

ANALYSIS OF MUNICIPAL SOLID WASTE (MSW) GENERATION AND IMPROPER MANAGEMENT ON THE HEALTH OF INTERNALLY DISPLACED PERSONS (IDPs) IN MAIDUGURI, BORNO STATE

Daniel Omang Ofre¹, Okechukwu Oko², Ummulkhair Hussaini³ & Silas Neji⁴

¹Department of Ecology and Resource Management, Chad Basin National Park Maiduguri, Borno State

²Department of Geography, Marist Brothers of Schools, MCA, Uturu, Abia State,

³Department of Urban and Regional Planning, Federal University of Technology Minna, Niger State

⁴Sinej Eco Global Consult, Federal Low Cost-Maiduguri, Borno State



Corresponding Author's Email: mefjordan@gmail.com

Abstract

Maiduguri Internally Displaced Persons (IDP) Camps are micro cities whose inhabitants live in the neighbourhood of stagnant water which favour the breeding of mosquitoes. In addition to nutritional, emotional and psychological anxieties, poor environmental sanitation favoured the spread of disease and their causing organisms thus worsening the social, environmental and public health of the IDPs. The aim of this study is to assess the quantity and effects of municipal solid waste (MSW) generation and management on the health of IDPs. A weight balance, GPS, personal observations and structured questionnaire were used to determine the quantity of MSW generated and how its management patterns adversely affected IDP's public health. The results revealed 32,073.18 tons of MSW were generated annually, and 99.9% of the generation was from home. The result also shows that 1,114 (69.6%) of the total MSW collection sites were unapproved, and an improper collection pattern was established using camp population and MSW collections sites. Burning and evacuation were the leading management practices, and 65.11% (20,881.84tons) of the total (32,073.18 tons per annum) MSW generated was improperly managed by burning (37.66%), composting (16.37%) and burying (11.08%) leading to frequent disease incidences. Finally, a positive relationship between improper MSWM and the prevalence of disease was established using Pearson Moment Correlation and the ratio of IDP population to disease prevalence shows that Malaria, STI/D, Diarrheal, Cough and Sore bronchitis and Skin infections were 4:1; 6:1; 7:1; 8:1 and 9:1 respectively. A total of 251,957 incidences of ill-health were observed from 23 clinics in 11 camps. The study concluded that the high incidence of infections/disease was due to improper MSW management by burning, burying, and composting on unapproved collection sites. The study recommended a follow-up medical for the five-leading cases to prevent aggravation. This study is limited to Maiduguri IDP camps and was carried out from September 2020 to August 2021. The intent of the work is to show the relationship between solid waste management and ill-health.

Keywords: *Environmental Contributions, Plight, Maiduguri, Health Conditions, Internally Displaced Persons, Solid Waste Management Practice.*

Introduction

Solid waste refers to all discarded solid materials from households, industry, healthcare, construction sites, agricultural, commercial, and institutional sources (Ziraba *et al.*, 2016; Kaza *et al.*, 2018). Globally, the quantity of Municipal Solid Waste (MSW) generation is increasing at an alarming rate due to rapid urbanization and population growth. In the last two decades, MSW generation has become serious challenges bedeviling the rapid rate of urbanization in developing countries like Nigeria where population growth is not equal to the rate of infrastructural growth and development.



This challenge is very conspicuous because the large volume of MSW generated is improperly managed. The high rates of resources overconsumption in developing with little or no regard for continuous availability for the future generations has led to excessive solid waste generation with very little dedicated skill manpower and technology to effectively manage the waste. The techniques mostly deployed for the management of MSW include composting, burying, burning and evacuation (Egun, 2009; Ziraba *et al.*, 2016; Mohammad *et al.*, 2023, Ofre *et al.*, 2024). Due to improper management, MSW have become a major source of environmental and public health concern (Egun, 2009). Internally Displaced Persons (IDP) are people or groups who have been forced or obliged to flee their homes and places of habitual residence because of natural or human-made disaster provided they have not crossed internationally recognized border (Adamu & Rasheed, 2016). Maiduguri IDP camps are micro cities (Mohammad *et al.*, 2023, Ofre *et al.*, 2024). These cities have schools, skill acquisition Centers, Clinics, psychosocial support centers, mobile courts, markets, national and foreign government institutions, local and international Non-Governmental Organization (NGOs) in addition to temporal infrastructures and social amenities in IDP camps. MSW have been observed to have been generated by IDPs at home, in schools, clinics, market places and skill acquisition centres where skills like tailoring, carpentry and hairdressing are taught. Studies (Nsofor, 2015; Ziraba *et al.*, 2016, Mohammad *et al.*, 2023, Ofre *et al.*, 2024) in IDP camps have been carried out to ascertain the characteristic, generation and management with a view of determining its effect of on their health. In view of the above, generates rate of 0.35kg per capita per day have been recorded and 65% of this waste was not managed by the agencies concerned (Mohammad *et al.*, 2023; Ofre *et al.*, 2024).

The lack of or improper management of MSW in IDP camps may have contributed to high incidence of infections and disease. Previous studies by (Abd El-Wahab, 2014; Olugbode, 2020; Ziraba *et al.*, 2016; Egun, 2009) have established a direct and indirect linked between improper MSWM and number of environmental, personal and public health issues ranging from unkempt environment, environmental pollution, fire and disease outbreaks. Some of the infectious, parasitic and diseases like Hepatitis B and C, Onchocerciasis and Lymphatic filariasis; Cancers, Cataracts and Asthma and neonatal and nutritional conditions (Prüss-Ustün *et al.*, 2016) have been recorded. In Maiduguri IDP where cholera, HIV and AIDs, Tuberculosis (TB), skin infections, measles, chicken pox, vomiting, fever, diarrhea and measles etc. have been recorded (Caprecon, 2018; ECHO, 2019; Medecine Sans Frontieres, 2015; Owoseye, 2019; Olugbode, 2020), MSW which Onazi, *et al.* (2018; Ofre *et al.*, 2024) claimed to have been improperly done may have caused, enhanced or increased the circle of infections and disease in affected camps. Maiduguri IDs camps where stagnant waters, severe overcrowding (ECHO, 2019) moderate to severe malnutrition (Medecine Sans Frontieres MSF, 2015), anxiety due to bomb blasting (PMNews, 2015), over utilization of unsafe, un-hygienic broken toilets (Owoseye, 2019; NRC, 2013), psychological and emotional trauma due to sexual and gender-based violence (Yakubu *et al.*, 2015) and human trafficking have been recorded (Obaji *et al.*, 2019), improper MSWM which favour the concealment of bombs would help to worsen the IDP social, environmental and public health hence the need for this study.

This study explored the survey method to uncover the quantity of solid waste generated and the relationship between solid waste management practices in Maiduguri IDP Camps and its effects on the health of inhabitants before their relocation and resettlement in December, 2021. The aim of this study is to assess the effects of MSWM generation and management on the health conditions of IDPs. The objectives include (i) to assess the quantity of MSW generated in IDP camps (ii) determine the collection pattern (iii) assess the quantity of MSW managed using different techniques and (iv) to determine the relationship between MSW management and the prevalent of diseases in camps. In view of the above, this study seeks to ascertain the quantity of MSW generated, the levels



of generation and the quantities generated at each level, how these wastes were collected and managed and how the management adverse affected the health of IDPs in 11 Camps from August, 2020-September, 2021.

The MSW generation and improper management on health of IDPs prompted this study, it has been observed between 2020-2021, that IDP camps suffer environment and health impact of solid waste generation and management. Hence the need for this study because little is known on MSW generation and improper management on the Health of internally displaced persons (IDPs) in Maiduguri, Borno state.

Literature Review

Solid waste may be defined as non-liquid and gaseous materials discarded from households, industrial, healthcare, constructional, agricultural, commercial, and institutional sources (Ziraba, *et al.*, 2016). Solid waste generated in a city is often referred to as municipal solid waste (MSW). Globally, in 2012, 1.2 kg of MSW was generated per person per day by the estimated 3 billion urban populations. In 2016 however, the rate was 0.74 kg per person per day amounting to 2.01 billion tons (World Bank 2019). By 2025, it is projected to be 1.42 kg per person day with an estimated urban population of 4.3 billion (Hoorweg and Bhada-Tata, 2012) while the 2050 projection would be a 70% from 2016 levels to 3.40 billion tons (World Bank, 2019). In Nigeria urban areas, MSW generation ranges of between 0.44-0.66 kg per capita per day (UNDP, 2016) based on financial background and the rate of resources consumption. In northern Nigeria, IDP, rates of generation of 0.3 kg per capita per day for rural inhabitants including IDPs while 0.6 kg per capita have been recorded in urban municipalities (Forni, 2013). With a rate of 0.35kg per IDP per day (Mohammed *et al.*, 2023; Ofre, *et al.*, 2024), Borno state IDPs have contributed to the shifting of about 825 tons of MSW daily from urban locations in 2016 with the state capital alone experiencing an extra 180 tons (570- 390) from the pre-insurgency quantity of 390 tons to 2016 estimates of 570 tones daily (UNDP, 2016).

Municipal Solid Waste Management (MSWM) refers to the techniques employed in the collection, transportation, and disposal of urban solid waste. Solid waste collection, transportation and disposal methods like burning, evacuation, burying (Onazi, *et al.*, 2018) and composting (Lim *et al.*, 2016), have been recorded in municipalities and in IDP camps.

IDP and Environmental Health Conditions

Statistics have shown that women and children are the most vulnerable urban IDPs to sexual and gender-based violence (NRC, 2013) and these violence ranges from sex-for-food, rape, forced marriage, infant marriage, sexually transmitted diseases and uncontrolled birth eliciting high infant and maternal mortality (Sambo, 2017) most of which have been reported in Maiduguri IDP Camps (Yakubu *et al.*, 2015). These psychological and emotionally destabilized people mostly malnourished (Medecine Sans Frontieres MSF, 2015) lived in deplorable environment with stagnant water being their closest non-living neighbours. Also, the living environment of these refugees was severe overcrowded as each IDP is confined to a space of about 2m x 2m per person. The rate of Overcrowding in Maiduguri camps was 20 times worst compared to the minimum emergency standard (ECHO, 2019). Overcrowding in camps triggered and exacerbated 15 incidences (Odunsi, 2020; Olugbode, 2020) of fire outbreaks and severed more than 15,000 people in 2020 only (Olugbode, 2020). Overcrowding also led to over-utilization of the infrastructure and facilities in camps with the toilets having their own fair share. Although the toilets are considered unsafe, unhygienic and broken, however, each toilet was used by about 466 persons; making it nine 9 times



worst compared to agreed humanitarian standards for emergency situations (Owoseye, 2019; NRC, 2013). In addition to living in between stagnant water and temporal solid waste disposal sites, the social and environmental conditions of these IDPs have negatively affected their health Prüss-Ustün *et al.* (2016) presented a World Health Organization (WHO) global assessment of the burden of disease from environmental risks. The study estimates that about 23% (12.6 million) of all deaths globally, were attributable to the environment. Environmental risks to health, according to Prüss-Ustün *et al.* (2016) refers to all the physical, chemical and biological manmade factors external to a person. Solid waste in its entirety from the quantity and forms generated to its management which involves collection, transportation, burning in open spaces or incinerators, composting and burying constitutes an environmental risk (Ziraba *et al.*, 2016). The situation is pathetic in IDP camps in Abuja (Nsofor, 2015) and Maiduguri (Onazi *et al.*, 2018) where reported volumes of unattended solid wastes with associated risk to human health were documented.

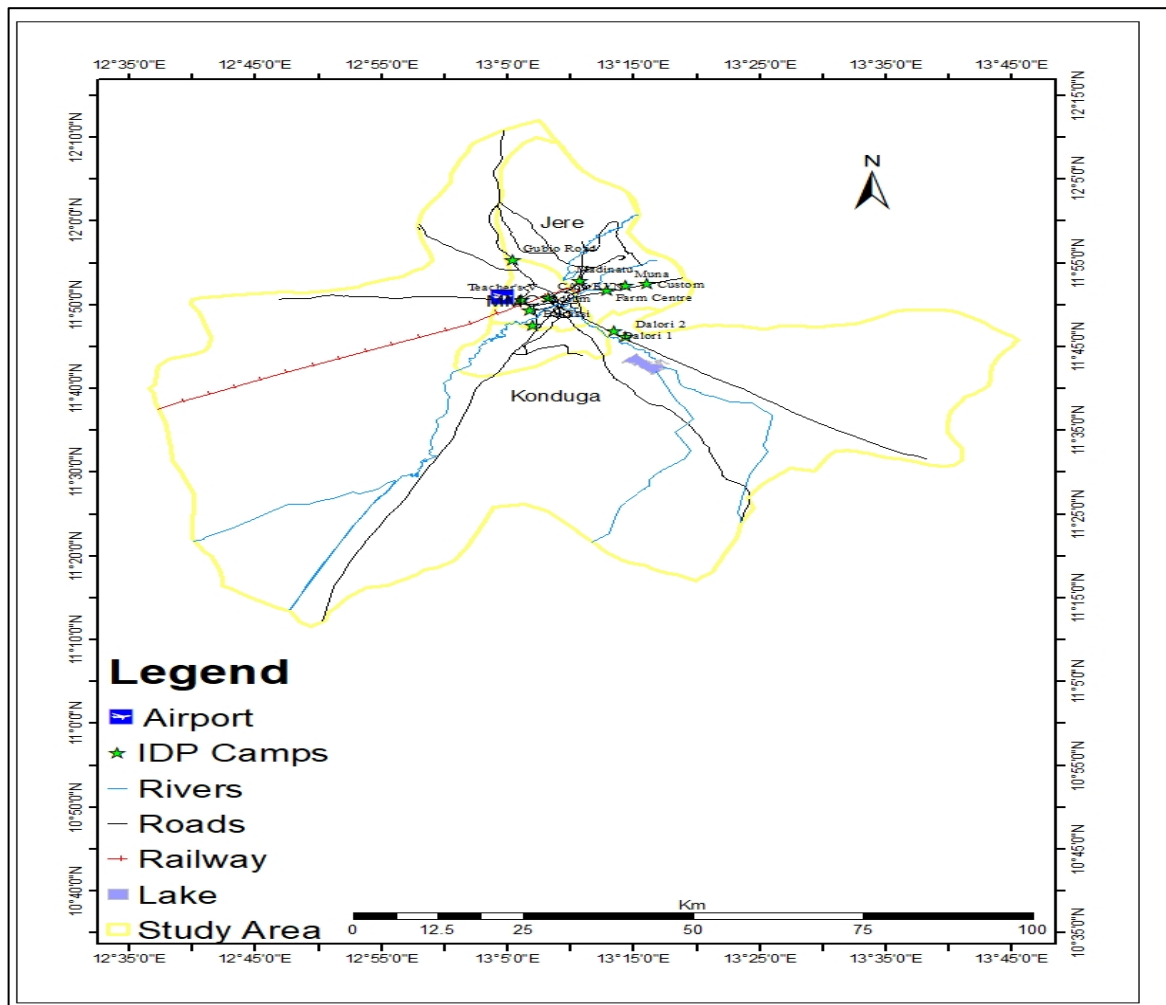
Municipal Solid Waste Management and the Health of IDP

In addition to inappropriate solid waste collection, transportation (evacuation) and disposal that were poorly practiced in IDP camps, another reason that encouraged the called for Maiduguri IDP's relocation and resettlement was overcrowding. The international Covid 19 preventive and management strategies encourages social distance, personal and environmental hygiene that cannot be achieved in congested camps (Njoku, 2020; Olugbode, 2020) where incidence of cholera, HIV and AIDs, Tuberculosis (TB), skin infections, measles, chicken pox, vomiting, fever, diarrhea and measles etc. have been recorded (Caprecon, 2018; ECHO, 2019; Medecine Sans Frontieres, 2015; Owoseye, 2019; Olugbode, 2020). Continuous generation and improper MSWM would therefore help to increase the incidence and circle of infections of these diseases/infections.

Study Area

Maiduguri is the capital of Borno state situated between Latitude 11° 50' 22"N of the equator and Longitude 13° 9' 13"E of the Green Witch Meridian (Onazi *et al.*, 2018). Maiduguri Township is divided into Maiduguri metropolitan council (MMC), Jere Local Government Council and Konduga Local Government Area (LGA).

Since July 2009, Boko Haram terrorist caused significant collateral losses, displaced people, destroyed lives and properties worth millions of Naira (National Emergency Management Agency [NEMA], 2016; Akanji, 2009) with Borno state being the most affected in the northeast geopolitical zone (Onifade & Osinowo, 2019). More than 1.6 million displaced persons from 21 out of the 27 Local Government Areas (LGA) in the state came to Maiduguri and its environs to seek refuge because security in these places was adjudged impassable (Agbibo, 2013a; 2013b; 2014; Yakubu, *et al.*, 2015). The mass movement of displaced people trooping into Maiduguri and LGA secretariats led to their reception and accommodation in newly completed, ongoing housing estates and open spaces which later became IDP Camps. Borno IDPs were officially accommodated in 14 Camps in Maiduguri and 10 camps in LGAs outside Maiduguri (Isa, 2021). Unofficial camps were managed by NGOs and the Christian Association of Nigeria's (CAN/EYN) camp to be precise was managed by the Christian Association of Nigeria (CAN) in collaboration with the government and other partners, until their eventual relocation and resettlement in 2020 (Njoku, 2020; Olugbode, 2020).

**Figure 1: Map of the Study Area****Source: Field Survey (2021)**

Materials and Methods

Nine official and two unofficial IDP camps located in Maiduguri Metropolitan City (MMC), Konduga and Jere LGA of Borno State were selected and studied using a Global Positioning System (GPS), structured questionnaires and personal observations. The camps are Bakassi, Stadium, Gubio Road, CAN/EYN and Teachers Village in MMC LGA; Dalori 1 and Dalori 2 in Konduga LGA while Farm Centre, Custom, Madinatu and Munna Elbadawy camps are in Jere LGA as shown in Figure 1. The sample size (400 respondents) was determined using Yamani (1967) formula and the questionnaires were administered to respondents proportionately. The Pearson Moment Correlation was used to find the relationship between improper MSWM and prevalence of disease in each camp studied. The average quantity of MSW generated in the dry and rainy seasons were determined using a physical measuring scale (weight balance) and questionnaire and their average were taken. MSW collection patterns were obtained using the Global Positioning System (GPS) through a developed system to track waste collection routes, including the location of waste collection point, and other relevant features and personal observations. MSW collection was done from each of the collection point by the research team and the measure using physical measuring scale (weight balance)

Personal interview was granted to the waste management authorities to determine the respondents for the study while the management techniques and the quantity managed at all levels using each technique were obtained from a set of 376 structured questionnaires administered to IDPs, camps Managers, school management, skill acquisition centers, other NGO workers, markers/shop owners, clinics and waste Management Agencies. Waste management agencies include the Borno State Environmental Protection Agency (BOSEPA), International Office on Migration (IOM), UNICEF, and Water Sanitation and Hygiene (WASH). Incidences of disease were obtained from another set of 24 structured questionnaires administered to health facilities within each camp with each having one questionnaire. Statistical Package for Social Science (SPSS) was used to analyze the data in tables and bar chart.

Analysis and Discussions

Table 1 shows the quantity of MSW generated by IDPs at homes, in schools, Clinics, Skill acquisition centres and markets places/shopping complex. Each camp has different but similar generation rate hence the consideration of their average rate of generation. It was observed that on daily basis, the average MSW generation rate of at home was 0.35kg, in schools, the average rate was 0.00021kg while in clinics, skills acquisition centres and shopping complex or markets, the average rate were 0.00028kg, 0.000028kg and 0.00030kg respectively. Using the above stated rates, 87,769.500kg of MSW was generated daily at home, 55.799kg was generated daily in schools, 29.21kg in clinics, 6.992kg in skills acquisition centres and 10.143kg in markers/shopping complex with a total daily generation rate of 87,871.64kg. These results aligned with Mohammed et al., (2023). In view of the above, stated generation rates, 250,770 IDPs from 11 camps generated 32,035.870 tons of MSW at home, 20.367tons in schools, 10.691tons in clinics, 2.551tons in skills acquisition centres and 3.701 in markets or shopping complexes summing up to 32,073.18 tons per annum.

Table 1: Municipal Solid Waste Generation in IDPs Camps

Camp	Camp Population (Pop)	Home Rate per day (HR in kg)	Pop x HR	Sch. Rate per day (SR in kg)	Pop x SR	Clinic Rate per day (CR in kg)	Pop x CR	Skills Acq Rate per day (SAR in kg)	Pop x SAR	Mkt/Bus. Rate per day (MR in kg)	Pop x MR
Madinatu	21,027	0.350	7359.45	0.000143	3.007	0.0000951	2.000	0.0000272	0.571	0.000295	0.886
Farm centre	23,782	0.350	8323.7	0.000244	5.803	0.0000781	1.857	0.0000282	0.671	0.000290	0.986
Munna Elbadawy	49,922	0.352	17472.7	0.000132	6.590	0.0000887	4.429	0.0000258	1.286	0.000188	1.343
Custom	9,605	0.352	3361.75	0.000187	1.796	0.000178	1.714	0.0000476	0.457	0.000448	0.614
Dalori 1	19,649	0.351	6877.15	0.000193	3.792	0.000145	2.857	0.0000218	0.429	0.000254	0.714
Dalori 2	13,157	0.350	4604.95	0.000167	2.197	0.000141	1.857	0.0000271	0.357	0.000547	1.029
Gubio road	33,332	0.350	11666.2	0.000258	8.600	0.0000986	3.286	0.0000214	0.714	0.000249	1.186
Teachers' village	19,880	0.351	6958	0.000312	6.203	0.000151	3.002	0.0000323	0.643	0.000029	0.829
Stadium	18,151	0.352	6352.85	0.000430	7.805	0.000181	3.286	0.0000472	0.857	0.000369	0.96
Bakassi	41,865	0.352	14652.75	0.000239	10.006	0.000102	4.286	0.0000239	1.000	0.000380	1.589
CAN/EYN	400	0.350	140	0	0.000	0.001786	0.714	0	0.000	0	0.000
Average per cam (kg)/day		0.35	7979.05	0.00021	5.073	0.00028	2.66	0.000028	0.635	0.00030	0.92
Total (kg)/day	250,770	3.861	87769.500	0.002305	55.799	0.0030445	29.21	0.0003025	6.992	0.00331	10.143
Total (kg)/ Yr			32035867.5		20366.64		10690.85		2551.35		3701.1
Total (Tons)/Yr			32035.870		20.367		10.691		2.551		3.701
Total MSW Generated	32,073.18 tons										

Source: Field Survey (2022)

Municipal Solid Waste Collection Pattern in IDP Camps

Table 2 shows the MSW collection pattern obtained using the number of MSW collection sites observed in each of the 11 IDP camps. It was observed that MSW was collected using evacuation tanks, collection bins, broken and abandoned pit toilets, concrete/build-up pits, earthen pits and gutters, earth's surface collection and collection on stagnant waters. The average quantity of MSW generated in the dry and rainy seasons were determined using a physical measuring scale (weight balance). While evacuation tanks and collection bins constitute the approved collection sites in each camp, broken and abandoned toilets, concrete and earthen pits in addition to earth's surface collection and stagnant water constitute the un approve collection sites as shown in the table 2 and plate 2 below. Table 2 shows the MSW collection pattern in 11 IDP camps obtained using Global positioning System (GPS) and personal observations.

Table 2: MSW Collection Pattern in IDP Camps

Name of IDP Camp	No. of evacuation tank	No. of Collection bins	No. of broken / abandoned toilets	No. of concrete pits	No. of earthen pits/gutters	No. on the earth surface	No. on stagnant water	Total No. of unapproved sites	Total No. of approved sites	Total collection sites
Madinatu	2	27	3	4	7	96	12	122	29	151
Farm Centre	2	43	2	5	0	102	14	123	45	168
Muna Elbadawy	2	69	5	4	0	167	19	195	71	266
Custom	2	4	7	0	0	102	2	111	6	117
Dalori 1	1	36	6	9	43	31	1	90	37	127
Dalori 2	1	29	2	4	5	98	0	109	30	139
Gubio road	1	61	5	3	0	143	16	167	62	229
Teachers' Village	1	33	4	2	0	52	2	60	34	94
Stadium	1	49	1	0	0	56	9	66	50	116
Bakassi	1	93	9	3	1	42	13	68	94	162
CAN/EYN	1	28	0	0	0	3	0	3	29	32
Total	15	472	44	34	56	892	88	1,114	487	1,601
%	0.9	29.5	2.7	2.1	3.5	55.7	5.5	69.6	30.4	100

Source: Field Survey (2021)

It was observed from table 2 that Madinatu camp had 29 approved and 122 unapproved MSW collection points. Farm Centre had 45 approved and 123 unapproved collection points. Muna Elbadawy had 71 approved and 195 unapproved solid waste collection points. Custom had 6 approved and 111 unapproved collection points. Dalori 1 had 37 approved and 90 unapproved collection points while Dalori 2 had 30 approved and 109 unapproved solid waste collection points. Gubio road had 62 approved and 167 unapproved collection points while Teacher's Village had 34 approved and 60 unapproved collection points. Stadium has 50 approved and 66 unapproved collection points while Bakassi had 94 approved and 68 unapproved collection points. Finally, CAN/EYN had 29 approved and 3 unapproved solid waste collection points. It was observed from the table above that out of the 1,590 MSW collection sites documented, 0.9% of the total MSW generated was collected in evacuation tanks and permanent evacuation sites while 29.7% was collected in collection bins. 2.7% of the waste were collected on broken or abandon toilets while 2.1% was collected on concrete pits such as uncompleted suck away. Also, 3.5% of the entire waste

was collected on open earthen pit while 55.7% was on the earth's surface. Furthermore, 5.5% was on stagnant water. It was deduced from table 2 that 69.6% of the total MSW generated was improperly collected while only 30.4% was properly collected using collection and evacuation bins. The improperly MSW collection pattern observed suggest that MSWM was inappropriate collected and this would increase the incidence, severity and circle of infection of disease and infections. Table 3 ranked MSW collection pattern in IDP camps to show the relationship between IDP population and number of MSW collection points in each camp.

Table 3: Ranking of MSW collection pattern in IDP Camps

S/N	Name of IDP camp	No. of approved solid waste collection points	No. of unapproved solid waste collection points	Total no. of solid waste collection points	IDP Population	Ranking according to IDP population	Ranking according to MSW collection points
1	Madinatu	29	122	151	21,027	5 th	5 th
2	Farm Centre	45	123	168	23,782	4 th	3 rd
3	Muna Elbadawy	71	195	266	49,922	1 st	1 st
4	Custom	6	111	117	9,605	10 th	8 th
5	Dalori 1	37	90	127	19,649	7 th	7 th
6	Dalori 2	30	109	139	13,157	9 th	6 th
7	Gubio road	62	167	229	33,322	3 rd	2 nd
8	Teachers' Village	34	60	94	19,880	6 th	10 th
9	Stadium	50	66	116	18,151	8 th	9 th
10	Bakassi	94	68	162	41,865	2 nd	4 th
11	CAN/EYN	29	3	32	400	11 th	11 th
	Total	487	1,114	1,601	250,770		
	%	30.4	69.6	100			

Source: Field Survey (2021)

It was observed from table 3 which ranked IDPs population and MSW collection points in each camp that Madinatu camp was ranked 5th both in terms of IDP population and MSW collection points while Farm Centre camp was 4th in terms of population and 3rd in terms of MSW collection points. Also, Muna Elbadawy camp was ranked 1st in terms of population and MSW collection points respectively while Custom camp was ranked 10th in terms of population and 8th in terms of MSW collection points. Furthermore, Dalori 1 is the 7th most populous and also the 7th camp with the highest MSW collection points while Dalori 2 is the 9th most populated and the 6th camp with the highest MSW collection points. Better still, Gubio road camp was the 3rd most populous with the 2nd highest number of MSW collection points while Teachers' Village is the 6th most populous and the 10th camp with the highest number of MSW collection points. Again, Stadium is the 8th most populated and the 9th camp with highest MSW collection points while Bakassi is the 2nd most populated and the 4th camp with the greatest number of MSW collection points. Finally, CAN/EYN is ranked 11th in terms of population and the number of MSW collection points.

Municipal Solid Waste (MSW) Management Techniques in IDP Camps

Table 4 shows the quantities of MSW managed in each of the 11 IDP camp using different management techniques.

Table 4: The Quantity and Techniques of MSW Management in each Camp

Name of IDP Camp	Camp Pop.	Qty. (tons) of MSW Generated per annum	% Evacuated	% Burned	% Composted	% Buried	Total % mgt.	Qty Evacuated	Qty Burned	Qty Composted	Qty Buried	Total Qty mgt.
Madinatu	21,027	2688.559	19.02	51.33	13.19	16.46	100	511.364	1380.037	354.621	442.537	2688.559
Farm Centre	23,782	3041.551	54.15	23.27	7.09	15.49	100	1647	707.760	215.646	471.136	3041.551
Muna Elbadawy	49,922	6382.517	41.28	22.57	34.43	1.72	100	2634.703	1440.534	2197.501	109.779	6382.517
Custom	9,605	1228.711	5.84	44.14	37.16	12.86	100	71.757	542.353	456.589	158.012	1228.711
Dalori 1	19,649	2513.004	25.17	31.49	19.87	23.47	100	632.523	791.345	499.334	589.802	2513.004
Dalori 2	13,157	1682.792	14.83	57.48	14.43	13.26	100	249.558	967.2690	242.827	223.138	1682.792
Gubio road	33,322	4263.195	49.64	31.75	4.89	13.72	100	2116.25	1353.564	208.470	584.910	4263.195
Teachers' Village	19,880	2543.567	33.45	46.12	16.83	3.60	100	850.823	1173.093	428.082	91.568	2543.567
Stadium	18,151	2323.502	51.77	33.91	5.33	8.99	100	1202.877	787.900	123.843	208.883	2323.502
Bakassi	41,865	5354.415	53.86	27.15	8.41	10.58	100	2883.888	1453.724	450.306	566.497	5354.415
CAN/EYN	400	51.36061	34.82	45.06	18.37	1.75	100	17.884	23.143	9.435	0.899	51.36061
Total	250,770	32,073.18	34.89	37.66	16.37	11.08	1100	12,818.63	10,620.731	5,186.654	3,364.751	32,073.17

Source: Field Survey (2021)

Table 4 summarized the results obtained from 376 questionnaires administered to MSW managers in 11 camps. It was observed from Table 4 that CAN/EYN camp managed (51.36061 tons) the least quantity of MSW per annum while Muna Elbadawy camp managed the highest quantity being 6,382.517tons. From the same table, 34.89% (12,818.63 tons) of the total (32,073.18) MSW generated was managed by evacuation, 37.66% (10,620.731 tons) was managed by burning, 16.37% (5,186.654 tons) by composting while 11.08% (3,364.751 tons) by burying.

Prevalence of Disease in IDPs Camps

Figure 2 shows the prevalence of disease that are directly and indirectly associated with improper MSWM in IDP camps. It was observed from table 4 that there were 58,593 cases of Malaria, 23,045 cases of Typhoid, 1,855 cases of cholera, 6,368 cases of Asthma and 30,842 of Cough and Sore bronchitis were recorded from September, 2020 to August 2021. Within the same period, 5,837 cases of Flue, 16,497 cases of eye infections, 39,586 cases of sexual transmitted infections/disease were recorded. Also, 5,954 cases of Hepatitis, 33,912 cases of Diarrheal and 29,468 cases of Skin infections with a total disease burden of 251,957 incidences recorded from 23 clinics in 11 camps.

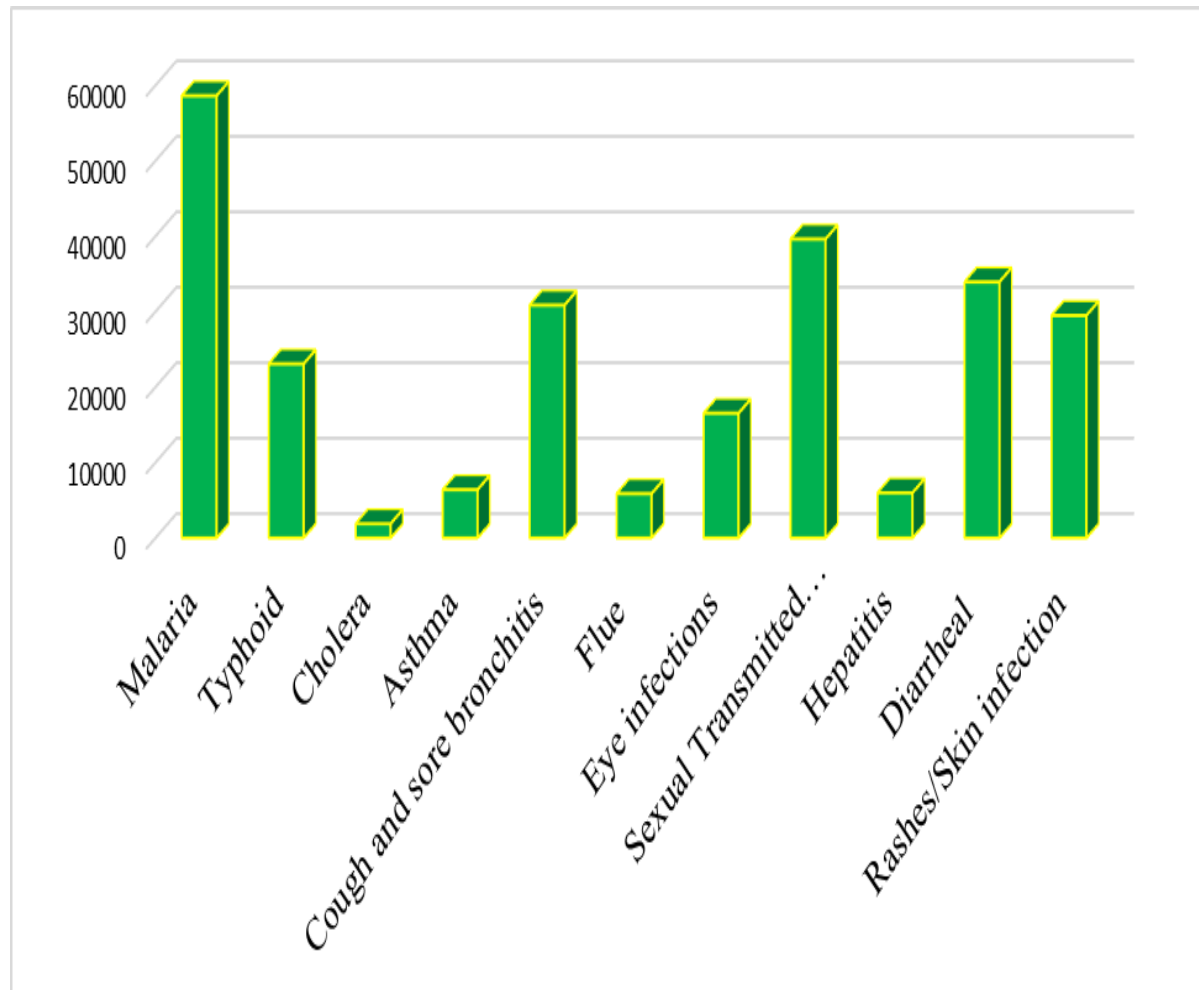


Figure 2: Prevalence of Ill-Health in IDPs Camps

Source: Field Survey (2021)

Table 5 shows the relationship between improper MSWM and prevalence of ill-health in Maiduguri IDP camps using Pearson's Product Moment Correlation.

Table 5: Adverse Ill-Health Associated with Improper MSWM in IDPs Camps

Name of IDP Camp	IDP Pop.	Total Qty (tons) of MSW Generated/ Annum	Qty of MSW that was improperly Mgt (X)	Total Disease incidence in each camp (Y)	XY	X ²	Y ²
Madinatu	21,027	2688.559	2177.195	9409	20485180.71	4740156.3	88529281
Farm Centre	23,782	3041.55	1394.551	21418	29868471.9	1944769.7	458730724
Muna Elbadawy	49,922	6382.517	3747.814	12709	47631044.38	14046154.8	161518681
Custom	9,605	1228.711	1156.954	11383	13169766.74	1338574.95	129572689
Dalori 1	19,649	2513.004	1880.481	35057	65923987.36	3536205.03	1228993249
Dalori 2	13,157	1682.792	1433.234	12337	17681758.51	2054148.23	152201569
Gubio Road	33,322	4263.195	2146.945	24176	51904663.2	4609394.3	584478976
Teachers' Village	19,880	2543.567	1692.743	17161	29049111.14	2865368.71	294499921
Stadium	18,151	2323.502	1120.625	34737	38926976.94	1255789.18	1206659169
Bakassi	41,865	5354.415	2470.527	55233	136449260.2	6103024.38	3050684289
CAN/EYN	400	51.36011	33.477	18337	613922.76	1120.9104	336245569
Total			$\sum X = 19254.458$ $\bar{X} = 1750.40274$	$\sum Y = 251957$ $\bar{Y} = 22905.18183$	$\sum XY = 451704143.8$	$\sum X^2 = 42494706.5$	$\sum Y^2 = 7692114117$

Correlation Coefficient (r) = 0.83 ~1

Source: Authors' Computation (2021)

It was observed from Table 5 that there was a positive correlation between improper MSWM and prevalence of disease in each camp. This implies that improper MSWM was responsible for the high prevalence of ill-health in IDP camps.

Discussions

It was observed from Table 1 that 32,073.18ton of MSW was generated per annum by IDPs at home, schools, clinics skills acquisition centres and market places with IDP homes account for about 99.9% (32,035.870tons) of the total waste generated while schools, clinic, skills acquisition and market places jointly account for the remaining 0.11% (37.31tons). About 69.6% of the wastes generated in table 1 were inappropriately collected in 1,114 unapproved collection sites as shown in table 2. The use of broken and abandoned toilets, concrete and earthen pits in addition to earth's surface and stagnant waters for the collection of MSW suggest that solid waste was improperly collected leading to improper management. This result aligned with (Onazi *et al.*, 2018; Ofre *et al.*, 2024) who and observed scattered unattended heaps of MSW in IDP's camps. The pattern of MSW collection shown on table 3 reveals that apart from Madinatu, Muna Elbadawy, Dalori 1 and CAN/EYN camps whose populations were directly proportional to the number of MSW collection points, the remaining 7 camps shows an inverse relationship between their population and the number of MSW collection

points. These inverse relationships imply that the number of MSW collection points in each camp was not influenced by IDP population. The absence or negligence of waste management education may not have triggered this pattern observed. Furthermore, only about 35% of the total quantity of MSW generated was properly managed by the concerned agencies (BOSEPA, UNICEF, IOM and WASH) using evacuation techniques. The remaining 65.11% (20,881.84 tons) was improperly managed using burning (37.66%), composting (16.37%) and burying (11.08%) as shown in table 4 and Plate 3 below. These results agree with (Onazi *et al.*, 2018; Yakubu *et al.*, 2015; UNDP, 2016; Caprecon, 2018; Ofre *et al.*, 2024) who observed improper MSWM in Maiduguri IDP using some of these methods. The high quantity of MSW that was improperly managed via burning, composting and burying adversely affected the health of IDPs living in camps.

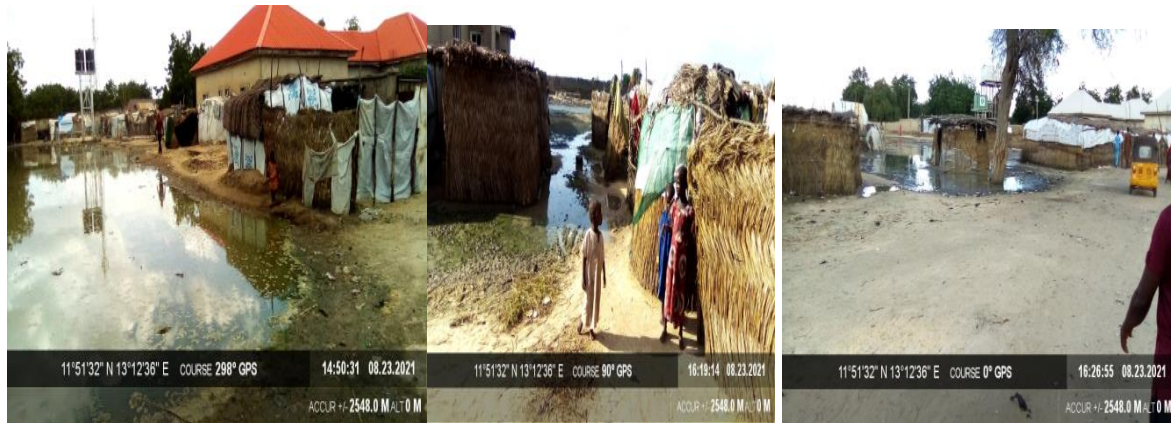


Plate 1: The living environment of Maiduguri IDPs
Source: Field Observation (2021)



BOSEPA Evacuation Tank

Collection bins

Broken

Pit Toilets



Concrete Pits

Earthen Pits

Surface Collection

On Stagnant Water

Plate 2: MSWM Collection Techniques in IDP Camps
Source: Field Observation (2021)

**Plate 3: MSW Management Techniques in IDP Camps****Source: Field observation (2021)**

Due to improper management of 65.11% of the total MSW generated, the health of IDPs were negatively impacted with 251,957 incidences of ill health that are directly or indirectly connected to poor environmental sanitation with the five leading cases being Malaria (58,593), STI/D (39,586), Diarrheal (33,912), Cough Sore bronchitis (30,842) and Skin infections (29,468). The ratio of the leading cases of disease to IDP population which expresses the severity shows that 1:4 IDPs had Malaria, 1:6 has STI/D, 1:7 had Diarrhea, and 1:8 had Cough and Sore bronchitis while 1:9 has Skin infections. Additionally, the positive relationship established between improper MSWM and the prevalence of disease in camps imply that improper MSWM was responsible for or sustained the circle of infections and disease that are directly and indirectly linked to solid waste management thus causing significant socio-economic impacts of the health budget.

Conclusion and Recommendations

Municipal solid waste generated in IDP camps was improperly collected and managed and the poor management shows the high prevalence of diseases such as malaria, typhoid, hepatitis, etc in the camp. The study therefore recommends the following:

1. The use of evacuation tanks and collection bins should strictly be used in IDP camps and Task Force to monitor the MSW disposal.
2. More collection points should be created to meet the demands of the camp population.
3. The introduction of mobile clinic in these camps to reduce the rate of disease spread and chance on the spot treatment of these diseases.
4. Some of these camps are highly populated. There is need for satellite camps to decongest the existing camps.



References

- Abd El-Wahab EW, (2014). Adverse Health Problems among Municipality Workers in Alexandria (Egypt). *International Journal of Preventive Medicine*. 5(5), 545–56.
- Adamu, A., & Rasheed, Z.H. (2016). Effects of Insecurity on the Internally Displaced Persons (IDPS) in Northern Nigeria: Prognosis and Diagnosis. *Global Journal of Human-Social Science Research*, 16. (1),1-7.
- Agbiboa, D.E. (2013a). ‘Why Boko Haram Exists: The Relative Deprivation Perspective. *African Conflict and Peace-building Review* 3(1),146-159.
- Agbiboa, D.E. (2013b). ‘The Nigerian Burden: Boko Haram and Religious Terrorism in Nigeria. *Conflict, Security and Development* 13(1), 1-29.
- Agbiboa, D.E. (2014). ‘Boko Haram and the Global Jihad: “Don’t Think Jihad is over. Rather, Jihad has just Begun”’ *Australian Journal of International Affairs*, X(X), 1-18.
- Akanji, O. O. (2009). The politics of combating domestic terrorism in Nigeria. In W. Okumu & A. Botha (Eds.), *Domestic terrorism in Africa: Defining, addressing, and understanding its impact on human security*. Pretoria Institute for Security Studies (pp55-64).
- Bakare, W. (2021). *Solid Waste Management in Nigeria*. BioEnergy Consult. Retrieved from <https://www.bioenergyconsult.com>.
- Caprecon. (2018). *Assessment of Trafficking Risks in Internally Displaced Persons Camps in North-East Nigeria*. United Nations High Commissioner for Refugees (UNHCR). <https://www.unhcr.org/nigeria-situation>.
- Egun NK (2009). Assessment on the Level of Recycling and Waste Management in Delta State, Nigeria. *Journal of Human Ecology*.27 (2), 77 – 82.
- European Civil Protection and Humanitarian Aid Operations (ECHO). (2019, May 16). *Nigeria – Measles outbreak (DG ECHO, WHO, NCDC, NGOs)*. ECHO Daily Flash. Retrieved from <https://www.reliefweb.int/report/nigeria/nigeria>.
- Forni, M. (2013). *Do Not Waste – SWM and Recycling in Post-Emergency Haiti* (Master’s thesis). Water, Engineering and Development Centre (WEDC).
- Isa, A. A. (2021). Borno State Emergency Management Agency (BOSEMA) Official Camp Population of IDPs in 24 Camps. Unpublished Database of IDP Camps in Borno State.
- Kaza, S., Yao, L., Bhada-Tata, P. A and Van W.F. (2018). [What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050](https://doi.org/10.1596/978-1-4648-1329-0). The World Bank Urban Development. Retrieved from <https://doi.org/10.1596/978-1-4648-1329-0>.
- Lim, S.L., Lee, L.H., Wu, T.Y. (2016). Sustainability of Using Composting and Vermicomposting Technologies for Organic Solid Waste Biotransformation: Recent overview, Greenhouse Gasses Emissions and Economic Analysis. *Journal of Cleaner Air Production*. 111, 262–278.
- Lohri, C.R., Diener, S., Zabaleta, I., Mertenat, A., Zurbrügg, C., (2017). Treatment Technologies for Urban Solid Bio-waste to Create Value Products: a Review with Focus on Low-and Middle-income Settings. *Review of Environmental. Science. Biotechnology*, 1–50.
- Medecine Sans Frontieres, (MSF, 2015, September 17). Cholera Spreads in Displaced Person’s Camps inBorno State. Retrieved from <https://www.msf.org.za/news-and-resources/press>.



- Mohammad, M. A., Ofre, D. O and Ibrahim, B. (2023). Quantitative Determination of Municipal Solid Waste (MSW) Generation and Management in Camps, Borno State. A Paper presented at Association of Nigerian Geographer, 63rd Annual Conference and AGM, 2023. Pp.19.
- National Emergency Management Agency (NEMA). (2016). Activities of IDP management in Maiduguri camps. Retrieved from [https:// www.nema.gov.ng/intervention-and](https://www.nema.gov.ng/intervention-and).
- Njoku, G. (2020, July 23). Displaced Children Navigate COVID-19 in Camps in North-East Nigeria. UNICEF Nigeria. <https://www.unicef.org/nigeria/stories/displaced-children-navigate-covid-19-camps-north-east-nigeria>.
- Norwegian Refugee Council (NRC). (2013). Field Visit Report – Maiduguri Camps Visited. Retrieved from [https:// www.nrc.no/resources/annual-report/nrc-report-2013](https://www.nrc.no/resources/annual-report/nrc-report-2013).
- Nsofor, I. (2015, August 8). Inside a Nigerian IDP Camp – A Public Health Perspective. Nigeria Health Watch. <https://nigeriahealthwatch.com/inside-a-nigerian-idp-camp-a-public-health-perspective>.
- Obaji, P., Bukkar, J., Gambo, S., Aloma, H., Jetem, B. and Amos, O. (2019). Assessment of Trafficking Risks in Internally Displaced Persons Camps in North-East Nigeria. *United Nations High Commissioner for Refugees*. PP.1-19.
- Odunsi, W. (2020, April 19). UN Confirms 3-Day Fire Outbreak at IDP Camps, Gives Troubling Details. Daily Post News Nigeria. <https://dailypost.ng/2020/04/19/un-confirms-3-day-fire-outbreak-at-idp-camps-gives-troubling-details>.
- Ofre, D.O., Kolo, M.A., Akawu, C.B. & Hussaini, U (2024). Effects of Municipal Solid Waste Management (MSWM) on the Health of Maiduguri Internally Displaced Persons (IDPs) in Borno State. *Lagos State Journal of Environmental Science* (4):pp 12.
- Olugbode, M. (2020). Nigeria: Decongest IDP Camps to Ward Off Fire Outbreak, COVID-19 – UN. This Day Newspaper Published 19 April.
- Onazi, O., Ella, I. I., Ola-Adisa, E. O. and Umar, M.A. (2018). Waste Management Characteristics of Selected IDP Camps in Maiduguri. *Journal of Management and Corporate Governance*. 10 (2):72-94.
- Onifade, V., & Osinowo, R. (2019). Living Conditions of Internally Displaced Persons (IDPs) in Northern Nigeria. In *Urbanism and Crisis Management in Nigeria* (pp. 369-389).
- Onwosi, C.O., Igbokwe, V.C., Odimba, J.N., Eke, I.E., Nwankwoala, M.O., Iroh, I.N., Ezeogu, L.I., (2017). Composting Technology in Waste Stabilization: On the Methods, Challenges and Future Prospects. *Journal of Environmental. Management*. 190, 140–157.
- Owoseye, A. (2019, April 1). Nigeria Moving Towards Cholera Outbreak in IDP Camps – NRC. *Premium Times Nigeria*. <https://www.premiumtimesng.com/news/headlines /324350-nigeria-moving-towards-cholera-outbreak-in-idp-camps-nrc.html>.
- PmNews, (2015). Bombs Found in Displaced People's Camp in Maiduguri. Published 15th March, 2025.
- Prüss-Ustün, A., Wolf, J., Corvalán, C., Bos, R. and Neira, M. P. (2016). Preventing Disease through Healthy Environments. A Global Assessment of the Burden of Disease from Environmental Risks. *World Health Organization* (WHO), 175. <https://iris.who.int/handle/10665/204585>.



- Sambo, A. S. (2017). Internal Displaced Persons and Their Information Needs. *Library Philosophy and Practice (E-journal)* Spring, 7(3), 1-15.
- UNDP (2016). North-East Nigeria Waste and Debris Assessment Report UNDP Nigeria .1-79.
- Yakubu, A., Dikko, A., Nwagbara, B., Oladele, E., Sheidu, H, Khamofu, H., Adamu, M.M., Ibrahim, M., Ajayi, O., Cartier, S., Johnson, S and Ochagu, V., (2015). Assessment of HIV/AIDs Services in AID Camps, Borno State Nigeria. Strengthening Integrated Delivery of HIV/AIDS Services (SIDHAS), USAID, 1-20.
- Yamane, T. (1967). *Statistics: An introductory Analysis*. 2nd Edition, Harper and Row, New York.
- Ziraba, A.K., Haregu, T.N. and Mberu, B. (2016). A Review and Framework for Understanding the Potential Impact of Poor Solid Waste Management on Health in Developing Countries. *Archives of Public Health* 74(55),1-11.