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*Research Article***Indiscriminate solid waste disposal and problems with water-polluted urban cities in Africa**Augustine N. Ozoh¹, Blessing T. Longe¹, Victor Akpe^{2,3} and Ian E. Cock^{2,3*}¹Department of Geography and Environmental Management, University of Abuja, Gari, PMB 117, Abuja, Nigeria.²School of Environment and Science, Griffith University, Nathan Campus, QLD 4111, Australia.³Environmental Futures Research Institute, Griffith University, Nathan Campus, QLD 4111, Australia.

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The high rate of illegal municipal solid waste disposal is alarming, as it is a global factor affecting the human environment. This applies to most developing countries without proper and active environmental protection laws and Agencies to keep the environment safe. Science and technology have proven to be a lead factor towards high rise of industrial modernization, urban growth and population increase, contributing to the adverse effect of refuse disposal in most cities. African countries are considered to be more prone to such deteriorating environment, exposing inhabitants to dangers of indiscriminate environmental waste. Nigeria at large is a country faced with such environmental problems and this is partly because, Nigeria failed to adopt new methods of scientific innovation and technology for waste management. More urban lands have been converted for building of industries which has led to the encroachment of natural life and eco-system. In respect to the ecosystem, the water treatment for domestic use may also be heavily polluted with water-borne diseases such as cholera, diarrhea, typhoid, gastroenteritis, and other diseases which may be nascent to mankind. These solid waste disposals are found in water ways, streets, drains, gutters, and around public places. Research has shown that Africa is faced with population explosion but with limited facilities to contain the collected waste from domestic users. A reconnaissance survey conducted to investigate the wastes volume and types from 3 different areas and 15 different drainages shows that drainage clogging contributed to increased rate of flooding, erosion, stagnant waters in areas not designated for water retention. As a result, there have been numerous cases of destruction/loss of houses, businesses, and farms, and some people have been forced to relocate, to escape an impending doom. Consequently, accumulation of stagnant water and sewage has resulted in unpleasant smell, especially in houses close to drainages. Furthermore, these areas are breeding grounds for mosquitoes and other insects. Furthermore, this paper recommends that adequate attention must be paid to the problem of drainage clogging in order to avoid flood and its attendant health problems.

Key words: Industrial modernization, water-borne diseases, drainage clogging, health problems

INTRODUCTION

Solid waste management is one of the major problems facing the environment globally as in recent times; the world has become increasingly aware of waste and its huge risk in environmental problems exposing our natural habitat. Risk such as water pollution, air pollution, degradation of natural habitat leading to a threat in environmental sustainability such as nature reserves open spaces and even public parks are expected to be encountered subsequently. The deadly flood event witnessed in Accra Ghana resulted as an act of

negligence and manipulating of water channels with improper poor sanitation and management (Citiserve, 2004). High rate of death recorded in China town as a result of outdoor pollution and lack of effective and proper waste management death cases recorded in Zimbabwean cities are just but a few cases in most developing countries (Citiserve, 2004). Waste disposal becomes a huge task in most developing countries, as poverty, rapid population growth and high rate of urbanization, combined poor government funding, prevent efficient management of waste. In Nigeria, due to poor waste systems, solid waste has become one the major environmental threats common in urban areas. Piles of waste are often found by the road, streams and rivers, and many other open spaces in cities. This becomes worse in the rainy season, when the

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wastes are flooded over the roads, people's homes and other places are submerged. One of the factors responsible for the increasing waste in many modern societies may be traced to increasing population that is as a result of rapid urbanization, industrialization, and the predominant commercial activities in the society. Industrialization has resulted to a rapid increase in the volume of waste generated; causing significant health and environmental problems (Achankeng, 2003). Waste deposits as such, provide breeding grounds for mosquitoes and other disease vectors. There are increasing difficulties as a result of inadequate disposal sites for proper and effective solid waste management.

Wastes are unusable materials which may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities (Agunwamba, 1998). Solid wastes are unwanted materials which are not in a liquid state. They can be found everywhere, especially in rural areas and developing countries. Examples include scrap metal, used tires, used cloths, plastic materials and abandoned papers. They can also be resulting factors from industrial, commercial, mining, and agricultural operations, and from community activities. Many activities carried out, leave behind multiple kind of waste in the environment. The definition of solid waste is not limited to physical solids materials only but can be semi-solid or may contain gaseous materials. Waste was an early problem of mankind and a growing one that is of major concern to every nation of the world (Ahiamadu, 2007).

Gwagwalada, an area council in the Federal Capital Territory (F.C.T.) of Nigeria, is the second most developed area council in the territory. There has been a rapid influx of people into the Federal Capital Territory over the last ten years, as a result of modern facilities, good working conditions and with the increase in residential population in all its area councils, especially the developed areas. In Gwagwalada, there has been a rapid growth in waste volume and the associated problems of locating new disposal sites, thereby resulting in open dumping of waste. Although there are several policies established to manage municipal solid waste, they have generally proved ineffective due to financial and human constraints (Bamgbose OA, 2002). Community participation plays an integral role in the success of any solid waste management system in accordance to good practices and environmental awareness which will play a significant role in the successful implementation of solid waste management system in Africa. Unguided refuse dump is an area that is relatively neglected in the current municipal solid waste management system for Abuja, Nigeria. Illegal waste disposal threatens human health and the environment at large (Boyle, 1977). In many instances, waste is illegally dumped in the open environment, including water bodies and storm-drainage channels. Various diseases have been recorded as a result of contact with smoke from burning of solid waste, gaseous emission from dumpsites, and water pollution (CPE 2010; Federal Ministry of Environmental Report 2004). Indiscriminate dumping of solid waste has contributed immensely in drainage clogging which plays a major role in the increase of flood rates (UNEP, 2013).

In Nigeria, the most common method of solid waste

disposal is open waste dumping (Imam A, 2008). In Abuja city, the local environmental protection agency has been unable to effectively and efficiently manage the increasing volume of waste generated from an increasing number of urban dwellers. In Nigeria, solid waste density generally ranges from 280-370 kg/m³, waste generation rate of 0.44-0.66 kg/Capital/day higher than solid waste density found in developed countries (Ayuba, 2013). Natural habitats are not considered in all of these; flood plains turned into major building sites with no room for good water channels or natural aesthetics. Most water channels have been filled up with refuses from big industries causing stagnancy. Most average and low-income earners live in these areas due to the high cost of living in the high lands, and therefore exposed to these dangers. In other to have free and a reduced risk of improper waste management impact on the environment and to ensure safety, the people most are ready to address environmental problems personally.

Gwagwalada Area Council falls within the Federal Capital Territory of Nigeria. It is one of the six Area Councils of the FCT. It consists of several wards of which some, Ungwan Dodo, Ungwan Zango, and Ungwan Shanu were considered for sampling. Gwagwalada town lies in the downstream of river Usuma and located between latitude 8°55' and 9°00'N and longitude 7°00' and 7°05'E. Gwagwalada has a population estimated to be 442,591, and a growth rate of 7.97% annual change since 2015 which is in addition to adjacent suburbs (source, world urbanization prospect). The temperature of the area ranges from 30°C-37°C yearly, with the highest temperature experienced in the month of March and with mean total rainfall of approximately 1,650 mm per annum (Momodu NS, 2011). About 60% of 7 hours rain falls between the months of July to September, and this period has the highest form of humidity and heat trap. The indigenes of Gwagwalada are chiefly subsistence farmers.

MATERIALS AND METHODS

This study considered an acceptable standard sampling method and analysis techniques as Chi Square; is a strong and a valid hypothetical non-parametric statistical test used to determine and compare results between variables. Readings were carried out on drainage channels to ascertain free flow of running water in channels. Data collected from each of the sampling point were statistically tested through Chi Square, by determining observed data collected from sampling points and was compared with a critical Chi Square table to determine the degree of freedom and ascertain a level of significance.

This study is on the hypothesis that there is no significance difference between the area covered with solid waste and the uncovered area at 0.05 significance level. Readings were carried out with the aid of Global Positioning System GPS to determine the latitude and longitude, and elevation on sampling points. Drainage depths and level of solid waste dungs in each sampling points were ascertained through a ranging pole and a measuring tape. This method was carefully followed to come out with an unbiased result.

Environmental health impact induced from drainage channels.

To appreciate the level of environmental problems in relation to man health, anthropogenic activities should be considered as a pioneer to this problem. UNEP [2009a] estimation from World Bank states that, developing countries are liable to spend 20%-50% of income and budget managing solid waste. Dumping in residential areas illegally has become common as environmental aesthetic value has been lost (Edith M, 2014). Anthropogenic activities have not only affected the environment but have placed a threat to his health. The emission of toxic substances into the environment unlawfully has affected the environment negatively, substances such as textile materials, plastics, sachet water bags, glass, metal, organic materials (food and garden waste), and rubber etc. These has contributed to clogging of drainages leading to water stagnancy, breeding ground for mosquitoes, flies, smells, and housing disease vectors and germs.

As shown in Table 1, after variables were compared by using Chi square test, the total area covered by solid waste is 93.1 m and the total area un-covered by waste is 28.9 m. The null hypothesis states that there is no significance difference between the area covered with solid waste and the uncovered area. With the result derived from Chi Square test analysis, it is observed that there is a significant difference in the amount of solid waste found here over the uncovered area. This has resulted to stagnancy of water, making the environment a breeding ground for insects. Anopheles mosquitoes are commonly known to inhabit environments associated with this characteristic, and spreading out to nearby areas. With the obnoxious smell coming out of this channel, research has shown that mosquitoes are attracted to such repugnant odours and skin odours, and carbon dioxide by exhaled-breath, transferring diseases between living things through blood infection, which can eventually lead to death.

Figure 1 is a captured area in Ungwan Dodo, showing the method of sewage and solid waste disposal on constructed drainage channels. As seen, research also reveals that flies are very important insects living in unhygienic environment known for diseases transmission and are capable of transmitting over 60 different diseases e.g. anthrax, dysentery, cholera, etc. This environment is being invaded by flies due to the presence of rotten food, dung disposals, stagnant liquid and garbage. This encourages perching around the environment as droppings

containing bacterial are left on human food. This environment is considered unhygienic and known to serve as a great threat to human lives around such environment.

Water quality in clogged drainages

Surface water contains numerous leaving physical and chemical components comprising of imperative part in the aquatic environment (Nabegu, 2010). Considering water as a basic necessity and a critical component in the growth of socio economy of a country, disproportionate amount of some microorganism and chemical component can destroy water quality leading to an unhealthy aquatic health (Ogwueleka TC 2009; Olarenwaju, 2009). Surface and ground water predominantly are most conspicuous water sources for several purposes such as irrigation, drinking and washing. Though these water sources might be valuable, they are recurrently polluted by human inhabitants (Onweghara IN 2010; Achieng A 2017). More than half of the globe largely depends on surface water and ground water features, as it is the main source of cleaning usable water. 95% of most rural regions in developing nations especially Nigeria, depends on ground water sources (Achieng A 2014; Nagamani CC 2014).

Table 2 displays total area covered by waste exceeds that of the un-covered area using Chi Square test and compared with at 0.05 significance level which also rejects the hypothesis. Waste content here contains organic chemicals from petroleum products such as engine oil, grease, and kerosene among others listed. These substances either sink down or washed into larger water bodies downstream and leading to death of aquatic animals when being ingested. Harvesting of fishes illegally in streams with chemical has further affected water quality. Water surface are being covered by these organic substances which lower the rate of air penetration into water bodies that aid respiration for aquatic animals. Also, most animals end up being infected and contaminated, becoming threat to humans eating them. Humans living downstream are unable to make good use of this water for domestic use as the quality has been affected. Grazing animals are also at risk because they depend on these waters for survival. The risk of dumps in water is now a major threat to life contributing to the changes in ground water. Leachate contaminated water are liable to transmit disease, bacterial and typhoid fever among all which is a major problem from contaminated water sources in Nigeria (Datta, 2018).

Table 1. Analysed waste data collected from drainages in Ungwan dodo.

S/N	Longitude	Latitude	Elevation	Drainage depth(M ²)	Drainage area	Covered areas	Uncovered areas
A	08°56'24.8"	007°05'40.5"	207	1.17	8.8	10	5
B	08°56'24.0"	007°05'40.1"	205	1.17	5.5	7.5	3
C	08°56'22.9"	007°05'39.5"	201	1.17	11.6	3.2	3
D	08°56'21.1"	007°05'39.3"	197	1.17	6	5	1
E	08°56'21.8"	007°05'39.2"	195	1.17	8.4	6.4	2.4
F	08°56'21.4"	007°05'38.9"	195	1.17	6.5	5.2	0.1
G	08°56'20.8"	007°05'38.9"	192	1.17	8.9	7.4	3
H	08°56'20.6"	007°05'38.8"	192	1.17	8	5.3	2.1
I	08°56'19.8"	007°05'38.6"	190	1.17	15.7	10	8.3
J	08°56'18.7"	007°05'38.3"	188	1.17	1.7	1.1	1
Total				11.7	81.1	95.31	28.9
Avg					8.1	47.66	2.89



Figure 1. Drains in Ungwan Dodo.

Table 2. Solid waste data collected along constructed water channels in Ungwan Zango.

S/N	Longitude	Latitude	Elevation	Drainage depth(M ²)	Drainage area	Covered areas	Uncovered areas
A	08°56'27.5"	007°04'58.6"	205	2	8.76	13.7	3.9
B	08°56'27.6"	007°04'58.9"	201	2.56	7.12	5.26	1.8
C	08°56'25.7"	007°04'59.3"	193	1.59	15	30.9	10
D	08°56'32.2"	007°04'54.2"	196	0.92	16	5.12	5.6
E	08°56'22.5"	007°04'54.1"	189	1.1	21.3	8.1	9.3
F	08°56'24.2"	007°05'02.2"	188	0.91	13.5	4.3	2
G	08°56'24.5"	007°05'01.3"	190	1.4	21.7	13	9
H	08°56'24.3"	007°05'02.9"	194	2.85	25.7	9.1	6.1
I	08°56'23.2"	007°05'04.5"	194	0.64	10	21.6	3.8
J	08°56'24.7"	007°05'04.8"	189	0.89	14.3	12.7	10.4
Total				15.16	153.4	121.08	61.9
Avg					15.3	12.108	6.19

Table 3 displays a list of municipal waste composition in quantity and percentage gotten from human effluents in Abuja. These are commonly found items in drainages, streets, and on water bodies. Majority of water found in drainages are connected to ground water and most interactions include solute expulsion of ground water into surface water features, and ground water recharging through surface water producing variations in ground water supply quality (Emenike 2016; Badia FG 2018). 60%-70% of ground water pollution resulted from surface pollution and it is therefore necessary to determine the role and connection between surface and ground water in the hydrological cycle for effective use. Drinkable water which

contains excess chemicals beyond the WHO approved standard, can constitute health issues.

Paiko River is located in Abuja, downstream of river Usman between latitude 8°59' and 9°00'35" longitude 7°00' and 7°02'. This is a major source of water for the population in this locality and also serves as a major dumping site. A recent study was carried out on the evaluation of waste discharge in this river through analysing water from stream, which result shows that, the water quality has been reduced as a result of the percentage and presence of oil, grease, alkalinity and chloride which surpasses the WHO acceptable standard (Gu, 2016).

Table 3. Municipal waste characterization for the Federal Capital City.

Composition of municipal waste	Quantity [tons]	Percentage %
Paper	16112.944	25.3
Textile	1930.3099	3.03
Plastic	5357.6878	3.4
Water sachets	9257.8228	14.5
Glass	2250.3883	3
Metal	2642.8035	3.14
E-waste	1786.329865	2.8
Organic materials; food and garden waste	28420.7616	42.6
Other organic materials	1948.06	2.15
Total	63707.10747	100

Figure 2 displays a photograph of the captured drainage which has been clogged with waste from sewage, household, and commercial activities. Inhabitants leaving here collect water from wells which have been polluted as a result of contaminated ground water. This water better still, are used for drinking and cooking. Research proves that typhoid fever is an acute illness caused by Salmonella enterica serotype typhi bacteria found in water and contacted by drinking and eating substances infected with it. Diarrhoea is not left out as this is commonly associated with children below 5 years old which always play around this environment and decide to suck their hands during and while playing, aiding the transmission of Rotavirus Escherichia coli which are the two most common etiological agent of moderate to severe diarrhoea in developing countries.

Failure of drainage channels

Flood is inevitable when drainages are blocked. Flooding depends on the amounts of causative factors which can be traced to the geography of a place, intensity of rain falls, capacity of

drainage channels, tidal flow and natural disaster. The effect derived from flooding is also been associated with the intensity of water flow around the environment.

Data collected from Table 4 at Ungwan Shanu, was analysed using Chi Square test and was calculated against a critical value at 0.05 significance. This rejects the hypothesis that there is no significance difference in the level of solid waste found in drainage channels. This finding show there should be expected flooding around neighbourhood during intense rainfall as shown from the table, there is a significant difference in the amount of space left for water to flow after waste has been deposited into drainage channels. Flash floods are expected to occur here as these floods are only for a short while.

Figure 3 displays a pictorial diagram of the research area showing how water channels are blocked by buildings, due to poor building plans and lack of inadequate spaces for water channels. Most drainage ways are being converted to building sites.

Table 4. Waste data causing drainage failures in Ungwan Shanu.

S/N	Longitude	Latitude	Elevation	Drainage depth(M ²)	Drainage area	Covered areas	Uncovered areas
A	08°56'27.5"	007°04'58.6"	205	2	8.76	13.7	3.9
B	08°56'27.6"	007°04'58.9"	201	2.56	7.12	5.26	1.8
C	08°56'25.7"	007°04'59.3"	193	1.59	15	30.9	10
D	08°56'32.2"	007°04'54.2"	196	0.92	16	5.12	5.6
E	08°56'22.5"	007°04'54.1"	189	1.1	21.3	8.1	9.3
F	08°56'24.2"	007°05'02.2"	188	0.91	13.5	4.3	2
G	08°56'24.5"	007°05'01.3"	190	1.4	21.7	13	9
H	08°56'24.3"	007°05'02.9"	194	2.85	25.7	9.1	6.1
I	08°56'23.2"	007°05'04.5"	194	0.64	10	21.6	3.8
J	08°56'24.7"	007°05'04.8"	189	0.89	14.3	12.7	10.4
Total				15.16	153.4	121.08	61.9
Avg					15.3	12.108	6.19



Figure 2. Garbage and decayed substances in Ungwan Shanu.



Figure 3. Constructed houses and domestic waste hindering flow of water.

A. Loss of habitat: As a result of flooding, ecosystem has been destroyed as external and foreign materials are being introduced and pioneers of the existing habitat are washed away such as flora and fauna are been displaced.

B. Loss of agricultural land: Agricultural lands are exposed to submerge there by reducing the amount of oxygen intake in the soil by plant. Nitrogen which are needed for growth are been washed away and slows the growth of crops. Here, soils are washed off exposing plant root to the surface. Microbes found in the soil have been displaced by water which leaves the soil bear and empty. Farm animals are affected because most farm animals end up drowning or falling ill as a result of exposure to unhealthy environment and the intake of contaminated water. Feeding becomes difficult as nearby grazing lands are being inundated.

C. Displacement of properties: Records shows it that most people staying along drainage areas, channels, and low land are more prone to loss of properties. Lives could also be lost if measures are not put in place. This could lead to mass migration and psychological effect.

D. Disruption of social economical activities: Movement, transportation, buying and selling could be affected as a result of infrastructures been destroyed in the affected areas. This will also affect the standard of living of individuals.

Some possible means of solid waste disposal

Sanitary landfill: The sanitary landfill is defined as a process of solid waste disposal on land surfaces without creating a threat to public health or safety by confining the solid waste to the smallest practical area, to reduce it to the smallest practical volume, and to cover it with layers of earth at the conclusion of each day's operation (Khound, 2016). Some landfills are used for waste temporary management purposes, such as storage, consolidation and transfer, or processing of waste material such as sorting, treatment, or even recycling (Kimosop, 2016). Landfill method should be carried out in such a way that both surface and underground water will not be contaminated by waste products (Kiyamaz, 2014).

Incineration: Incineration also called combustion is a thermal treatment of majorly municipal solid waste, hazardous

waste, and medical waste converting them to gaseous products and ash. This is highly efficient as it can also be used to generate energy using incineration plants. It is a more practicable and efficient way of disposing municipal solid waste as volume of waste is being reduced by 85%-90% (Li, 2014).

Recycling: Recycling is a sustainable method of waste disposal which reprocesses waste into a raw state that can be used to make a quality product for continuous use. Recycling is a method which involves the collection and re-use of specific classes of solid waste generated such as glass bottles, stainless steel, food and drink cans, metals etc., for the purpose of sterilization, refurbishing, and reuse (Luo, 2017).

RESULTS

The results of waste data collected from drainages shows that the total area covered by solid waste is 95.31 m and the area uncovered by waste is 28.9 m. Solid waste data collected from constructed water channels shows that total area covered by waste exceeds that of the uncovered area. Data collected from wastes causing drain failures shows expected flooding during intense rainfall.

DISCUSSION

As a result of human activities on water channels the effects of drainage clogging cannot be over emphasised as this is significant to increased flooding's, air and water pollution, poor aesthetic quality of the environment and the number of mosquitoes, rodents, cockroaches and flies found in the environment. Unlawful waste dumping in Nigeria must be stopped through maintaining law and others. This can also be achieved through making of public announcement in social media and placing restrictions by attaching penalties to any one going against the authorities, and being monitored by the Abuja Environmental Protection Board AEPB.

CONCLUSION

Recycled materials should be encouraged and financially supported by both government and private stakeholders. There is a need for urgency so that Nigeria government can implement policies that can promote measures to proper

collection and improved method of disposal. Human health and the environment need to be safeguarded from unsanitary conditions caused by indiscriminate solid waste disposal that has always led to pollution and outbreak of diseases.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

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