Faculty of Natural and Applied Sciences Journal of Scientific Innovations
Print ISSN: 2814-0877 e-ISSN: 2814-0923
www.fnasjournals.com
Volume 7; Issue 2; March 2026; Page No. 1-8.
DOI: https://doi.org/10.63561/fnas-jsi.v7i2.1148

Assessing the Impact of Plastic Waste Pollution on the Environment in Gombe Metropolis, Gombe State, Nigeria

***[1,2]Patrick, D.B., [3]Nsor, C.A., [1,2]Abubakar, B., [1]Musa, A.M., [1]Ishaku E.E., & [1]Mu'azzam, A.H.**

[1]Department of Science Laboratory Technology, Federal Polytechnic Kaltungo, Nigeria.
[2]Department of Biological Science, Gombe State University.
[3]Department of Zoology and Wildlife Ecology, Gombe State University

***Corresponding author email:** patrickdathehbello@gmail.com

Abstract

Plastic waste pollution has emerged as a major environmental concern in the world, Nigeria, and Gombe State metropolis, Gombe, Nigeria. This study assessed its impact on environmental health, particularly in relation to water industries and market areas. Quantitative survey approach was employed. A total of 237 respondents participated in the survey. Four sites were used: Inex Dumpsite, Main Market, Tumfure Market, and Old Market. Findings revealed a male-dominated respondent pool (59.1 %), with most participants aged 18–50 years. A significant majority (72.6 %) acknowledged the harmful effects of plastic waste on health and the environment, 64.1% linked plastic waste to disease transmission and increased mortality. Waste management relied on community collection points (42.2 %) and private companies (38 %), with indiscriminate disposal and burning widely discouraged. 87.3 % agreed that sorting reduces bulk waste while 12.7% disagreed. Inadequate recycling industries and waste collection points are the major challenges to effective plastic waste management. The sturdy also revealed that majority of the respondents (89.4%) agreed that plastics should be recycled. Main market out of the three markets surveyed emerges as the highest distributor of plastic bags having 34% of its vendors dispensing over 100 bags daily. 94.9% of the respondents depend on sachet water for drinking.0nly 6.3% of the water industries produce less than 100 bags of water a day. The study recommends intensified public awareness campaigns on proper plastic disposal and provision of adequate waste recycling systems, alongside improved sanitation measures to mitigate pollution and health risks.

Keywords: Plastic, Waste, Pollution, Environment, Metropolis

Introduction

Plastics are basically petroleum derive non-biodegradable materials with a unique polymeric structure that offers low specific weight, low electrical and thermal conductivity, and high durability, excellent mechanical properties, reasonable pricing, etc. (Landon-Lane, 2018; Mazhandu et al., 2020). This high amount of waste plastics consequently affects the ecosystem through soil pollution by land filling, marine pollution by ocean dumping, air pollution by open dumping as they are not a part of our food chain (Mourshed et al., 2017). According to World Bank group report, plastics comprise about 5 –12 % of the world's total waste generation (20–30 % by weight) (Awasthi et al., 2017; Kaza et al., 2018) and about 60% of plastics enter environment as plastic waste. Management of waste generated from different sectors is the sole responsibility for agencies like the Federal Environmental Protection Agency (FEPA), Ministry of Environment, Local Authorities and Environmental Sanitation Authorities. Gombe State Environmental Protection Agency (GOSEPA) is not an exception (Sulaiman et al., 2019).

Plastic waste pollution poses challenges to economic development not only animals are affected by this pollution. For example, by reduced tourism due to plastic pollution on shorelines, vessel damage and damage to public health (Hardesty, Good and Wilcox, 2015). Plastic bags constitute the large part of the litter found in catch basins and drain inlets of storm water management systems. Environmental problem due to soil contamination by trace metals has received great global attention in recent times (Sulaiman et al., 2019). 80 % of diseases are water borne due to drinking

Cite this article as:
Patrick, D.B., Nsor, C.A., Abubakar, B., Musa, A.M., Ishaku E.E., & Mu'azzam, A.H. (2026). Assessing the impact of plastic waste pollution on the environment in Gombe Metropolis, Gombe State, Nigeria *FNAS Journal of Scientific Innovations, 7*(2), 1-8. https://doi.org/10.63561/fnas-jsi.v7i2.1148

of contaminated water in developing countries according to WHO (Khan et al., 2013) and about 3.1% deaths occur due to the unhygienic and poor quality of water (Pawari & Gawande, 2015). In many developing countries including Nigeria, poor water supply including Nigeria, had led to seeking for alternatives by residents (Bakker et al., 2008; Vedachalam et al., 2017). This Study aims to assess the impact of plastic waste pollution on environment in Gombe metropolis, Gombe State Nigeria.

Materials and Methods

This study was conducted in three key markets: Main Market, Cross Market, and Tumfure Market, as well as the water industries surrounding these markets and the INNEX waste dump site, all located within Gombe metropolis, the capital of Gombe State. Gombe State is situated in the North-Eastern region of Nigeria, between latitudes 10°15'N and 10°19'N, and longitudes 11°07'E and 11°15'E. This research employed a quantitative research design, which is well-suited to the nature of the study. This can be achieved through various types of questionnaires. The study involved a survey approach to examine waste characterization at the final dumpsite in Gombe metropolis. The survey spanned four weeks, with 20 total days dedicated to data collection at the INEX waste dump site. Over five days each week (Tuesday to Saturday), water bottles, sachets, and packaging leather waste were sorted and weighed to assess their volume. Additionally, a Waste Management Questionnaire (WMQ) was developed to gather responses from participants regarding waste management practices. The target population for this study consists of 550 individuals residing in Gombe town. This group includes bottled water vendors, manufacturers, consumers, and market sellers. A total of 550 respondents were selected as the focus of this research.

Sampling is a procedure or technique for drawing a representative's group of people or cases from a specific population. Sample can be defined as an unbiased subset representing the population (Collis & Hussey, 2014). Random sampling technique was used. The sample size for this study from the target population of 550 bottle and sachet water handlers, manufacturer and food stuff consumers were calculated from the formula of Yamane because of the number of the population is finite; therefore:

$n = N/[(1+Ne^2)]$

Where:

n = sample size

N = known population

e = alpha level i.e., e = 0.05 if the confidence interval is 95%

=> n = 550/ [1 + 550 x 0.05 x 0.05] = 550/ [1 + 1.325] = 550/2.325 = 237.

The sample size for this study was two-hundred and thirty-seven (237) bottle and sachet water handlers to be the respondents of the study. For this study, stratified random sampling technique was used in drawing a sample of 237 bottle and sachet water handlers and manufacturers.

Additionally, 50 shop owners in the three markets were interviewed in three markets namely, Tumfure, Cross and Main Market.

The research instruments for this study include field observation and waste characterization, supplemented using Google Forms for digital data collection. Equipment required for plastic waste characterization consists of a Camry weighing scale, hand trowel, shovel, empty sacks, tarpaulin, heavy-duty waste sacks (polythene), cutlass, hand gloves, and a flat floor. Structured questionnaires were developed to gather responses from participants, as outlined by Collis and Hussey (2014). The questionnaire for this research consists exclusively of closed questions, which offer several advantages over open-ended questions. This format allows for easier data processing, comparison, and analysis of relationships between variables.

The data collection instruments were administered randomly to respondents in various community locations using survey questionnaires. Data were analysed using SPSS version 23. Descriptive statistics (Frequencies, percentages, means and standard deviations), summarized questionnaire responses, inferential statistics including ANOVA and t-tests, were applied at a 5% significance level to assess relationships between plastic waste accumulation and environmental pollution.

Cite this article as:
Patrick, D.B., Nsor, C.A., Abubakar, B., Musa, A.M., Ishaku E.E., & Mu'azzam, A.H. (2026). Assessing the impact of plastic waste pollution on the environment in Gombe Metropolis, Gombe State, Nigeria *FNAS Journal of Scientific Innovations, 7*(2), 1-8. https://doi.org/10.63561/fnas-jsi.v7i2.1148

Results

Demographic Characteristics of Respondents

Of the 237 respondents, I found a predominance of male participants (59.1 %) compared to females (40.9 %); Age-wise, the largest group was the 31-40 age range, comprising 38 % of respondents, followed by the 18-30 range at 31.6 % (Table 1a). Educationally, majority of participants had secondary education (42.2 %), with a notable portion (28.3 %) having tertiary education. Only a small percentage lacked formal education (8.4 %), indicating an educated population in this study (Table 1).

Table 1: Demographic Characteristics of Respondents

Characteristics	Frequency	Percentage (%)
1a-Gender		
Male	140	59.1
Female	97	40.9
1b-Age Group		
18-30	75	31.6
31-40	90	38.0
41-50	50	21.1
51 and above	22	9.3
1c-Educational Level		
No Formal Education	20	8.4
Primary Education	50	21.1
Secondary Education	100	42.2
Tertiary Education	67	28.3

Environmental and Health Impacts of Plastic Waste

Most respondents acknowledged the adverse health and environmental effects of plastic waste (Table 2), where 72.6 % recognized its role in waterway blockage, a common cause of flooding. Similarly, 70.9 % highlighted mosquito breeding and infestation due to waste, with implications for malaria transmission. There was significant agreement regarding the spread of infectious diseases linked to poor waste management, with 64.1 % agreeing that waste contributes to disease spread and higher mortality rates. Additionally, 62.4 % noted increased health care expenses and loss of aesthetic appeal as consequences of plastic waste.

Table 2: Environmental and Health Impacts of Plastic Waste

Values outside brackets are counts and values inside bracket are percentages

Health Effects of Plastic Waste	SD (1)	D (2)	MA (3)	A (4)	SA (5)	Percentage sum of disagreed	Percentage sum of agreed
Waterway blockage leading to flooding	10 (4.2)	15 (6.3)	40 (16.9)	90 (38.0)	82 (34.6)	10.5	89.5
Infestation of flies and mosquito breeding	12(5.1)	20 (8.4)	37 (15.6)	98 (41.4)	70 (29.5)	13.5	86.5
Spread of infectious diseases	8 (3.4)	17 (7.2)	60 (25.3)	87 (36.7)	65 (27.4)	10.6	89.4
Increase in mortality due to disease	15 (6.3)	25 (10.5)	40 (16.9)	87 (36.7)	70 (29.5)	16.8	83.1
Increased treatment expenses	18 (7.6)	30 (12.7)	47 (19.8)	85 (35.8)	57 (24.1)	20.3	79.7
Loss of aesthetics	22 (9.3)	27 (11.4)	40 (16.9)	100 (42.2)	48 (20.3)	20.7	79.4

Keys: SD = Strongly Disagree (1), D = Disagree (2), MA = Moderately Agree (3), A = Agree (4), SA = Strongly Agree (5), Mean = Average score (1-5 scale). SD = Standard Deviation

Cite this article as:
Patrick, D.B., Nsor, C.A., Abubakar, B., Musa, A.M., Ishaku E.E., & Mu'azzam, A.H. (2026). Assessing the impact of plastic waste pollution on the environment in Gombe Metropolis, Gombe State, Nigeria *FNAS Journal of Scientific Innovations, 7*(2), 1-8. https://doi.org/10.63561/fnas-jsi.v7i2.1148

Public awareness on proper plastic waste management in various communities of the study area

The survey results reveal critical insights into public perceptions and systemic challenges regarding waste management in Gombe. Most respondents (70.4%) agreed that sorting waste reduces waste bulk (Mean = 3.44, SD = 1.10), indicating a general awareness of waste segregation benefits. However, nearly half (47.2%) either disagreed or strongly disagreed that waste management is solely a government duty (Mean = 2.92, SD = 1.33), suggesting that many residents acknowledge shared responsibility in waste handling. Notably, an overwhelming 76.7% supported plastic reuse or recycling (Mean = 3.99, SD = 1.06), reflecting strong public endorsement of sustainable practices.

Table 3: Public awareness on proper plastic waste management in various communities of the study area. Values outside brackets is count and values inside brackets are percentage

Awareness of Plastic Waste Management Practices	SD (1)	D (2)	MA (3)	A (4)	SA (5)	Percentage sum of disagreed	percentage sum of agreed
Sorting of waste reduces waste bulk	12 (5.1)	18 (7.6)	40 (16.9)	92 (38.8)	75 (31.6)	12.7	87.3
Waste management is solely a government duty.	47 (19.8)	65 (27.4)	30 (12.7)	50 (21.1)	45 (19.0)	47.2	52.8
Plastics should be reused or recycled	10 (4.2)	15 (6.3)	30 (12.7)	95 (40.0)	87 (36.7)	10.5	89.4

Key:
SD = Strongly Disagree (1), D = Disagree (2), MA = Moderately Agree (3), A = Agree (4)
SA = Strongly Agree (5), Mean = Average score (1-5 scale). SD = Standard Deviation

Table 4: Challenges in Efficient Plastic Waste Management.

Challenges in Plastic Waste Management	**SD (1)**	**D (2)**	**MA (3)**	**A (4)**	**SA (5)**	**Percentage sum of disagreed**	**Percentage sum of agreed**
Inadequate of recycling industries in Gombe	20 (8.4)	25 (10.5)	30 (12.7)	100 (42.2)	62 (26.2)	18.9	81.1
Insufficient waste collection points	15 (6.3)	18 (7.6)	30 (12.7)	110 (46.4)	64 (27.0)	13.9	86.1
Lack of waste management law enforcement	22 (9.3)	30 (12.7)	50 (21.1)	92 (38.8)	43 (18.1)	22.0	78.0
Poor household waste management practices	18 (7.6)	35 (14.8)	47 (19.8)	87 (36.7)	50 (21.1)	22.4	77.6

Key:
SD = Strongly Disagree (1), D = Disagree (2), MA = Moderately Agree (3), A = Agree (4)
SA = Strongly Agree (5), Mean = Average score (1-5 scale). SD = Standard Deviation

Distribution of Plastic Bags Served Daily by Shop Owners in Three Markets

This research reveals significant variations in plastic bag usage patterns that reflect both commercial practices and potential opportunities for waste reduction interventions. Our survey of 150 shop owners across three major markets (Tumfure, Main, and Cross).

Most notably, Main Market emerges as the highest plastic bag distributor, with 34 % of vendors dispensing more than 100 bags daily - more than double the proportion observed in Tumfure Market (16 %) and four times that of Cross Market (8 %). This heavy usage pattern suggests that Main Market, likely being the largest and most commercially active of the three, faces challenges in plastic waste management that warrant targeted policy interventions. Cross Market presents the most promising profile, with 16 % of vendors using fewer than 30 bags daily (twice the proportion of other markets) and only 8 % exceeding 100 bags. The market's predominant usage cluster (38 %) falls in the 51-70 bags range, indicating more moderate consumption patterns. This distribution may reflect either greater environmental consciousness among vendors, different product mix characteristics, or more effective existing waste management practices that could serve as a model for other markets.

Cite this article as:
Patrick, D.B., Nsor, C.A., Abubakar, B., Musa, A.M., Ishaku E.E., & Mu'azzam, A.H. (2026). Assessing the impact of plastic waste pollution on the environment in Gombe Metropolis, Gombe State, Nigeria *FNAS Journal of Scientific Innovations, 7*(2), 1-8. https://doi.org/10.63561/fnas-jsi.v7i2.1148

Tumfure Market shows a balanced but still concerning distribution, with 36% of vendors in the 51-70 bags category and another 24% distributing 71-90 bags daily. The simultaneous presence of both moderate (36%) and high-volume (16%) users suggests the need for differentiated intervention strategies within the same market space.

Table 5: Distribution of Plastic Bags Served Daily by Shop Owners in Three Markets

Daily Plastic Bags	Tumfure Market	Main Market	Cross Market
	Freq. (%)	**Freq. (%)**	**Freq. (%)**
<30	4 (8.0)	4 (8.0)	8 (16.0)
30-50	8 (16.0)	9 (18.0)	8 (16.0)
51-70	18 (36.0)	8 (16.0)	19 (38.0)
71-90	12 (24.0)	12 (24.0)	11 (22.0)
>100	8 (16.0)	17 (34.0)	4 (8.0)
Total	50 (100)	50 (100%)	50 (100)

Plastic Waste from Water Industries

A significant portion of water industries (94.9%) confirmed their reliance on plastic packaging, showing the prevalence of plastic use in local water distribution.

Table 5: Number of Plastic Bags of water Produced Weekly from Water Companies and Capacity of water sachets Production in Gombe metropolis (Daily)

5a. Number of Plastic Bags Produced Weekly	Frequency	Percentage (%)
Less than 100	2	6.3
100–200	6	21.1
201–300	11	38.8
301–400	7	23.2
More than 400	3	10.5
Total	**29**	**100**

5b. Capacity	Number of sachet water factories	Sachet water Produced	Mean sachets produced
Less than 10,000 sachets	2	13,000	6,500
11,000 – 50,000 sachets	20	382,00	191,00
50,000 -100,000 sachets	3	160,000	53,333
101,0000-150,000 sachets	3	460,000	153,333
320,000 sachets	1	320.000	320,00
Total	**29**	**1,335,000**	**46,034**

Plastic Waste Handling before Disposal

When assessing preferred methods for plastic waste management, 42.2 % agreed that establishing a community collection point is beneficial, with a smaller yet notable proportion strongly agreeing (15.6 %). Utilizing private waste disposal services also received support, with 38% in agreement. GOSEPA - managed waste transport was similarly supported (35.9 % agreed). However, burning or indiscriminate disposal (such as throwing waste into open spaces) were strongly opposed; 50.6 % and 54.9 % of respondents respectively strongly disagreed with these methods, highlighting a general awareness of their environmental harm (Table 6)

Cite this article as:
Patrick, D.B., Nsor, C.A., Abubakar, B., Musa, A.M., Ishaku E.E., & Mu'azzam, A.H. (2026). Assessing the impact of plastic waste pollution on the environment in Gombe Metropolis, Gombe State, Nigeria *FNAS Journal of Scientific Innovations, 7*(2), 1-8. https://doi.org/10.63561/fnas-jsi.v7i2.1148

Table 6: Plastic Waste Disposal method

Method of Plastic Waste Management	SD (1)	D (2)	MA (3)	A (4)	SA (5)	Percentage sum of disagreed	Percentage sum of agreed
Community collection point	20 (8.4%)	30 (12.7%)	50 (21.1%)	100 (42.2%)	37 (15.6%)	21.1	78.9
Transported by private waste disposal company	15 (6.3%)	25 (10.5%)	60 (25.3%)	90 (38.0%)	47 (19.8%)	16.8	83.1
Transported by GOSEPA to waste dumpsite	18 (7.6%)	27 (11.4%)	80 (33.8%)	85 (35.8%)	27 (11.4%)	19.0	81.0
Burning the waste	12(50.6%)	57 (24.1%)	30 (12.7%)	20 (8.4%)	10 (4.2%)	74.7	25.3
Throwing into available spaces	13(54.9%)	60 (25.3%)	20 (8.4%)	15 (6.3%)	12 (5.1%)	80.2	19.8

Keys: SD = Strongly Disagree (1), D = Disagree (2), MA = Moderately Agree (3), A = Agree (4)
SA = Strongly Agree (5), Mean = Average score (1-5 scale). SD = Standard Deviation

Discussion

This study's findings on waste management practices, plastic waste contributions, and associated environmental and health impacts both align with and diverge from existing research in significant ways, offering insights that are locally relevant yet globally contextualized. The demographic profile of respondents, with a male predominance (59.1%) and a significant proportion aged 31–40 (38%), reflects trends observed in similar studies, such as Ayeleru et al. (2020), who noted comparable gender distributions in waste-related surveys, and Duru et al. (2019), who linked middle-aged demographics to higher engagement in waste management due to economic activity. The environmental and health risks associated with plastic waste were widely recognized by respondents, with 72.6 % linking plastic waste to flooding due to blocked waterways (mean = 3.93), a finding consistent with Verma et al. (2016), who highlighted similar issues in densely populated urban areas. Unlike studies from regions with advanced waste systems, where aesthetic concerns are secondary, this study found that visual pollution (mean = 3.24) was a significant local issue, underscoring how regional priorities differ based on infrastructure and environmental conditions.

Public awareness of recycling and reuse was notably high (76.7 %, mean = 3.99), mirroring global advocacy by UNEP (2018) for community-based waste initiatives. However, the study diverged from Kaza et al. (2018), who emphasized government-led waste management, as 47.2% of respondents here endorsed a collective responsibility approach. This reflects a growing trend in developing regions toward participatory waste governance, where communities play an active role alongside authorities. The study also revealed heavy reliance on plastics in local markets (80.2%) and the water packaging industry (94.9%), trends that align with global patterns reported by the World Bank (2018). However, unlike Andrady et al. (2015), who noted a shift toward biodegradable alternatives in some regions, this study found minimal adoption of sustainable substitutes, pointing to gaps in policy enforcement and technological accessibility. However, while Geyer et al. (2017) focused on global economic consequences, this study provided a granular, community-level analysis, emphasizing actionable interventions tailored to the study region's unique challenges.

Summary

Cite this article as:
Patrick, D.B., Nsor, C.A., Abubakar, B., Musa, A.M., Ishaku E.E., & Mu'azzam, A.H. (2026). Assessing the impact of plastic waste pollution on the environment in Gombe Metropolis, Gombe State, Nigeria *FNAS Journal of Scientific Innovations, 7*(2), 1-8. https://doi.org/10.63561/fnas-jsi.v7i2.1148

This section presents a comprehensive summary of the research findings, highlighting the significant contributions of water industries and marketplaces to plastic waste pollution in Gombe State metropolis. The study revealed that plastic waste is a major environmental problem in the study area, with most respondents acknowledging its adverse impacts on the environment and community health. The preferred methods of plastic waste management in the study area were community collection points and private waste disposal companies, while burning and indiscriminate disposal were strongly disapproved. The study also identified key challenges to efficient plastic waste management, including the absence of recycling industries, insufficient waste collection points, and lack of waste management law enforcement.

Conclusion

In conclusion, this study has provided valuable insights into the contributions of water industries and marketplaces to plastic waste pollution in Gombe State metropolis. The findings have highlighted the need for effective plastic waste management strategies, including the establishment of recycling industries, improvement of waste collection points, and enforcement of waste management laws. The study has also underscored the importance of public awareness and education on proper plastic waste management practices. The results of this study have significant implications for policymakers, planners, and stakeholders involved in solid waste management in Gombe State metropolis.

Conflict of interest

The Authors declare that there is no conflict of interest regarding the publication of this paper

Acknowledgements

The Authors appreciate the effort of field assistants who contributed to sample collection.

References

Andrady A., Bomgardner, M., Southerton, D., Fossi, C., & Holmström, A. (2015). Plastics in a sustainable society, *MISTRA The Swedish Foundation for Strategic Environmental Research*, 1-40.

Awasthi A.K, Shivashankar M, Majumder S (2017) Plastic solid waste utilization technologies: a review. In: IOP conference series: *materials science and engineering, IOP Publishing*

Ayeleru, O.O., Dlova, S., Akinribide, O.J., Ntuli, F., Kupolati, W.K., Marina, P.F., Blencowe, A., & Olubambi, P.A.J.W.M. (2020). Challenges of plastic waste generation and management in sub-Saharan Africa: *a review. 110:24–42.*

Bakker, K., Kooy, M., Shofiani, N.E., & Martijn, E.J. (2008), "Governance failure: rethinking the institutional dimensions of urban water supply to poor households", *World Development, Vol. 36 No. 10, pp. 1891-1915.*

Collis, J. and Hussey, R. (2014). Business research: a practical guide for undergraduate and postgraduate students. 4th ed. Basingstoke: *Palgrave Macmillan*.

Duru, R.U., Ikpeama, E.E., & Ibekwe, J.A.(2019). Challenges and prospects of plastic waste management in Nigeria. *Waste Disposal Sustain Energy* 1(2):117–126

Geyer, R., Jambeck, J.R., Law, K.L. (2017). Production, use, and fate of all plastics ever made. Sci Adv 3(7):e1700782

Hardesty, B. D., Good, T. P., and Wilcox, C. (2015). Novel methods, new results and science-based solutions to tackle marine debris impacts on wildlife. Ocean and Coastal Management, 115, 4-9.

Kaza, S., Lisa, C.Y., Perinaz, B.T., &Frank, V.W. (2018). What a waste 2.0. World bank Publications-Books.The World Bank Group,no.30317.

Khan, N., Hussain, S.T., & Saboor, A., 2013. Physiochemical investigation of the drinking water sources from mardan, badan pakhtunkhwa, Pakistan. Int. J. *Phys. Sci. 8 (33), 1661–1671.*

Landon-Lane M (2018) corporate social responsibility in marine plastic debris governance. *Mar Pollut Bull 127:310–319.*

Mazhandu, Z.S., Muzenda, E., Mamvura, T.A., & Belaid, M. (2020) Integrated and consolidated review of plastic waste management and bio-based biodegradable plastics: challenges and opportunities. *Sustainability* 12(20):8360

Mourshed M, Masud, M.H., Rashid, F., & Joardder, M.U.H. (2017). Towards the effective plastic waste management in Bangladesh: *a review. Environ Sci Pollut Res 24(35):27021–27046.*

Patti, A., & Acierno, D. (2022). Towards the sustainability of the plastic industry through biopolymers: properties and potential applications to the textiles world. Polymers, 14(4), 692.

Pawari, M.J., Gawande, S.(2015). Ground water pollution and its consequence.International 536 *Journal of Engineering Research and General Science 3 (4), 773–776.*

Sulaiman, M.B., Asegbeloyin, J.N., Ihedioha, J.N., Oyeka, E.E., & Oji, E.O.(2019). Trace Metals Content of Soil around a Municipal Solid Waste Dumpsite in Gombe, Nigeria: *Assessing the Ecological and Human Health Impact.JCHR (2019) 9(3), 173-190.*

United Nations Environment Programme (UNEP). (2018). *Single-use plastics: A roadmap for sustainability*. https://www.unep.org/resources/report/single-use-plastics-roadmap-sustainability.

Vedachalam, S., MacDonald, L.H., Omoluabi, E., OlaOlorun, F., Otupiri, E., & Schwab, K.J. (2017), "The role of packaged water in meeting global targets on improved water access", *Journal of Water, Sanitation and Hygiene for Development*, Vols 1-9, washdev2017155.

Verma, R., Vinoda, K.S., Papireddy, M., & Gowda, A.N.S.(2016).Toxic Pollutants from waste- A review. *Procedia Environmental Sciences*, vol 35,701-708.

World Health Organization (WHO). (2020). *Guidelines on sanitation and health*. https://www.who.int/publications/i/item/9789241514705