Assessing Households' Sanitation and Sewage Management Practices in Kaduna Metropolis, Kaduna State Nigeria

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Abstract

This study assessed households' sanitation and sewage management practices in Kaduna Metropolis. Published and unpublished literature on domestic sewage, Sanitation Chain and World Health Organisation (WHO) and Joint Monitoring Programme (JMP) reports were reviewed to form the study's conceptual framework. A sample size of 1,874 houses was drawn from a sample frame of 88,621 homes representing the city core, North, South, East and western sectors of the metropolis. The systematic sampling technique was used to collect primary household data using a questionnaire and filling out the checklist. Cross tabulations were used to analyse data, while pictures expressed additional facts and discussion of results was in prose. The variables assessed were derived from the WHO, UNICEF and JMP 2018 SDG monitoring template for water sanitation and hygiene. The study ascertained that most (52.9%) households use water closets. The majority (61.2%) do not share a toilet, yet, not open defecation free. Toilets (81.1%) are built with cement blocks, 89.4% have roofs, 84.5% have lockable doors, 72.5% of pit latrines have no covers, 53.8% use water and soap as hand washing and cleansing material, containments are 72.2% offset link to toilets, with most (40.7%) horizontal buffer of < 15mto water source. Most (89%) households use motorised methods to empty filled pits. Recommendations include public education and enlightenment on appropriate practice, establishing an abatement committee to combat emerging open defecation, creating biogas plants for alternative energy, and securing hot spots for Open Defecation (OD) forms.

Keywords: Containment, domestic sewage, sustainable development, open defecation, practices

Introduction

Sewage is a composite of grey water, black water and faecal sludge that is usually generated from houses (World Health Organisation (WHO), 2006; United Nations Environmental Programme (UNEP) and United Nations Human Settlements (UN-HABITAT), 2010; Department for Environment, Food and Rural Affairs, DEFRA, 2010; United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP), UN-HABITAT and Asian Institute of Technology (AIT), 2015). The World Health Organisation (2019) reports that only about 55% of the city population has access to safely managed sewage globally, mainly from Asia and other African countries, Nigeria inclusive.

Onsite domestic sewage management is mainly practised in most developing nations, including Nigeria (Looker, 1998; Iwugo et al., 2003; WHO, 2016; Federal Capital Development Authority, 2018; Sengupta, 2019). Studies have shown that the onsite option is often associated with issues such as the poor location of sewage containment in relation to water sources, the absence of treatment plants, and unsanitary disposal methods that yield unsafe practices (Idris-Nda et al., 2013; Oladimeji et al., 2016; Abubakar, 2017; Oji et al., 2018). This is a clear symptom of the potential for the spread of sewage-borne diseases, loss of environmental quality (air, water and aesthetics quality), pollution of underground, surface water, farmlands and soil degradation in those regions (Kuvaja, 2001; WHO 2002; Iwugo et al., 2003; Aina, 2007; Obada & Oladejo, 2013; Idris-Nda et al., 2013; UN-ESCAP et al., 2015; Rigasa, 2016; Ngasoh et al., 2020).

The living areas or residential quarters of Kaduna Metropolis also manage domestic sewage on-site and have exhibited some symptoms of indiscriminate and inappropriate practices at the household-based user interface and containment stages of the city's sewage management chain. In an attempt to empirically investigate the symptoms mentioned above, Habila (2021) revealed that in examining any city's sanitation and sewage management status, the first point of assessment starts from the households, being the generators of domestic sewage and providers of sanitation option/ user interface.

Notably, the metropolitan population grew from 40,000 people in the early 1950s to two million (2 million) people in 2015. (Urquhart, 1977; United Nations Development Programme, UNDP, 1978; Max Lock & Partners, 1967; Nigerian Urban Reproductive Health Initiative, 2019). This may further translate into increasing challenges associated with the onsite metropolitan sewage management, city management and realisation of SDG 6.2, 6.3 and 11 on sanitation and hygiene, ending open defecation and sustainable, liveable cities, respectively.

Previous studies on municipal sewage by Rotowa, Olujimi, Omole and Olajuyigbe (2015); Abenu et al. (2016); Abubakar (2018); Rotowa and Ayadi (2020) focused more on the socio-economic factors influencing the choice of toilet types, public knowledge on sewage reuse, the determinants of Open Defecation (OD) amongst households and containment emptying practices in low-income areas of cities, respectively. Despite their contribution to the body of knowledge on domestic sewage management, there remain unanswered questions on the social and physical dimensions of household domestic sewage practices from the lens of physical and social sustainable indicators. Therefore, there is a need to explore with empirical facts the current situation of households' sanitation on sewage generation points (user interface) and containments via the physical and socio-cultural lens to provide adequate information for appropriate intervention towards sustainable practice. The study will further provide adequate baseline data on the sanitation and hygiene of the Kaduna metropolis, which the reports of the Kaduna State Water and Sanitation Sector (2016) and Kaduna State Planning and Budget Commission (2017) revealed the availability of only 18% of data on those described above.

In response to the issues mentioned previously, this paper attempts to answer the question, "What is the nature of sanitation and sewage management practices of households in the study area? "To answer this question, the paper aims to assess households' sanitation and sewage management practices in Kaduna Metropolis, Kaduna State, Nigeria, to uncover its present situation and provide appropriate recommendations for improvement. The following objectives were used to achieve the abovementioned aim: domestic sewage concept review and situational analysis of onsite domestic sewage management in some cities of low-income developing countries and Nigeria and ascertaining the physical and social conditions of household sanitation and sewage management practices in the study area.

Literature Review

Conceptualising Sewage, Sewage Management and Sanitation

'Sewage' is an old term that modern scholars refer to as 'wastewater' (Metcalf & Eddy, 1991). The American English use sewage and sewerage terms interchangeably and see them as the same, while the British view the terms differently, that is, 'sewage' as wastewater from homes, and 'sewerage' as the pipe network that conveys it out of homes (William et al., 1934; Funk & Wagnal, 1960; and Flexner et al., 1993). The countries' technical and professional usage refers to sewerage as the infrastructure that conveys sewage (Flexner et al., 1993; www.oxforddictionaries.com).

Sewage is waste in liquid form and is synonymous with wastewater. It is generated from used water in bathrooms and toilets, kitchen washing sinks, laundry water, black water (dissolved faecal solution) and industrial processes (Department for Environment, Food and Rural Affairs (DEFRA), 2010). Sewage is also viewed as adversely degraded water due to anthropogenic/man activities and contains some pollutants or contaminants (UN World Water Development Report, 2017). The United Nations Economic and Social Commission for Asia and the Pacific, UN-ESCAP, United Nations Human Settlements Programme, UN-HABITAT, and Asian Institute of Technology, AIT, (2015) add that sewage could be domestic wastewater that consists of black water (urine, excreta or septage) and grey water (laundry, kitchen and bathrooms effluent); released from markets, all commercial activity systems and hospitals; Industrial effluent, storm and run-off; agricultural, horticultural and aquaculture wastewater that is in the dissolved or colloid form. United Nations Environmental Programme, UNEP and United Nations Human Settlements, UN-HABITAT (2010); DEFRA (2010); Akcin et al. (2013) posit that sewage is a domestic or municipal wastewater originating from living communities that produce grey and black water that is either carried by sewerage network and or flows on open drains. However, with the definitions above and views, this paper conceptualises sewage as grey and black water and faecal sludge or septage generated from homes stored in containments, disposed of in situ, emptied, or conveyed to disposal sites.

Sewage management refers to handling wastewater in a way that enhances the protection of the environment, public health, and economic, social and political soundness of a community ((Metcalf & Eddy, 1991). It is usually possible by providing all institutional, funding, technical and regulatory roles, that is, sewage governance (United Nations Environmental Programme, UNEP; World Health Organisation, WHO; UN-HABITAT, and Water Supply and Sanitation Collaborative Council, WSSCC, 2004).

Sanitation is a deliberate action to achieve safe and sound management of sewage (black and grey water) and human excreta or other human wastes (Avvannavar & Mani, 2008). World Health Organisation, WHO (2018) views it as providing facilities and related services to safely dispose of human wastes (urine and faeces). Sanitation can be considered safe management and disposal of human excreta and domestic sewage (Maharashtra Jeevan Pradhikaran, MJP, 2012).

The content views of sewage management and sanitation reveal the mutuality between the two concepts. Therefore, treating each as independent but mutually exclusive entities may not be possible. The WHO (2018) adds that the aim of sewage management and sanitation is to promote public health and user privacy. When these are absent, sewage-borne diseases and infringement of user privacy may be inevitable (Curtis et al., 2002; WHO, 2018).

Situation of Domestic Sewage Management in Low-Income Developing Countries and Nigeria

In most low-income developing countries, domestic sewage is handled at the onsite management systems with less and or unavailable sewage treatment plants and sometimes open defecation (OD), contrary to the use of robust sewerage systems, offsite treatment Plants in most Developed nations (Environmental Protection Agency, 2014; Ouda, 2015; United et al. (UN-Water) et al., 2018; Hyun et al., 2019). The untreated sewage, about 80-90% generated in developing countries, is discharged into surface water bodies and the environment, which pollutes freshwater courses, degrades soils/ farmlands ecosystems and source point for sewage-borne diseases (UN-ESCAPet al., 2015; Adewumi & Oguntuase, 2016; Ngasoh et al., 2020). The practices described above encourage poor environmental performances in terms of poor outdoor air quality, loss of aesthetics and creation of conducive media for thrive of disease or pathogenic agents such as mosquitoes, protozoa, bacteria, helminths (worms) and viruses (Kuvaja, 2001; WHO 2002; Iwugo et al., 2003; Obada & Oladejo, 2013; Idris-Nda et al., 2013; Rigasa, 2016).

In Nigeria, there are challenges in achieving safely managed domestic sewage (WHO, 2016). This is because most of their onsite containments are poorly located from domestic water sources, absence of treatment plants and residents' poor knowledge and ignorance of sewage reuse schemes (Idris-Nda et al., 2013; Oladimeji et al., 2016; Abubakar, 2017; and Oji et al., 2018). In addition, the social dimension to the challenge is gender violence, social conflicts and disharmony experienced amongst households where inappropriate practices exist (Amnesty International, 2010; Joshi et al., 2011; Robins, 2014; Oladimeji et al., 2015; Srinivasan, 2015). According to the report of the Sustainable Development Goals Centre for Africa (SDGCA) and Sustainable Development Solutions Network (SDSN) (2019), there is a declining performance in Nigeria in Water, Sanitation and Hygiene (WASH) below the expected growth of 50% and currently at a stagnant point. This reveals that Nigeria is still in the practice of disposing of untreated domestic sewage to the environment with a high potential of propagating sewage-borne diseases and other environmental problems (UNEP et al., 2004; WHO, 2006; UN-ESCAP et al., 2015; Adewumi & Oguntuase, 2016).

Nigeria's Federal Capital Territory-Abuja was planned with sewerage systems and treatment plants to cleanse the city of sewage-borne diseases (Oluwadamisi, 2013). However, only Phase I, II and some parts of Phase III have offsite sewage management. The larger parts of Phase III, IV and Area Councils are practising onsite sewage management (Federal Capital Development Authority, 2018). Abubakar (2018) further revealed that 32% of Nigerian households engaged in open defecation, comprising 8% in urban and 24% in rural areas. Despite this low proportion, an environment that is not open defecation free has a high potential for a faecal-oral route for the transmission of water-borne sewage diseases (Bartram & Caincross, 2010; WHO/UNICEF, 2013; Ogbonna & Erheriene, 2017).

The National Population Commission (NPC) and Inner-City Fund (ICF) International (2019) ascertained that urban household sanitation facilities in Nigeria are predominantly (26.6%) flush and pour flush and 23.5 % of unimproved pit latrines as user

interfaces, with about 15.4 % households involved in open defecation including all other forms unsanitary practices. They further established that the areas described above have 47.8% of basic sanitation services and 39.6% of limited sanitation services. This demonstrates that Nigerian cities have yet to achieve an acceptable level of home sewage management, which may increase sewage-borne disease transmission, loss of environmental quality, and pollution of water sources. As a result, unsafe onsite home sewage management practices continue to proliferate in Nigerian cities, necessitating intervention.

The Study Area

Kaduna Metropolitan area is located between Latitudes 10°25'15"N and 10°36'08"N and Longitudes 7°23'31"E and 7°29'33"E. The metropolis is situated in the North-west geopolitical zone of Nigeria, as shown at the top right side of Figure 1.2. It is the capital of Kaduna state and comprises two (2) Local Government Areas-Kaduna, North, Kaduna South, and parts of Chikun and Igabi LGA with distinct local administrators, as shown on the left side of Figure 1.2. It comprises twenty-five (25) urban districts, mainly residential neighbourhoods, as shown in Figure 1.3. The metropolis has a projected population of 1,123,581 persons, with a growth rate of 2.55%. Kaduna City (Metropolis) is the fifth largest city after Lagos (10, 578,000), Kano (3,395 000), Ibadan (2, 837, 000) and Abuja (1, 995,000) (Max Locket al., 2010). Historical records have shown that metropolitan Kaduna has prominence from its status as an administrative capital and military garrison of Northern Nigeria Protectorate from 1912 to 1917 and headquarters of North Central State (made up of Zaria and Katsina provinces) between 1967 and 1975. In 1975 the name changed to Kaduna, State carved out from North Central State to Kaduna metropolis, remaining as the capital in 1996. It is inhabited by at least 59 to 63 distinct ethnic groups, if not more (Max Lock et al., 2010). However, the precise number cannot be determined without additional fieldwork.

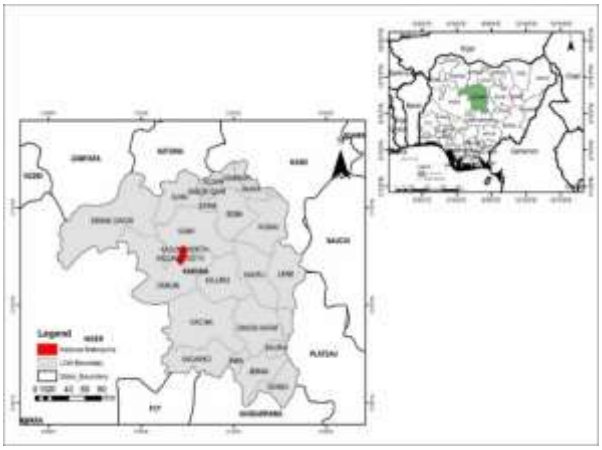

Figure 1. Top Right side-Kaduna State in Nigeria Left Side- Kaduna Metropolis in Kaduna State Source: Centre for Spatial and Information Science, Department of URP, ABU, Zaria (2021)

Figure 1.2: Urban Districts in Kaduna Metropolis
Source: Adapted from Max Lock et al. (2010)

RESEARCH METHODOLOGY

Data were collected from household heads via the administration of questionnaires and the filling of checklists by field assistants from their physical observations of the household's sewage management settings. Published electronic and hard copies of relevant literature as well as unpublished scholarly works, were reviewed to establish the situation of domestic sewage management practices in Nigeria. WHO/UNICEF Joint Monitoring Programme (2018) reports were used to derive physical and social variables for assessing households' sanitation and sewage management practices. A sample frame of 88 6621 houses from five (5) residential neighbourhoods (RN), namely, the core city, north, south, east and west sectors of the metropolis, for fair representation of the metropolis (see Figure 1.4). It was sourced from the attribute data of structures captured from Global Mapper 18.0. The RN were further stratified

into medium/ low and high densities, established from the dimensions of plots for high and medium/ low densities. Krejcie and Morgan's sampling table (1970) of 95% confidence level (CL) was used to draw samples (see Table 1) from the aforementioned residential neighbourhoods derived from the formula:

n= X^2NP (1-P) / d^2 (N-1) + X^2 P(1-P)

Where:

n=required sample size

X^2= the Table value of chi-square for 1 degree of freedom at the desired confidence level (3.841)

N=the population size

P = the population proportion (assumed to be 0.50 since it provides the maximum sample size;

d= the degree of accuracy expressed as a proportion

Systematic sampling (selection of every 8th house/ property on every street) technique was used to conduct the questionnaire interview on households' heads and filling of the checklist. Statistical Package for Social Sciences (SPSS) version 23 was used to compute cross-tabulations, frequency, percentages and bar charts to analyse data and descriptive mode in discussing results. Pictures were used to illustrate additional facts on sanitation and sewage management practices.

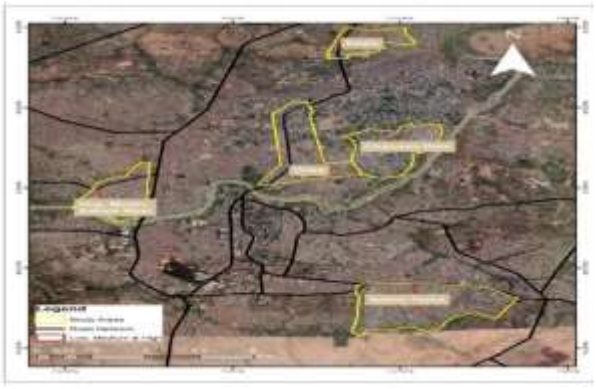

Figure1.4: Study areas in Kaduna Metropolis
Source: Google Earth (2020) and modified by CISS, URP, ABU, Zaria (2021).

Table 1: Sample Size Determination

Residential neighbourhoods	Total population of houses 'N.'	Krejcie and Morgan, (1970). Table for determining sample size from a given population (see Appendix vii)	Sample size 'n'	Sample in each stratum by purposive disproportionate strata of 60:40% of high and Medium/Low R/N and responses
DK (City Core)	12, 320	**N' is 10,000 – 'n' is 370 'N' is 15,000- 'n' is 375.** Approximated 12,320 to 10,000 and adopted its 'n'	370	High density (60% of 370= 222) **214 responses Low**/Medium density (40% of 370= 148) **141 responses**
ST (South)	21,604	N' 21,604 approximated to 20, 000; 'n' is 377	377	High density (60% of 377=226) **216 responses** Med./Low density (40% of 377=151) **114 responses**
KW (North)	21,502	N' 21,502 approximated to 20, 000, 'n' is 377	377	High density (60% of 377= 226) **189 responses** Med/Low density (40% of 377= 151) **137 responses**
UR (East)	17,209	'N' 17, 209 approximated to 15,000, 'n' is 375	375	High density (60% of 375= 226) **201 responses** Med/Low density (40% of 377= 151) **139 responses**
UMK (West)	15, 626	'N' 15, 626 approx. 15,000; 'n' is 375	375	High density (60% of 377= 226) **198 responses** Med/ Low density (40% of 377= 151) **132 responses**
Total	**88, 621**		**1,874**	**1716**

N.B: DK-Doka; **ST**-Sabon Tasha; **KW**- Kawo; **UR**-Unguwan Rimi; **UMK-** Unguwan Mu'azu-Kabala West

Source: Author (2021)

Results and Discussion

Sanitation Options or Toilet Type

The result in Table 1.1 showed that most (52.9%) households in Kaduna Metropolis use water closets (WC) as a sanitation option or toilet type. Pour flush is the second most used sanitation option, with the least option classified as others, that is, households with inappropriate sanitation options such as 'short put', which is defecation into polythene bags and in situ disposal at collapsed sub-structures, pit latrine, open pit, back yards or open drains. Water closets are used more in medium-low residential neighbourhoods than in high-density neighbourhoods. It can be inferred that the improved sanitation option for managing sewage is predominant in the study area as prescribed by the WHO/ UNICEF JMP (2018) sanitation ladder. However, this finding on sanitation options refutes the National Population Commission housing survey census (2006) on the predominant (62.7%) use of pit latrines as the most improved sanitation option in many Nigerian cities.

Table1.1: A Cross Tabulation of Sanitation Options or Toilet Type and Residential Neighbourhoods

		Sanitation Options or Toilet type					
	Residential Neighbourhoods	A	B	C	D	E	Total
1.	Sabon Tasha (High Density)	57 (26.4)	3 (1.4)	96 (44.4)	55 (25.5)	5 (2.3)	216 (100)
2.	Sabon Tasha (Medium-low dens.)	0 (0) 51 (23.8)	0 (0) 5 (2.3)	25 (16.8) 76 (35.5)	124 (83.2)82 (38.3)	0 (0) 0 (0)	149 (100) 214 (100)
3.	Doka (High density)	2 (1.4)	2 (1.4)	16 (11.3)	121 (85.8)47	0 (0)	141 (100)
4.	Doka (Medium-low density)	61 (32.3)	2 (1.1)	79 (41.8)	(24.9)116	0 (0)	189 (100)
5.	Kawo (High density)	2(1.5)	2 (1.5)	17 (12.4)	(84.7)64	0 (0)	137 (100)
6.	Kawo (Medium-low density)	62 (31.3)	5 (2.5)	67 (33.8)	(32.3)119	0 (0)	198 (100)
7.	Ung. Rimi (High Density)	2 (1.5)	0 (0)	13 (9.8)	(90.2)74	0 (0)	132 (100)
8.	Ung. Rimi (Medium-low density)	43 (21.4)	1 (0.5)	83 (41.3)	(36.8)	0 (0)	201 (100)
9.	Ung. Mu'azu- Kabala West (High)	4 (2.9)	1 (0.7)	28 (20.1)	106 (76.3)	0 (0)	139 (100)
10.	Ung. Mu'azu- Kabala West (Medium-low density Density)						
	TOTAL	282 (16.4)	21 (1.2)	500 (29.1)	908 (52.9)	5 (0.3)	1716 (100)

***All figures in bracket are in percentages (%)**
KEY: A-Simple Unimproved Pit Latrine; **B**-Ventilated improved Pit; **C**-Pour Flush Pit Latrine; **D**- Water Closet; **E**- Others
Source: Author's Fieldwork, 2020.

Toilet Sharing with Other Households

The result in Figure 1.5 reveals that 1 049 (61.2%) of 1,716 households do not share toilets with other households. However, most households in all the high-density neighbourhoods share toilets, possibly, because of the predominant type of housing of the two-room apartment with toilets located outside the rooms and within the compound intended to be shared amongst households. The medium-low-density neighbourhoods do not share toilets because their housing types are mostly apartments with toilets inside their rooms (bungalow or flat housing type). The entire city promotes household user privacy, discouraging social disharmony between households and transmitting certain faecal oral routes sewage-borne diseases, such as hepatitis, cholera, and typhoid fever. Nonetheless, high-density neighbourhoods may continue to be plagued by discontent and disease transmission. The WHO/UNICEF Joint Monitoring Programme (JMP) (2018) stipulates that when two or more households share a toilet, the sanitation status is risky. Consequently, this would negate the intended progress on the sanitation level of such areas.

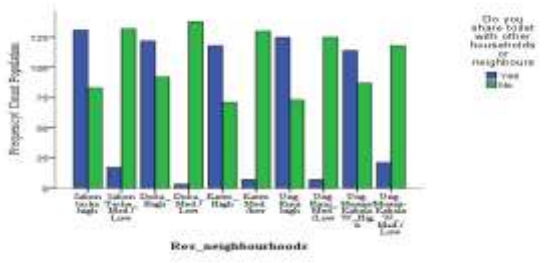

Figure 1.5: Sharing of Toilets with Other Households.
Source: Author's Field Work, 2020.

Presence of Other Forms of Open Defecation and In Situ Faecal Disposal

The results in Table 1.2 reveal the presence of other forms of open defecation (OD). About 30% of households (that is 537 of 1,716 respondents) indicated the practice of OD. This aligns with the findings of Abubakar (2018) that only about 30% of Nigeria's urban population practices OD. Most OD in the study areas occurs in open spaces, as observed by 35% of households. The open spaces are passive spaces within the metropolis's built-up area, including vacant plots, backyards of houses, solid waste dumpsites and railway lines. Other households reported throwing polythene bags into open drains, streets, solid waste collection points, and nearby vacant plots. According to Bartram and Caincross (2010), WHO and UNICEF (2013), and Ogbonna and Erheriene (2017), areas with open defecation practices are prone to faecal-oral route transmission of diseases such as Hepatitis A, E, and F, viral diarrhoea, cholera, salmonellosis, typhoid, paratyphoid, amoebiasis, malaria, and Escherichia coli.

Table 1.2: Presence of Other Forms of Open Defecation and in Situ Feacal Disposal

	Other Forms of Open Defecation and Feacal Disposal					
Residential Neighbourhoods	A	B	C	D	E	Total
Sabon Tasha High Density	34 (22.7)	34(22.7)	62(41.3)	3(2)	17(11.3) 1(2.8)	150(100) 36(100)
Sabon Tasha Medium/Low Density	29 (80.6)	2 (5.6)	3(8.3)	1(2.8)		
Doka High density	3(5.9)	16(31.4)	27(52.9)	5(9.8)	0(0)	51(100)
Doka Medium/Low Density	3(8.3)	25(69.4)	3(8.3)	2(5.6)	3(8.3)	36 (100)
Kawo High density	13(25)	17(32.7)	15(28.8)	6(11.5)	1(1.9)	52(100)
Kawo Medium/Low density	8(21.1)	23(60.5)	4(10.5)	1(2.6)	2(5.3)	38(100)
Ung. Rimi High Density	10(16.7)	20(33.3)	28(46.7)	1(1.7)	1(1.7)	60(100)
Ung. Rimi medium/ Low density	8(29.6)	14(51.9)	3(11.1)	1(3.7)	1(3.7)	27(100)
Ung. Mu'azu- Kabala West High Density	6(11.1) 10 (30.0)	19(35.2) 18(54.5)	21(38.9) 4(12.1)	7(13) 0(0)	1(1.9) 1(3)	54(100) 33(100)
Ung. Mu'azu- Kab. W. Med/ LowDens.						
Total	124(23.1)	188(35)	170(31.7)	27(5)	28(5.2)	537(100)

*****All figures in bracket are in percentages (%)
KEY: **A**-Defecation in abandoned/ uncompleted buildings; **B**-Open Spaces; **C**-Use of Polythene bags and disposed into open drains or streets; **D**-others; **E**-None.
Source: Author's Fieldwork, 2020

Type of Building Material and Presence of Roof

Table 1.3 shows that most (81.1%) of toilets in all the neighbourhoods are built with cement blocks and the least (1%) with other materials such as zinc and wood. The high-density areas have toilets built with mud blocks, though not predominant. However, Kawo's high-density neighbourhood has the most (33.5%) toilets built with mud blocks amongst other

high-density areas, while Unguwan Rimi is the most (100%) built with cement blocks. This finding implies the vulnerability of some toilet collapses to harsh weather conditions in the high-density areas of the study area, except for toilets built with cement blocks.

Figure 1.6 further reveals the predominance (89.4%) of roofs on toilet superstructures across metropolitan Kaduna. By the current situation of building material type and presence of a roof on the toilet superstructure, as also shown in Table 1.3 results, it can be inferred that the physical conditions of the user interface are good enough for user protection from harsh weather conditions and invasion by rodents and insects, this in turn, promotes user comfort and risk reduction on sanitation option use. However, areas where toilets were built with mud and without a roof pose risks and discomfort to users, as shown in Plates 1 and 2.

Table 1.3: Cross Tabulation of Building Material Used for Toilet Superstructure and Residential Neighbourhoods

	Building material of User interface/Toilet's Superstructure				
Residential Neighbourhoods	Wood & Zinc	Mud Blocks	Cement Blocks	Others	Total
1. Sabon Tasha High Density	3 (1.4)	66 (30.6)	137 (63.4)	10 (4.6)	216 (100)
2. Sabon Tasha Medium-low density	0 (0)	1 (0.7)	148 (99.3)	0 (0)	149 (100)
3. Doka High density	1 (0.5)	59 (27.6)	154 (72)	0 (0)	214 (100)
4. Doka Medium-low density	1 (0.7)	1 (0.7)	139 (98.6)	0 (0)	141 (100)
5. Kawo High density	0 (0)	63 (33.5)	121 (64.4)	4 (2.1)	188 (100)
6. Kawo Medium-low density	1 (0.7)	1 (0.7)	135 (98.5)	0 (0)	137 (100)
7. Ung. Rimi High Density	0 (0)	48 (24.2)	147 (74.2)	3(1.5)	198 (100)
8. Ung. Rimi medium-low dens.	0 (0)	0 (0)	132 (100)	0 (0)	132(100)
9. Ung. Mu'azu-Kabala West High D.	1 (0.5)	55 (27.4)	145 (72.1)	0 (0)	201 (100)
10. Ung. Mu'azu-Kabala West Medium-low density	0 (0)	6 (4.3)	133 (95.7)	0 (0)	139 (100)
TOTAL	7(0.4)	300(17.5)	1391(81.1)	17 (1)	1715 (100)

***Figures in bracket are in percentages (%)**
Source: Author's Fieldwork, 2020

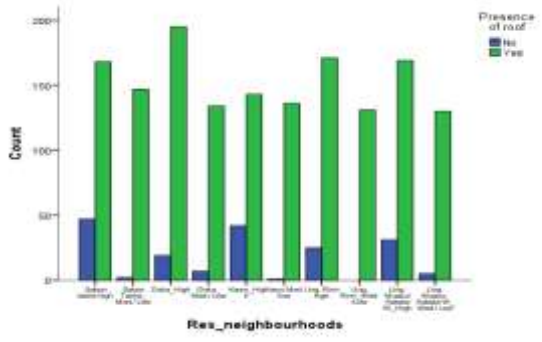

Figure 1.6: Presence of Roof on Toilet Superstructure
Source: Author's Fieldwork, 2020

Plate 1: Mud block-built Toilet without roof at Sabon Tasha High Density
Source: Author's Fieldwork, 2020

Plate 2: Mud block-built Toilet without roof at Unguwan Mu'azu/ Kabala West High Density
Source: Author's Fieldwork, 2020.

Presence of Lockable Doors

The result from Figure 1.7 reveals that most (84.5%) toilets have lockable doors. This discourages infringement of user privacy and social hazards. However, most of the high-density areas with unlockable toilet doors, as shown in Plate 3, may encourage infringement of user privacy and social hazard amongst households.

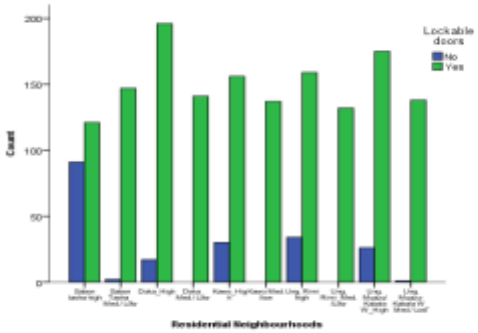

Figure 1.7: Presence of Lockable Doors
Source: Author's Field survey, 2020.

Plate 3: Toilets without lockable doors Sabon Tasha high density
Source: Author's Fieldwork, 2020.

Presence of Pit Covers on Pit Latrines

The results in Table 1.1established that 16.4% of households use Simple Unimproved Pit Latrines, and 1.2% with Ventilated Improved Pit Latrines in the entire Kaduna metropolis. This provides the target households that should use pit latrine covers for their toilets. Figure 1.8 reveals that most (72.5%) households with sanitation options described above do not use pit latrine covers, predominantly in high-density neighbourhoods. These areas would be highly vulnerable to unpleasant odours/smells and breeding grounds for houseflies, mosquitoes and rodents. Thus, violating the provisions of KEPA regulation No. 2 (i and ii) (2010), WHO (2002), and MJP (2012) on the compulsory provision of pit covers for users of Simple unimproved pit latrines and VIP.

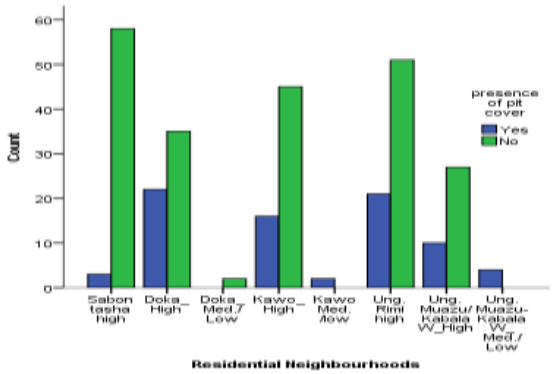

Figure 1.8: Presence of pit covers on Pit Latrines
Source: Author's Field Survey, 2020

Anal Cleansing Material

Figure 1.9 shows the predominance (53.8%) use of water and soap as anal cleansing material by households in the Kaduna metropolis. It declines from medium-low to high-density neighbourhoods. This indicates good personal hygiene of households in the Kaduna metropolis; perhaps, the COVID-19 preventive guidelines and protocol on frequently washing hands with soap and clean water had influenced the practice. However, it is an excellent non-pharmaceutical prevention therapy against transmittable sewage-borne diseases, such as typhoid fever, dysentery, hepatitis A and B, Escherichia coli, bloody diarrhoea, and gastroenteritis (Holmes et al., 2016; WHO, 2017; UNICEF *et al*., 2018).

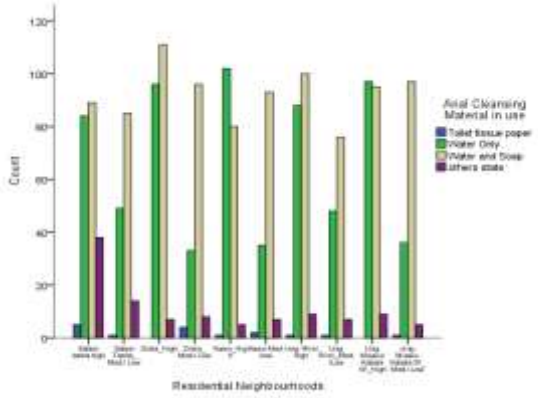

Figure 1.9: Anal Cleansing Material
Source: Author's Field survey, 2020.

Toilet Link to Containments

Table 1.4 result shows that most (72.7%) toilets are linked to off-set soak-away containment, 26.0% of toilets are directly linked to pit on-set containment, 0.9% are directly linked to streams (water body), and 0.2% are linked to an open drain and 0.1% to open ground. The containment facility for the entire study area is relatively good. However, Kawo's high density has a practice of toilets directly linked to the 'Lafia stream' as shown on Plate 4, which is quite appalling. This makes the downstream areas and those involved in sand dredging prone to sewage-borne diseases and infection. The entire metropolis is relatively good on offset containment.

Table1.4: Cross Tabulation on Toilet Link to Containment and Residential Neighbourhoods

	Residential Neighbourhoods	Toilet Link to Containment: Link to Open Ground	Link to Open drain	Link to Stream	Link direct to pit (ONSET)	Link to the septic tank (OFF-SET)	Total
1.	Sabon Tasha High Density	2(0.9)	2(0.9)	0(0)	97(44.9)	115(53.2)	216(100)
2.	Sabon Tasha Medium-low density	0(0)	0 (0)	0(0)	5(3.4)	144(96.6)	149(100)
3.	Doka High density	0(0)	2(0.9)	0(0)	83(38.8)	129(60.3)	214 (100)
4.	Doka Medium-low density	0(0)	0(0)	0(0)	4(2.8)	137(97.2)	141(100)
5.	Kawo High density	0(0)	0(0)	16(8.5)	83(43.9)	90(47.6)	189(100)
6.	Kawo Medium-low density	0(0)	0 (0)	0(0)	4(2.9)	133(97.1)	137 (100)
		0(0)	0(0)	0(0)	83(41.9)	115(58.1)	198(100)

7. Ung. Rimi High Density	0(0)	0(0)	0(0)	4 (3)	128 (97)	132(100)
8. Ung. Rimi medium-low density						
9. Ung. Mu'azu-Kabala W High D.	0(0)	0(0)	0(0)	71(35.3)	130(64.7)	201 (100)
10. Ung. Mu'azu-Kabala West Medium-low density	0(0)	0(0)	0(0)	12(8.6)	127(91.4)	139(100)
Total	2 (1.4)	4 (0.2)	16 (0.9)	446 (26)	1248 (72.7)	1716 (100)

***Figures in bracket are in percentages (%)**
Source: Author's Field Survey, 2020.

Containment buffer or distance from domestic water sources

The result in Table 1.5 discloses that the majority (40.7%) of households have an 8-14m buffer or horizontal distance of containment from water sources, thus, violating the 15m horizontal prescribed buffer of the WHO (2018) and KEPA regulation (2010) on containment distance from water sources. The result above agrees with the findings of Idris-Nda et al. (2013), Oladimeji et al. (2016), Abubakar (2017a) and Oji et al. (2018) that many houses in Nigerian cities violated 15m horizontal safe distances of pit containment in relation to groundwater sources. Therefore, in the event of a collapse or crack in containment, many households' groundwater sources would be prone to pollution, which may occur unnoticed and could be a source point of sewage-borne disease transmission.

Table 1.5: Cross Tabulation on Containment Distance from Water Source and Residential Neighborhoods

Residential Neighbourhoods	Containment Horizontal Distances from the Source of Water in 1-7m	8-14m	15-21m	22m and above	Total
1. Sabon Tasha High Density	108(50)	61(28.2)	30(13.9)	17(7.9)	216(100)
2. Sabon Tasha Medium-low density	25(16.8)	43(28.9)	53(35.6)	28(18.8)	149(100)
3. Doka High density	67(31.3)	100 (46.7)	36(16.8)	11(5.1)	214 (100)
4. Doka Medium-low density	34(24.3)	51(36.4)	42(30)	13(9.3)	140(100)
	69(36.5)	80(42.3)	28(14.8)	12 (6.3)	189(100)
5. Kawo High density	2719.9)	54(39.7)	43(31.6)	12(8.8)	136(100)
6. Kawo Medium-low density					
7. Ung. Rimi High Density	53(26.8)	95(48)	40(20.2)	10(5.1)	198(100)
8. Ung. Rimi medium-low density	25(19.1)	47(35.9)	41(31.3)	18(13.7)	131(100)
9. Ung. Mu'azu-Kabala W High D	35(17.4)	107(53.2)	47(23.4)	12 (6)	201(100)
10. Ung. Mu'azu-Kabala West Medium-low density	29(21)	59(42.8)	43(31.2)	7 (5.1)	138(100)
Total	472 (27.6)	697 (40.7)	403 (23.5)	140 (8.2)	1712 (100)

***Figures in bracket are in percentages (%)**
Source: Field survey, 2020

Plate 1.5: Safe distance of 2.3m between soak away pit and well in Kawo high density
Source: Author's Field survey, 2020.

Plate 1.6: Safe distance of 2.8m between soak away pit and well in Kawo high density
Source: Author's Field survey, 2020.

Methods of Emptying Filled Pits or Containment

Sewage emptying is critical in determining the safety of sewage management. Thus, Table 1.6 result revealed that, out of 1,716 households, 1,140 had emptied their containment and the others had not. Most (89.2%) households patronise the motorised services of private sewage providers, who empty the

filled pits with vacuum suction trucks. This finding agrees with the WHO (2016) and Sengupta (2019) reports that most developing countries employ the services of Private Service Providers to empty their containment, that is, filled toilet pits/ soak away. It also disagrees with Rotowa and Ayadi's (2020) position that most households in urban high-density areas empty pits manually with buckets and spades. Although, 7.2% of households use manual scavengers for pit emptying, where faecal sludge is manually scooped and dumped in dug pits around the house, as shown in Plates 1.7 and 1.8. It can be inferred that the pit emptying practices are predominantly fair to encourage safe and sustainable sewage management in the study area.

Table 1.6: Cross Tabulation on Emptying of Containment and Residential Neighbourhoods

	Emptying filled Containment			
Residential Neighbourhoods	Manual Scavenger	Private Sewage Operator	Government Agency	Total
1. Sabon Tasha High Density	23	108 (78.8)	6(4.4)	137(100)
2. Sabon Tasha Medium-low density	(16.8) 0(3.4)	52(96.3)	2(3.7)	54(100)
3. Doka High density	12(6.3)	170(89.9)	7(3.7)	189(100)
4. Doka Medium-low density	2(2.9)	65(94.2)	2(2.9)	69(100)
5. Kawo High density	15(9.1)	141(86)	8(4.9)	164(100)
6. Kawo Medium-low density	2(3.1)	61(95.3)	1(1.6)	64(100)
7. Ung. Rimi High Density	16(9.5)	149(88.7)	3(1.8)	168(100)
8. Ung. Rimi medium-low density	0(0)	54(98.2)	1(1.8)	55(100)
9. Ung. Mu'azu- Kabala W High D.	10(5.8)	154(89)	9(5.2)	173(100)
10. Ung. Mu'azu- Kabala West Med-low D.	2(3)	63(94)	2(3%)	67(3)
Total	82 (7.2)	1017 (89.2)	41 (3.6)	1140 (100)

***Figures in bracket are in percentages (%)**
Source: Author's Field Survey, 2020

Plate 1.7: Dug Pit at Sabo Tasha High density
Source: Author's Field survey, 2020.

Plate 1.8: Disposed in-situ faecal sludge into a dug pit within the residence at Sabon Tasha High density
Source: Author's Field survey, 2020.

Conclusion

This paper has ascertained that household sanitation and domestic sewage management practices in Kaduna Metropolis are fairly good for most of the social and physical indicators. These indicators include the sanitation options, building material and roof on the toilet superstructure. Others comprise sharing the status of toilets amongst households, presence of lockable doors, use of appropriate hand washing cleansing material, toilet link to containment and methods of pit emptying practices that would promote the achievement of SDG 6.2, 6.3 and 11 on environmental sustainability and liveable cities. However, the predominant violation of containment buffer in relation to water sources, the presence of other forms of Open Defecation (OD) practices and the non-use of pit covers by users of unimproved pit latrines pose challenges to achieving the SDG targets mentioned above.

Recommendation

Based on the study's key findings, the following are advised to help actualise environmentally friendly practices: Public awareness campaigns and enlightenment efforts established by concerned environmentalists and private organisations. In addition, the Kaduna State Environmental Protection Authority (KEPA) should help inform the general public about the dangers of utilising unimproved sanitation alternatives and their influence on public health. An abatement committee (consisting of community leaders, key members, and government authorities) on open defecation and households with inadequate or no toilet facilities will aid in combating the terrible behaviour. The committee should also be tasked with monitoring and surveillance of alleged growing OD hotspots, as well as imposing severe penalties on perpetrators. Biogas plants can be established at the neighbourhood levels in order to

achieve an alternative energy source from methane gas (CH_4) emission, which is a clean energy source and corroboration of the International Renewable Energy Agency (IRENA, 2020) global movement for transforming sewage to the resource.

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