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Mitigating Plastic Pollution in Nigeria through Circular Economy: A Prospect in Azare Bauchi State Nigeria.

Aiyedipe Alexander O, Faruk Umar Ahmed, Chindo Istifanus Yarkasuwa, Amin Sanusi Labilam

Department of Sustainable Environmental Studies (SPESSE CE), Abubakar Tafawa Balewa University Bauchi

Abstract

Plastic pollution has emerged as a pressing global challenge despite the undeniable benefits plastics bring to modern society. Traditional plastic production relies on the assumption of abundant, cheap, and easily accessible natural resources—an assumption that has become increasingly unsustainable as rapid population growth and economic expansion push the Earth toward its ecological limits. The circular economy (CE) presents a viable alternative to the prevailing linear model of *make, use, and dispose* by promoting resource efficiency, waste reduction, and environmental regeneration. This study critically reviewed existing waste management frameworks in Nigeria, evaluating their alignment with the core principles of a circular economy: eliminating waste and pollution, circulating products and materials, and restoring natural systems. Findings reveal that although Nigeria has made deliberate efforts to integrate CE principles into national development plans and extend them to sub-national levels, tangible impacts remain limited. Weak implementation, inadequate institutional capacity, and low public awareness continue to hinder progress. Focusing on the city of Azare, where rising urbanization and population growth intensify plastic waste challenges, the study highlights the potential of circular economy strategies in mitigating plastic pollution while fostering sustainable urban development. Key recommendations include the adoption of politically backed policies, the strengthening and modernization of recycling facilities through both human and technological capacity upgrades, and sustained public education and awareness campaigns to promote behavioral change and encourage the use of recycled products. By addressing these gaps, Nigeria can accelerate the transition toward a circular economy, reduce the burden of plastic pollution, and align its development trajectory with global sustainability goals.

Keywords

Circular,
Economy,
Plastics,
Pollution,
Waste.

INTRODUCTION

Plastic pollution has emerged as one of the most pressing environmental issues of the 21st century (Geyer, Jambeck, & Law, 2017). Plastic pollution has far-reaching environmental, economic, and social impacts. Studies have shown that plastic waste is ubiquitous, found from the deepest ocean trenches to the highest mountain peaks (Thompson et al., 2009). The persistence of plastic debris in the environment leads to detrimental effects on wildlife and ecosystems, including ingestion and entanglement of marine species and the disruption of natural habitats (Gall & Thompson, 2015).

Plastics are one of the world's greatest industrial innovations, but the sheer scale of their production and poor disposal practices are resulting in growing adverse effects on human health and the environment, including on climate change, marine pollution, biodiversity, and chemical contamination, which require urgent action. Plastics are used in many sectors such as packaging, construction, automotive manufacture, furniture, toys, shoes, household appliances, electrical and electronic goods, and agriculture. This wide demand has caused plastics production to explode globally, now outgrowing most man-made materials (Geyer et al., 2017). The production of plastics increased by more than twenty-

fold between 1964 and 2015, with an annual output of 322 million metric tonnes (Mt), and is expected to double by 2035, and almost quadruple by 2050. Plastics contribute to economic growth, but their current production and use pattern, on a linear model of 'take, make, use, and dispose', are a primary driver of natural resource depletion, waste, environmental degradation, climate change, and has adverse human health effects (Barra et al., 2018).

The state of plastic pollution in Nigeria and measure to tackle them: a review was reported (Chukwuemeka and Onyekachi 2022). The study presented the status of plastic pollution in Nigeria and some policies to curb the menace. Analysis of data from the study revealed that Bayelsa, Katsina, Lagos, and Oyo are the four states that generated the majority of the plastic waste in Nigeria. The number of industries, markets, and urbanization in a location affect the quantity of plastic waste that is produced there and is not dependent on the population. The review made some policy suggestions and recommendations such as the federal prohibition and taxation on the use of plastic, ocean clean-up, technological innovation that will support the recycling industry in Nigeria, and the need for additional plastic research.

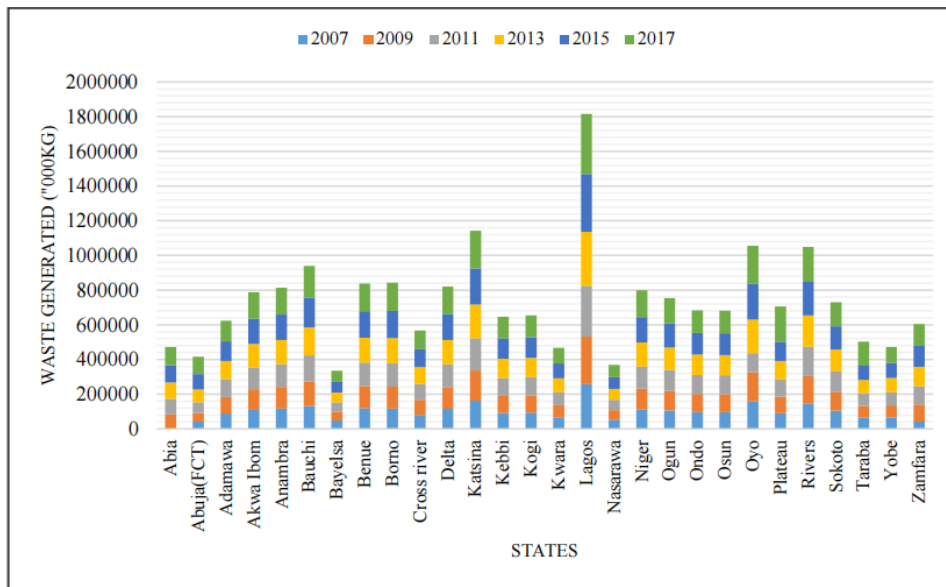


Figure 1: Plastic waste generation across states in Nigeria, (Bokani, 2019)

Effects of plastic pollution

Jeopardizing human health

Plastic pollution poses significant risks to human health. Plastic is in the water we drink, the food we eat, and the air we breathe. The average person ingests microplastics equivalent to up to 50 plastic bags a year. (Bai *et al.*, 2022). As a result, micro- and nano-plastics are commonly found in human bodies. Recent studies have found plastic particles in the placentas of pregnant women, (Ragusa *et al.*, (2021), in human breast milk (Ragusa *et al.*, 2022), and in human blood samples, raising concerns about the potential long-term health effects on human well-being.

Degrading vital ecosystem

Plastic pollution harms biodiversity by contaminating natural habitats, posing a variety of threats to many species. From elephants to sea turtles, wildlife often ingests plastic debris, mistaking it for food, which can lead to internal injuries, starvation and even death (UNEP 2021). Additionally, the presence

of plastics in ecosystems disrupts food chains and alters behaviours, impacting species reproduction and survival. Every year, millions of tonnes of plastic leak into nature harming wildlife and disrupting critical

Ecosystem services. With more than 14 million metric tonnes of plastics entering aquatic ecosystems annually the world's oceans are deeply affected (UNEP 2021). Plastic pollution also has a profound impact on land ecosystems with terrestrial micro plastic pollution estimated at four to 23 times higher than marine microplastic pollution, depending on the environment (Horton *et al.*, 2017).

A number of cases of flooding in major cities in Nigeria are as a result of improperly disposed plastic wastes blocking the water drainages (Duru *et al.*, 2019). In many cases, these wastes eventually find their ways through water bodies, into the ocean thereby constituting marine debris. Marine debris from plastic wastes has been estimated to be about 8 million metric tons per year (Jambeck *et al.*,

2017) with consequent ecological aesthetic and economic damage to the ocean resources (Yang et al., 2018).

Fueling climate crisis

The relationship between plastic pollution and climate change is equally troubling. Almost all plastics we use today are derived from fossil fuels. In 2019, plastics generated 3.4 percent of global greenhouse gas emissions, with 90 percent of those emissions stemming from plastic production and the conversion of fossil fuels. (OECP, 2022) Projections suggest that by 2040, greenhouse-gas emissions associated with the lifecycle of plastics, including production, use and disposal, could account for up to 19 percent of the world's carbon allowance, under the target of restricting global warming to a maximum of 1.5 °C. (UNEP 2021) Plastic pollution not only hampers climate action but also hinders climate change adaptation as it damages critical ecosystems such as coral reefs and mangroves that serve as buffers from storm surges and rising sea levels. Plastic waste may also clog drainage systems and obstruct runoff, resulting in increased risk of flooding. (Rain et al., 2011) In addition, the burning of plastic waste releases toxic gases into the atmosphere, driving climate change and air pollution.

Harming Local Economies

While plastic-related activities can contribute to economic development, the degradation of nature due to plastic pollution can lead to substantial revenue losses in key sectors, including tourism, fishing and transport. In the Asia-Pacific region, marine debris directly costs the tourism industry approximately \$622 million, the fishing industry \$364 million

and the transportation/shipping sector \$279 million each year. (UNDP 2024) These figures underscore the significant economic consequences tied to the unsightly and harmful presence of plastics in natural environments.

Circular economy (CE) and sustainability

The CE proposes a paradigm change from the old linear model of "take-make-consume-dispose" to an innovative and restorative approach in which waste is minimized and resources are retained in continuous use (Kirchherr et al., 2023). The generation of energy from biomass and efficient waste management, two interrelated elements that hold the key to not only reducing environmental degradation but also promoting economic growth and societal well-being, are at the center of this transformation (Zhou and Wang, 2020). CE is an economic model aiming to create value at every operational level by systematically reusing products and their constituent components, recycling materials, and conserving natural resources. Positioned as an innovative form of sustainability, CE addresses the challenges posed by resource abundance, material scarcity, and the evolution of the reuse and recycling framework (de Melo et al., 2022).

Governmental agencies, educational institutions, corporations, and the general public increasingly adopt this concept as essential to sustainable development (Sgroi, 2022). CE has received a lot of appreciation for its ability to promote long-term, ecologically responsible growth. According to the Ellen MacArthur Foundation (2015), CE is inherently restorative by design and aspires to maintain products, components, and materials at their maximum efficacy, emphasizing

distinguishing between biological and technical cycles. Geissdoerfer et al. (2017) defined CE as a regenerative system. In circular economy, there exist the intentional monitoring, closure, and narrowing of material and energy loops work to minimize resource input, waste, emissions, and energy leakage (Muller et al., 2022).

The primary goal of CE is to minimize adverse environmental impacts while simultaneously optimizing organizational performance and productivity. Despite the development of several frameworks and metrics by governmental bodies, corporations, and researchers aimed at a thoughtful understanding of CE (Corona et al., 2019), the concept of CE has evolved. Many governments have led by establishing objectives and nationally targeted key performance indicators related to sustainable development and CE. These indicators are a strategic tool for policy-makers and decision-makers in pursuing sustainability goals (Lamba et al., 2023).

The prevailing literature on CE prominently highlights the 3R principles: reduce, reuse, and recycle (Reike et al., 2018). Reduce is the process of reducing inputs and outputs, which includes waste and raw resources. Meanwhile, reuse involves utilizing a product for the same purpose even after reaching its shelf life. Finally, recycle refers to reusing discarded resources to create new products (Merewether et al., 2023).

The combined qualities of cheap prices, flexible, and chemical stability and less corrosive have increased the use of plastic materials for storage and transport purposes in priority to other materials according to Duru et al., 2019 review of plastics consumption, waste production, collection, and treatment in Nigeria and a few selected countries. However, such unchecked use and the ensuing rise in plastic pollution can harm wildlife, human health, and Nigeria's economy Thompson 2017.

Despite laws that may address these issues already being in place in Nigeria, the problem of plastic pollution still exists and may even be getting worse NASREA. However, these laws are either not executed or enforced inconsistently Enyoh 2019. Nigeria's plastic industry is experiencing rapid growth as a result of massive investment. However, based on the volume of plastic imports and consumption between 1990 and 2017, Nigeria was ranked second among some specific African nations Babayemi et al., 2019. Given that the use of packaged goods has become a part of our daily lives, the packaging industry is actually the largest consumer of plastics Babayemi et al., 2019.

According to estimates from Patel 2000 and Shah (2008), 30 percent of plastics produced globally are used for packaging purposes. Humans prefer to use plastic to wrap food products rather than using bare hand to hold the food product cheaply because they believe that hand flora contains pathogens which can be harmful.

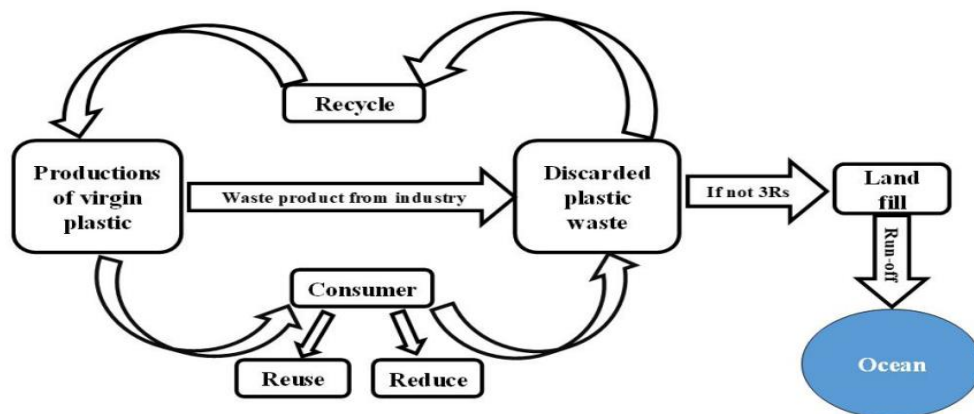


Figure 1

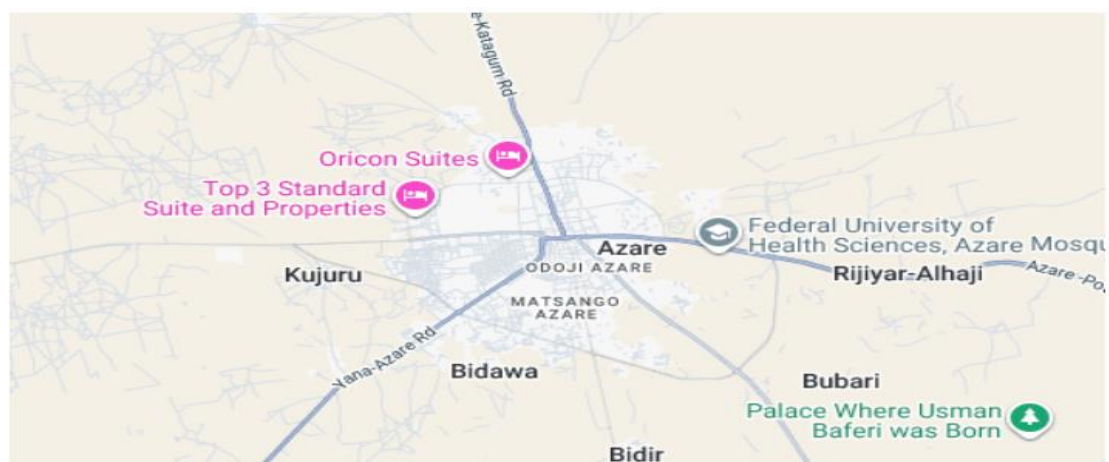
Source: Onyekachi and Chukwuemeka 2022

2. Materials and Methods

Study Area

Azare, Bauchi State Nigeria is located on longitudes 10.2039° E of the meridian and latitudes 11.6726° North of the Equator. Azare is in the northern part of Bauchi State Nigeria. Jigawa and Yobe states form its

western and eastern borders, respectively. Azare covers a territory of $1,436 \text{ km}^2$ and there are more than 105,687 people living in an unevenly distributed manner.



Map of Azare, Nigeria

Figure 2

Source Google map 2025

Types of Data

The data set for this study consist of primary data collected through structured interview and secondary data that where obtained from a paper presentation "current status of waste management and plastic management in Nigeria, policy and industry aspects" by Federal Ministry of Environment Abuja, Nigeria. The data contain background information on volume of plastic waste

generated by each state. Twenty-eight (28) states with at least 11-year records (2007 - 2017) of volume of plastic waste generated were considered and the results were used to predict for the entire 36 states (Onyekachi and Chukwuemeka 2022). A total of 350 respondents were used for the study, 330 returned the filled questionnaire. Out of the 350 respondent, 250 were involved in picking and processing of plastic waste in Azare.

3. RESULTS AND DISCUSSION

Table 1: showing the major plastic waste collected, use-age, influence to use plastic, frequency of plastic collection and effectiveness of plastic waste collection

QUESTIONS					
What types of plastic waste are most commonly collected in your area? (Select all that apply)	PET 140	*PB 70	FC 50	PB 50	O 20
How often do you use single-use plastics in your daily life?	N 0	R 0	S 0	O 30	A 300
What factors influence your decision to use or avoid plastic products?	C 200	*C 50	E I 30	AA 30	L 20
Are there designated drop-off points for plastic waste in your community?	YES 0	NO 330			
How often does your community/Government agency conduct plastic waste collection	D 0	W 0	B 0	M 0	N 330
How effective do you believe the current plastic waste collection system	VE 0	E 0	N 20	IE 30	VIE 280

PET = POLYETHYLENE, *PB= PLASTIC BOTTLES, FC= FOOD CONTAINERS

PB= PLASTIC BAGS O= OTHERS

N= NEVER R= RARELY S= SOMETIMES O= OFTEN A= ALWAYS

C= CONVINIENCE *C= COST EI= ENVIRONMENTAL IMPACT AA= AVAILABILITY L= LUXURY

Y= YES N= NO

D= DAILY W= WEEKLY B= BIWEEKLY M= MONTHLY N = NEVER

VE= VERY EFFECTIVE E= EFFECTIVE N= NEUTRAL IE= IN-EFFECTIVE VIE= VERY INEFFECTIVE

Various circular economy strategies have been reported (Salvacion and Campos 2024, Samitthiwetcharong et al., 2024, ERIA 2023, UNDP 2019). From this review, it is indicated that more 90 % of the plastic waste (PW) generated is collected through informal system while less than 10 % of the PW is processed in Azare, the rest of the uncollected PW ends up in open and unlined dump sites, drainages, farmland, and open spaces without any form of separation or segregation.

Despite Nigeria has taken deliberate steps and made conscious efforts to promote the adoption of circular economy principles and practices in the country and mainstream such into our National Development Plans and cascade to the sub-nationals (Charles 2022). In Azare, the people engaged in picking of plastic have no regulatory framework regarding their activities. This is similar to a report by UNDP 2019 on a project implemented in India in which rag pickers were organized into self-help groups and were engaged to pick plastics from which they earn income. Over the years, Nigerian government has demonstrated its willingness to have a robust waste management system through formulation and implementation of waste management policies (shown in Table 2).

The inclusion of the Circular economy principles and waste in the revised NDC (2021) provided measures that includes; Community Based Waste Management Programme that encourages the involvement of local communities in modern waste management practices such as waste sorting, segregation, composting and recycling as well as ownership of projects; National Plastic Waste Recycling

Programme (NPWRP) under which at least one plastic recycling plant is to established in each of the 774 Local Government Areas in the country and Waste to wealth entrepreneurship programme for the empowerment of the most vulnerable group especially youth and women among others. The waste recycling plant built by the government under the NPWRP in Azare is not fully functioning while a privately operated recycling facility also exists but their operation is limited to sorting, segregation and crushing into small bits and then transporting he crushed bits to Kano for further processing.

Challenges and barriers to adopting the circular economy include but not limited to:

Technical Capability of Plastic Waste Recycling Numerous intellectual researchers have identified an assembly of barriers posing challenges to the successful implementation of Circular Economy (Durdyev et al., 2023, Holly et al., 2023, Osei-Tutu et al., (2022), Ye et al., (2020), Govindan and Hasanagic (2018). Research findings highlight that insufficient knowledge about CE strategies impedes the widespread implementation of circular practices.

Market Acceptability of Recycled Plastics: In Nigeria, there are very few organized recycling infrastructures but mostly by individuals who are using improvised methods with little training, hence the low quality of the recycled products with consequent low demand (Duru et al., 2019; Dumbili and Henderson, 2020). It is however noted that the challenge with market acceptability of recycled material affect the recycling rate hence hindrance on the promotion of circular economy through

plastic recycling process (Mancini and Medeiros, 2021)

Institutional Framework The institutional structure at the national and sub-national levels exist but no enough political will to enforces polices. This tends to be a problem in

most developing economies. The presence of international cooperation could be leveraged by the Federal Ministry of Environment to offset the threats of climate change complexities affecting the effective waste management.

Table 2: Showing the Potentials of Circular Economy in Azare

Response	Y	%	N	%	Total
Have you heard of circular economy before	0	0	250	100	250
Are you registered with any government agency?	0	0	250	100	
Do you receive incentives for picking / collecting plastic waste?	250	100	0	0	
Are there ready markets available for the plastics waste collected	197	78.8	53	21.2	
Is there a functioning recycling plant in Azare	0	0	250	100	
Are your activities regulated by any government agency	280	84.8	50	15.2	330

Table 2 shows the prospects of the circular economy strategy in Azare regarding plastic pollution. A total of 250 respondents were sampled which comprised of plastic pickers and collectors within Azare. 100 % of respondents used in the sample said they are not registered with any government agency and do not receive any incentives for picking and collecting plastics. On the availability of market for the plastic collected, the 250 respondents

indicated yes. 78.8 % indicated that there is a plastic waste treatment plant in Azare while 21.2 % indicated on the contrary. On the usage of recycled plastic (this applied across the 330 sample size) 84.8 % affirmed they would while 15.2 % said they would not use a recycled plastic.

Future prospective

To tackle the challenges of plastic waste, an innovative strategy is required for plastic waste collection and treatment. This will require a conceptual framework incorporating the product's whole life cycle into the plastic waste management system. The objective is to reduce waste from one system and repurpose it as a resource for other systems in an ideal waste-free city. Transitioning to a zero-waste smart city necessitates three critical steps: waste prevention, proper garbage disposal, and practical value recovery from collected waste.

The 'resource waste' concept prioritizes waste reduction upstream, emphasizing resource management by separating trash at its source to improve value recovery rather than relying exclusively on treatment. This strategy aims to improve efficiency by merging principles from CE and sharing economy (Esmaeilian et al., 2018). Municipalities can more effectively handle the timely collection and recovery of waste by keeping apprised of the rate of waste development. This information may also be used to modify the layout and size of waste containers for different geographical locations. Overall, utilizing product lifecycle data provides opportunities for information interchange, the investigation of new data formats, the introduction of creative business models, and the possibility to boost resource utilization, minimize capability waste, and shorten product lifecycles

4. Conclusion and Recommendations

Though Specific figures for plastic waste generation by individual local government areas (LGAs) in Bauchi State are not readily

available. However, it is known that Nigeria, as a country, produces a large volume of solid waste annually, estimated to be around 32 million tons, with poor collection and management practices being a significant concern. Nigeria have focused on national averages and city-level data, but detailed breakdowns by LGA for Bauchi State are not presented. It is recommended that policies should be followed by strong political will so that the effect will be felt at the grassroots. Development and implementation of Specialized Programmes and projects such as: Community Based Waste Management Programme that encourages the involvement of local communities in modern waste management practices such as waste sorting, segregation, composting and recycling as well as ownership of projects; National Plastic Waste Recycling Programme under which at least one functioning plastic recycling plant is established in each of the 774 Local Government Areas in the country.

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