more than 25% of the world's resins utilized in the creation of single-use plastics (China, Hong Kong, Japan, Republic of Korea and Taiwan). This is followed by North America, the Middle East and Europe (Geyer et al., 2017).

### 2.2 Plastic Types and their detrimental effects

Basically, Callister and Rethwisch, identified two types of commercial plastics, thermoplastic (reheated, melted, and molded into different shapes) and thermosetting plastics which degrade and turn into other substances if reheated after molding (Callister and Rethwisch, 2008). But currently, there are many different types of plastics manufactured in the plastic industry namely: - Polyethylene terephthalate (PET or PETE),

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High-density polyethylene (HDPE), Polyvinyl chloride (PVC), Low-density polyethylene (LDPE), Polypropylene (PP), Polystyrene (PS). Certain plastics are regarded as safer than others, and others are placed in a catch-all category that contains anything that does not fit into any of the other six categories. This category includes polycarbonate, biodegradable bio-based plastics made from renewable resources such as corn and potato starch and sugar cane. Polycarbonate is used in many plastic baby bottles, clear plastic sippy cups, sports water bottles, medium and large water storage containers, metal food can liners, compact discs, cell phones, and computers. Numerous studies have indicated a wide array of possible adverse effects from low-level exposure. Polycarbonate leaches Bisphenol A leads to chromosome damage in female ovaries, decreased sperm production in males, early onset of puberty, various behavioral changes, altered immune function, and sex reversal in frogs (Boris Worm et al., 2017). Other health effect related to plastics includes endocrine disruption, asthma and allergies in children, cancer which has been linked to negative effects on the liver, kidney, spleen, bone formation, and body weight (Callister and Rethwisch, 2008).

### 2.3 Plastic Additives

During the manufacturing process of plastics, a range of additives are added to enhance physical characteristics including colour, hardness, and flame resistance. They may consist of inorganic or organic materials, low molecular weight or polymeric. Plasticizer is the most often used ingredient, used to increase viscosity or plasticity. For instance, plasticizers like phthalates and bisphenol A are required for PVC to reduce its susceptibility to heat and photo-degradation (Hammer et al., 2012). Colorants and flame retardants are examples of additional additives. These potentially hazardous compounds are expected to build up through the process of bioaccumulation in human bodies. According to some research, individuals are exposed to chemicals such phthalates, bisphenol A, polybrominated diphenyl ethers, and tetrabromobisphenol A (Talsness et al., 2009). Furthermore, certain heavy metal compounds, like lead, cadmium, and chromium, are frequently employed in the manufacturing of plasticizers, stabilizers, and colorants (Murphy, 2001). They can be released from plastic debris into water systems and further enter the food chain to cause bioaccumulation of toxins in organisms.

### 2.4 Plastics Consumption and Momentous

The amount of plastic waste generated can be used to estimate the global use of plastic. Most plastic packaging, particularly in business-to-consumer applications, is single-use and thrown away the year it is made. Plastic packaging waste made for 47% of all plastic garbage produced in 2015, with Asia appearing to be the source of half of that waste. China continues to be the world's leading producer of waste from plastic packaging. The USA is the largest generator of plastic packaging waste per-capita basis, followed by Japan and the EU (Geyer et al., 2017; Clapp and Swanston, 2009). Plastics have provided a unique advantage for humanity, frequently providing functionality that cannot be easily or economically replaced by other materials. Humans and society have benefited from plastic products in terms of employment, economic activity, and general quality of life.

The majority of plastics are strong and persist for hundreds of years. They have taken the place of metals in the majority of manufactured goods' components, including refrigerators, computers, and auto parts, making the items stronger, lighter, safer, and more affordable. Paper, glass, and cardboard have been surpassed by plastics as packing materials, which lowers costs and better preserves the goods. In hospitals, plastics are also extremely important. The plastic waste includes disposable syringes, glucose bottles, catheters and cannulas etc. are disposed of on daily basis (Pintu and Nazmul, 2016). Plastic have been used as a substitute for Iron and rubber materials in aerospace technology what has brought a significant advancement in this technology. In this modern age, plastics are being used in rockets as part of solid fuel boosters and in space shuttles.

This is also one of very usable materials in making of helicopters too because of its rigidity, flexibility and durability (Plastic Europe, 2016). Additionally, plastics are playing a major role in the building and construction industries. These industries have seen tremendous development during the last few decades. Actually, plastics are now the second-largest raw material and packaging used by industry. These days, the construction industry uses plastic to make windows, doors, decorative elements, pipes, and valves. They are frequently seen in panels, insulation, windows, gratings, railings, floors, and bathroom fixtures. Due to their improved corrosion resistance, plastics are a preferable material choice than metals when it comes to manufacturing pipes and valves. Conversely, plastic is more easier to install and use in a variety of operating setups, including freshwater, saltwater, laboratory waste, and crude oil, due to its reduced weight compared to heavier materials.

They are also very cheap compared to others materials in the construction and building industries (Njeru, 2006; Pintu and Nazmul, 2016). Plastics are the most commonly utilized materials because they are strong, stiff, and adaptable. They are utilized in the packaging industry and are in fact a very protective substance. Plastic is the best material to use in packaging when convenience and protection are required. Additionally, they can be combined with other materials. Moreover, plastics can be designed into any desirable shape and size such as transparent material or as any imaginable color. Plastic packaging helps people and their needs in various ways. It has been used in medical facilities to dispose of contaminated items. In a same way, it is protective to use in fragile medical devices in plastic containers which precisely help to keep them intact during shipment. Various kinds of intravenous bags are also made of plastic to help the medical workers to monitor the flow and intake of some important medicines and foods in real time.

Plastics are used at home to store a variety of goods. The shatterproof bottles made by plastics are protective from harm if the product should accidentally fall or got rotten. The packaging for child resistance and leak proof are also made of plastic. Stakeholders in the automobile industries have also taken the advantages of plastics at their best. (Clapp and Swanston, 2009; Pintu and Nazmul, 2016). Plastics are utilized in the production of numerous electronic gadgets for a variety of uses. Plastic is the perfect material for electrical fixtures in homes because of its thermal and insulating qualities. Different types of plastic are used entirely or partially in household appliances such microwave ovens, refrigerators, computers, cellphones, laptops, cameras, fans, coffee makers, shavers, irons, hair dryers, mixers, and even coffee makers. Additionally, a highly specific kind of plastic foam is utilized as insulation in numerous devices, including refrigerators (Pintu and Nazmul, 2016). Without computers, the modern world is unthinkable, and without plastic, computers are unthinkable. Computers that are lighter and smaller can now be built thanks to plastics. Circuit boards, processors, screens, covers, fans, keyboards, and other components of computers are now conveniently built of plastic without sacrificing functionality or performance. Without a doubt, the diverse applications of plastics merit a very positive assessment.

However, we cannot ignore the detrimental effects that plastics have on our health. Its non-biodegradable nature causes it to continuously accumulate in the environment, producing masses of rubbish all over the planet. As more innovative plastic items are produced to suit demand, it is anticipated that the applications of plastics will expand in the near future. It is especially concerning since developing and growing nations are using and producing more plastic. It's possible that their waste management system isn't becoming more sophisticated quickly enough to handle the growing amount of plastic waste. Additionally, new items and technology that emerge from in-depth field research (Li et al., 2009). Hence, plastics are a full circle of problems and challenges that needs global attention.

### 2.5 Plastic waste Sources

Plastic wastes come from several sources, such as:- Industrial waste, also known as primary waste, which is derived from large-scale plastic manufacturing, processing, and packaging businesses. Waste or rejected material is typically clean and has good qualities for recycling. Even though there are instances when there is a shortage of material, overall supply tends to increase as demand and output rise. Supermarkets, wholesalers, factories, and craftsmen's shops frequently provide commercial garbage. Many of the plastics that are offered by these suppliers will be PE, which is frequently contaminated (Greene, 2011). Agricultural wastes can be obtained from farms and nursery gardens outside the urban areas. This is usually in the form of packaging (plastic containers or sheets) or construction materials (irrigation or hosepipes). Municipal waste can be collected from residential areas (domestic or household waste), streets, parks, collection depots and waste dumps. Globally, these types of wastes are common and can either be collected from the streets or from households by arrangement with the householders (Kurudufu, 2009; Greene, 2011; Nkwachukwu et al., 2013).

### 2.6 Regional, National and Local Trends of Plastics

Regional trends can be seen depending on the policies and tools put in place to reduce the use of plastic bags and Styrofoam goods. Africa is notable for having the highest number of countries that have completely outlawed the manufacture and usage of plastic bags. Between 2014 and 2017, twenty-five (25) African nations enacted national bans on plastic bags, of which more than half (58%) came into effect. Several Asian nations have tried to impose taxes on the production and consumption of plastic bags, and some governments—like Bangladesh—have outright banned the plastic bag industry more than ten years ago. Nevertheless,

despite bans and fees, single-use plastic bags are nevertheless widely used and improperly handled since restrictions are frequently not enforced.

In contrast, another Asian example is Japan, where no bans are in place on single-use plastic, but thanks to a very effective waste management system and a high degree of social consciousness, the country accounts for relatively limited leakages of single-use plastics in the environment (Dezalyx 2016). In Europe, in response to European Union EU Directive 2015/720, to achieve a sustained reduction in the number of lightweight plastic bags used per person by 2025, countries choose different control measures (EU, 2015). They include bans, like in Italy and France, agreements with the private sector, in Austria. A "European Strategy for Plastics in a Circular Economy" is currently being finalized by the European Commission (2018-2030), to reduce the unnecessary generation of single-use plastic waste and eliminate over packaging (EU, 2015).

Today most of the states in Australia have banned lightweight plastic bags and in Papua New Guinea, non-biodegradable plastic bags are banned (PNG, 2015). In Central and South America, regulations to curb the consumption of plastic bags are in place at both national and subnational levels, and countries such as Haiti and Costa Rica also regulate the use of foamed plastic products. Costa Rica in particular aims to become the first country in the world to eliminate single-use plastics by 2021. (United Nations Development Programmed (UNDP), 2017). Most restrictions in North America have been implemented at the state or local level. Certain places, like Hawaii and California in the USA, as well as Montreal in Canada, have outlawed lightweight plastic bags. New York City has taken action on single-use Styrofoam items; this was reintroduced in 2017 following an initial attempt in 2015 (Babin, 2017).

## 2.7 Climate Change and Pollution from Plastics

Pollution from plastics is thought to be a significant contributor to climate change. The majority of the toxic gases emitted during the plastic manufacturing process are greenhouse gasses, which are the primary contributors to global warming. In addition, some of these gases cause acid rain and ozone layer thinning (Ruban, 2012). According to an Environmental Protection Agency (EPA) report, the creation of plastic products is thought to be responsible for 8% of the world's oil production. Five ounces of carbon dioxide are released for every ounce of polyethylene terephthalate produced, according to estimates from the EPA.

One of the most important problems the planet Earth is currently facing is climate change. If the preceding arguments for reducing plastic consumption weren't enough to persuade you to take action, you should be concerned about how plastic use contributes to climate change. For this reason, accepting personal accountability and resolving to contribute to the end of plastic pollution should be paramount (Earth day, 2018).

## 2.8 The impact of plastics in the air

The main cause of air pollution is the open-field incineration of plastic garbage. Burning is the most common method used to dispose of municipal solid waste, which contains 12% plastic. Consequently, the atmosphere was exposed to hazardous gasses such as Dioxins, Furans, Mercury, and Polychlorinated Biphenyls (Rinku et al., 2016). Further, burning of Poly Vinyl Chloride liberates hazardous halogens and pollutes air, the impact of which is climate change. The environment as a whole, as well as the health of people and animals, are at risk from the poisonous compounds that have been discharged. Central Nervous System damage can result from polystyrene. The dangerous brominated chemicals have mutagen and carcinogenic properties (Rinku et al., 2016).

Dioxins land on our crops and in our streams, where they eventually find their way into our food and then into our bodies. These dioxins are the deadliest persistent organic pollutants (POPs). Their worst component is 2, 3, 7, and 8-tetrachlorodibenzo-p-dioxin (TCDD), often referred to as agentorangeis. It is a toxic chemical that damages the thyroid, pulmonary, and reproductive systems in addition to causing cancer and neurological damage. Burning plastic wastes raises the risk of heart disease, exacerbates respiratory conditions like emphysema and asthma, and can result in rashes, headaches, nausea, and nervous system damage. Thus, scientists and environmentalists must act quickly to take a sustainable step toward a cleaner and better environment of the future.

## 2.9 Plastics in Terrestrial and Aquatic Environments

Plastic pollution also has a significant negative impact on aquatic environments. Despite the fact that plastic bags contribute to marine

debris in marine ecosystems, not much research has been done on plastic pollution in freshwater systems (lakes and rivers) (Dris et al., 2015). Microplastics, which are smaller pieces of plastic, are produced by some of the macroplastics plastic bags found in oceans. The amounts of plastic trash in freshwater and marine environments are influenced by microplastics, which are produced when ultraviolet (UV) radiation breaks down macroplastics (Dris et al., 2015).

Microplastics in lakes consist of mostly polyethylene, polypropylene, and polystyrene (Wangner et al., 2017). These microplastics that are present in freshwater and marine environments are usually deposited via effluents of industrial activities. Runoff from agricultural land also adds microplastics to lakes and rivers. Microplastics can also be transported by wind to freshwater environment. Studies on the presence of microplastics in lakeshore sediments have demonstrated that microplastics exist in freshwater lakes and rivers and impact aquatic animal life. For instance, sediments from four German rivers revealed that sixty percent of the microplastic present in the rivers is composed of plastic fragments (Wagner et al., 2017).

Microplastic pollution has a negative impact on species living in freshwater environments. Aquatic animals such as fish can consume microplastics; see plate 2, thereby affecting their digestive track. In a study that was conducted to investigate the occurrence of microplastics in the digestive system of *gudgeon (Ptereleotris microlepis)* from French rivers, microplastics were found present in the digestive tracts of 12% of freshwater fish (Sanchez, and Porcher, 2014). When fishes are exposed to the accumulation of microplastics, it can lead to adverse effects, such as histopathological alteration and depletion of glycogen (Wagner et al., 2017).

The majority of plastic bags that are discarded on land wind up in streams and the ocean, where they can damage marine life and entire marine ecosystems. One of the most obvious and significant changes that has happened in the last fifty years is the proliferation of plastic waste (Barnes et al., 2009). Since the 1950s, when plastic product production began, plastic has been accumulating in the deep sea, open sea, terrestrial habitats, and shorelines over the course of a few decades (Barnes et al., 2009). Plastic pollution from land may enter the ocean through wastewater outflow, transport by wind, and inland waterways. That is because of their lightweight properties that make them easily carried by wind and water from landfills or litterbins to the oceans.

Another reason plastic bags are major constituent of marine debris is their non-biodegradable nature. It may take centuries before they disintegrate by photodegradation (Sutton and Turner, 2012). As a result of their non-biodegradable nature, they accumulate in the sea, increasing the amount of marine pollution. When they accumulate in the ocean, waves and currents keep breaking them down into smaller pieces (Sutton and Turner, 2012). They can also be broken down into smaller pieces by UV radiation, a process known as photo degradation (Clapp and Swanston, 2009). For most marine species, the tiny plastic particles or pieces might pass for food. Each year, marine debris puts marine ecosystem inhabitants at risk, including seabirds, dolphins, whales, and sea turtles. For instance, marine life like whales and dolphins may eat plastic bags believing them to be tiny fish like jellyfish (Sutton and Turner, 2012).

Before the World Oceans Day, on June 8, 2018, with the 'theme' '*preventing plastic pollution and encouraging solutions for a healthy ocean.*' Almost 20 pounds of plastic bags and other plastic trash were pulled from the stomach of a pilot Whale that died in Thailand. This led to resolve by Thailand's marine agency to use the case and call for change in human behavior ahead of World Oceans Day Columbia Broadcast System' (CBS, 2018). According to a statement on the Marine and Coastal Resources Department's website, an autopsy revealed the enormous harvest of plastic bags and other human debris in the animal's stomach: 80 bags and other pieces of plastic, weighing a total of 17 pounds. The whale became ill from this plastic waste and was unable to search for food (CBS, 2018).

Plastic products littering the country side are also a danger to livestock. Grazing cattle, sheep, Donkeys and goat consume them and die when such plastic product becomes entangled in their stomachs. Farmers, especially those who farm near towns, often report this tricky. Domestic and wild birds are not left out as death from swallowing plastic products are well pronounced globally, see plate 1.



**Plate 1:** Displays a dead albatross bird stomach filled with plastic waste including some bottle caps it had swallowed, Source: (Jordan, 2011).



**Plate 2:** Plastic of different fragments found in guts of rainbow runner fish *Elagatis bipinnulata* after dissection. Source: (Alice and Mark 2018; Algalita Marine Research Foundation).

mixed plastic garbage, such as electrical and electronic waste (Jefferson Hopewell et al., 2009). Recycling methods for plastic bags include primary, secondary, tertiary, and quaternary processing. Primary recycling, which involves mechanically reprocessing into a product with equivalent qualities, is frequently referred to as closed-loop recycling. Secondary recycling, sometimes called downgrading, is the mechanical treatment of materials to create goods with less desirable qualities. When the polymer is broken down into its chemical components, tertiary recycling—also referred to as feedstock or chemical recycling—occurs (Fisher, 2003). Energy recovery, energy from garbage, or value-adding is quaternary recycling. Composting biodegradable plastics is an additional example of tertiary recycling. This recycling might be categorized as biological or organic (Song et al., 2009).

### 3.3 Re-Use of Plastics

Plastic products can be reused by making it easier to disassemble and replace pieces. This can entail standardizing components amongst producers. For instance, standardizing components would help LED lamp designs by making disassembly and remanufacturing easier (Hendrickson et al., 2010).

### 3.4 Reduced plastics

By employing alternatives and reducing the use of plastic products, plastic pollution can be decreased. Globally, between 500 billion and 1 trillion plastic bags are used annually. That equals more than a million times a minute. Every year, billions wind up in landfills or as litter (WED, 2018). Reducing and reusing plastic is a crucial aspect of living an eco-friendly lifestyle. This can be achieved by making changes to the way plastic items and materials are designed, manufactured, or used. For instance, since 1977, a 2-liter plastic soft drink bottle's weight has decreased from 68 grams to 51 grams. As a result, the annual amount of plastic in the trash stream decreased by 250 million pounds (Hendrickson et al., 2010).

### 3.5 Biodegradable Plastics

Biodegradable plastics (BDP) are an additional substitute for plastic pollution. This is an alternative to traditional plastics. Polyhydroxyalkanoate is a frequent component of BDP (PHA). Beyond their ability to spontaneously break down into safe and natural by-products, BDPs are comparable to traditional plastics in every way. Therefore, if all of the plastic in the city's garbage were biodegradable, it might just be left to break down with the food and other non-recyclable but biodegradable materials like cotton fibers and moist paper (Begum, 2010). The production cost is higher since BDPs are made using relatively new and uncommon technologies. Thus, there is a global call to study for additional studies on more economical and energy-efficient manufacturing processes for creating biodegradable polymers.

A progressive step toward a healthier, greener, and better environment is the adoption of BDP (Begum, 2010). The plastics business is currently agitated by the steady advancement of many biopolymers. One exciting development that will significantly lessen reliance on fossil fuels is the introduction of biodegradable plastics. Only in comparison to conventional plastics is it available at this time. The incorporation of BDP is a progressive approach to a greener, healthier, and a better environment. This progressive development of several biopolymers currently has stirred the plastic industry. The induction of biodegradable plastics is a promising work in progress that will greatly reduce the dependence on fossil fuels. At present, it is only an option over traditional plastics. It is believe that in the future, it will totally replace conventional plastic. Not only would the usage of biodegradable plastics ease the burden on fossil fuels, but it would also incentivize farmers to explore and develop natural fibers. If biodegradable plastics are widely accepted, vast amounts of money can be gained from agriculture. Biodegradable polymers are not only helpful for daily tasks but also hold considerable promise for use in the medical industry.

## 4. GLOBAL PLASTICS POLICIES AND INNOVATIONS

There was different approved ways to transform plastic pollution into valuable items and rid the environment of plastic pollution. There is an increasing worldwide agreement that the current linear take-make-dispose model must be replaced with a more cyclical strategy immediately. Plastic products are made to be recycled or reused in a cyclic economy. "Annie MacArthur Foundation" (EMAP, 2015). This strategy is producing a fresh set of solutions. An evaluation of solid waste management and system leakage can guide such activities. The fact that these activities can be combined with one another across the whole spectrum of potential solutions is crucial.

## 3. PLASTICS WASTE MANAGEMENT ON PRACTICES

### 3.1 Land Fills

Due to the difficulties associated with managing solid waste, plastic bags typically wind up in landfills. They account for almost 12% of municipal waste, making them the primary contributors to landfill waste (Negussie and Mustefa, 2017). Even if plastic bags are occasionally reused, they eventually wind up in landfills. An estimated 6.67 billion plastic bags are disposed away in landfills in Australia. Waste output rises in tandem with an increase in human population. The more waste from plastic bags produced, the more landfills are used, which reduces the number of landfills available and raises the risks associated with landfills.

Since plastics take centuries to disintegrate by photo degradation, and when they end up in landfills, they take much longer time because of the lack of access to UV radiation (Sutton and Turner, 2012). Landfills pose a threat to the natural world and human health. Rivers, lakes, and groundwater are contaminated by the vast majority of landfills, especially open dumps. Animals and people who drink contaminated landfill water may get sick or even die (Sutton and Turner, 2012). According to a 2008 survey, 82% of landfills had openings that released poisons into surface and ground water. The sustainability element of landfills is another drawback because there is rarely any significant recovery from them (Jefferson Hopewell et al., 2009).

### 3.2 Incineration

In addition to recovering some of the plastic's energy content, incinerating waste plastics reduces the requirement for landfills. It might vary significantly depending on whether energy is used to generate power, heat, or electricity. Energy recovery methods work well with heavily

Industries, governments, and citizens can all take part in the responsibility for these acts. Africa's heavily populated residential areas pose a considerable challenge to solid waste management, especially in areas with poor infrastructure. Wecyclers and Recycle have partnered with the Lagos Waste Management Authority (LWMA) in Nigeria to collect recyclable waste goods directly from customers, such as plastic bottles and bags, in order to provide much-needed collecting and sorting services. They encourage consumers to collect and sort their used recyclable wastes at home by exchanging it for points that can then be used for valued items. These initiatives not only provide employment opportunities for Lagosians, but also allow them to recycle their waste by sorting it and selling it to larger recycling facilities. (Wecyclers, 2017).

In Nairobi, Kenya, Taka-Taka Solutions provides similar services to both residential and business clients. In order to collect post-consumer waste, they ask customers to separate their waste into organic and inorganic fractions. High-quality composts made from the organic waste are sold to nearby farms. After additional sorting, all inorganic trash is either sold to recycling companies or used for other desirable purposes. Taka-Taka Solutions gathers 10 tons of waste per day and recycles up to 95% of it because of their effective operation (Taka-Taka, 2017). USEIT in South Africa, a Non-Profit organization, is working on a holistic approach to solid waste management through several recycling programs. Within Africa, there are also several groups specifically focused on plastic waste management. Proplast began in 1997 in Senegal with 14 women were collecting and processing plastic wastes.

Proplast now employs 100 women and processes 1500 metric tons of plastic per year turning it into granulated plastics, sold to local plastic processing companies. New public kiosk drop-off centers allow for more public access to recycling in Dakar (Sane, 2017). Polyco, an industry group in South Africa, has several projects around the country outlined on their website (Poly, co. 2017). Taka-Taka Solutions offers comparable services to both residential and business clients in Nairobi, Kenya. They advise consumers to divide their waste into organic and inorganic fractions so that post-consumer waste can be collected. Using the organic waste, premium composts are produced and sold to surrounding farms. After additional screening, all inorganic trash is either sold to recycling companies or used for other beneficial purposes. Taka-Taka Solutions gathers 10 tons of waste per day and recycles up to 95% of it due to their effective operations (Pack-a-ching, 2017).

Across Africa, there are a number of initiatives turning plastic waste into valuable retail opportunities. For example, Sole Rebels in Ethiopia use recycled tires and traditional Ethiopian hand-loom techniques to create fashionable fair trade footwear. This provides workers with four times the local minimum wage 'Ocean Sole' (OS, 2017). Comparably, Kenya's Ocean Sole gathers more than 400,000 plastic flip flops annually from landfills, rivers, and the ocean. As part of a global awareness campaign on the value of a clean ocean for both humans and marine life, these are repurposed into works of art. (OS 2017). All Women Recycling is a women empowerment initiative in South Africa that upcycles plastic bottles to make the Kliketyklikbox™, now sold worldwide. This initiative upcycled over 500,000 plastic bottles in 2016 and also provided a safe place for women from marginalized backgrounds to develop skills (All Women Recycling' AWR, 2017). Repurpose School Bags, based in South Africa, makes school bags out of plastic bags and billboard materials and distributes them to underprivileged students. These backpacks come with a foldable solar panel that may be utilized as a night-time desk illumination for kids' schoolwork and reading.

Technology can help with data collection and innovation in plastic pollution solutions, particularly mobile technology. For instance, Ecopost in Nairobi, Kenya, employs an app for trash management to entice locals and businesses to sort and collect their rubbish in exchange for points. Ecopost collects both plastic waste and agricultural waste (example, rice husks, wheat bran, and sawdust) to create plastic lumber that can be used for fencing. This helps to reduce deforestation, create jobs for local citizens and provide income for residents from their wastes (ECOPOST, 2017). Although some of these programs and waste streams are niche or local solutions at the moment, the ideas and products are increasingly capturing people's interest. Depending on the model, the enterprises are either able to provide full-time employment, casual jobs or supplementary income to enhance local livelihoods.

There are Regulations and Bans of plastic bags due to their negative environmental impacts. Some states, regions, and countries around the world have taken actions on it. In some cases, plastic bags have been banned completely, or taxed. Incentives to use re-usable bags have also been provided to shoppers. Since the 1990s, countries such as Denmark, Ireland, South Africa, Canada, and Australia introduced taxes on plastic

bags (Dunn, 2012). Some states in the United States., such as Washington, Minnesota, New York, Texas, California, Idaho, and Oregon, also proposed a tax on plastic bags. Denmark was the first nation to impose an obligatory tax on plastic bag producers in 1994. Denmark's levy on manufacturers and retailers was a great success, as the country's plastic bag consumption dropped to 66% (Akullian et al., 2006).

Similarly, Ireland levied a fee in March 2002 on customers' usage of plastic bags in supermarkets and grocery stores. The people backed the price of plastic bags, and Ireland's demand for plastic bags dropped by 90–95%. (Convery et al., 2007). Implementation of plastic bag regulation in Botswana took place in 2007, involving an environmental levy on retailers (Dikgang and Visser, 2012). In September 2002, a plastic bag regulation took effect in South Africa (Hasson et al., 2007). This regulation placed a levy on each bag that is thicker than 30 microns and a ban on plastic bags with a gauge 30 microns. Consumers were asked to pay 46 cents for each plastic bag, after which plastic bag sales decreased by 60 percent to 90 percent because of the tax (Hasson et al., 2007).

Early 1980s Plastic bags were introduced to China (He, 2010). In China, state and local governments attempted, but were unable, to restrict the use of plastic bags in the 1990s. As a result, China implemented a plastic bag usage regulation in 2008. The law is based on fees assessed to each merchant, store, and supermarket for customers' use of plastic bags. China's use of plastic bags decreased by 49% as a result of the new legislation, according to a research that compared data collected before and after it was put into effect (He, 2010). Several governments and localities in the US and Canada have suggested imposing a fee on the use of plastic bags. Several states have imposed fees on the usage of plastic bags, including California, Toronto, New York, and Washington, D.C. For instance, from 2008–2009, plastic bags have been subject to 5 cent and 6 cent levies in Toronto and New York, respectively (Gupta, 2011).

## 5. KANO METROPOLITAN PLASTICS LITTER

Kano state is situated between longitude 10° 25 N and 13° 53 N and latitude 7° 10 E and 10° 35 E, with an altitude range from 400m-800m above the sea level. Kano state is among the largest and most lively cities in Nigeria. Plastic are used in Kano for different purposes.



**Figure 1:** Map of Nigeria showing Kano province and other neighboring countries.

In Kano state, plastic is used for everything from sports equipment to different car parts and household items. Buckets, jugs, plates, plastic pouches, Wraps refrigerators, dishwashers, dishes, glasses, plastics pipes, Doors, toilet flush, bathroom units, insulation, plumbing, siding, flooring, irons, mixers, cookers, microwave ovens, food processors, electric switches, wires, electrical cables, connectors, regulators, laptops, desktop computers, PCs, office accessories, and so forth.

This high degree of plastics waste generation in Kano has tremendously contributed to land, water and air pollutions in the city. The huge heaps of refuse dumps that are commonly seen in open spaces and shoulders of the major streets in Kano metropolis are washed by rainstorm scattered all over the environment. Most of these plastic wastes choke drainage channels and finally lead to flooding on the highways and sometimes people homes. Livestock such as Donkeys, Goats Cows and Sheep at times feed on those plastics dump sites which are threats to their health as they are unable to sort out their feed from the plastics bags. This may cause blockage of their digestive tract and eventually death. In addition, large dumps tend to attract local scavengers called "Baban Bola".

These scavengers play an important role in the process of plastic waste recycling. They sort out the useful materials including the non-degradable

plastics and sell them to the waste recycling industries. A private project to build a plastic trash recycling sector is now underway, funded by the federal government and the state governments of Kano. This falls within the Leda Jari program, which is a community-based trash management initiative in Kano State Metropolis and means "converting nylon bags to wealth." In an attempt to curb the spread of various plastics and plastic sachets, the government backed and encouraged these measures.

Below are some photos to support the plastic proliferations in Kano Metropolitan, Nigeria



**Plate 3:** Roaming goats searching for food waste within widespread of plastic materials.



**Plate 4:** Vast land for residential render useless as plastics dump site at Kantudu, Dala local Government area Kano state.



**Plate 5:** Environmental research student standing in an area filled with plastic waste with domestic goats searching for food waste and Leda Jari (Youths) searching for recycle plastic materials.

## 6. CONCLUSION

Plastics manufacturing and innovation have a lot to offer our society. On the other hand, there are numerous other issues associated with plastic pollution that require immediate attention. Additionally, because to

plastics' numerous applications in modern society, it is particularly challenging to discover alternatives. Both the demand for and waste from plastics are rising daily. Bans on plastic bags have the potential to effectively address one of the causes of plastic misuse if they are well-planned and implemented. Nonetheless, governments must enhance waste management techniques, notably reuse, to address the plastics issues. The game-changing strategies will include the introduction of financial incentives, as well as altering the behaviours of makers, merchants, and consumers and implementing strict laws that encourage a more cyclical model of plastics flow. In addition, the government ought to encourage the development of substitute materials and increase consumer awareness. It is highly advised to fund innovations, make sure plastic items are properly labelled, and carefully consider any potential solutions to the current situation. To put an end to plastic pollution, nations, businesses, communities, and civil society organizations should all make a decisive contribution.

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