Journal for Worldwide Holistic Sustainable Development
ONLINE ISSN: 2409 9384
PRINT ISSN: 2414 3286
2020 VOLUME 6 ISSUE 2

Rethinking The Approach to Domestic Sewage Management in Nigerian Cities

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Abstract

This paper reviewed the current situation of domestic sewage management in Nigerian cities with the aim of suggesting more sustainable ways of improvement where necessary. Secondary data were largely explored through existing published and unpublished materials, reports, dissertations, and other related documents relevant to domestic sewage management, both in electronic copies (online or offline) and hard copies and are acknowledged in the references. The paper revealed that sewage management is one the key services in cities that largely influences its environmental performance and sustainability. Past studies have shown that developed nations are characterized by a robust sewerage system that encourages sustainability, unlike, the developing countries that are basically practicing onsite and non-sewerage systems. In Nigeria, only Abuja the Federal Capital Territory has an operational treatment plant for phase one and parts of phase two with 20-30% capacity due to technological gap. However, most of the laws and regulations, governance structure and research / studies within and outside Nigeria had focused on sewage management from the quality of the effluent released from industrial processes but neglected domestic sewage where waste water is also generated in cities and is a major contributor of municipal sewage. Therefore, this study concludes with the need to refocus interventions, and research by relevant stakeholders on sewage, and provision of sustainable frameworks that will enhance realization of Sustainable Development Goal 6.2 & 3 and 11 on reduction of the release of untreated domestic sewage to the environment, end open defecation in order to actualize sustainable and habitable cities.

Key words: Cities, Domestic sewage, Framework, Sewage management, Sustainability.

1.0 Introduction

Sewage management is amongst the key municipal services that determines the environmental performance and quality of cities. Societies with highly urbanised systems have their production and consumption activities, largely depending on the infrastructural resources, flow on energy, water, sanitation and sewage management for their existence and sustainability (Nigerian Advisory Infrastructural Facility, NAIF, 2012). When these service provision become inadequate or fail, the functionality and status of such cities drifts to a 'sorry state.' Nigeria is a

signatory to the Sustainable Development Goals on "achieving equitable sanitation, hygiene, end to open defecation and reduction of pollution through untreated sewage by year 2030" (Office of the Senior Special Assistant to the President on SDG's, National Bureau of Statistics and United Nations Development Program, 2017), yet its cities are experiencing challenges in domestic sewage management. Today, cities now house 55% of the global population and by the year 2050, they shall accommodate 68%, an increasing inflow of 2.5 billion urbanites with 35% contribution from Asia and Africa from years 2018-2050 (United Nations Department of Economics and Social Affairs, UNDESA, 2017). Therefore, as urban populations increase, consequential increases on sewage generation, quantity and services become inevitable (Asemota, Alkhadar, Sertyesilisik and Tunstall, 2011). In addition, most urban dwellers in developing nations live in slums and do not have adequate access to basic urban services, such as sewage management (UN-Habitat, 2016). By extension, without any significant intervention, more and more challenges associated with urbanisation including sewage management, shall abound in years to come.

Records of the past centuries have shown that across large parts of Europe, sewage was disposed on streets of living quarters with dense population, resulting in filthiness and source points for epidemics (Lucking, 1984; Sorcinelli, 1998; Brown, 2005; Human Development Report (HDR) 2006; and Aiello, Larson, and Sedlak, 2008). In response to the health problems that emanated from sewage borne diseases, modern cities evolved some management approaches for proper handling of sewage and provision of clean drinking water to help curb aforesaid menaces (Seeger, 1999; Schifrin, 2005; Brown, 2005; Vuorinen, Juuti, and Katko, 2007; Cooper, 2007).

In addition, agreements emerged on the use of appropriate, best available practices, and technological know-how in sewage handling (HDR, 2006). It is against this background that most developed and developing countries of the world established sewage governance, and technologies in order to ensure proper sewage handling to achieve good sanitation, environmental performance, and quality. Though, up till now, the extent to which the sewage is managed varies from one country to another depending on the enabling environment available for it to thrive.

Nigeria is a West African state that has remained a Federal republic since its amalgamation (North and southern parts) by the British colonialists in 1911 and currently has thirty-six states within six geo-political zones. It is located on longitude 3^0E and 15^0E degrees and latitude 4^0N and 14^0N as shown on figure 1.1, within the tropical region of sub-Saharan Africa (National Communication, 2003; Oguntunde *et.al*, 2011). The country covers a land mass of 923, 768 sq. km and a total coastline distance of 850 kilometres National Communication, 2003; Nwilo *et.al*, 2006), with a three predominant climatic regions of Highland climate Jos Plateau and Mambilla Plateau (Adamawa, Taraba and Obudu mountains of Cross rivers); Tropical savanna (North central, North East, and North West region); and Tropical rainforest/ Monsoon (South East, South-South, and South West) (Allu, 2014; Allu and Ochedi, 2015). Its land border includes, Niger to the North, Chad and Camero on to the east, Gulf of Guinea and Atlantic Ocean to the South and Benin to the West as shown in figure 1.1. It is amongst the most populous countries in Africa with a projected 2016 population size of 193, 392,517 (https://nigeria.opendataforafrica.org/hlvbkge/nigeria-population).

The topography is multifarious of plains in the north (Hausa plains), plateaus and hills and outcrops of inselbergs, mesa and butes in the North, central and southern parts is made up of the Basement complex, while the depressed areas such as the Lake chad, River Niger, Coastal areas, and Sokoto basin consists of Sedimentary basin. The south western parts of the country consisting of Cameroun and Adamawa highlands with highest points of 2,419 meters above sea level and Gotel and Dimlang mountains 2,042 meters (encyclopaedia britannica.com).

However, in spite of the aforementioned setting, Nigeria is still living with the quagmire of inappropriate onsite domestic sewage management that has the potential of polluting underground sources of water, the predominant water supply source for most households and a major cause of sewage borne diseases (Obada and Oladejo, 2013; UN-ESCAP, UN-HABITAT, and AIT, 2015). Without treatment plants and with many of open defecation and indiscriminate release of untreated sewage to the environment in urban areas, the issues are dire (Federal Government of Nigeria and UNICEF, 2016). This inspired the thrust of this paper with the aim of suggesting ways forward that may initiate reconsidering more sustainable ways of improvement, where necessary.

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Figure 1.1: Nigeria and its borders
Source: http://www.infoplease.com/atlas/country/nigeria.html

2.0 Conceptual issues on sewage

The British Department of Environment, Food and Rural Affairs (2010) and Corcoran, Nelleman, Baker, Osborn and Savelli (2010) define sewage as a liquid waste that occurs in the form of black water (toilet-used water and feacal sludge) and grey water (all other forms of used water from bath tubs, kitchen sinks, showers, and laundry). In some countries like the United States of America, sewage and sewerage are the same, while the British use the terms differently (Neilson William, Knott and Thomas, 1934; Wagnal, 1960; Flexner, Sturat, Hauck, Leonore, 1987). But in the technical sense, sewerage means the various wares (network of pipes) that aid the movement of sewage (Flexner, Sturat, Hauck, Leonore, 1987; Oxford Dictionaries.com). Metcalf and Eddy (1991) observed that sewage is an old term in use for liquid waste, but recently, waste water seems to be the most often used by scholars. In this light, the term *sewage* can be used interchangeably with waste water, being that they both are liquid waste and are municipal, domestic or industrially generated. Sewage can be classified based on their sources of generation, for instance, sewage generated from bathing, cooking, laundry in residences, car-washing services in commercial areas and abattoirs, and swimming pools in institutional facilities can be referred to as *domestic sewage* or *sanitary waste water*. *Industrial sewage* or

effuent emanate from processing, washing and water-cooling systems of industrial activities. Infiltration and Inflow sewage are usually the waste water that flows through leaking points and cracks in pipes/ sewerage or manholes that covers the sewerage networks. Storm water and runoff sewage are sourced from rainfall and snowmelt that flows on surfaces (https://cgi.tuharburg.de).

2.1 Global situation of sewage management.

Globally, about 9, 500, 900 m^3 of sewage (9.5 million m^3 of human feces and 900 m^3 of grey water) are generated daily in cities (Mateo-Sagasta, Raschid-Sally, and Thebo, 2015). The management of this huge quantity differs from one country or continent to another, largely influenced by the existing governance structure, guidelines for practice, and available technological options. Sewage management in developed and some developing nations is anchored by standards, guidelines and regulations on sewage management, with established agencies for regulation and enforcement of the provisions of the guidelines. In such cases, cities are served with well-designed waterborne sewerage systems that are linked to offsite sewage treatment plants.

2.1.1 Developed nations context

The European Union (EU) countries handle their sewage within the three pillars of sustainability the sanitation spheres of environmental, economic and social responsibility (Asemota, Alkhaddar, Sertyesilisik and Tunstall, 2011). They manage their sewage in accordance to the provisions of the EU council directive 91/271/EEC of the 21st of May 1991, as amended by Commission directive 98/15/EC of 27th February, 1988 (EU Council Directive, 1991; Stamou, 2014). For instance, the England and Wales public sewerage network collects approximately 10 billion litres of sewage from households and industries, and about 9,000 sewage treatment plants treat this sewage to permissible levels before discharge to inland water, estuaries and the sea (Department for Environment Food and Rural Affairs, DEFRA, 2010). However, before now, the World Health Organisation, WHO and UNICEF (2000) had reported that over 20 million EU citizens, mostly in Central and Eastern Europe, lacked access to safe sanitation. This manifests more in rural areas where financial resources are insufficient to

provide the requisite facilities for appropriate management. The simple explanation to the problem, was the undermining of the weakness of article 3 of the EU regulation on urban waste water which states that "...only localities with populations equivalent of more than 2,000 persons should be served with urban water collection systems and adequate biological treatment (https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1991L0271:20081211:EN:PDF) ". However, several approaches were imbibed to overcome the constraints to achieving a sustainable management practice, such as the decentralisation of the sewerage systems (Asemota, Alkhaddar, Sertyesilisik and Tunstall, 2011). Interestingly, the proportion of population that are connected to waste water treatment plants in European countries which was low before 1995, has now increased above 80% with 75% receiving tertiary treatments (www.eea.europe.eu)

The Environmental Protection Authority, EPA is a governance structure for the United States of America that provides the guidelines and framework for sewage management, and its cities are connected to an offsite central sewerage network (Burian, Nix, Robert, Pitt, and Durrans, 2000). In some American states, onsite waste water management is in use, while about 76 per cent to 100 percent sewage from residential areas are safely treated before release to surface water and environment (United Nations Water, World Health Organisation and UN Habitat 2018).

In the Kingdom of Saudi Arabia, sewage management is regulated and controlled by the Ministry of Water and Electricity (Ouda, 2015), and they regulate and guide the permissible level of organic pollutants such as nitrates, phosphorus, and ammonium just to mention a few. These pollutant levels are measured using certain techniques such as the alkalinity, conductivity, dissolved solids in sewage, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), just to mention a few. The sewerage systems are only available in large urban towns and waste water disposal is restricted to only a few cesspits in smaller towns and rural areas (Abu-Rizaiza, 1999).

In South Africa, the National Environmental Management Act 107 (1998) and the constitution of the Republic of South Africa (1996) guide the operations and regulation of the waste treatment plants in the country (Gopo, 2013). The central offsite sewerage system is predominantly in use in most cities of South Africa with about 824 treatment plants and only about 10% of the plants release treated or clean water, and about 50,000 liters of sewage is discharged every second (Kings, 2017). This means that most of the treatment plants are not operating in full capacity or are dysfunctional. This situation has negative implications on sewage management in the region.

The notable feature that is common amongst the aforesaid countries on sewage management is the presence of a strong sewage governance regime in terms of regulatory agency, guiding policy and regulation, and treatment plants that ensures the release of only treated waste water to the environment.

2.1.2 Some Developing nation's context

In most low-income developing nations, the onsite sewage management (pit latrines, septic tanks/vaults, soak way, pour flush) and significant incidences of open defecation are largely in use (Asemota, Alkhaddar, Sertyesilisik and Tunstall, 2011; Strande, Ronteltap, and Brdjanovic, 2014).It is also globally estimated that, 2.4 billion people do not have access to improved sanitary facility including one billion people who will resort to open defecation (Joint Monitoring Programme, JMP, 2015). The population of users of onsite sanitation systems are projected to double by the year 2030 (Strande, Ronteltap, and Brdjanovic, 2014). Looker (1998) adds that, in most cases the sewage collection systems in many cities of Asia, Africa and Latin America are mostly water-borne systems that lack treatment plants. A large population in most developing countries lack sewer network connections, and only 10% of populations of some sub-Saharan countries, for example, Cote d'Ivoire, Kenya, Lesotho, Madagascar, Malawi and Uganda, are connected to a sewer system (Banrjee and Morella, 2011). Most alarming is the release of about 80%-90% untreated waste water into flowing rivers and streams (Chung and Badiane, 2016).

Furthermore, reports of the UN Water, WHO and UNICEF (2014) highlighted that some households in middle and low-income developing countries had improved sanitary facilities, yet just a few have access to safe functioning toilets along the sewage management chain. For example, Tanzania in Dar Es Salam has about 97% of its urban population with an unsafe sewage management practice with regard to on-site feacal matter disposal (Jenkins, Cumming, and Cairncross, 2015).Therefore, it is obvious developing nations that are without adequate or weak sewage governance, technologies and adequate regulations will continue to dispose untreated sewage that pollutes streets, freshwater bodies and degradation of environment, undermining the goals and targets of the SDGs 6.2 and 3 on Water, Sanitation and Hygiene, WASH, which seek to end open defecation and halve the release of untreated waste water by the year 2030.

2.1.3 Sewage management situation in Nigeria

Studies by several scholars have revealed the status of sewage management practices in Nigeria, ranging from sewage governance to the non-existence of sewerage systems in cities. Adewumi and Oguntuase (2016) in their study on planning for waste water reuse programme in Nigeria revealed that most Nigerian cities do not treat their sewage before final release to the environment. Further, they recommended the reuse of waste water after treatment to avoid the negative effects it would have on ecosystems and humans.

Oji, Chukuma, Friday and Philip (2018) also carried out a perception study on reuse of urban waste water and the existence of urban waste water treatment plant in the Awka urban area of Anambra state. Their study revealed the absence of a treatment plant in the city, and about 53.4% of residents in Awka indicated low knowledge of waste water treatment, while 56.8% would not want to reuse waste water in any form. Their study corroborates the earlier findings of Idirs-Nda, Aliyu, and Dalil (2013) on Minna-Niger State, who ascertained the absence of municipal waste treatment plant and how most residents practice onsite vaulting management via septic tanks and pit latrines. Also, about 63% of residents of Minna town-Niger state are not aware of sewage treatment and the possibilities of waste water reuse and its consequences.

Studies by Ishaya (2016), Ogbonize, Adie, Igboro, and Giwa, (2016), Daya and Abbas (2016), Musa and Okonkwo (2017) revealed the presence of industrial wastewater treatment plants in Kaduna town. These treatment plants are owned by, and also domiciled in individual industries for the purpose of treating effluents from their production activities. It was observed that some of the treatment plants sometime fail and malfunction, thus leading to the release of untreated effluent to streams and the environment. This situation agrees with the reports of Asemota, Alkhaddar, Sertyesilisik and Tunstall, (2011), that in Nigeria, only a small fraction of urban sewage is treated with some wealthier and industrial neighbourhoods having offsite central sewerage and treatment plants, whereas, the low-income neighbourhoods have none.

In the Federal Capital Territory (FCT) Abuja, studies by Kadafa, Ayen, Idris, and Braimah (2018a & b) revealed the presence of a waste treatment plant in WUPA Phase III. This facility works at a 92-99% efficiency rate. Oluwadamisi (2013) also established the presence of some treatment plants in Phase I and II of the FCT such as the Wuye Lagoon, Gudu, Niger, Lungi, Mogadishu barracks, and Sheraton treatment plants. He ascertained a working capacity of about 20%-30% efficiency capacity, due to problems associated with population explosion that increases high sewage generation beyond the capacity of installed facilities and poor maintenance, as well. The FCT because of its model city plan philosophy has the aforesaid treatment plants because Abuja was envisaged to be a city free from sewage-borne diseases and to serve as an example to all Nigerian cities on sanitation and hygiene. Unfortunately, only Phase I and parts of Phase II is fully-served with treatment plants. Later parts of Phase III, IV and the Local Councils (satellite towns) are yet to be served, partly because the rate of urbanisation and leap frog development of the FCT undermines the urban services provision phasing of the city. The Federal Government of Nigeria and UNICEF (2016) and Obinna, (2019) reports that sustainable sewage management has continued to be a problem in Nigeria, with over 146 million people involved in open defecation, making the country rank second (2^{nd}) in the global ranking of countries with this ugly practice.

Lagos generates over 1.5 million m^3 of sewage per day, and just about 1-2% of the population is connected to an offsite treatment plant. Its black water is collected in septic tanks; soak-away onsite systems and their grey water discharged in open drainages; or gutters in some

cases flowing on streets (Anderson, et.al, 2016). Adekanbi, 1979, Adenuga, Ogujiuba and Ohuche, 2003, Aina, 1991; Orubu, (2006); Awomeso, Taiwo, Orebiyi, Orekoya and Odjegba (2010) justified the above assertion by their findings that sewage management in Lagos-Nigeria includes direct disposal of the sewage or release of by-products (sludge) of the minimally treated ones to the environment. This is associated with some problems such as the pollution of coastal waters, eutrophication of receiving water bodies (streams, lakes, and rivers), and disposal of sludge from wastewater treatment plants that causes siltation of surface water bodies and difficulty in flowing rates, flooding during storm events, and ultimately high pollution and depletion of underground water. Awomeso, Taiwo, Orebiyi, Orekoya and Odjegba (2010) and Asemota, Alkhaddar, Sertyesilisik and Tunstall (2011) corroborate the aforesaid findings that is, about 94 per cent of Lagos population have no access to sanitary toilets and the predominant management practice is the onsite sanitation systems such as the soaka way pit latrines, pit privies, pour flush latrines, and the septic and soak away pits.

Using the United States Environmental Protection Agency (USEPA) standards of 15 meters setback, Oladimeji, Shittu, and Amali (2016), in a study of on-site septic tanks proximity to water wells in Samaru, Zaria, found that out of 190 hand-dug wells studied in the area, 71% (134) were not located at the relatively safe setback of 15 meters from the nearest septic tanks. This shows the vulnerability of such populations to health risks associated with sanitary practices related to sewage management in our context.

It is noteworthy that poor sewage management practices can also have socio-environmental dimensions, as found in a study carried out by Oladimeji, Atere, Meshubi, Dauda and Ikpe (2015) in Zaria, Nigeria, where it was shown that social conflicts also occurred between residents living in unplanned neighbourhoods because of poor household wastewater management practices engaged in by some residents. This finding highlights the fact that poor wastewater management practices do not just impact on health and hygiene but can also impair peaceful coexistence between residents living in unplanned neighbourhoods especially in cases where neighbours carelessly dispose of wastewater into the property boundaries of other residents.

From the aforesaid studies and revelations, the sewage management practices in Nigeria can be said to have the following features: sewage management practice in Nigeria, is predominantly onsite non-sewerage systems. Urban dwellers dispose sewage, largely grey water, through open drains/ gutters and in some areas, it flows on the streets and through the vaulting of black water into septic tanks and soak away pits. There is an almost non-existent system of treatment plants for domestic sewage generated in urban areas. The presence of waste treatment plants, where found, are largely in the industrial areas of most cities and the central seat of government in the FCT. Formal regulations only exist for industrial effluent and none for domestic sewage. There is also poor knowledge of Nigerians on domestic sewage treatment plants and the integrated wastewater management approaches, for instance, reuse of treated waste water. Generally speaking, the sewage generated in Nigerian cities do not pass through any form of treatment and carries heavy loads of bacteria, viruses, protozoa that transmit infectious diseases, degrade environmental performance and quality and continue to pollute soils, surface and underground water sources through infiltration and seepage.

3.0 The way forward

Considering the findings of studies on the status of sewage management in Nigeria, it is obvious that we need a rethink on the approach to sewage management generally and particularly for the domestic situation. The current approach is not sustainable and makes the majority of our population vulnerable to sanitary risks. Sewage management needs a roadmap geared towards achieving the Sustainable Development Goals (SDG) 6.3 & 6.4 because of the huge gap that exists between industrial sewage handling in relation to domestic sewage. Most towns in Nigeria, with the exception of FCT, Abuja do not have domestic sewage treatment plan. Even the FCT, Abuja, only has 20-30% efficiency of the treatment facility in use within the Phase I and parts of phase II of the territory. There is therefore, the need to carry out additional studies on the predominant sewage management systems in Nigerian cities, in order to synthesise baseline data on the management practices currently in use. Such studies will help in developing models and strategies for improvement towards achieving the SDG's goal on Water, Sanitation and Hygiene, ending open defecation, and reducing the quantity of untreated sewage released into our environment. This may also help in mitigating other less obvious endemic consequences.

Domestic sewage (black water) contains methane gas (CH_4), which is good for energy generation. Perhaps, viewing sewage as a resource and the adoption of International Renewable Energy Agency, IRENA (2020) will move Nigeria towards generating renewable bio-energy as an alternative supply to cities in pursuit of sustainable development. So, to start, research might begin to focus on the quantity, quality and infrastructure as a way domestic sewage can be harnessed as an alternative source of power for cities. Also, there is the need for more public awareness on the threats posed by untreated sewage in our cities. In addition, integrated wastewater management systems should be promoted in our cities. Considering the prevalence of informal urban development of most neighbourhoods in our context, it is also important to promote safer practices in the location of water wells, particularly in relation to on-site septic/ soak away tanks. This will help in mitigating risks associated with maintaining hygienic potable water supply from such sources.

4.0 Conclusion

Sewage Management is critical in determining environmental performance, quality and aesthetics. Therefore, there is a need to rethink the approach to current practices and find more sustainable ways of managing the situation. This cannot be achieved by government and its agencies alone but will take the involvement of all stakeholders, including the private sector and households. There is a need to provide sustainable frameworks that can promote proper sewage management and make cities move towards the path of less sewage-borne diseases, creating more aesthetic living environments and a more sustainable urban ecosystem in general.

REFERENCES

Adekanbi, E. O. (1979). A study of the industrial effluents and waste disposal habits of some industries discharging directly into the Lagos Lagoon (Unpublished MSc. dissertation) submitted to the Department of Chemistry, University of Ibadan, Nigeria.

Adenuga, A. O., Ogujiuba, K., & Ohuche, F. K. (2003). Sustainability of the environment and water pollution in Nigeria: Problems, management and policy options. Washington, DC, United States Agency for International Development.

Adewumi, J.R. and Oguntuase, A.M. (2016). Planning of waste water Reuse programme in Nigeria. *Consilience: The Journal of Sustainable Development* Vol. 15 (1) pp. 1-33.

Allu, E. L. A. (2014). Climate Change and Buildings in Nigeria: A Search for Mitigation and Adaptation Framework for Residential Design Guide. A PhD Thesis Submitted at De Montfort University, Leicester- UK.

Allu, E.LA., and Ochedi, E.T. (2015). Sustainable Urban Built Environment for Nigeria: a Framework Approach. *International Journal of Contemporary Applied Science,*Vol. 2 (5), pp. 96-107

Anderson, K., Arno, R., Lamizana, B., Kvarnström, E., McConville, J., Seidu R., Dickin, S. and Trimmer, C. (2016). Sanitation, Waste water management and Sustainability from waste disposal to resource recovery. Report of United Nations Environmental Program (UNEP) and Stockholm Environment Institute (SEI) Report.

Asemota, L., Alkhaddar, R., Sertyesilisik, B., and Tunstall, A.(2011). Wastewater Management in Lagos: Moving toward a more sustainable Approach. Retrieved from www.researchgate.net/publication/260357925on the 18th of October, 2019.

Awomeso, A.J,Taiwo, A.M.,Orebiyi, O.E,Orekoya, A.O, and Odjegba E.E. (2010). Effect of Untreated Sewage Dump on the Quality of Groundwater in Iddo Co mmunity, Lagos Nigeria. *Journal of Agricultural Science and Environment,* 10 (1), pp. 98-106.

Burian, S J., Nix, S.J., Robert E. Pitt, R.E, and Durrans, S.R. (2000). Urban Wastewater Management in the United States: Past, Present, and Future. *Journal of Urban Technology*, Volume 7 (3), pp. 33-62.

Chung, R. and Badiane, (2016). Policy guidance manual on waste water management with special emphasis on decentralized wastewater treatment systems. United Nations. ESCAP, UN Habitat, Asia Institute of Technology, AIT. Retrieved from www.unescap.org/publicationsprinter/inkon paper.co.ltd/ Bangkok Thailand on the 6th October, 2018.

Corcoran, E., Nellemann, C., Baker, E, Bos, R., Osborn, D., and Savelli, H. eds. (2010). Sick Water? The central role of wastewater management in sustainable development. A rapid

response assessment Arendal Norway: UNEP/ GRID-Arendal. Issbn 978-82-7701-075-5 retrieved on the 23.03.2019 from pdf file.

Daya, B.A, and Abbas, M.A. (2016). Analysis of Waste Water Treatment in Kaduna Refining and Petrochemicals Corporation, KRPC, NNPC, Kaduna. *Journal of Engineering Research and Application*. Vol. 6 (7), pp. 46-51. Retrieved on the 19th of November, 2019 from www.ijera.com

Department for Environment, Food and Rural Affairs, DEFRA (2010).National Policy Statement for Waste Qater: A framework document for planning decisions on nationally significant waste water infrastructure presented to parliament pursuant to section 9(2) of the planning Act 2008 retrieved from https://www.defra.gov.uk/corporate/consult/wastewater ISBN: 9780108509520 Printed in the UK for The Stationery Office Limited on behalf of the Controller of Her Majesty's Stationery Office published by TSO the stationary office.

Domestic Wastewater sources and its characteristics retrieved from https://cgi.tu-harburg.de/~awwweb/wbt/emwater/lessons/lesson_a1/lm_pg_1066.html on the 28th of October, 2019.

European Environment Agency www.eea.europe.eu retrieved on the 22.01.2019.

European Union Council, (1991). Directives concerning Urban Waste Water Treatment 91/271/EEC. *Official Journal of the European Communities* no. 1 135/ 40 on the 30th May, 1991. Retrieved from CELEX-31991L0271-en TXT.pdf http://eur-lex.europa.eu/legal-content on the the 30.01.2019 @ 1532hrs

Federal Government of Nigeria and UNICEF (2016). Making Nigeria Open-Defecation-Free by 2025; A National Road Map. Retrieved from https://www.unicef.org/nigeria/reports/making-nigeria-open-defecation-free-2025-national-road-map on the 15th March, 2019.

Flexner, Sturat, Hauck, Leonore, 1987, the Random H ouse Unabridged Dictionary. 2nded. New York City, Random House published in 1993) p. 1754

Funk and Wagnal, 1960. Standard Dictionary (International Edition) New York, p.1960. p.1152

Gopo, Q.N. (2013). Regulation of wastewater treatment plants in the Ba-Phalaborwa Municipality. Mini-dissertation submitted in partial fulfillment of the requirements for the degree Magister Legumin Environmental Law and Governance at the Potchefstroom Campus of the North-West University, South Africa.

https://nigeria.opendataforafrica.org/hlvbkge/nigeria-population 2016 Projected Population of Nigeria retrieved on the 06th of November, 2020.

https://www.britannica.com/place/Nigeria/Languages#ref259742 Nigeria.

Idris-Nda, A., Aliyu, H.K., and Dalil, M. (2013). The challenges of domestic wastewater management in Nigeria: A case study of Minna, central Nigeria. *International Journal of Development and Sustainability* Vol.2 (2), pp. 1169-1182. Retrieved from www.isdsnet.com/ijds on the 18th of June, 2018.

Ishaya, S.L. (2016). Effects of Kaduna Refinery Effluent on the water Quality of Romi River Kaduna State, Nigeria. An unpublished M.Sc. Thesis submitted to the Department of Geography and Environmental Management, Ahmadu Bello University, Zaria.

IRENA (2020). Rise of Renewables in Cities: Energy Solutions for the Urban Future, International Renewable Energy agency, Abu Dhabi, p. 114.

Jenkins, M.W, Cumming, O., Cairncross, S. (2015). Pit Latrine Emptying Behaviour and Demand for Sanitation Services in Dar Es Salaam, Tanzania. Int*ernational Journal of Environmental Research and Public Health* ISSN 1660-4601. Retrieved from www.mdpi.com/journal/ijerph on the 07.10.2018.

Joint Monitoring Programme, JMP, (2015). Progress on Sanitation and Drinking Water – 2015 Update and MDG Assessment. Geneva, UNICEF and WHO Press. Retrieved from http://www.wssinfo.org/fileadmin/user_upload/resources/JMPUpdate-report-2015_English.pdf.on the 12th of June, 2020.

Kadafa, A.A., Ayeni, M.F., Idris, N.M., and Briamah, O. (2018a). Assessing the effectiveness of Mechanical Technology for Waste Water Treatment Plant in WUPA Sewage Treatment Plant, Abuja, Nigeria. A conference paper presented at the 9th International Conference tagged "Water, Energy, Food, and Environment (WEFE) Linkages organized by the Nigeria Association of Hydrological Sciences (NAHS) that held at the University Of Benin 19th -12th, October, 2018.

Kadafa, A.A., Ayeni, M.F., Idris, N.M., and Briamah, O. (2018b). Assessing the effectiveness of the Process of WUPA Waste water treatment plant, Abuja, Nigeria. A conference paper presented at the 9th International Conference tagged "Water, Energy, Food, and Environment (WEFE) Linkages organized by the Nigeria Association of Hydrological Sciences (NAHS) that held at the University Of Benin 19th -12th, October, 2018.

Kings, S. (2017). Environment. Mail and Guardian newspaper. Africa's B est R ead retrieved from www.mg.co.za on the 24th January, 2019.

Looker, N. (1998), "*Municipal Wastewater Management in Latin America* Municipal Water for the Canadian Environment Industry Association, 1998.

Mateo-Sagasta, J., Raschid-Sally, L. and Thebo, A. (2015). "Global wastewater and sludge production, treatment and use". In Drechsel,P., Qadir, M. and Wichelns, D. (Eds.)Wastewater: Economic Asset in an Urbanizing World. London, Springer.

Musa, U.,andOkonkwo, P.C. (2017). Assessment of Effects of Wastewater Discharge and Self Purification Potential of 'rafingiya' stream in Kudenda, Industrial Layout, Kaduna, Nigeria. *Asian Journal of Environment and Ecology* Vol. 4(2), 2017. Retrieved from www.journalrepository.org pdf on the 10thNovemeber, 2018.

Neilson William A., Knott and Thomas, A. 1934. Webster's new international dictionary of the English language. 2nded . Springfield, New York, C & C Merriam Company, p.2296.

Nigeria Infrastructural Advisory Facility (2012). Scoping study for solid waste management Audit of Kaduna Metropolitan Area report submitted to Kaduna state Environmental Protection Authority (KEPA).

Nwilo, P.C. and Badejo, O.T. (2006). Impacts and Management of oil spill Pollution along the Nigerian coastal line. *Administering Marine Spaces: International Issues*, Vol. 119, pp. 1-15.

Obada, E.M., and Oladejo, O.I. (2013). Groundwater Quality Appraisal in Southern Parts of Kaduna State, Nigeria. *American Journal of Environmental Engineering.* Vol. 3 (1), Pp. 77-83. Retrieved from online Doi: 10.55923/j.ajee.20130301.11 on the 17th of January, 2018.

Obinna, C. (2019). 47 million Nigerians practice open defecation-UNICEF published on the 25th of June, 2019 retrieved from https://www.vanguardngr.com on the 15th march, 2019.

Office of the Senior Special Assis tant to the P resident on SDG's, National Bureau of Statistics and United Nations Development Programme. (2017). Nigeria: Sustainable Development Goals, SDGs Indicators Baseline Report 2016. Published by Government of the Federal Republic of Nigeria. Retrieved from www.ng.undp.org on the 19th of October, 2019.

Ogbozie, F.J, Adie, D.B., Igboro, S.B., and Giwa, A.A. (2017). Evaluation of the Water Quality of River Kaduna, Nigeria Using Water Quality Index. *Journal of Applied Science Environment Management* vol. 21 (6), pg. 1119-1126 JASEM ISSN 1119-8362. Retrieved from www.ajol.info on the 26thNovember, 2018.

Oguntunde, P.G., Abiodn, B.J., Lischeid, G. (2011). Rainfall Trends in Nigeria, 1901-2000. Journal of Hydrology, Vol. 4(11), Pp. 207-218.

Oji, I.S., Chukwuma, N. P., Friday, N.K. and Philip, P. (2018). Domestic Waste water Treatment and Re-use in Awka Urban, Anambra State, Nigeria. *IIARD International Journal of Geography and Environmental Management* ISSN 2504-8821 vol. 4 (2). Retrieved from www.iiardpub.org on the 12.08.2019.

Oladimeji, J. S., Shittu, A. O., and Amali, I. D. (2016) Locational implications of water wells and septic tanks on sustainable urban environment. Paper presented at the 12th Annual National Conference of SOSEH.Held at the Ahmadu Bello University, Zaria, from the 14th to 17th of November 2016, pp.225-230.

Oladimeji, J.S., Atere, P.M., Meshubi, A.O., Dauda, P. I. and Ikpe, E. (2015). Socio-environmental dimensions of urban stormwater drainage development in an unplanned

neighbourhood of Zaria, Nigeria, *ARCHISEARCH International Journal of Architecture and Environment*, 5(1): 34-45.

Orubu, C. O. (2006). Water resources, environment and sustainable development in Nigeria. Journal of Human Ecology, 19, 169–181.

Ouda, O.K.M., (2015). Treated wastewater use in Saudi Arabia: challenges and initiatives. *International Journal of Water Resources Development*, Routledge Taylor and Francis Group. (Online) Journal homepage:http://www.tandfonline.com/loi/cijw20retrieved on the 19.01.2019.

Oxford Dictionaries.com sewerage- definition of sewerage in English from the Oxford dictionary Archive from the original on 24.09.2015 and retrieved on the 12.02.2019.

Stamou, A. (2014). Implementation of Urban Waste Water treatment Directive. Retrieved from www.researchgate.net/publication/237636171 on the 21.01.2019.

Strande, L., Ronteltap, M., Brdjanov ic, D., (2014). Feacal Sludge Approach for implementation and Operation. London IWA publishing.

UN Water, WHO and UNICEF. (2014). Progress on Drinking water and sanitation. 2014 update. Printed in Switzerland. Retrieved from pdf file www.unicef.org on the 04.11.2018.

UN W ater, WHO, UN H abitat (2018). Progress on Safe Treatment and Use of Wastewater. Piloting the monitoring methodology and initial findings for SDG indicator 6.3.1. ISBN 978-92-LEE

UN-Habitat (2016). Urbanization and Development: Emerging futures. World C ities Report 2016. Retrieved from from www.unhabitat.org on the 16.09.2019

United Nations Department of Economics and Social Affairs (2017). World Population Prospects (revised). Retrieved from www.vanguardngr.com/ on the 2017/ 07/08

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), United Nations Human Settlements Programme (UN-Habitat) and Asian Institute of Technology (AIT), (2015). Policy Guidance Manual on Wastewater Management. Bangkok, Thailand, United Nations and AIT publications, p. 144. Retrieved from http://www.nescap.org/publicationson the 16th of November, 2018.

World Health Organization/UNICEF. (2000). Global water supply and sanitation assessment, 2000 report. USA, WHO and UNICEF press, p. 79. Retrieved on the 16th of June, 2018from http://www.who.int/water_sanitation_health /monitoring/globalassess/en