A Review of the Environmental and Health Implications of Plastic Wastes Pollution in Nigeria

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Abstract

We are in the age of plastic, and it has become an issue of concern in the environment. The aim of this paper is to review the environmental and health implications of plastic waste pollution, its sources, mitigative measures and challenges that impede its effective mitigation. From the review, we discovered that plastic is everywhere due to its versatility and cost efficiency, in the environment it affects every area; the lithosphere, the hydrosphere, the atmosphere and the biosphere, the soil gets polluted by it, hindering the growth of plant, underground water also gets polluted by it, the aquatic animals are threaten by it, as it destroys coral reefs and causes death in aquatic organisms, there is also emission of gases during its production and decomposition, yielding green house gases that leads to global warming, some of the chemicals used in its production causes headache, cancer, skin damage and affect the central nervous system, mitigative measures such as eco-labeling, extensive research, awareness and community involvement as well as plastic ban has been recommended, the challenges of effective mitigation as seen are; lack of technical skills, lack of data and most of the methods for waste management are expensive and unsustainable. This paper concludes that there is need harness other alternatives to plastic; restructuring of the mind is a tool that would help in mitigating plastic waste pollution. This essay aims to find gaps in literature in order to research further.

Keywords: Environmental and Health Implications, Plastic Waste Pollution, Mitigative Measures

1.0 INTRODUCTION
1.1 BACKGROUND OF THE PAPER

The ever increasing production and use of plastics for domestic and industrial activities have become a menace to human health, biodiversity and the abiotic components of the environment. Leo Hendrik Baekeland was the first person to use the term "plastic materials" to describe products made from macromolecules (resins, elastomers and artificial fibers). In 1907, he had invented Bakelite (the first synthetic plastic) and Telephones were made of it for numerous years. It is worthy of note that plastic Production started in 1833, where Frenchman Henri

Braconnot had produced nitrocellulose, which the Hyatt brothers manufactured industrially in the United States from 1868 to make billiard balls. And so plastic started its long career as an "imitation" – in this case, to replace ivory. But as it was manufactured from cellulose, we were still not in the realm of synthetics (Philippe, 2019).

Plastic is the general term for a wide range of synthetic and semi-synthetic organic solid materials, they are polymers of high molecular weight and are mostly derived from petrochemicals, but many are partially natural (Singh and Sharma, 2016). Plastic usage worldwide has been on the increase in the recent times, as it is assumed to be convenient, cheap, easy for transportation and also effective in our various activities such as packaging, manufacturing, storage and display of goods (Ajoku and Okoro, 2020). Griffith (2010) noted that plastics are becoming a part of the human society and human environment is now characterized by plastics. Plastics play an important role in every aspect of our life, it's everywhere; they are used for manufacturing everyday products such as beverage containers, furniture, water bottles, toys, kitchen wares, the list of places and things that plastic are used in goes on and on.

However, the current level of their usage and disposal generate several environmental, social and economic problems. The amount of plastic waste generation has increased considerably. Urbanization and the increasing consumption of plastics have resulted in a rapid generation of plastic waste, thereby making it a major component of municipal solid waste; it is the third components after food and paper. The environmental problems from plastic wastes are exacerbated by the general property of plastics which includes its durability and non-biodegradable. When it is not well disposed, plastic gather around the city, block drains, threaten small animals, damage the soil, pollutes rivers and its chemical composition causes problems to human health (Hopewell, Dvorak and Kosior 2009).

Accumulation of plastic in the environment occurs when the rate at which plastic enters an area exceeds the rate of natural removal processes or cleanup actions. This is prevalent in the world at the moment, there is so much introduction of plastic in the environment and we cannot even account for most of it, because, plastic is persistent in the environment, with rates of natural removal on the scale of decades to centuries (Chamas, Moon, Zheng, Qiu, Tabassum, Jang, Abu-Omar, Scott and Suh, 2020). Cleanup actions are not feasible in many areas of the global environment where plastic accumulates, particularly in remote locations. Plastic therefore fits the profile of a "poorly reversible pollutant," both because emissions cannot be curtailed and because it resides in the environment for a long time (Harremoës, Gee, MacGarvin, Stirling, Keys, Wynne and Vaz, 2001).

Conventional ecotoxicological risk assessment indicates that plastic currently poses a risk to only a small, although likely increasing, fraction of the global ocean (Everaert, De Rijcke, Lonneville, Janssen, Backhaus, Mees, van Sebille, Koelmans, Catarino and Vandegehuchte, 2020). Sadan and Kock (2021), stated that, the increase in imports of manufactured plastic

products and packaging into African countries is concerning, this is because most rural towns and burgeoning cities, rivers and coastlines are increasingly becoming heavily polluted with discarded plastic packaging and other plastic wastes. Plastics are made up of many chemical and hazardous substances such as Bisphenol-A (BPA), thalates, antiminitroxide, brominated flame retardants, and poly- fluorinated chemicals etc. which are a serious risk factor for human health and environment (Halden, 2010).

Different human health problems like irritation in the eye, vision failure, breathing difficulties, respiratory problems, liver dysfunction, cancers, skin diseases, lungs problems, headache, dizziness, birth effect, reproductive, cardiovascular, genotoxic, and gastrointestinal cases have been found to occur due to the toxic chemicals found in plastic and also as a result of the reaction of the chemicals found in plastic with other chemicals or during heat processing. Environmental pollution such as soil pollution, water pollution, and air pollution also occurs as a result of the accumulation of plastic wastes in the environment (Proshad, Ram and Kormoker, Tapos and Islam, Md and Haque, Mohammad and Rahman, Md and Mithu, 2018).

In our day to day activities, we are exposed to plastics and its chemical composition in different ways. We use it to eat and for packaging our drinks and water, micro plastics are in the air, in aquatic organisms, and unfortunately even in our body systems due to exposure overtime. But, it's hazardous effect on the environment and human health can be avoidable with proper education and awareness. It is against this background that this paper seeks to review the environmental and health implications of plastic wastes Pollution in Nigeria.

1.2 STATEMENT OF THE PROBLEM

Globally, the increase in plastic wastes pollution has become an issue of concern because increasing it affects human health, wildlife, the aquatic organisms and land use. Since 1950, 8.3 billion metric tons of plastic have been produced. In a 2018 study, the International Energy Agency predicts production of around 600 million metric tons by the middle of the century (Philippe, 2019).

In Europe, there are 60,000 plastics factories, with 320 billion Euro annual turnover, and direct employment of 1.45 million people. In the last decades the European Union produced 25.2 million tons of post consumer plastics waste. Today, an average person in developed countries consumes 100 kg of plastic each year, mostly in the form of flexible packaging materials and household items (Plastics Europe, 2015). With 1.3 billion people living in Africa as of 2018 (16% of the world's population), Africa produces 5% and consumes 4% of global plastic volumes (according to 2015 data). Plastic plays a vital role in preserving and protecting goods during transportation and storage. However, the convenience and widespread use of plastic packaging have led to its accumulation and inadequate disposal, resulting in environmental pollution and ecological damage.
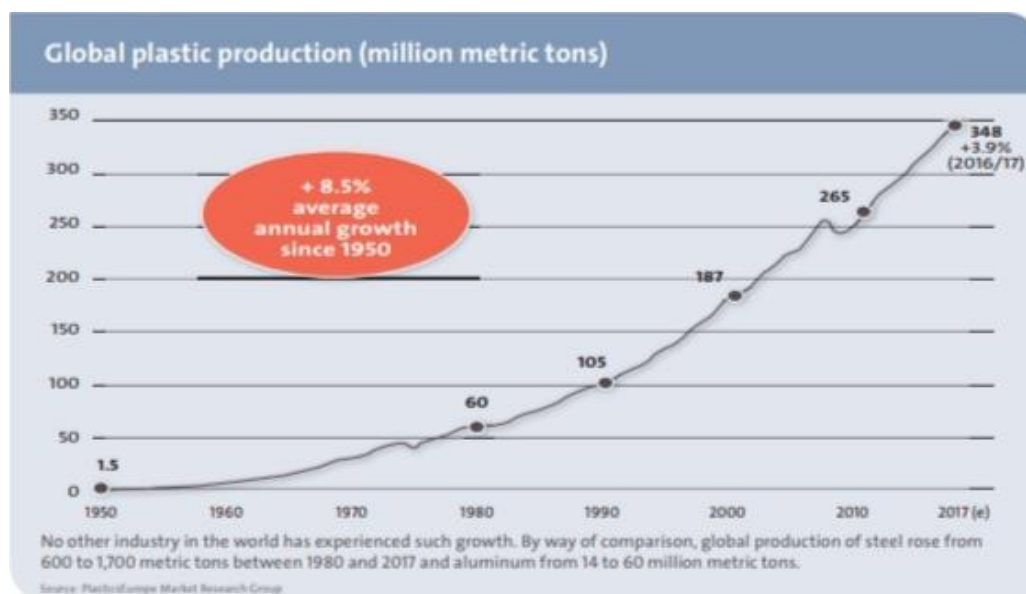
Fig 1: A graph showing the global plastic production in million metric tons

The increasing volume of plastic wastes in the environment has drastically reduced the available land for various purposes such as Agricultural activities, industrial activities and even social and economic activities, when it is left for a long time, starts to weather and its chemical properties leaches into the soil, it contaminates the soil and in most cases contaminates the ground water of that zone.

The aquatic habitat is not left out of the menace of plastic pollution, many birds, turtles, fishes, seals and other marine animals have died by drowning or suffocation as a result of entanglement in plastic debris. Plastics are persistent in the marine environment, some lasting for up to 400 years like the six packs rings, and plastic bottles lasting for up to 450 years, as they continue to stay on the marine environment they leach, and these chemicals affect the aquatic organisms around there. Microplastic can easily be mistaken for food by these animals, thereby causing contamination of marine invertebrates, Stomachs so packed with plastics reduce the urge to eat, causing starvation with more than 400,000 deaths of marine mammals (Eriksen, Lebreton, Carson, Thiel, Moore and Borerro, 2014), it also aid the pathway for transfer of plastic through the food chain, Microplastics have been found in more than 100 aquatic animal species, including fish, shrimp, and mussels destined for our dinner plates.(SADGURU , 2017)

Plastics are made up of many chemical and hazardous substances such as Bisphenol-A (BPA), thalates, antiminitroxide, brominated flame retardants, and poly- fluorinated chemicals etc. which are a serious risk factor for human health and environment (Halden 2010). There are considerable adverse effects of these chemicals on wildlife and humans (Meeker, Sathyanarayana, and Swan, 2009). Different human health problems like irritation in the eye, vision failure, breathing difficulties, respiratory problems, liver dysfunction, cancers, skin

diseases, lungs problems, headache, dizziness, birth defect, reproductive, cardiovascular, genotoxic, and gastrointestinal cases resulted from using toxic plastics. Phthalates, one of the chemical found in plastics, migrate into the air, into food and into people including babies in their mother's wombs. Phthalates can be released from soft PVC by surface contact, especially where mechanical pressure is applied. (SADGURU, 2017)

The impact of plastic pollution on animals is majorly through ingestion and entanglement; however, ingestion is more frequent than entanglement. Reports have shown that more than 260 different species of animals ingest plastics or are entangled by plastic or plastic products, Most of the deaths to animals are caused by entanglement or starvation (Rustagi, Pradhan and Singh, 2011). Ingestion of plastic wastes is capable of causing obstruction and physical damage to animal's digestive system, reduce the digestive ability of the system, blocking digestive tracts and piercing organs, causing death. Animal entanglement by plastic debris also contributes to death from predators, as the animals are unable to untangle themselves and escape (Hammer, Kraak, and Parsons 2012). Coral reefs have been damaged by dragging nets and other plastic products along sea beds (Gregory, 2009).

Lack of awareness of from the populace of Nigeria is a problem, most people reuse plastic, but they are not aware that plastics has expiring dates and as it expires it releases chemicals that are harmful to humans and the environment at large. Plastic pollution gives rise to serious environment problems such as soil pollution, water pollution, and air pollution, when deposited on soil; it causes loss of vegetation, bioaccumulation in plants, and release of toxic chemicals into the soil which affects crop production and death of microorganisms in the soil. When deposited in water bodies it contaminates the marine environment and causes a loss of biodiversity. Plastic wastes pollution fouls man's environment and poverty chains him to it, so there is need to get rid of pollution and improve the quality of our environment, which will eventually improve man's health (Mark, Philip Grime and Thompson, 2001).

1.3 AIM AND OBJECTIVES
Aim: To review the environmental and health implications of plastic wastes pollution with a view to recommending measures to mitigate the negative effects of plastic waste pollution.
T o achieve this aim, the following objectives were pursued:
1. to review the environmental implications of plastic wastes pollution,
2. to review the health implications of plastic wastes pollution,
3. to review the measures already in place to mitigate plastic waste pollution,
4. to discuss the challenges to effective and efficient mitigation of plastic waste pollution and
5. to suggest from the reviewed literatures practicable measures of achieving effective and efficient plastic wastes pollution.

2.0 CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW
2.1 CONCEPTUAL FRAMEWORK
IMPACT ANALYSIS MODEL WAS ADOPTED FOR THIS STUDY.

The impact Analysis model was developed by Chiras (1998), it indicates that human activities have profound impact on the components of the environment which are the Lithosphere, the Atmosphere, Biosphere and the hydrosphere, this model is based on the concept that many activities of man lead to the generation of pollutants in the environment. it goes to show that man's activities impacts on all aspects of the environment and is never in isolation, an activity carried out on the land can find its way to the sea and affect it, in other words, the components of the environment are interconnected, so when one is affected, the others are also affected, therefore, an action carried out in Nigeria can affect the populace of America, as we can see in our world today, the whole globe is affected by climate change as a result of our activities.

Plastic pollution has generated a lot of toxic chemicals which pollute the various components of the environment, altering its chemical and physical nature. Its impact is great and it affects the fauna and flora, killing organisms in the environment, it also affects the aesthetics and economics of nations, even leading to health and psychological problems in humans. In the marine environment macroplastic fragments gets ingested, while other organism gets entangled from fishing net or plastics in fishing gears having a lethal or sub lethal effect, some of the lethal effects are dead or injury of organisms, while we have impaired reproduction, loss of sensitivity and inability to escape from predator, plastic pollution causes different socioeconomic impact on various aspects, an over accumulation of plastic in the ocean has impact on aquaculture, commercial fishing, because the time meant for fishing is used instead for cleaning up the water body, we also have the case of ghost fishing which reduces fish meant for commercial purposes (Gamage and Senevirathna, 2020).

According to Newton's third law, every action has an equal and opposite reaction, so does man's action bring about complex reaction in the environment, if the environment is threatened, that means our activities are bringing about the reaction and the state of the environment would have a direct reflection on man. The continuous pollution by man, is bringing about the degradation of the environment, we have animals going into extinction, plants because of bioaccumulation dying off, barren lands and climate change issues. We fail to understand that, the quality of the environment really means the quality of life, nothing less (Cunningham, 1990). The indiscriminate disposals and subsequent pollution by plastic wastes would have direct impact on the environment and eventually affect man through diverse channels such as food chain and inhalation of these chemicals, these chemicals can also seep into the groundwater and into the soil, affecting the output of the soil, it impedes growth of plants, changes the soil structure and chemical composition of the soil, it also affects the microorganisms found in the soil, for example an earthworm burrows differently when there is presence of microplastic in the soil adversely affecting the health of the earthworm, which in turn affects the environment by reducing the forest flora which largely depends on the burrowing of the earthworm (Dhairykar, Jawre and Rajput, 2022).

We have failed to maintain minimum impact on the environment as we carry out our various activities, as we are all in pursuit of economic growth and a quick fix lifestyle without

considering the impact it would have in the long run, most of the time, we dispose of our waste in waterbodies, thinking it does not matter, but it does, because as the plastic waste decompose in the water body causing pollution and deposition of microplastics, which floats on the surface of the water, affecting aquatic organism, and releasing harmful chemicals as bacteria acts on it, such as lead, mercury, cadmium, phthalate, causing carcinogenic effects on fishes, humans and other animals that partake of the water (Walker and Xanthos, 2018).

Plastic pollution is one of the leading causes of air pollution, the process of production, processing, transmission and storage releases different gases that affect air quality, the truck used in transporting materials emits toxic chemicals like BTEX and particulate matter, which causes shortness of breath, asthma symptoms and cardiovascular disease when inhaled. The incineration of plastic gives off methane, volatile organic compound (VOC), metals(lead, mercury, etc), NOX, PAHs, PCBs, acid gases (SO_2, HCl), particulates (dust), CO, CO_2 interacts with the sunlight to form ozone, which causes depletion of the ozone layer, climate change and in humans, it causes health issues such as cancer, birth defects, respiratory problems, etc, these particles can fly a long distance an get deposited on plants, surface waters, the skin, the soil, entering into the bodies of human due to bioaccumulation (Sarkingobir, Bello and Yabo, 2021).

Apart from being affected health-wise humans are affected in other areas too by plastic waste pollution, aquaculture, fisheries and agriculture are impacted, seafood is our main source of animal protein, marine debris can drastically reduce the efficient delivery of commercial fisheries and aquaculture harm of aquatic organisms, which can either directly feed on these plastic or eat a prey already contaminated by plastics, studies show, productivity, viability, profitability and safety of the fishing and aquaculture industry is vulnerable to the impact of marine plastic. There is also consequence on the mental and physical health of individuals, such as visitors and worker, getting cut by sharp debris, getting tied up in nets and beginning exposed to unsanitary conditions and this has effect on the mood and mental wellbeing of individuals (Beaumont, Aanesen, Austen, Borger, James, Cole, Hopper Tara and Pascoe 2019).
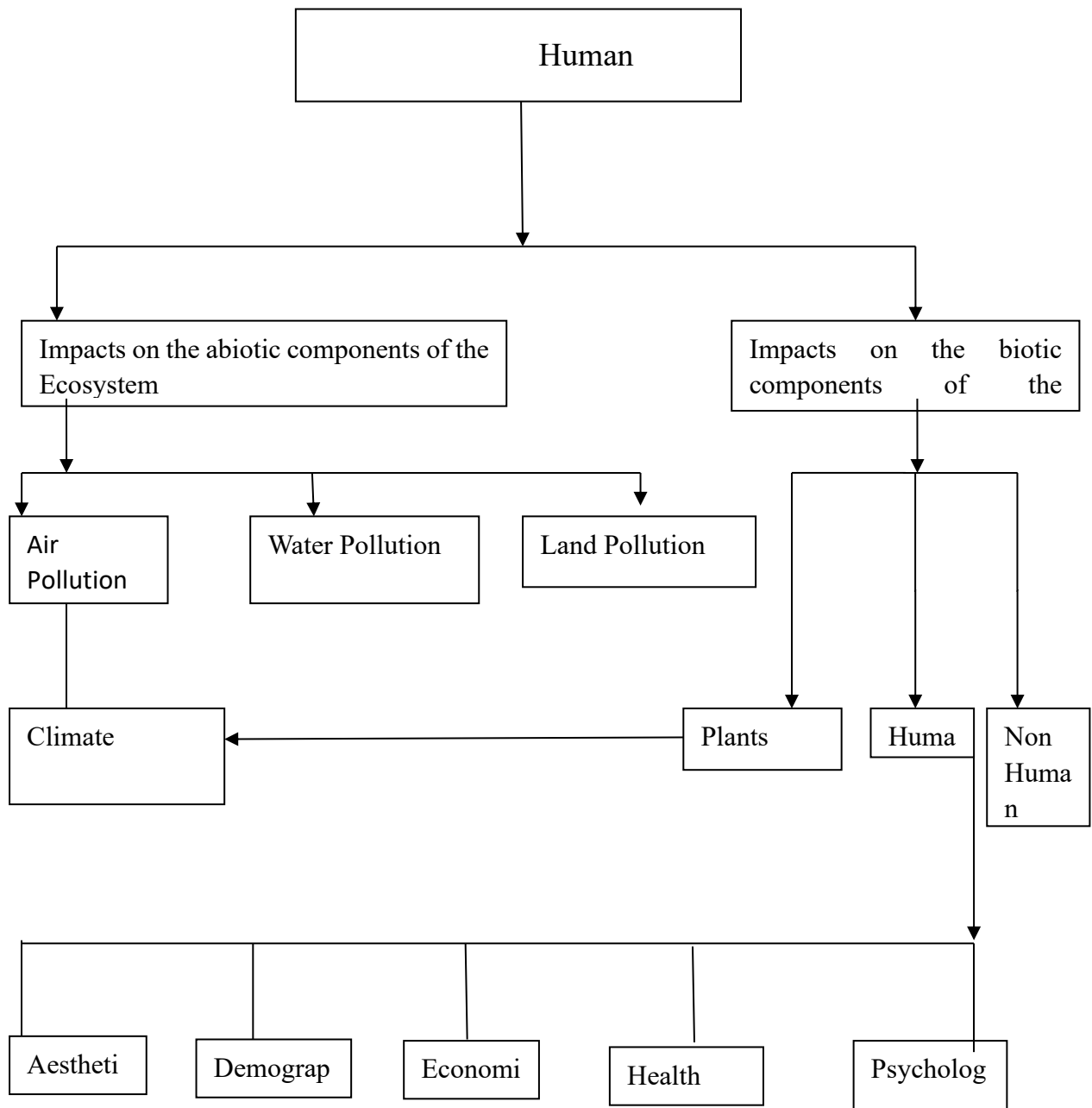
Fig.2:   Impact analysis model showing the range of impacts caused by improper plastic waste disposal.
Source: Chiras   1988

2.2 LITERATURE REVIEW
Review of relevant literatures on plastic waste pollution is done under the following sub headings:
- Sources of plastic wastes in the environment
- Environmental implications of plastic wastes pollution
- Health implications of plastic wastes pollution
- Measures to mitigate plastic wastes pollution

- Challenges to effective and efficient mitigation of plastic wastes pollution

2.2.1 SOURCES OF PLASTIC WASTES IN THE ENVIRONMENT

In a research work; *"Household Plastic Wastes Mis-Management Effect On Environmental Plastic Pollution"* by Singh and Sharma (2023), domestic waste is one of the main sources of municipal solid waste including food waste, paper, plastic, rags, metal, and glass from residential areas, the study was carried out in Jaipur city, and the methodology employed was random sampling technique for questionnaire distribution; with data collected from 160 respondents, a deductive approach was selected to gather the data, then these data were represented in the form of a pie diagram. Some of the findings of the paper were: respondents' practice of garbage sorting can be considered low, with respondents sorting their garbage comparable to those who don't, implying that there is still room for 'improvement', the main components of solid waste generated at home are largely compostable leftovers and recyclable plastics, most of which are disposed of without segregation. The recommendation of the paper was that local solid waste management agency should focus on using this organic waste on a larger scale and involve more people in the composting program and, the development of small-scale community composting could be a potential starting point to accelerate this program without significant investment from local governments.

A research work done by Ajoku *et al.,* (2020) in Obio/Akpor Local Government Area of Rivers State, Nigeria, utilizes both primary and secondary sources of data, as well as a descriptive survey design, with a study population of sixty communities of the Local Government Area, the sample size was made up of l2 communities which represent 20% of the study population and simple percentage was used to analyze the data, in order to reveal the major sources of plastic waste generation, which include; household, commercial centers (companies and market), others are generated from institutional sources including: educational, social, health and religious centers, some of the findings of the paper show that, plastic waste also destroys the aesthetic quality of the area; blocks drains and canals causing flooding in the area, impacts on the soil and affects the microbial diversity of the area, it revealed also the fact that plastic waste dumped indiscriminately is responsible for the spread of diseases in the area, the paper's recommendations are; designated locations should be made available by the Local Government Authority for disposal of plastic waste and penalties should be imposed on defaulters who refuse to sort and bag their waste before disposal. More so, recycling of plastics will help to reduce the number in circulation.

Becerril and Bucklin (2021), studied the potential for reducing plastic waste by examining the efficiency with which different polyethylene terephthalate (PET) bottles deliver beverages, using Empirical models, first model, the relationship between bottle weight and bottle capacity for PET beverage container, next, the model PET waste tonnage as a function of beverage sales and the capacity mix of bottles sold, they made a finding that 80% of the variation in bottle weight is explained by bottle capacity, 16% by product category, and 1% by brand, bottle weight is quadratic and convex function of capacity, which implies that medium capacity

bottles are most efficient at delivering consumable product, local data on PET bottle sales and municipal waste recovery validate the finding and, a 20% shift in consumption from smaller to larger bottles could reduce the production of PET waste by over 10,000 t annually in the U.S. alone

Du, Cai, Zhang, Chen and Shi (2020), carried out a study where they collected take-out containers made of common polymer materials (polypropylene, PP; polystyrene, PS; polyethylene, PE; polyethylene terephthalate, PET) from five cities in China, the microplastic in the containers were analyzed after different treatments (direct flushing and flushing after immersing with hot water). In order to analyze the differences in production and transport process of the containers by different manufacturers, as well as the effects on microplastic characteristics in the containers, the collected microplastic were analyzed and compare and the results showed that microplastic were found in all take-out containers and abundance ranged from 3 to 29 items/container with the highest abundance occurring in PS containers with rough surface, the study indicated that microplastic in take-out containers came from atmospheric fallout and flakes from container's inner surfaces, under slight mechanical force, loose structure and rough surface of PS containers can flake off microplastic, entering water more easily and based on the microplastic abundance in take-out containers, people who order take-out food 4–7 times weekly may ingest 12–203 pieces of microplastic through containers.

Gallego, Alejandro, Mendoza, Joan and Azapagic (2018) writing on the *"Environmental impacts of takeaway food containers"* said that, the consumption of takeaway food is increasing worldwide, single-use containers used for takeaway food represent a significant source of waste and environmental impacts due to their low recyclability, this study therefore estimates and compares for the first time the life cycle impacts of three most widely-used types of takeaway container: aluminum, polypropylene and extruded polystyrene, the environmental impacts of the containers have been estimated using LCA, which has been carried out in accordance with the ISO 14040/44 (ISO, 2006a,b) guidelines, these are also compared to reusable polypropylene containers, the findings suggested that single-use polypropylene containers are the worst option for seven out of 12 impacts considered, including global warming potential, they are followed by the aluminum alternative with five highest impacts, including depletion of ozone layer and human toxicity. Overall, extruded polystyrene containers have the lowest impacts due to the lower material and electricity requirements in their manufacture, they are also the best option when compared to reused takeaway polypropylene containers, unless the latter are reused 3–39 times. The number of uses needed for the reusable "Tupperware" polypropylene food savers is even higher, ranging from 16 to 208 times, with terrestrial ecotoxicity being always higher than for extruded polystyrene, regardless of the number of uses.

Phelan, Meissner, Humphrey, and Ross (2022) did a review of plastic pollution and packaging with interest in Corporate commitments and actions from the food and beverage sector, they discovered that a large percentage of the global plastic waste leakage is estimated to come from

Asia, and most of this is from food and drink packaging, in order for them to contribute to filling this gap, a systematic review of 68 corporate sustainability reports was conducted to examine how major multinational companies in the food and beverage sector are addressing plastic pollution, their main emphasis was on how these companies address plastic pollution and packaging in their corporate sustainability reports, what sustainable packaging strategies they present, and how the companies address producer responsibility, hence the findings of the paper show that the transition to sustainable packaging in the food and beverage sector is slow and inconsistent as most corporate sustainability reports fail to address plastic pollution, also there is a tendency for companies to report on collection and recycling, rather than sustainable packaging solutions aimed at systemic change finally, producer responsibility concerning packaging is growing, however, most companies are doing very little to reduce plastic waste especially in regions lacking waste management infrastructure, such as those in emerging economies.

Dumbili and Henderson (2020) reviewed critically the sources, causes, and consequences of plastic pollution in Nigeria and suggest some priorities for future policy and research, the paper noted that over 60 million plastic sachet water bags are consumed and disposed of daily in Nigeria, and single-use plastic shopping bags and takeaway packs are ubiquitous, these plastic sachets, single-carrier bags, and other disposable plastic products end up on the land and in the marine environment because of indiscriminate disposal and the popular social practice of dumping waste on the roadside, under bridges, and in drainage channels (gutters) during periods of rainfall, thereby littering the streets, while others end up in the marine ecosystem, some of their findings were, waste management habits/behavior facilitate indiscriminate disposal of plastic waste, which in turn exacerbates plastic pollution in Nigeria among others, some of the recommendations were the regulation of single-use shopping bags through taxes/levies and refillable sachet water and Media programs and special education, focused on societal values and an awareness/knowledge of the causes of plastic pollution, should be designed.

According to the work done by Mahesh Kumar, Irshad, Raghunath and Rajarajan (2016), about waste management in India, the increasing amount of food packaging waste is perceived as a problem in urgent need of solution in all industrialized countries. The environment protection act, define waste is any substance which constitutes scrap materials, an effluent, unwanted surplus substance, article which requires disposing off as being broken, worn out, contaminated or otherwise spoiled, these waste leads to the production of significant greenhouse gas, methane which is over 20 times more potent than carbon dioxide, they recommended source reduction, reuse and recycle as the most powerful and effective thing to manage waste, management practices such as paper/carton recycling, glass recycling, etc, were analyzed. Plastic Waste Management has assumed great significance in view of the urbanization activities as plastic wastes generated by the polymer manufacturers at the production, extrusion, quality control and laboratory testing etc., stages, as well as, by the consumers requires urgent disposal and recycling to avoid health hazards.

The North Sea Foundation carried out a 'bottle cap survey' in Dutch North Sea coast and the report was written by Boonstra and van Hest (2017), this is the first time that pollution from plastic bottle caps has been researched this thoroughly, more than 2,000 volunteers picked up as many bottle caps as they could find along the entire Dutch North Sea coast, the plastic/bottle caps were brought to The North Sea Foundation's cap lab in separate bags, most of which were labeled. They were then sorted according to stage number and put in separate plastic containers. Staff and volunteers then counted, categorized and analyzed the caps in each container, using existing literature; nine categories were defined for registering the caps in an Excel database. The categories were: 1. Type, 2. Color, 3. Brand, 4. Usage, 5. State of weathering, 6. Location and density, 7. Recycle code (only for the first 1,000 caps), 8. Producer (only for the first 1,000 caps) 9. Other features, some of important findings and conclusions are: 10,004 bottle caps were collected from the Dutch North Sea coastline during the 2016 Boskalis Beach Cleanup Tour and more than 80% came from consumer drinks and food packaging, whereas, more than 70% were damaged, ranging from slight to severe damage. This may indicate that the bottle caps had been floating at sea for a long time and Bottle caps are among the top 5 items found during beach cleaning and beach litter monitoring around the world.

Aligbe (2021), in her study in Lagos state stressed that Plastic bags which became popular because of their versatility, affordability and durability have now become a major source of environmental degradation requiring the use of more environmentally friendly alternatives like Jute, woolen bags, and biodegradable types of plastic, the goal of her study is to determine reasons for the continued use of plastic bags to contribute to better management of plastic bags waste, this study investigates the available alternatives and willingness of the residents of Lagos to embrace some alternatives to plastic bags, to get our primary data anonymous online surveys were distributed across social media platforms and interviews involving shop owners described as "givers" who are off social media in this study was carried out the responses from both quantitative and qualitative sources have been analyzed using the Nvivo software and connection circles have been developed to describe feedbacks within the system, the results showed that the lack of alternatives and convenience are the biggest reasons for the continued use of plastic bags in Lagos, Nigeria, it further shows that the proposed bill has not made provision of alternatives to plastic bags and incentives for manufacturers of plastic bags revealing poor public participation in policy-making of this nature, furthermore, respondents have indicated a willingness to embrace alternatives to plastic bags and have mentioned that the situation is worsened by poor waste management in the state, she recommended more extensive research into the use of plastic bags with a bigger sample size with both online and offline platforms as could encourage effective public participation in policy-making important for creating useful nudges in behavioral change in the shift from plastic bags.

Ningxn, Minghui and Xinyu (2022), wrote an article aimed at finding better alternatives to address the potential environmental problems associated with plastic straws and mitigate the environmental hazards associated with the use of plastic products, it explores the hazards of

plastic straws and analyzes whether the decision to replace plastic straws with paper straws in the context of plastic restriction is entirely environmentally friendly, the results show that plastic films used in agricultural production remain in the soil after weathering and degradation, affecting soil structure, water and nutrient transfer processes, secondary salinization, and hindering plant growth, while microplastic in terrestrial and marine ecosystems are taken up by and accumulate in organisms and enter the human food web, affecting the human central nervous system and reproductive system, they conclude however, that paper straws contain harmful additives, are challenging to recycle and degrade, are costly to build, are not environmentally friendly, and have a low promotional rate by studying their life cycle, content, recycling rate, degradation rate, usage problems, and applying, the paper also encourages use of environmentally friendly alternatives along sides the advantages of some new green straws, such as bamboo straws, wheat straws, PLA straws, and stainless-steel straws, which are durable, biodegradable, recyclable, and reusable.

Roy, Ashton, Wang, Corradini, Fraser, Thimmanagari, Tiessan, Bali, Saharan, Mohanty and Misra., (2021), Undertook a study that considers plastic straws as an exemplar that captures the evolution of plastic use, its persisting problems, on-going efforts and advances in single-use plastic waste management, and the search for viable alternatives, the principles of sustainability to explore the environmental, economic, and social impacts of different types of straw, this paper relied on a content analyses where key papers were identified through a literature search and carefully coded to answer the two research questions that sit at the center of this analysis: (1) What are the environmental, economic, and social impacts of different types of straws? And (2) how might producing drinking straws with (bio) materials reduce their ecological impact, improve waste management? In doing this, they contrast how producing drinking straws with (bio) materials could reduce their ecological impact, improve waste management, additionally, they evaluated alternative approaches that have the potential to include straws within a broader "circular economy" strategy. However, alternative ways of producing straws only provide a partial solution.

Anil and Angom (2019), carried out a study and concluded that, Single use plastics (SUP) like cups, plates, straws, stirrers, bottles, food containers are substantial sources of plastic pollution, also microplastic include primary (Micro beads) and secondary (Fragments generated from plastics), it is no news that microplastic impose a great danger to marine and human life through consumption and toxicity, it's worthy of note that mass production, consumption of plastics and lack of scientific management of plastic waste has led accumulation of plastics in natural habitats, which causes entanglement, habitat damage, ingestion of plastic litter and introduction of invasive species, the physiological impact include reduced growth rate, lower or blocked enzyme production, reproductive loss and adsorption of toxicants, also plastic waste is causing serious impact on economy of coastal countries in form of cost of cleanup, reduced fisheries stock and drop in tourism, they recommended creating awareness, sensitization of consumers, effective and stringent policy measures to overcome menace of single use plastics and microplastic.

2.2.2 ENVIRONMENTAL IMPLICATIONS OF PLASTIC WASTE POLLUTION

Reddy, Reddy, Subbaiah and Subbaiah (2014), Stressed that the accumulation of plastic products in the Environment adversely affects wildlife, wildlife habitat, and humans and is now a major concern for the governments as plastic Pollution occurs in many forms, including but not limited to littering, marine debris (man-made waste that has released in a lake, sea, ocean, or water way), plastic particle water pollution, plastic netting and friendly Floaters, it was emphasized that a large percentage of plastic produced each year is used to make single-use, disposable packaging items or products which will get permanently thrown out within one year, often, consumers of the various types of plastics mainly use them for one purpose and then discard or recycle them, the environmental impact of plastic pollution are diverse, chlorinated plastics can release harmful chemicals into the surrounding soil, which can then seep into ground water or other surrounding water sources, this can cause serious harm to the species that drink this water, another way of plastic Pollution is nurdles (plastic pellets), a significant amount of it are spilled into oceans, and it has been estimated that globally, around 10% of beach litter is nurdles. Animals can be significantly harmed or killed by plastic pollution, it has potential to poison animals, which can then affect human food supplies, it is highly detrimental to large marine mammals as it contains many different types of chemicals, depending on the type of plastics, this paper reviews the addition of chemicals in plastics and its associated problems, like some of the chemicals used in plastic production have the potential to be absorbed by human beings through skin absorption.

Ningxn *et al*., (2022), as earlier cited, showed that the aquatic environments stability and sustainability is affected by plastics waste, as they are persistent in the oceans and sea, taking a long time to degrade, even when they do, they break down into fragments forming microplastic, harmful chemicals such as polychlorinated biphenyls, polycyclic aromatic hydrocarbons, petroleum hydrocarbons, and other organic pollutants, leach out of plastics, adversely affecting aquatic organisms, other effects of plastic in hydrosphere, include but isn't limited to; entanglement of aquatic organisms (such as seabirds, returnees, mammals, fish, invertebrates, etc.), destruction of habitat/coral reefs, species transportation, and extinction (Goldstein and Goodwin, 2013), due to the nature of their size they can be ingested or inhaled by seabirds and pelagic fish feeding on the water surface, causing intestinal blockage, weakened feeding stimulation, reduced steroid hormone levels, delayed ovulation, and reproductive disorders (Marion, Jessica, Douglas, Debra, Thomas and Carol., 2017), because we consume aquatic organisms plastic fragments, ingested by them and other toxic substances may be transferred to the food chain (Goldstein and Goodwin, 2013).

The lithosphere is endangered by plastic pollution, for instance, the agricultural ecosystem is affected by the plastic film is widely used in agricultural production, after weathering and degradation, many plastic film fragments remain in agricultural soil, affecting soil structure, water, nutrient transmission, and secondary salinization and hindering plant growth, Plastic film fragments (Microplastic) retained in the soil may also flow into the ocean through runoff (Marion, Jessica, Douglas, Debra, Thomas and Carol., 2017).

Kumar, Verma, Shome, Sinha, Sinha, Kumar Jha, Kumar, Kumar, Shubham, Das, Sharma and Prasad (2021) in their review stated that Plastic pollution is ubiquitous in terrestrial and aquatic ecosystems. Plastic waste exposed to the environment creates problems and is of significant concern for all life forms. Plastic production and accumulation in the natural environment are occurring at an unprecedented rate due to indiscriminate use, inadequate recycling, and deposits in landfills. In 2019, the global production of plastic was at 370 million tons, with only 9% of it being recycled, 12% being incinerated, and the remaining left in the environment or landfills, this causes leakage of plastic wastes into terrestrial and aquatic ecosystems is occurring at an unprecedented rate. Here, the current understanding and concerns of plastics pollution is summarized as the goal of the review was to provide background assessment on the adverse effects of plastic pollution on natural ecosystems; interlinking the management of plastic pollution with sustainable development goals; and also addressing the policy initiatives under trans-disciplinary approaches through life cycle assessment, circular economy, and sustainability; identifying the knowledge gaps; and provide current policy recommendations, discussion on Plastic waste management through community involvement and socio-economic inputs in different countries were presented, the need for life cycle assessment and circularity to assess the potential environmental impacts and resources used throughout a plastic product's life span were also emphasize, Innovations as a tool to reduce, reuse, recycle, and recover plastics and finding eco-friendly replacements for plastics were some of their suggestions.

Anil, *et al.,* (2019) as cited above said, If current trend of plastic production continues then green house emission by plastic sector will account for 15% of global annual Carbon budget by 2050. In 2012 alone Global plastic production accounted for 390 million tons of Carbon dioxide emission to atmosphere, at present around 150 million tons of plastic waste is lying in oceans, since plastics is made up of additives, plasticizers, stabilizers and colorants which are toxic in nature, It is estimated that around 23 million tons of additives is present in plastic waste in oceans, which is raising serious concern, Plastics in no small way significantly impacts maritime economy which includes tourism, fishing and shipping industry (Jang, Hong, Lee, Lee and Shim., 2014).

Also Akinola, Adeyemi and Adeyinka (2014) noted that plastic waste fragments into smaller toxic components that eventually pollute the soil and waterways, clogging up the drains, causing water and sewage to overflow, and can then become the breeding grounds for germs and bacteria that spread disease, Edoga, Onyeji and Oguntosin (2008), discovered that 70% of Nigerians consume at least one bag of sachet water daily, this amounts to about 60 million plastic sachets that are being used and disposed off each day, these plastic sachets are made of non biodegradable elements; therefore, they do not decompose, and this affects the physical environment in many ways, some of the environmental risks of sachet water disposal are drainage obstruction/blockage, water pollution, and air pollution from burnt plastic sachets— a common practice in Nigeria (Ezeokpube, Obiora and Phil-Eze, 2014).

Nnaji (2015) in his study: "Status of municipal solid waste generation and disposal in Nigeria", This study was executed by a combination of an extensive literature search and field study, solid waste generation rates for 31 Nigerian cities were obtained from literature, in addition to this, characteristics of municipal solid waste from 26 Nigerian cities were also obtained from literature, other aspects such as characterization of solid waste obtained from final dumpsite and heavy metals accumulation in solid waste dumpsites were undertaken first hand, their findings were that solid waste generation rate vary from 0.13 kg/capita/day in Ogbomosho to 0.71 kg/capita/day in Ado-Ekiti, factors affecting solid waste generation rates were identified and deliberated on, food waste was found to constitute close to 50 percent of overall municipal solid waste in Nigerian cities. The study showed that the rate of generation of plastics, water proof materials and diapers has assumed an upward trend. Due to the dysfunctional state of many municipal waste management authorities, many cities have been overrun by open dumps. For instance, more than 50 percent of residents of Maiduguri in northern Nigeria and Ughelli in southern Nigeria dispose off their wastes in open dumps. Indiscriminate disposal of waste has also resulted in the preponderance of toxic heavy metals in agricultural soils and consequent bioaccumulation in plants as well as groundwater contamination.

Dumbili *et al*., 2020, as reviewed above stated, improper disposal is one of the major environmental challenges of polyethylene bags in Nigeria, It upsets the delicate balance of sanitation, majorly in the sub and urban area because of their high patronage to products that comes with Polyethylene bags, several reports (Olanrewaju and Oyebade, 2019) revealed heaps of waste Polyethylene bags (Nylon bags) scattering throughout the major cities of Nigeria, for instance, Anunonwu, Agwu, Benjamin, Nnadozie, Nnaemaka, Kachi and Uchechukwu (2009) reported a heap of waste nylon bags in Owerri, the capital city of Imo State, the same trend was also noticed in Benin City, where improper disposal of waste in Nylon bag was prevalent on the major streets (Isah and Okojie, 2007), the Federal Capital Territory is not exonerated from this, as many dump areas are plagued with waste nylon bags flying all around, especially in a slum area surrounding the Federal Capital, this improper disposal may be seen as one of the contributing factors to flooding, as (Ayalona, *et al*. (2009) revealed that the accumulation of polyethylene bags can block the drainage system, thereby causing water to go in wrong direction, the study further revealed that household sewerage system can be jeopardized as a result of throwing away wastewater with waste polyethylene bags used for wrapping solid meals, a practice which is prevalent among middle and low-class families.

Palansooriya, Shi, Sarkar, Parikh, Sang, Lee, and Ok (2022) carried out an empirical analysis on Low-density polyethylene, the presence of LDPE in soil was recently reported to show the most negative effect among other plastic types reducing the growth and quantitative phytochemicals in plants (Enyoh, *et al*. (2020), their study investigated the effect of low-density polyethylene (LDPE) microplastics (MPs) on the chemical and microbial properties of agricultural soil using a set of microcosm experiments, the soil was incubated for 100 days with LDPE at concentrations of 0%, 0.1%, 1%, 3%, 5%, and 7% at 25 °C with 70% water holding capacity, along with soil chemical analysis, we conducted analysis of soil microbial

properties on the first day and again after 100 days of incubation, they found out that the LDPE concentrations of ≥1% significantly ($p < 0.05$) decreased the pH but increased the electrical conductivity of the soil in comparison with the control (0% LDPE at 100 days), increasing the LDPE concentration did not affect the soil exchangeable cation content or the available Pb concentration, Firmicutes were the most abundant phyla in the soil on the first day, whereas Proteobacteria, Firmicutes, and Actinobacteria became dominant in all treatments after 100 days, an increasing LDPE concentration increased the abundance of Actinobacteria, and decreased Proteobacteria, Principal component analysis demonstrated that only 7% LDPE was positively correlated with Actinobacteria, indicating that higher concentrations of LDPE contributed to the growth of these phyla, these findings imply that MP contamination could affect soil chemical properties and microbial activity and that these effects primarily depend on MP concentrations in soil.

According to Sarkingobir, Bello and Yabo (2021), one of the harmful nature of Plastics is their ability to pollute our air and consequently spurring harmful effects on humans, plants, and other organisms, along the lifecycle of plastics, extraction and drilling of fuels releases toxic chemicals including HS_2, benzene, methane, and volatile organic compounds, like-wise, burning/incineration of plastics is characterized with the emission of hazardous sub-stances including furans, volatile organic compounds, heavy metals, etc, these are various plastics disgorging microplastics which can be spread in the air and easily gets into the body to cause harms. Particularly, CO can cause suffocation and death, dioxins and ethylbenzene are carcinogens, and Polycyclic Aromatic Hydrocarbons cause tumors in animals. They concluded however, the need to reduce plastics use, reuse plastic, and educate the public on dangers of plastic.

2.2.3 HEALTH IMPLICATIONS OF PLASTIC WASTE POLLUTION

Apart from direct economic losses there is adverse impact on human health and livelihood, food chains and other environmental factors (Green, Boots, O'Connor and Thompson, 2017). Halden (2010) in his research noted that Pthalates get deposited in fat bearing tissues and act as endocrine disrupters. It can also lead to dysfunctioning of reproductive system, inhibition of secondary sexual characteristics and lead to cancer. BPA act as estrogen disrupter and has deleterious effect of placental tissue growth. It can lead to premature birth, still birth, intrauterine problems and preeclampsia. In a study BPA was found to have carcinogenic effect in rodents especially on prostrate glands and urinary tracts. Recently, community solid waste, which includes waste polyethylene bags has been utilised in landfilling. All polymers including polyethylene bags decompose very slowly, due to limited availability of oxygen and humidity (North and Halden, 2013), the product yielded CH_4 (methane), H_2O and CO_2 (carbon dioxide) with biomass. Methane is one of the gasses that cause Greenhouse effect (depletion of ozone layer, thereby allowing the penetration of direct sunlight). Skin cancer and skin diseases are the direct consequence of greenhouse effect. Also, Moharam and Maqtari, 2014, revealed that domestic animals fed on plants from this contaminated soil risk being choked to death.

Ningxn *et al.*, (2022), noted that in the production of plastic industrially, Several additives are combined to the primary polymer resin to improve product performance, such as heat stabilizer, colorant, ultraviolet stabilizer, etc, (Meeker, J.D., Sathyanarayana, S., Swan, 2009), these additives have potential toxicity, such as dibutyl terephthalate (Thompson, R., Moore, C., Vom Saal, F., Swan, S., 2009), however, the impact of plastic additives on the human body is controversial because the impact is related to the type, dose and biological absorption, and accumulation of additives, for example, the additives of phthalates, bisphenol A, BPA, and other plastic products may have adverse effects on human endocrine function and reproductive development, at present, the research on the impact of plastic additives on the human body faces great difficulties, such as the change of plastic and additive production mode, low-dose chronic exposure of plastic additives, the confidentiality of industrial production, etc, In addition, plastic straws are degraded into microplastics in terrestrial and marine ecosystems, they will be ingested by organisms, accumulate in the liver, brain, and other tissue, and enter the human food web. Theoretical studies have shown that plastics may affect the central nervous and reproductive systems when the exposure level is exceptionally high (Waring, Harris, Mitchell, 2018).

Ajoku *et al.*, (2020), as reviewed above, opined that plastic wastes have also been linked with the spread of malaria because; they block drainages causes stagnant water, which provides site for mosquito breeding, as the survey (Nigeria Demography and Health Survey, 2019) revealed that malaria remains the foremost public health problem among pregnant women and infants under five (5) years in Nigeria. WHO (WHO, 2018) further approximately estimated that 57 million cases of malaria are reported, and nearly 100,000 malaria-related deaths occur each year. This cost the Federal government 40% of total GDP in prevention, treatment and cost of labors (Federal Ministry of Health, 2014), the indiscriminate disposal of plastic waste constitutes a lot of environmental and health problems, the vast majority of the plastic wastes end up in the environment, clogging sewers and drains causing air pollution when burnt, introduces harmful substances with toxic fumes that contain chemicals such as dioxin, furan, etc which have been linked with cancer, and posing a danger to marine life and causing death to livestock when inadvertently consumed, (National Environmental Management Authority NEMA, 2004).

Azoulay, Villa, Arellano, Gordon, Moon, Miller and Thompson (2019), in their magazine noted that Plastic production results in the release of many of those substances, as many of the chemicals integral to producing plastic are hazardous air pollutants. For example, a report by the Union of Concerned Scientists (UCS) reviewed the most dangerous hazardous air pollutants present daily. Four of the six pollutants examined are related to plastic production: 1,3 butadiene, benzene, styrene, and toluene. Many of these chemicals, as well as others released through the production of plastic, pose an especially serious threat to human health because they have a variety of impacts, including cancer, and can be difficult to detect, as some are colorless and tend to have mild to no odor. Some chemicals produced during Plastic production and their health effects

1,3-butadiene is used to make rubber, plastic, and other polymers (Nat'l Ctr., 2019), both short-term and long-term exposure to this pollutant can lead to negative health impacts, such as irritation of the eyes and throat, headaches, fatigue, decreased blood pressure and pulse, central nervous system damage, and unconsciousness. Long-term exposure can cause cancer and increase the likelihood of leukemia. Benzene can have severe health impacts, short-term exposure to benzene causes headaches, tremors, drowsiness, and dizziness, and exposure to high levels of benzene can even lead to death within several minutes or hours, Longer, or a lifetime of, exposure can cause wide-ranging health impacts from anemia to leukemia Additionally, studies have shown that Women exposed to a high density of benzene through air pollution can also experience specific reproductive health impacts, including irregular menstrual cycles and underdeveloped ovaries (Robert, 2011). Styrene is used in the production of polystyrene plastic and resins, limited exposure to styrene can cause irritation of the lungs, eyes, nose, and skin. High exposure can cause changes in vision, slowed reaction times, problems maintaining balance, and even cancer (U.S. EPA). Toluene is used both to produce other chemicals, including benzene, and in the production of polymers such as polyethylene terephthalate (PET), a key component of plastic bottles and nylon, among other products, Short-term exposure to low or moderate levels of toluene can cause fatigue, weakness, memory loss, nausea, and appetite loss. Long-term exposure can cause irritation of the eyes or lungs, head-aches, and dizziness. Toluene may also affect the nervous and reproductive systems and cause developmental problems in children.

Sharma and Chatterjee (2017), expressed in their review that, the health hazards resulting from the use of face washes, hand cleansers, toothpastes and dental care products containing PE microplastic particles has been evaluated by the German Federal Institute for Risk Assessment, they however concluded that, microplastic particles used in face pack peelings and shower products are larger than 1 μm, and prolonged use of these products lead to absorption of PE and PP particles in the tissues which ultimately results skin damage, microplastics and microbeads particles from toothpaste can unconsciously be swallowed and are absorbed via the gastrointestinal tract causing alteration in chromosomes which lead to infertility, obesity and cancer, in women, estrogenic mimicking chemicals can cause breast cancer. It is evident that humans are exposed to microplastics through their diet and the high ratio of microplastic pollutants in seafood creates a major risk to food safety. Therefore, a detail analysis and assessment of the potential health risk of microplastics coming from a range of foods across the total diet should be carried out to evaluate the causative risk of contaminated marine food on human health.

Seltenrich (2015), while difficulty lies in separating the comparative exposure from pollution and food webs and exposure via food packaging, it could be argued that this separation is a moot point should significant human health effects begin to unfold. Human health risks from plastics stem from their component monomers such as bisphenol A (BPA), additives such as plasticizers, or a combination of the two (Halden, 2010). While there is very limited information about the long-term human health effects of plastics, research has demonstrated

high levels of (BPA) in women and young infants (Rolland, Lyon-Caen, Sakhi, Pin, Sabaredzovic and Thomsen *et al.,* 2020) and this may cause alterations in neurological white matter in children (Ellahi and Rashid, 2017). These findings require more long-term research. BPA is both a plastic monomer component and an additive to many varieties of plastic. Ingestion is the commonest route of exposure via plastic packaging, particularly re-usable plastic packaging where repeated washing and storage results in polymer breakdown. BPA chronic exposure, even at nanomolar concentrations, has been reported to be deleterious, mainly involving human reproduction, development, metabolic and inflammatory pathway, There are significant knowledge gaps, ecological concerns, and serious public health concerns regarding the toxicity of Microplastics and Nanoplastics, as they will lead to a burden for the health system infrastructure in society, especially in the third world nations, whose current medical infrastructure is already overwhelmed. The public health concern will directly lead to lowering the HDI (Human Development Index) and simultaneously will be a major hurdle for achieving the SDGs targets (UNDP, 2015).

Verma, Shankarappa, Papireddy and Gowda (2016), in their review stated that, the burning of plastic in an open environment causes severe human health (due to the release of noxious chemical substances such as dioxins and particulate matter) and it is directly contributing to climate change (UNEP, 2020). Similar to other pollutants, humans inhale Microplatics; therefore, the continuous inhalation of Microplatics leads to serious health concerns including lung congestion, cancer, ulcers, and several other nasal and olfactory infections, when the Municipal Solid Waste containing about 12% of plastics is burnt, it releases toxic gases like Dioxins, Furans, Mercury and Polychlorinated Biphenyls into the atmosphere, and further, burning of Poly Vinyl Chloride liberates hazardous halogens and pollutes air, the impact of which is climate change, the toxic substances thus released are posing a threat to vegetation, human and animal health and environment as a whole, for instance Polystyrene can damage the Central Nervous System, the hazardous brominated compounds act as carcinogens and mutagens, while Dioxins settle on the crops and in our waterways where they eventually enter into our food and hence the body system. These Dioxins are the lethal persistent organic pollutants (POPs) and its worst component, 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD), commonly known as agentorange is a toxic compound which causes cancer and neurological damage, disrupts reproductive thyroid and respiratory systems. Thus, burning of plastic wastes increase the risk of heart disease, aggravates respiratory ailments such as asthma and emphysema and cause rashes, nausea or headaches, and damages the nervous system.

North and Halden (2013), made a review concentrating on the benefits and downsides of plastics and identifying opportunities to change the composition and disposal practices of these invaluable polymers for a more sustainable future consumption, the benefits of plastics are particularly apparent in medicine and public health, plastics are versatile, cost-effective, require less energy to produce than alternative materials like metal or glass, and can be manufactured to have many different properties, due to these characteristics, polymers are used in diverse health applications like disposable syringes and intravenous bags, sterile packaging for medical

instruments as well as in joint replacements, tissue engineering, etc, however, not all current uses of plastics are prudent and sustainable, as illustrated by the widespread, unwanted human exposure to endocrine-disrupting bisphenol A (BPA) and di-(2-ethylhexyl)phthalate (DEHP), problems arising from the large quantities of plastic being disposed of, and depletion of non-renewable petroleum resources as a result of the ever-increasing mass production of plastic consumer articles, using the health-care sector as example, It highlights ongoing efforts to phase out DEHP and BPA in the health-care and food industry and discusses biodegradable options for plastic packaging, opportunities for reducing plastic medical waste, and recycling in medical facilities in the quest to reap a maximum of benefits from polymers without compromising human health or the environment in the process.

2.2.4 MEASURES TO MITIGATE PLASTIC WASTE POLLUTION

Ncube, Ude, Ogunmuyiwa, Zulkifli and Beas (2021), emphasized in their paper that, packaging plastics account for half of the global total plastic waste, their paper seeks to give an overview of the use, disposal, and regulation of food packaging plastics, demand for food packaging is on the rise as a result of increasing global demand for food due to population growth, most of the food packaging are used on-the-go and are single use plastics that are disposed of within a short space of time, while the bulk of this plastic waste has found its way into the environment contaminating land, water and the food chain. They encouraged the food industry to reduce, reuse and recycle packaging materials and recommended that a holistic approach to waste management involving all stakeholders working to achieve a circular economy and a robust approach to prevent pollution today rather than handling the waste in the future should be adopted especially in Africa where there is high population growth.

Singh, *et al*., (2023), as cited above, explained that plastic waste management can be managed through community involvement in segregation at source, waste minimization, and recycling as a habit and way of life, this can be facilitated by providing bins for sorting waste and by setting up waste banks and recycling facilities on a larger scale than those currently available by the Local governments.

Kumar, *et al*., (2021), expressed in their study that, Plastic ban policies and public awareness are major mitigation interventions, The need for life cycle assessment and circularity to assess the potential environmental impacts and resources used throughout a plastic product's life span should be emphasized with innovations that are needed to reduce, reuse, recycle, and recover plastics and find eco-friendly replacements for plastics, the following were also recommended: Efforts should be made at different levels and should encompass, where possible, science-based or science-informed solutions. Further research is needed, not only at the level of new materials and technologies to deal with plastic waste but also to expand the already (limited) existing knowledge regarding presence, fate and effects of macro, meso, micro and nanoplastics once in the environment. As such, initiatives should be carried out from a holistic perspective120, with a view to:

- identifying the underlying drivers of plastic waste;

- fostering stakeholder engagement, which may be ensured by calls for early inputs, policy discussion and awareness campaigns;
- reducing the use of single-use plastics and establishing reduction targets whilst supporting alternatives to retailers;
- devising policies to support the implementation or reusable packaging and to regulate packaging practices throughout the different sectors, with an emphasis on the food supply chain and the cosmetic industry, as well as considering stricter measures to combat single-dose or monodose packaging;
- creating the right for EU customers to return plastic packaging to retailers, thus promoting higher collection efficacies and improved separation for recycling;
- creating clear and concise regulations for the labeling of biodegradable and bio-based plastics, with associated investments in education and dissemination efforts aimed at raising public awareness and education levels;
- Fostering activities and actions that stimulate zero-waste or reusable packaging strategies. This may be achieved by harmonizing the regulatory framework schemes throughout the EU and promoting the 4R rule: reduction, reuse, repair and recycling. This should be accompanied by severe discouraging penalties for single-use plastics;
- ring-fencing revenues originating from fines and levies for activities associated with zero plastic waste, including awareness programs, financing the recycling industry or supporting specific environmental projects;
- combating the economic preference for the use of virgin polymers by contemplating the application of progressive taxes on these materials, thus reducing the industry's impulses on the unhindered use of plastics in manufacture and packaging;
- concurrently promoting fiscal incentives or tax rebates for manufacturers, suppliers and retailers who develop and implement zero waste transition activities;
- Funding and investing in modern infrastructures for the collection, separation and processing of plastic waste, including in rural areas, which are frequently left out of such operations. This should include provisions to disincentives waste generation or downstream processes (e.g. landfilling as opposite to waste generation)

Empowering and educating communities and citizens to act collectively to minimize plastic pollution and use alternative options for plastics must be promoted and enforced. Plastic pollution is a global concern that must be addressed collectively with the utmost priority. Boonstra and van Hest (2017), in their report for the North Sea Foundation, advocated for dealing with bottle caps at the source and for good waste management on land and at sea. To deal with bottle cap pollution, The North Sea Foundation suggests the following solutions by sector:

1. Government: introduce deposits for disposable plastic (single-use) drink packages, including the caps
2. Industry: develop new types of packaging so that plastic leakage will no longer be a problem
3. Consumers: use as many reusable bottles and caps as possible, and dispose of waste properly.

Aligbe (2021), Recommended included more extensive research into the use of plastic bags with a bigger sample size with both online and offline platforms as this could encourage effective public participation in policy-making important for creating useful nudges in behavioral change in the shift from plastic bags.

Ajoku, *et al*., (2020) based on the findings of their work made the following recommendations to mitigate plastic waste:

1. Since the major sources of plastic waste generation in the study are household, commercial and institutional, there is need to educate the residents on sorting out their waste accordingly such as plastics, glass, metals and biodegradable materials for proper management.

2. Designated locations should be made available by the Local Government Authority for disposal of plastic waste. Plastic waste should be evacuated as quickly as possible when dumped in the environment by the residents because of its adverse effect.

3. Recycling of plastic waste should be taken seriously and sophisticated machines and equipment provided to help in the management of plastic waste.

4. To reduce the excesses of littered plastic waste, the residents should use paper for packaging their products that can easily degrade when discarded and finally,

5. Penalties should be imposed to defaulters who refuse to sort and bag their waste before disposal.

Jiang has discussed the initiatives taken to mitigate microplastic pollution by-laws, levies, policies, and the role of government, non-governmental organizations (NGOs), and international institutions to control the detrimental impacts and to protect the ecosystem. Several government agencies, research organizations, and institutions have concerted mitigation and management strategies to protect the ecosystem by plastics exposure and monitoring harmful impacts on aquatic animals and humans (Jiang, 2018).

As of now, 127 countries regulate the use of plastics, countries like Germany, the Netherlands, Switzerland, Sweden, and Norway, have put supermarket charges for the use of plastic bags and a tax on plastic bags was imposed in Portugal in 2015, this has made plastic consumption has reduced by 26% (Martinho, Balaia and Pires, 2017), while 115 countries have implemented various laws and policies to combat plastic waste both nationally and locally. Many countries have completely banned plastic use or there are restrictions and a fee to pay for the use of plastic. Approximately 30 countries in Africa, Asia, North America, or Europe have completely banned plastic bags; these countries have banned single-use plastics, and in some parts, there are restrictions on single-use plastic, whereas one countries have imposed user fees from the sales so that the use of plastic can be reduced as well as plastic pollution can be decreased (Dikgang, Leiman and Visser, 2012) (Gold, Mbika, Horowitz and Herzog, 2013).

Eco-labeling is a tool that is used to reduce marine plastic pollution (Pettipas, BernierandWalker, 2016). Eco-labeling has been adopted by many developed countries and also succeeded (Auta, Emenike and Fauziah, 2017); for example, the UK and the European

Union (EU) have adapted eco-labeling to reduce the plastic pollution in the ocean (Ogunola, Onada and Falaye, 2018). Many Nordic regions such as Iceland, Norway, Sweden, Denmark, and Finland have adopted eco-labeling, and it is widely used in those countries (Klauss, 2001). The European Commission in January 2018 embraced a strategy that proposed reusing and recycling all the plastic packaging and also to reduce single-use plastic and microplastic consumption (Guerranti,Martellini, Perra, Scopetani and Cincinelli, 2019).

Agreements and international conventions have been adopted to mitigate plastic waste pollution. The first convention addressing the regulation of plastic can be traced back to the International Convention for the Prevention of Pollution from Ships (MARPOL) of 1973. Annex V of the convention deals with the complete ban on the disposal of any forms of plastic wastes; it came into force on 31 December 1988 (Parker, 2021), this gave rise to the Action Plan on Marine Litter (OSPAR Convention, 2014), which came into force on 22 September 1992 and was signed by 14 countries including: Denmark, Finland, Germany, France, Belgium, the EU, Ireland, Norway, Spain, the UK, Portugal, Sweden, Northern Ireland, Switzerland, and Luxembourg. The main proposal of this convention was to reduce marine litter in the Northeast Atlantic and not to harm the ecosystem by 2020, which included the prevention and elimination of pollution from offshore sources, land-based sources, dumping or incineration, quality assessment of the environment, protection of the ecosystem, and biological diversity of the maritime area *(https://www.ospar.org/convention; accessed on 25 June 2023, (Ogunola, 2018).*

Other agreements and other strategies were also adopted to reduce plastic and microplastic pollution such as the strategy of either cleaning up or removing wastes from the sources (González-Fernández and Hanke., 2020) and the HELCOM Baltic Sea Action Plan which was adopted to protect the Baltic Sea and its catchment area from both sea and land-based plastic and microplastic pollution, with reduction of pollution as its main concern *(https://helcom.fi/about-us/convention/; accessed on 25 June 2023).*

Several countries have initiated national approaches to reduce marine debris by implementing laws, action plans, and policies. For instance, the United States implemented the Marine Debris Research, Prevention and Reduction Act (2006), which was later on modified in 2012, Australia also enacted the Environment Protection and Biodiversity Conservation (EPBC) Act in 1999 and listed the aquatic species that were threatened (Vinceand Hardesty, 2017). In addition, in Canada, the Environmental Protection Act was adopted to prevent the manufacture, sale, and import of microbeads, especially in cosmetic products (Jiang 2018 and Pettipas, 2016); likewise, the US Federal Government also introduced an act (Microbeads-Free Water Act, 2015), which imposes the prevention of sale and manufacture of those products containing micro beads (Lam, Ramanathan, Carbery, Gray, Vanka, Maurin, Bush and Palanisami, 2018). To control the marine litter and mitigate the pollution in the Mediterranean, the EU Marine Strategy Framework Directive was proposed.

Another plan for plastic pollution management was made, which was called the Barcelona

Convention Regional Plan, in December 2013, a first regional sea programme to look after the adverse impact on the coastal and marine environment due to the marine litter, and it contains measures, policies, and a technical nature as well as regulatory measures (Fossi, Vlachogianni, Galgani, Degli, Zampetti and Leone, 2020). Oman, Bahrain, Iraq, Iran, Kuwait, Qatar, the United Arab Emirates, and Saudi Arabia have adopted a regulatory body to look after the marine environment and to reduce pollution, this regulatory body is known as the Regional Organization for the Protection of the Marine Environment (ROPME); commonly known as the Kuwait Action Plan, this regulatory body contains legal binding signatories (ROPME, 1979). There are also other similar plans, agreements, and projects that have been adopted by the East Asian Region such as the Sustainable Development Strategy for the Seas of East Asia, the East Asian Seas Action Plan, UN's Global Environment Facility (GEF), and the Association of Southeast Asia Nations (ASEAN) (Dugarov and Gülasan, 2017).

Gallego, Alejandro, Mendoza, Joan and Azapagic (2018), however, extruded polystyrene containers are currently not recycled and cannot be considered a sustainable option. If they were recycled in accordance with the European Union 2025 policy on waste packaging, most of their impacts would be reduced by >18%, while also reducing littering and negative effects on marine organisms. Most of the impacts of the other two types of container would also be reduced (>20%) through increased recycling. Implementing the European Union 2025 policy on recycling of waste packaging would reduce all the impacts by 2%–60%, including a 33% reduction in global warming potential. Based on 2025 million takeaway containers used annually in the European Union, the latter would save 61,700 t CO2 eq./yr, equivalent to the emissions of 55,000 light-duty vehicles. The outcomes of this study will be of interest to packaging manufacturers, food outlets, policy makers and consumers.

2.2.5 CHALLENGES TO EFFECTIVE AND EFFICIENT MITIGATION OF PLASTIC WASTE POLLUTION

Kedzierski, Frère, Maguer, and Bruzaud (2020) in their work, *"Why is there plastic packaging in the natural environment? Understanding the roots of our individual plastic waste management behaviours"* stated that Plastic waste is now a classic contaminant of the natural environment and the origins of the contamination need to be well understood. The results underline that the low direct impact of the consequences on their users of the discarding of plastic packaging seems to be an important reason for individual mismanagement. Furthermore, the modern individual behaviors of the discarding of plastics are often deeply rooted in the past of the populations. Policies to reduce waste disposal come up against strong individual behavioral constraints that limit the proper management of plastic waste. Thus, incivilities, difficulty in enforcing sanctions, or public opposition to changes in waste management are all factors that contribute to the maintenance waste discarding behavior. The reuse behavior of objects that have become useless is also historically attested, but has tended to disappear with the rise of the consumer society. This type of behavior, whose valorization is a way of reducing plastic waste abandonment behavior, remains, however, less scientifically studied than other ways such as recycling.

Singh, *et al*., (2023), mentioned that the indiscriminate disposal of plastic waste at an astonishing rate has led to the search for comprehensive, effective, and sustainable remediation studies in search of a practical alternative to the management, disposal, and destroy plastic debris. While there are a number of processes such as incineration, land filling, and recycling already in place, they are unsustainable, expensive, and have serious impacts on the environment, wildlife, marine, and human health.

Phelan, *et al*., (2022), stressed that as a major user of single-use packaging, the food and beverage sector plays an important role in addressing plastic pollution, yet investigation of the uptake and transition to sustainable packaging by this industry sector remains limited. To contribute to filling this gap, a systematic review of 68 corporate sustainability reports was conducted to examine how major multinational companies in the food and beverage sector are addressing plastic pollution. This study focuses on how these companies address plastic pollution and packaging in their corporate sustainability reports, what sustainable packaging strategies they present, and how the companies address producer responsibility. The results showed that the transition to sustainable packaging in the food and beverage sector is slow and inconsistent. Most corporate sustainability reports fail to address plastic pollution. There is a tendency for companies to report on collection and recycling, rather than sustainable packaging solutions aimed at systemic change. Producer responsibility concerning packaging is growing, however, most companies are doing very little to reduce plastic waste especially in regions lacking waste management infrastructure, such as those in emerging economies.

Aligbe (2021), The Nigerian legislature proposed a plastic bag prohibition bill to reduce the manufacture and use of plastic bags with fines and time behind bars which is Nigeria's first attempt at managing the menace of single-use plastic bags, but it was never followed due to corruption in the political sector.

Consumer's acceptance and behavioral response is also a problem to the mitigation of plastic pollution, but a broader beneficial effect on the environment will only be attained through consumer acceptance and behavioral changes. Any shift to resolve the persisting issues surrounding single-use plastics must be done from a systems approach to sustainability in order to mitigate environmental and economic risks and their rebound effects on the society (Roy, *et al.,* 2021).

Nnaji (2015), the main limitation of this research is municipal waste management authorities do not have relevant data. Hence, there was heavy reliance on published materials. The status of waste management in Nigeria is very deplorable and therefore poses serious threats to public and environmental health. There is urgent need for both government and individuals to adopt holistic and sustainable waste management strategies in order to safeguard public/environmental health.

Kibria, Masuk, Safayet, Nguyen and Mourshed, (2023), noted that Lack of technical skills for managing hazardous waste, insufficient infrastructure development for recycling and recovery, and above all, lack of awareness of the rules and regulations are the key factors behind this massive pile of plastic waste.

2.2.6 SUMMARY OF FINDINGS
A. SOURCES OF PLASTIC WASTE

Plastic waste as seen above can be gotten from industries, commercial areas, domestic areas and from institutions (Ajoku *et al.,* (2020)), it is one of the main components of municipal solid waste, coming before food waste, paper, rags, metal, and glass (Singh and Sharma (2023)). One of the major issue is the single use plastics (SUP) like cups, plates, straws (Anil *et al*., 2019), stirrers, bottles, food containers (Gallego *et al*., (2018)), packaging (could be food, drink, even appliances), we also have some PET bottles (Becerril *et al*., (2021)) and nylons (Shopping bag and sachet water) (Dumbili *et al*., 2020; Mahesh *et al*., 2016), these plastics are hazardous and persistent in the environment, we should note that plastics can actually been down in the environment, but it forms Microplastics, which is subdivided into primary and secondary Microplastics, funny enough, most plastic waste leakage is estimated to come from Asia (Phelan *et al*., 2022), and most of this is from take-away and drink packaging (Du, *et al*., 2020);

B. ENVIRONMENTAL IMPACT OF PLASTIC WASTE POLLUTION

Plastic pollution adversely affects the Environment, nothing is safe from its menace as wildlife, the marine environment, the air, the land and even humans are affected by it (Reddy *et al*., 2014), plastic pollution occurs in many forms, some of the environmental impact of plastic pollution as reviewed in this work are: chlorinated plastics can release harmful chemicals into the surrounding soil, which can then seep into ground water or other surrounding water sources, this can cause serious harm to the species that drink this water , nurdles also pollute the aquatic environments, as aquatic organisms can see this as food and ingest, this causes suffocation, makes the organism feel full because of the plastic filling it's stomach, which eventually leads to the death of the organism, animals can be significantly harmed or killed by plastic pollution, it has potential to poison animals (Ningxn *et al*., 2022), which can then affect human food supplies, it is highly detrimental to large marine mammals as it contains many harmful chemicals such as polychlorinated biphenyls, polycyclic aromatic hydrocarbons, petroleum hydrocarbons, and other organic pollutants, leach out of plastic when left for a while, other ways it hurts animals is through entanglement of organisms (both aquatic and terrestrial) destruction of habitats too (Kumar *et al*., 2021), the agricultural ecosystem is also affected by the plastic, the film is used in agricultural production (Nnaji, 2015), after weathering and degradation, remain in agricultural soil, affecting soil structure, water, nutrient transmission, and secondary salinization and hindering plant growth, it could affect soil chemical properties and microbial activity, but that is dependent its concentrations in soil (Palansooriya *et al*., 2022). Plastic clogging up the drains, causing water and sewage to overflow, and can then become the breeding grounds for germs and bacteria that spread disease (Akinola *et al*., 2014), since it is managed improperly some of it gets burnt and this leads to air pollution, green house gases

occurs when there's excessive production, if current trend of plastic production continues then green house emission by plastic sector will account for 15% of global annual Carbon budget by 2050, other gases should as HS_2, benzene, methane, etc are released from the incineration and dumping of plastic (Anil, *et al.,* 2019; Sarkingobi *et al*., 2021).

C. HEALTH IMPACT OF PLASTIC WASTE POLLUTION

There are addictives added during the production of plastic to improve its performance such as heat stabilizer, colorant, ultraviolet stabilizer, these addictives are potentially toxic, some of the chemical includes Pthalates, 1,3 butadiene, benzene, styrene, toluene, etc (Halden 2010; Ningxn *et al*., 2022), all of these has toxic effects depending on the period of exposure and concentration, they have short-term and long-term exposure health effects, some of the short term effect include irritation of the eyes and throat, headaches, fatigue, memory loss, nausea, appetite loss, tremors, drowsiness, and dizziness, while some long term effect include cancer, increase the likelihood of leukemia, irregular menstrual cycles and underdeveloped ovaries in women, it could also affect the nervous and reproductive systems and cause developmental problems in children, these chemicals could get deposited in fat bearing tissues and act as endocrine disrupters, it leads to inhibition of secondary sexual characteristics premature birth, still birth, intrauterine problems and preeclampsia (Azoulay *et al*., 2019; Seltenrich, 2015), also polymers including polyethylene bags decompose very slowly yielding CH_4 (methane), H_2O and CO_2 (carbon dioxide) with Biomass (Ajoku *et al*., 2020), these gasses that causes Greenhouse effect leading to Skin cancer and skin diseases, humans inhale Microplastic leading to serious health concerns including lung congestion, cancer, ulcers, etc, when plastic is burnt it releases toxic gases like Dioxins, Furans, Mercury and Polychlorinated Biphenyls into the atmosphere, polluting the air (Verma *et al*., 2016), it also results skin damage (North *et al*., 2013), microplastics and microbeads particles from toothpaste can unconsciously be swallowed and are absorbed via the gastrointestinal tract causing alteration in chromosomes which lead to infertility and obesity (Sharma *et al*., 2017).

D. MITIGATIVE MEASURES TO ADDRESS PLASTIC WASTE POLLUTION

Plastic pollution is a global concern that must be addressed collectively with the utmost priority, there are some mitigative measures that have been recommended such as empowering and educating communities (Singh, *et al*., 2023) and citizens to act collectively to minimize plastic pollution and use alternative options for plastics must be promoted, enforced and penalties given (Ajoku, *et al*., 2020), this is a form of public awareness (Kumar, *et al*., 2021), we more promote extensive research into the use of plastic bags with a bigger sample size to encourage effective public participation in policy-making for a behavioral change (Aligbe, 2021), plastic ban policies (Jiang, 2018), agreements (Ogunola, 2018) and international conventions (González-Fernánde *et al*., 2020) are also mitigative measures that can be used to combat plastic pollution, there are some mitigative measures that give responsibility to the Government: this is where the plastic ban policies come in, taxes for use of plastic (Martinho *et al*, 2017) Industries: this involves changing packing style to reduce plastics waste and to consumers: here, we talk about proper disposal and reuse habits (Ncube *et al*., 2021; Boonstra *et al*., 2017), Eco-

labeling is a tool that is used to reduce marine plastic pollution (Pettipas *et al*., 2016; Ogunola *et al*., 2018).

E. CHALLENGES TO EFFECTIVE AND EFFICIENT MITIGATION OF PLASTIC WASTE POLLUTION

Even though many have researched on the problems of plastic pollution to the environment and human health, it's production and use is till prevalent, some challenges of effective plastic pollution mitigation, include the fact that most methods of plastic waste management are unsustainable, expensive (Singh, *et al*., 2023) and have serious impacts on the environment, wildlife, marine, and human health, also low direct impact of the consequences on their users of the discarding of plastic packaging, another challenge is that most corporate sustainability reports fail to address plastic pollution, there is a tendency for companies to report on collection and recycling, rather than sustainable packaging solutions aimed at systemic change and most companies are doing very little to reduce plastic waste especially in regions lacking waste management infrastructure (Phelan, *et al*., 2022), they did not forget to mention Consumer's acceptance and behavioral response (Kedzierski *et al*., 2020; Roy, *et al.,* 2021), as well as lack of technical skills for managing hazardous waste, even insufficient infrastructure development for recycling and recovery, and above all, lack of awareness of the rules and regulations (Kibria *et al.,* 2023), corruption (Aligbe, 2021) and relevant data by municipal waste management authorities (Nnaji, 2015).

2.2.7 GAP IN LITERATURE.

From the relevant literatures reviewed the following gaps were identified which accounts for the need for further research on the environmental and health impact of plastic waste pollution. These gaps are;

- Most of the studies were undertaken to identify the effect of plastic pollution on the marine environment in recent times, with little work done on its effect on the lithosphere
- The ways to improve people's participation in protecting mitigating the effect of plastic waste pollution in Africa has not been looked into.
- The health implications of burning plastic waste and using unsafe incineration method to control plastic waste pollution have not been effectively investigated.
- There are significant knowledge gaps about the environment and health implications of micro and nano plastic
- A detail analysis and assessment of the potential health risk of microplastics coming from a range of foods across the total diet has not been evaluated to know the causative risk of contaminated marine food on human health.
- No research has been done to assess the environmental and health impact of plastic pollution in Awka, Anambra State.

3.0 DISCUSSION OF FINDINGS

As seen from above reviews, plastic are made from resins or artificial fibers, this makes them persistent in the environment (Roy et al., 2021), there are not just limited to bottles, because

that's where our mind goes to first, plastic include your bag you carry to the market, the straw you use to sip drinks on a hot afternoon, the sachet water you take when you are thirsty, the takeaway pack given to you at your favorite restaurant (Dumbili *et al.*, 2020; Du et al., 2020; Gellego et al., 2018), even the little cute spoon added to the takeaway pack, the fancy nylon bag that our goods are packaged in from the supermarket (Aligbe, 2021), most of our earrings and jewelries, food wrappers, container caps, the PET bottles containing out soft drinks (Becerril et al., 2021) and more. Plastic pollution in the ocean is mostly caused by the fishing industry (abandoned fishing nets), naval operations (abandoned sea vessels) and aquaculture, it's a component of our appliances including, but not limited to, our televisions, our mobile devices, the air conditioner, the fan, the refrigerator, everything is made up of plastic. If everything is made up of plastic, that means it's waste can be gotten from everywhere, our institutions (financial institutions, religious institutions and educational institution), from households, that is residential areas, from commercial areas (market, etc), industries too (Ajoku *et al.,* 2020).

Why has plastic become so renowned in our society and the world at large? This is due to its versatility, it is also convenient, cheap, easy (Aligbe, 2021), it can be used for display, packaging, for manufacturing, transportation, bringing it down to our everyday lives, plastic is used for eating (plates, spoons and cups are made from it), we use it for shopping (the nylon bags we have) (Mahesh *et al*., (2016), we use it to refrigerate things, it contains our makeup, our clothes & Textiles, Cookware, Tea Bags & Coffee Strainers, gift Wrapping, decorations most of the things we do and have contains plastic or is made of it.

So, it is evident that plastic is important, but the problem lies with the level of its usage and its disposal, from the studies above you would understand that most people do not know that plastic actually have an expiry date, you might think, 'that's impossible', but it's true, in our households we wait patiently for the plastic to break before we dispose it, even when those materials starts to fade and we can obviously see that it's peeling off, we ignore it because the material is still useful, we also see cases where Zobo and soya milk sellers go and pick PET bottles, even the ones that have already been discarded to sell their products, they keep reusing and reusing these bottles without considering how long it has been in use, all these I say happens because of lack of awareness of the implications of their actions, single-use plastic is an another problem in our society, because once they are used they are discarded immediately, your straw (Ningxn, 2022) is an example of this, one you use your straw to take your soft drink, you no longer have use for it, discarding it becomes the next step, as long as we keep using single-use plastic, we will continue having plastic waste pollution, in developed continents like Asia, there is so much accumulation of plastic because so much plastic goes into packing, which gets disposed once used (Phelan et al., 2022; Mahesh et al., 2016) .

The main sources of plastic debris found in the ocean are land-based, a lot of things are washed out to the sea from the land, this could be when flooding occurs, a runoff during a storm, another way is through the overflowing of sewers, improper disposal of waste and inefficient

management of these waste, illegal dumps site is also a way plastic is introduced into the water body (Boonstra et al., 2017).

The impact of plastic waste pollution is numerous, it has impact on the environment, touching every single aspects of the environment, the lithosphere, the hydrosphere, the biosphere and the atmosphere, no one is left untouched by the hands of plastic waste Pollution, it also has impact on the health of humans, ranging from minor cases like a headache to extreme cases like an cancer (Anil et al., 2019; Reddy et al., 2014; Kumar et al., 2021). Let's consider the impact of plastic waste pollution on the soil, when there is a dump of chlorinated plastics on the ground and it has stayed for a while, there is release of harmful chemicals into the surrounding soil, the effect does not stop there, it then seep into ground water or other surrounding water sources, this can cause serious harm to the species that drink this water, not only that the micro organisms in that soil would be adversely affected, most of them would die off because of the concentration of chemicals in the soil, the plants will be equally affected, some might die, while others will accumulate these chemicals and become inedible, we should not forget that it also affects soil chemical properties and microbial activities, the agricultural ecosystem is adversely affected by plastic, film is widely used in agricultural production, after weathering and degradation, many plastic film fragments remain in agricultural soil causing a lot of problems in the soil, there is also introduction of toxic heavy metals into the soil (Nnaji, 2015; Palansooriya et al., 2022), affecting, the soil structure, nutrient transmission and hindering plant growth, the impact of plastic waste pollution on the soil is a chain reaction, it does not stop at one aspect, but it encompasses all.

How about how plastic pollution affect animals? According to our review, animals are harmed and killed by plastic pollution (Reddy et al., 2014), many animals get trapped in the webs of plastic as they go through the forest because we have turned every single place into our dump site, the animals might ingest these plastic because it's looks attractive, this causes them to choke, some might actually succeed in swallowing the plastic which will make them fill full and not want to eat again, but due to the fact that plastic is not food, they eventually starve to death, ingestion of these plastic could as well lead to obstruction and damage to the digestive system of the animal, thereby reducing the digestive ability of the system and piercing the organs, ultimately leading to death, we also have cases of animal poisoning due to the chemical composition of the plastic, we have seen reports of injuries, strangulation and entanglement of animals, preys get easily captured by predators because they are trapped by plastic, all these in turn would affect human food supplies.

In the aquatic environments, plastic marine debris are having a field day, this is because most waste are dumped into the sea, some fishing vessels are abandoned there too, even fishing nets and some other equipments are left in the ocean, floods and urban runoff deposit plastic and other debris into the sea, Coral reefs have been damaged by dragging nets and other plastic products along sea beds, destroying the habit of aquatic organisms, nurdles get into the sea from vessels littering the water body (Ningxn et al., 2022; Reddy et al., 2014), they eventually

get eaten by sea birds, turtles, other fishes in the marine environment leading to the accumulation of plastic in their body systems, other effects like choking, injuries, reduced steroid hormone levels, delayed ovulation, and reproductive disorders and death from starvation is associated with this, the chemical composition of these litters also stability and sustainability of the marine environment, as they are persistent in the oceans and sea, taking a long time to degrade, even when they do, they break down into fragments forming microplastics, because we consume aquatic organisms plastic fragments, ingested by them and other toxic substances may be transferred to the food chain, there are also cases of entanglement of aquatic organisms such as seabirds, fishes as a result of abandoned nets and ghost ships, this causes a scar in the aquatic environment, drastically reducing the amount of fishes in the sea and extinction of some rare species

Air pollution can be caused by plastic waste accumulation, during the production of plastic there are some harmful gases that are released into the atmosphere such as carbon dioxide and benzene which pollutes the air and as an aftermath spring harmful effects on humans, plants, and other organisms. The entire lifecycle of plastic is accompanied by emission of toxic gases, from the extraction, to the drilling and even its incineration; some of the toxic chemicals include: HS_2, benzene, methane, and volatile organic compounds, furans, volatile organic compounds, heavy metals, etc (Anil *et al.,* 2019), these chemicals get into the air and circulate easily, enters into the body of animals and humans, for instance, CO can cause suffocation and death, dioxins and ethylbenzene are carcinogens, and Polycyclic Aromatic Hydrocarbons cause tumors in animals.

Plastics significantly impacts maritime economy which includes tourism, fishing and shipping industry, it is also a leading cause of flooding because it blocks waterways, clogging up the drains, causing water and sewage to overflow, and can then become the breeding grounds for germs and bacteria that spread disease, like-wise the aesthetics of the environment is ruined as a result of plastic waste Pollution (Akinola *et al.,*; Dumbili *et al.,*),the tourism sector is highly influenced by plastic waste; the beaches, parks, museums, forest reserves, and shopping malls (example the great wall of china), are littered by the presence of bottles, nylons, gift wraps, etc destroying the aesthetics of the area, reducing the amount of tourist attraction, which in turn affecting the economy of the country. The fishing sector is affected; the number of fishes in the sea has reduced drastically due to the presence of chemicals, shipwrecks, nets, introduction of other plastic waste into the ocean, this kills them, poisons them and reduces the fishes available for commercial purposes. In some urban areas, once it rains people empty their refuse into the gutters which eventually blocks the gutter and can which can also lead overflowing of sewages and flooding, littering the environment and finding its way into the water bodies.

There are direct and indirect health implications of plastic waste pollution according to our review, let's talk about the direct implications first. There are some chemicals used in plastic production have the potential to be absorbed by human beings through skin absorption which could lead to dysfunction of reproductive system, inhibition of secondary sexual characteristics

and lead to cancer (Verma *et al.,* 2016; Ningxn *et al*., 2022). Chemicals like BPA act as estrogen interrupter and has pernicious effect of placental tissue growth (Sharma et al., 2017), some of its effects are premature birth, still birth, intrauterine problems, preeclampsia, and even cancer.

1,3-butadiene leads to irritation of the eyes and throat, headaches, fatigue, decreased blood pressure and pulse, central nervous system damage, unconsciousness and increase the likelihood of leukemia (North *et al.,* 2013; Halden, 2010). Exposure to benzene causes headaches, tremors, drowsiness and can even lead to death within several minutes or hours, it is worse for women as it causes irregular menstrual cycles and underdeveloped ovaries. Toluene is used in the production of polyethylene terephthalate (PET), a key component of plastic bottles and nylon, causes fatigue, weakness, memory loss, nausea, and appetite loss, irritation of the eyes or lungs, head-aches, also affects the nervous and reproductive systems and cause developmental problems in children (Seltenrich 2015;Azoulay et al., 2019). Continuous inhalation of Microplatics leads to serious health concerns including lung congestion, cancer, ulcers, and several other nasal and olfactory infections (Verma et al., 2016), microplastic particles used in face pack peelings and shower products are absorbed in the tissues which ultimately results in skin damage, even microplastics and microbeads particles from toothpaste can unconsciously be swallowed and are absorbed via the gastrointestinal tract causing alteration in chromosomes which lead to infertility, obesity.

Now, some indirect health implications: the burning of plastic wastes increase the risk of heart disease, aggravates respiratory ailments such as asthma and emphysema and cause rashes, nausea or headaches, and damages the nervous system, during the production of plastic the toxic chemicals released such as CO and methane are green house gases which destroys the ozone layer causing UV rays to penetrate the earth leading to skin irritations, cancer and skin diseases (North *et al.,* 2013).

For us to solve this problem of waste pollution we have to identify the factors driving plastic waste multiplication; some mitigative measures have been recommended, like the plastic ban policies, many countries like Rwanda have completely ban the use of plastic bags for shopping in a bid to mitigate the environmental and health implications of plastic, but in Nigeria, we are so dependent on plastics that even when a bill was passed to ban the use of plastic, enforcement could not be carried out and till date our environment is ravaged by the plague of plastic waste pollution (Aligbe, 2021).

Public awareness is major mitigation intervention, like I said earlier, most people are not aware of the effect of plastic pollution on their health and in the environment, it's all trying to make gain and convenience, we put all that first before our selves– this is already telling on our environment, there is a need to get word out about the effect of plastic waste pollution, we can use the social media platforms, we can advertise on websites, organize seminars, go out to the streets and villages and all to people about it, because it's effect is real and it's must be mitigated. Practice of the 4R's should be emphasized, this stands for reduce, reuse, recycle, and recover

(Ncube et al., 2021), to this we must ensure the life cycle assessment and circularity to assess the potential environmental impacts and resources used throughout a plastic product's life span should be emphasized with innovations eco-friendly replacements for plastics, no stone should be left unturned, industries must ensure that every materials used is eco-friendly and recyclable, it should not be single-use, if not the amount of waste produced would be excessive, on the consumers part, we must switch over to the eco-friendly products, for instance; instead of using a plastic straw, we can use a bamboo straw.

The problem also comes from the behavior of individuals (Kedzierski *et al.,* 2020), if we want to see a change in behaviors, we have to include people in policy making, this way they feel heard and try to clean up after themselves, in other words, we need to carry out an extensive research (Singh, *et al*., 2023) to understand the reason people use plastic bags involving a lot of people with both online and offline platforms as this could encourage effective public participation in policy-making important for creating useful nudges in behavioral change in the shift from plastic bags.

Empowering and educating communities and citizens to act collectively to minimize plastic pollution (Singh, *et al*., 2023) and use alternative options for plastics must be promoted and enforced; the community needs to get involved the management of waste, so that the habit or the attitude of recycling, sorting, etc can get to the grass roots (Kumar, *et al*., 2021).

Food industry to reduce, reuse and recycle packaging materials and recommended that a holistic approach to waste management involving all stakeholders working to achieve a circular economy and a robust approach to prevent pollution today rather than handling the waste in the future should be adopted especially in Nigeria where there is high population growth,

The mitigative measures do not seem to be working due to some forces or factors hindering its effectiveness and efficiency, they include lack of technical skills for managing hazardous waste, insufficient infrastructure development for recycling and recovery, must countries do not have the skills to manage waste, the facilities to manage them are inefficient and this causes indiscriminate dumping (Kibria *et al.,* 2023), this is because you are only as good as your equipment and facilities, we can solve this by adequately funding and investing in modern infrastructures for the collection, separation and processing of plastic waste in urban areas and rural areas this has to be emphasized because most times they are left out from such operations.

Lack of awareness of the rules and regulations are the key factors behind this massive pile of plastic waste (Roy, *et al.,* 2021), most people do not what is going on, and because they don't know, they dispose their trash without sorting, they throw sachet of water outside a moving vehicle, clogging up the drainage, this can also be called ignorance and illiteracy, even though some literates behave the same way.

Information is power, how would waste be managed effectively is there's no existing data? The

municipal waste management authorities do not have relevant data to help us mitigate plastic waste pollution (Nnaji, 2015), the Nigerian legislature proposed a plastic bag prohibition bill to reduce the manufacture and use of plastic bags with fines and time behind bars but they never enforced it, because of corruption in the country, that is to say that political culture play a role in the mitigation of plastic pollution.

Consumer's acceptance and behavioral response impedes the mitigation of plastic pollution (Kedzierski *et al*., 2020), a broader behooveful effect on the environment will only be attained through consumer acceptance and behavioral changes, most people do not buy recycled products because they view it as inferior, if that's the market trend, you don't expect companies to keep pushing recycled products in the market as it would only get rejected, that is why we need a change or a shift in ideologies in order to appreciate eco-friendly products and services.

There are producer responsibilities (Phelan, *et al*., 2022) and there are consumer responsibilities, however, concerning packaging, most companies are doing very little to reduce plastic waste especially in regions lacking waste management infrastructure, such as those in emerging economies, we need to enforce the producer pays principle, to keep company's in–check and ensure that sustainable practices are used in production of plastic, can as well promote fiscal incentives or tax rebates for manufacturers, suppliers and retailers who develop and implement zero waste transition activities in all aspect of production.

The Government has a lot of roles to play too, by devising policies to support the implementation or reusable packaging and to regulate packaging practices throughout the different sectors (Kumar, *et al*., 2021), with an emphasis on the food supply chain and the cosmetic industry, as well as considering stricter measures to combat single use plastic.

4.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

4.1 SUMMARY
The impact of plastic waste pollution on the environment and health cannot be denied, there are a lot of forms in which it occurs, as shopping bags, bottles, cutleries, sachet water, even to the Microplastic in toothpaste and beauty products, it destroys the aesethics, clogs drainage and causes flooding, not only humans are affected by this menace, wildlife and all parts of the environment is affected, this goes to show that nothing is ever done in isolation, everything interacts, this shows that the accumulation of plastic waste affects the lithosphere, the biosphere, the atmosphere and the hydrosphere, there is need to educate people in the effect of some of the chemists used in plastic Production, to reduce its harmful health effects like cancer, loss of memory, etc, even though most people get knowledge about the effects, a behavioral change is necessary to see a shift, also companies would have to switch to sustainable production to ensure the safety of the environment and health.

4.2. CONCLUSION
Having seen all these reviews, there is need to take knowledge of plastic waste pollution and

its implications to the grassroots, many papers have been written to address this issue, but how effective are the mitigative measures that have taken to solve this? The urgency to take this information to the populace should be emphasized, we need the restructuring of the mind if we want to succeed in purging the earth, there are alternatives to plastics, even though they are not readily available, we can still harness them for use, like the bamboo straw, so also enforcement is a must especially in a country like Nigeria, jail terms and large amount for settlement for offenders. We can do it, the earth can be plastic free.

4.3 RECOMMENDATIONS

The following specific recommendations are made based on the findings in this study:

1. Government: introduce deposits for disposable plastic (single-use) drink packages, including the caps, reduce plastic waste pollution by implementing laws, action plans, and policies and regulate the use of plastics by putting supermarket charges for the use of plastic bags and a tax on plastic bags

2. Industry: develop new types of packaging so that plastic leakage will no longer be a problem, there is a need to switch to sustainable production practices, and am assessment of the life cycle of plastic.

3. Consumers: use as many reusable bottles and caps as possible, and dispose of waste properly, go for eco-friendly products, choose recycled products.

4. Recycling of plastic waste should be taken seriously and sophisticated machines and equipment provided to help in the management of plastic waste

5. To reduce the excesses of littered plastic waste, the residents should use paper for packaging their products that can easily degrade when discarded and Penalties should be imposed to defaulters who refuse to sort and bag their waste before disposal.

6. Awareness, Education and re-education is important to get these information out to the grassroots and experience more brilliant changes in the environment.

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