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Dumping on Waters: The Lacunae in Waste Management in the Niger Delta, Nigeria

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ABSTRACT

The need to provide additional information towards adopting a well-developed and standard waste management scheme in Yenagoa Metropolis prompted this study. It was based on waste source, transferring process and stakeholders, location and elevation, ecological sensitivity, risk factors and general people's wellbeing. The operation of waste stakeholders and their activities were recorded on daily basis through Mass-Volume Analysis method using weighbridge scale for twelve (12) months (January–December 2021); Student-T test (t) and Two-Ways ANOVA were used to analyzed results. Results confirmed that, Etelebou is a government approved open-air-dumpsite for both liquid and solid waste; the Brikari Nig. Ltd. Company is transferring 50% solid waste while the Patico and Saturday (21.8% each) merged top commuters transferring liquid waste to the central Dumpsite. In general, the open-air-dumpsite is receiving an average 546.830 tonnes of waste annually consisting of 91% solid and 9% liquid with less than 10% material recovery for reuse and recycling. At 5% ($\alpha=0.05\%$) interval, the difference between weekly waste stream and wastes stakeholders (commuters) is insignificant ($0.324 < 2.57$); so also waste stream per monthly summary ($0.32 < 2.14$). We therefore discouraged the current dumping operation at Etelebou due to its elevation (5 meters below sea level), proximity to natural drainage with a porous geological structure that posses' ecological health risk on flora and fauna. Therefore, the study advises alternative disposal site and recommends controlled incineration, composting and waste recycling for best practice in low regions like the Niger Delta of Nigeria.

INTRODUCTION

Waste simply means the unusable part of a thing in a moment in life. Waste remained anything solid, liquid or gaseous that is seemingly useless or unwanted, stored up, dumped or discarded at a fixed point that may be reused, recycled, recovered for resources utilization or energy generation (Ebuete, Eremasi & Berezi, 2022). It also entails all material substances that are discarded after primary use or worthless, useless, defective and of unusable quality at a particular moment in time space by the direct users. Waste is an unavoidable daily by-product of all human activities; an aspect of life that has tied man as an aproned string in a geometrical form as against the arithmetic increase in the global population. This is because different stages of production and consumption process generate different forms and types of waste globally. The alteration of biological processes, to suit social, political, and economic systems through the industrial diversification and the provision of expanded health-care facilities have added substantial quantities of hazardous waste and biomedical waste into the waste stream with potentially severe environmental and human health consequences (Kaza, et.al., 2018). On this premise, records has showed that an average human generate about 0.74kilogram (range of 0.11 to 4.54 kilograms) per day; amounting to 2.01 billion tonnes annually by all human race and expected to grow due to the changing standard of human living (Chinedu, et al., 2018), with at least 33% extremely conservatively not managed in environmentally manner particularly in developing nations. Thus, it has exposed the world to the trajectory of where waste

generation (3.40 billion tonnes) will drastically outpace population growth (9.74 billion) by more than double by 2050.

On a continental view East Asia and Pacific region is generating over 361 million (23%) of the world waste; Sub-Sahara Africa about 174 million (9%) tonnes per year and it is expected to rise to 516 million (15%) by 2050. Nigerian alone is generating about 42 million tonnes annually, at an estimated rate of 66,828 (0.66kg/Cap/d) tonnes per day in cities and 44,657 (0.44kg/Cap/d) in rural areas, which is projected to rise to 125,473 tonnes per day by the year 2040 (Ezendu et al. 2020; Abila & Kantola, 2020). The focus has been on the right economic management tools at all stages of production and consumption process to achieve Sustainable Development Goal (SDG) 7 (Responsible Consumption and production) and 12 (Affordable and Clean Energy) respectively by 2030.

Waste management entails all humanly possible safe processes (technological, mechanical, electronically) from cradle (source) to grave (final resting) without further implications on the environment, environmental resources (aquatic and terrestrial). Contrarily, in this 21st century; improper waste management is an essential utility services underpinning societies, particularly in the urban areas (UNEP, 2015); although it has attracted some improvement levels, innovations and fortunes in the global management system.

Solid waste management costs over \$205.4 billion in 2020 and is projected to cost over 375.5 billion Dollars by 2025 (Okoli et al. 2020); despite theses it has not sustainably

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met the management target due to influential variety drivers, outlooks and emerging features such as high rate of urbanization; dyeing human consciousness; demand for fast profits and population growth (2.62%). Out of the 20-30% Solid Waste collected, 90% is either openly dumped or openly burned; contributing to the black soot phenomenon bedeviling Nigerians particularly the Niger Delta Region. Today, the practice of collect and dump is a mere material transfer syndrome as it turns available bushes and watercourses to final receptacles.

These current disposal methods besides the unsightliness and odor nuisances is of public health threats and safety through the transmission of diseases and aiding fertile ground for vectors breeding; increasing respiratory problems through airborne particles from Waste burning; and the aquatic ecosystem through the contamination of the world's water bodies (oceans and fresh water sources), causing drains and flash floods, affecting revenue drive and tourism.

LITERATURE REVIEW

Inadequate waste disposal techniques have created subtle and serious environmental pollution and ecological deterioration in Niger Delta, Nigeria and have attracted researcher interest within and outside the region. Few of this reports are Bariweni, Izonfuo and Amadi (2002) focused on the quantity and types of domestic solid waste; Sunday (2013) waste disposal problems and management in the Niger Delta region; Amadi *et al.* (2019) general reviewed on the poor state of solid waste management in the Niger Delta region; Aroloye (2019) environmental implication and management strategies in municipal Solid waste disposal on the mangrove forest; Amukali, *et al.* (2020) perception and participation in solid waste management; Okpara, Kharlamova and Grachev (2021) on the problem of proliferation of household waste irregular dumpsites; non has comprehensively determined the quantum of mixed waste in the Study area, non ecological impact of the dumpsite has been undertaken, the operation of waste transferring activities and the overall activities at the dumpsite, given the phenomenal increase in the volume of waste generated daily in the state. This study closes these gaps by dragging attention on the little priority given to the systematic surveying of waste disposal practices in quantities, characteristics, seasonal variations, the choice of waste dumping site and the practices of waste dumping in Bayelsa State in the Niger Delta Region, while providing a comprehensive analysis on the quantities of waste (solid and liquids) stream per tonnage, waste characteristics and compositions and activities at the Central Waste Dumpsite (ETELEBOU) in Yenagoa, Bayelsa State of Nigeria to make professional suggestions for policy formulation, implementation and monitoring.

METHODOLOGY

Description of the Study Location

The study location is in Yenagoa metropolis and suburb;

however, special focus is in the ETELEBOU Central waste dumpsite, off Yenagoa-Amassoma road in Yenagoa Local Government Area of Bayelsa State. The ETELEBOU is the largest and biggest dumpsite in the State receiving over 95% household waste from the Yenagoa metropolis and environs since the year 2010. The Etelebou is located within latitude 4°59'128.320"IN–5°00'016.342"IN and longitude 6°19'138.346"IE–6°20'118.942"IE covering an area of about 1.5km² within a low swampy land (5meters below sea level) and it is about 50 meters away from the ABANIGELE LAKE (5°00'2112.565"II 6°13'184.660"II) Figure 1 and 2. The most stricken of all is that the Dumpsite is sited in an area that is 5 meters below sea level; about 60% inundated all through the dry seasons and totally submerged during the wet seasons; under annual mean rainfall of about 3191mm; crisscrossed among networks of natural drainages such as the Abanigele Lake, Epie creek, Tailor creek and River Nun.

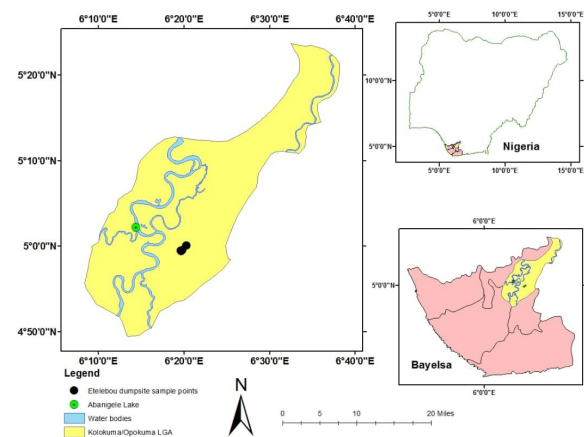


Figure 1: Map of Yenagoa showing Etelebou Central Dumpsite

Source: Ebuete, Eremasi and Berezji (2022).

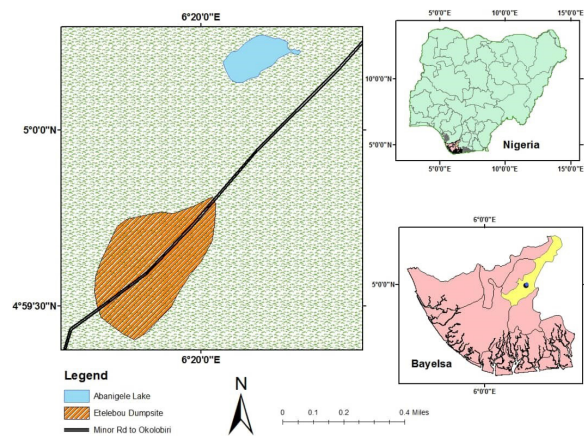


Figure 2: Etelebou Central Dumpsite showing Abanigele Lake

Source: Ebuete, Eremasi and Berezji (2022)

Data Collection and Data Analysis

The management of waste in the state is undertaken by contracted stakeholders and individual investors.

The Mass-Volume Analysis method recommended by Lenkiewicz and Webster (2017) using weighbridge scale was adopted to develop waste stream (solid and liquid) data per kilograms for twelve (12) months (January-December, 2021); by subtracting the weight of empty vehicle from the weight of loaded vehicle. The generated waste stream data per weeks; months into yearly (table

2.2) were tested at 5% using Two-Ways ANOVA (Analysis of Variances); while the difference among waste stakeholders per weeks were tested using T-test.

RESULT

At the ETELEBOU central Dump Site, the weekly, monthly summary of waste stream are presented per tonnages

Table 1: Waste Stakeholders (Contracted Collections and Transportation Waste Management Firm)

S/N	Operating Companies	Montly Tonnage	Annual Tonnage In Percentage
1	Brikari Nig. Ltd (S)	22.79	273.42 (50%)
2	Miscelline (S)	3.19	38.28 (7%)
3	Government House (S)	1.37	16.41 (3%)
4	Erettech Nig Ltd (S)	0.91	10.94 (2%)
5	Tynaebi Waste Services (S)	0.91	10.94 (2%)
6	Boko Marine Waste Services (S)	0.91	10.94 (2%)
7	Volunteer Truck (S)	0.91	10.94 (2%)
8	Bina Group (S)	0.91	10.94 (2%)
9	Nengi Waste Services (S)	0.91	10.94 (2%)
10	Waste Scoop Nig Ltd (S)	1.37	16.41 (3%)
11	T.I.G Harry Group (S)	0.91	10.94 (2%)
12	Airforce Waste Mgt (S)	0.91	10.94 (2%)
13	Patico Global (L)	1.82	21.87 (4%)
14	Elohim Sewage (L)	1.37	16.41 (3%)
15	Osasco Sewage (L)	0.91	10.94 (2%)
16	Saturday (L)	1.82	21.87 (4%)
17	U.J. Jonnex Nig Ltd (L)	0.46	5.47 (1%)
18	Kataka Sewage Services (L)	0.91	10.94 (2%)
19	De Lord Is My Shepherd (L)	0.91	10.94 (2%)
20	Friday (L)	1.37	16.41 (3%)
	Total	45.57	546.84 (100%)

Source: Researcher, 2022. Where: S (Solid Waste) and L (Liquid Waste); (t=2.1; α=1.729)

Table 2: Weekly summary of waste Streams per tonnage at the Etelebou Dumpsite.

Monthly	Week 1	Week 2	Week 3	Week 4	Week 5	Total
January	1.08	2.489	0.909	1.462	0.979	6.919
February	0.874	0.876	0.876	0.881	0.138	3.645
March	0.896	0.875	0.906	1.026	0.417	4.141
April	0.684	0.807	0.804	0.934	0.535	3.764
May	0.266	0.226	0.936	0.937	0.937	3.302
June	0.896	0.832	1.050	1.108	0.307	4.193
July	0.765	1.071	1.156	1.086	1.214	5.292
August	1.224	0.988	1.204	1.187	0.306	5.017
September	1.152	0.988	1.036	0.926	0.915	4.471
October	1.159	0.949	0.752	0.845	0.937	4.732
November	0.937	0.912	0.859	0.899	0.758	4.365
December	0.978	1.276	0.772	0.888	0.666	4.580
Total	10.911	12.28	11.26	12.18	8.109	546.8

Source: Researcher, 2022. *kg -to-tones (mass in kg/1000)=546830kg/1000 = 546.830 tonnes

Table 3: Two-Way ANOVA

Source	SS	d.f	MS	F-ration	5% F-limit
Columns (Weekly)	0.959	(5-1) = 4	(0.959/4) = 0.124	0.324	(4,44) = 2.57
Row (Monthly)	1.359	(12-1) = 11	(1.359/11) = 0.124	0.325	(11,44) = 2.14
Error	4.194	(4x11) = 44	(4.194/44) = 0.381		

Source: Researcher, 2022.

DISCUSSION

Seasonal Variation in Waste Stream

Waste composition differs in quantities and characteristics with seasons in the study area, reflecting varied patterns of consumption between the wet (harvesting) and dry

(planting) seasons. This according to Khitoliya (2004) is determined by factors such as geographical location; seasons; collection frequency; population characteristics; extent of salvaging and recycling; public attitude and legislation. Table 1 shows that waste stream during the

wet season is slightly higher amidst agricultural harvesting as against dry planting/cultivating season period. In addition, the open air burning of combustible waste at home during the dry seasons also reduces the quantum of waste stream. Stanley et.al. (2018) revealed that 6.3% of the total generated waste in Yenagoa is openly burned. More so, the fraction of organic waste increases with the wet seasons when economic levels decrease in this study is aligning with the observations by Bariweni, Izonfuo and Amadi (2002) who opened that 82.2% of total waste in Yenagoa is made up of food waste; and that food waste in Yenagoa city accounted for about 88.74% during the harvesting (wet) period compared to 70.25% during the planting (dry) season while the percentages of other waste type's increases proportionately with food waste. At 5% degree of freedom, the differences concerning waste stream in various months of the year 2021 is significant (Table 2). Kaza, *et al.* (2018); also observed that the generation rates and disposal of municipal solid waste vary with seasons; having a stronger correlation with the levels of economic development and activities with the seasons.

Waste Management Processes

Waste management entails sequences of processes from the cradle to the grave; underscored by functional elemental factors such as generation; onsite handling, storage and processing; collection; transfer and transportation; processing, recovery and disposal. The account of waste management processes in the state is abysmal; although the State has over 40 (28 approved and 12 unapproved) waste storage/collection centers within the metropolis; with additional 2 at Otuoke, 6 at Amassoma and 3 at Okolobiri Town.

These centers enhanced public health and aesthetics while servicing the daily collection/storage of waste within the Yenagoa Metropolis and environs between 5pm to 6am (13 hours). These collection centers are been manned by contracting firms such as Brikari and Miscelline at the cost negotiation with the state government while other companies outline in Table 1 curb within newer and older residential areas, low-rise multi family apartments, complexes, mini factories and companies, Banks etc at pay per services operation rate. There Containers are usually small compare to the organized Brikari and Miscelline companies.

It is of dismayed and unprofessionally vile at the sight of waste transfer collection point where staff of this companies manually loading/handling mixed waste without Personal Protective Equipment (PPEs) (Figure 12-13); also transporting/transferring waste without proper coverage, capable of causing accidents while spreading pollutants along its path. However, to an extent, the Brikari Company has showed level play standards in both collection and transfers but needs to be educated and encouraged to boost the system. Of the all processes, collections and transportation determine the disposal form in the study area.

The Choice of Dumpsite (ETELEBOU) Selection

The ETELEBOU central Dumpsite was acquired by the Bayelsa State Government to be maintained by the State Ministry of Environment, from the ancestral land owner (Opolo community of the Epie clan) on 23 November, 2010 for the sole purpose of transferring and dumping of both solid and liquid (effluents) waste. Succinctly, the choice of site location failed to adhere to Oborie and Nwankwoala (2017) recommendations that, municipal water wells and bore holes for domestic supply should be sited in the northern part of Yenagoa while dumpsites and sanitary landfill should be confined to the southwest. By this current dumpsite location decisions, I strongly agreed it is unprofessional; perhaps the target is to reclaim swampy land using waste materials without direct public outcry which is unfit, unsanitary and unprofessional for waste dumping practices; may be the name "landfills". The most striking of all is that the dumpsite is situated in a low swampy land that is 60% inundated all through the year, transverse around by networks of natural watercourse (Pound's, Creeks, Lakes and Rivers) (Fig.1&2).

One should know that the Planetary Health and One Health initiative stresses on ecosystems and human health in an inextricably linked; none is isolated from one another. Therefore, Toxins from polluted soil, the water bodies through waste dumping can affect all environmental compartments, including water, food, and air, as well as organisms, including humans (Raimi, et.al., 2022).

The study challenged and condemned the choice of the dumpsite and the practice of open dumping on account of environmental and human risk in the Niger Delta region of Nigeria. Shockingly, Merem *et al.* (2019) has revealed that the Niger Delta Region is experiencing one-meter rise in sea level and that 20cm rise in sea level will inundate 3,400km² of the coastal environment and by the year 2100 the region could lose over 15,000km² of coastal land, discretionary receding to the available swampy lands for human habitations and agricultural practices.

Disposal at the ETELEBOU Central Dumpsite

Municipal Waste faces interesting challenges related to Climate change, circular economy, dematerialization, poor funding, poor public awareness and poor implementation of policy and overbearing of political interest, inadequate information on waste benefits, limited infrastructure and professionals. At a glance, Nigeria is the home to sixth of the largest and biggest dumpsites in Africa mostly located in Lagos, Ibadan and Port-Harcourt (BioEnergy Consults, 2020). Unfortunately, Bayelsa State is among States that view waste management from the social service perspective rather than revenue generation as in Lagos, hence spending huge sum of money in Waste picking, transportation and disposal in the State capital (Yenagoa) as against the recommendations by Agbaeze, Ofobruku and Chukwu (2020). The practice of waste disposals in

Yenagoa in the Niger Delta region of Nigeria range from open dumping and other rudimentary waste management methods (Figure 5). Globally, open dumping accounts for about 33 percent of waste dumped out of the 37 percent in all forms of landfill (Kaza, *et al.*, 2018).

Distinctively, Bayelsa State is practicing open waste dumping and burning in the name and purpose of landfilling to reclaimed swampy low land areas for residential and agricultural purposes; leaving nothing but repetition/reoccurring catastrophic events similar to the July 2000, that claimed over 100 lives due to the collapsed of a seven story high building at the Quezon City garbage dumpsite in Manila Philippines. Obnoxiously, the ETELEBOU central Dump Site houses both liquid (sewages and sludge); Solid (municipal, industrial, construction, hazardous, ignitable etc.) and medical (special) waste (Figure 5 and 10) with no regards to professional advice, leaving untold short and long time effects on the environment, environmental resources and human health. Waste burning is a menace to the Environment and a health threat to human, for study by Agunbiade and Odukoya (2019) at the Olisosun Dumpsite in Lagos observed variations in the concentrations of atmospheric pollutants which decreased with increasing distance from the landfill. Similarly, Melai, *et al.* (2018) reported on the negative impact of constant waste burning that has accorded a solid dumpsite in Italy a name as ‘*Terra dei Fuochi*’ (Land of Fires).

Annually, a total of 546.83 tonnes (compared to the 2.1million tonnes at Olusosu in Lagos; 36,000 tonnes at Awotan-Apete in Ibadan and 45,000 tonnes at Eneka in Rivers State) of waste is openly dumped at the Etelebou (Table 1); of the volume of waste recorded at the dumpsite for the year 2021, 91% of the total volume is solids and only 9% liquids and at 5% T-test ($t=2.1 > \alpha=1.729$) and ANOVA, the differences concerning waste types; monthly waste generation and stakeholders is significant at the Etelebou dumpsite (Table 1 and 3). The wide variance can be attributed to the unprofessional and illegal channeling of liquid waste into available natural water sources with no regards to environmental and human health by sewage/sludge management companies to circumvent against registration/renewal fees with the authorities for annual dumping permits; an act that serve as point source pollutants to the environment. Similarly, the study by Stanley *et al.* (2018) confirmed that 5% waste generated in Yenagoa metropolis is freely dumped into water course.

Interestingly, the BioEnergy Consults (2020) pointed out that the untold effects of open dumping are felt within 10km² radius of its environs and the Abanikele Lake is suffering the same faith. The effect of the open dumping is traceable to the diminishing/poorer fish yield at the Abanikele Lake as fisher men in the just concluded two years interval fishing festival of the lake recorded poorest yield of all time on Wednesday 3rd March, 2021 (Figure 3). In the same vein, Ayodeji (2012) has pointed that Pollutants from open dumping site reach the human

body, via drinking water, vegetables and animal products, while burning solid waste pollutes the air, causing serious health risks, including respiratory infections, cancer and other illnesses.

Interestingly, there are pockets of farm lands used for growing vegetables, ephemeral, biannual fruits and root tubers crops few meters adjacent to the dumpsite while an extensive Piggery (Porcine) farm and Bovines Herder’s (Figure 4, 6 & 9) were successfully carried out both at the Dumpsite and adjacent land; which of course is revealing the negative position of the dumpsite in relation to human health through food chain contamination. Similarly, Ebuete *et al.* (2020); reported that the farm is a first point of contact in meat food contamination. On the coronary, further health implications of Heavy metals intake by human population through food chain contamination is well documented in Musa and Ifatimehin (2013); Njagi, Ngugi and Njagi (2017); Nkwunonwo, Odika and Onyia (2020).

In 2010; Awosusi related the presence of hydrogen sulphide in most surface water and reservoir to the putrescible sludge in the bed of rivers to the deposition of settle able organic solids waste. Similarly, studies by Roger, Smith and Wilson (1989); Stanley, *et al.* (2018) also revealed that a high percentage of workers who handle refuse (scavengers) and of individuals who live near or on disposal sites are always infected with gastrointestinal parasites, worms and related organisms that causes cancer and other congenital malformations. In considering these negative factors, the open dumping practice is recommended condemnable, discouraged to be discontinued at the Etelebou and if there is a need for siting any approved dumpsite, then it must be sanitary in consideration of Oborie and Nwankwoala (2017) recommendations.

Activities at the Etelebou Central Dumpsite

There are various active and passive activities within and around the ETELEBOU central Dump Site, among which are professional (mechanical waste dumping and shifting, Fumigation) and non-professionals (activities of scavenger in waste material selections/segregation for reuse, Recycling and energy recovery). At the ETELEBOU central Dump, open dumping is freely done at no designated spots and shifted mechanically with a Bulldozer were applicable while untreated effluents (liquid waste) are freely lowered in the open (4⁰59I13.098IIN and 6⁰19I34.560IIE) at about 40 meters away from the solid waste dumping spot to avoid solid/liquid mixed up (Figure 11). However, such act is routing environmental concern as the untreated effluents flow through the swamp water into other natural water bodies within the area, while large proportion sink (percolate) underground to contaminate groundwater sources (Figure 7). Further effects of open dumping on the ecosystem and the natural resources is well recorded in Alam and Ahmde, 2013; Orodu and Leizou, 2017; Ikoko, Osu and Horsfall, 2020; Okpara, Kharlamova and Grachev, 2021.

Solid Waste generally is in the eyes of the beholder; therefore one person's trash is another person's treasure. Interestingly, the discarded unwanted man's by-products are among today's most renounced archeological artifacts and according to the report of Environmental Protection Agency (EPA, 2001), an estimated \$2 million valuables are buried in landfills every year. The activities of the scavengers are preeminence at the dumpsite. Unfortunately, at Etelebou dumpsite, less than 10% (less than the 19% global estimated by Kaza, *et al.*, 2018) of all solid waste (bottles, paper, metals and plastics) is recovered for reuse, recycling and energy recovery by the Scavengers; a voluntary act that is saving the Environment from over burden due to the long durability (Half-life) of some commonly discarded materials. Abdul-Rahman in 2014; advocated for reused by displaying half-life of most commonly used materials as: Paper towel (2–4 weeks), Newspaper (6 weeks), Apple core (2 months), Waxed milk carton (3 months), Plywood (1–3 years), Wool sock (1–5 years), Cigarette butt (1–5 years), Plastic bag (10–20 years), Plastic film container (20–30 years), Tin can (50 years), Styrofoam plastic cup (50 years), Rubber boot sole (50–80 years), Aluminum can (80–200 years), Disposable diaper (450 years), Plastic beverage bottle (450 years), Monofilament fishing line (600 years), Glass bottle (1 million years).

Globally, an estimated 125 million cell phones are discarded each year, generating more than 65,000 tons of hazardous waste (EPA, 2004) while an estimated 242 million tonnes of plastic waste generated in 2016 is accounted for an estimated 1.6 billion tonnes of carbon dioxide– equivalent (CO²-equivalent) greenhouse gas emissions and anticipated to increase to 2.6 billion tonnes of CO²- equivalent by 2050. The terms of scavengers in successfully steaming down the quantum of waste stream openly dumped at any dumpsite through waste transactions is unrecorded, yet helpful to the environment and human life.

Taiwo *et al.* (2022) opined that recovering material from dumpsite involved physical energy and manually operated rudimentary tools. Scavengers activities at the Etelebou dumpsite is of prominence both economically and environmentally, for instance emptied wine/whisky bottles, perfume cane/bottles and olive oil bottles is costing relatively low between 30-70 Naira (\$0.07_0.15) each while copper wire, metals and caste materials are sold at 1000 naira per kilogram (\$2.2); other plastic bottles; rubber material, materials of ethane; used poly bags are sold in kilograms per 3 Naira (\$0.007); Cell phones motherboard is sold at the rate of 50 Naira(\$0.1) (Figure 8) to encouraged reuse and recycling; while cutting down production cost and energy; it also save man's environment from direct effect of the hazardous waste.

However, as much as the activities of the Scavengers are prominent and nexus to the safety of the Environment and its resources; they are also guiltily to the human health. On October 15th, 2020; about 200 kilograms worth of

expired food (Garri) (Figure 9) that was originally meant for distribution as palliatives for 2012, 2014, 2018 and 2019 flood victims in the State were dumped openly at the site; were retrieved, partially reprocess and successfully reintroduced into the labor market at lower cost for consumption by the impeccable populaces; exposing the populace to various curable and incurable ailments.

CONCLUSIONS

Solid and Liquid waste management is a universal issues affecting barely every living being on earth. This is because human beings are living creatures with choices and varieties which has landed mankind to the trajectory of where to discard by-products of our actions, choice and varieties. Nations had designed various management methods that suit her environment, nature of generated waste and characteristics, available resources and level of technologies for best practices. Unfortunately, Sub-Sahara Africa has adopted these methods for her failure; among most adopted method is open dumping and burning.

These current disposal methods in the Niger Delta is a treat to our health, safety and environment, which pose additional indirect costs to society as it contaminate ground and surface water sources, released hazardous gases into the air, leaving toxic residues as ash when burned adding to the black sooth phenomena bedeviling the region. Unfortunately, future trends of waste disposal are poorly understood as comprehensive or consistent disposal information at the country level are lacking while few broad trends and common elements are discernible. The work therefore pinched on the criticism of the choice of dumpsite, the rudimentary disposal practices, and activities at the site and revealed the quantum of waste stream at the Etelebou central dumpsite with the following conclusion.

The study therefore, condemned the choice of the dumpsite and the practice of open dumping and waste burning in the Niger Delta region particularly in Yenagoa; a city situated at 5metres below sea level with mean annual rainfall of 3191mm, transverses among networks of natural water course which over flows during the wet seasons cannot cope with the indices of the practices.

Furthermore, the 546.83 tonnes of untreated and unmanaged waste stream annually dumped at the Etelebou dumpsite with less than 10% recovery for reuse and recycling is occupying on landed spaces from development and agricultural (FADAMA) purpose. The region (Niger Delta) is at a risk of losing over 3,400km² of her coastal environment by the year 2100. The present waste disposal practices in Yenagoa needs urgent professional inputs to save society's most vulnerable people from losing their lives and homes from landslides occasioned by waste dumps, accessing underground and surface water around the dumps, unsafe waste-picking scavenging conditions and suffering of profound health repercussions. Therefore, waste stream generation in Bayelsa State and in Niger Delta region be controlled through policy implementation, enforcement and

monitoring through the practice of waste management Hierarchy (Refuse, Reduces, Reuse, Recycling and Recovery); but where seems unbearable go for control incineration and composting.

RECOMMENDATIONS

Upholding unto Waste Refusal and Reduction right from production and processes through the improvement in technology and human capacity under the enlisted form:

1. The implementation and enforcement of Waste-End Fees/Volume Based Collection Fees System: This system will heighten the general public's awareness on the need for saving the environment by reducing the volume of waste generated since disposal is made more expensive than recycling. Tokyo and Seoul city are into it.

2. The implementation and enforcement of Disincentives/ Polluters-Pay-Principles (PPP): This system will also help reduced the volume of waste coming into the dumpsite annually as it allows the polluters bear the responsibility of managing its waste.

3. By enforcing Deposit_Refund System (DRS): DRS combined both tax and subsidy into operation under which a consumer pay a deposit usually as part of the product price and only refunded if the waste product such as empty bottles and aluminum cans is returned to the seller as it is successfully obtainable in Australia. This will help in the management of waste within and outside the state.

4. Composting: The processes of turning biodegradable waste into farm manure for agricultural used either aerobically or anaerobically. If 82.2% of all waste in the study area is composed of food waste, then composting is an option to improve agricultural yield in the region.

5. Incineration: The art and science of reducing waste stream through controlled burning at a higher temperature is incineration. The Commissioning into the commencement of the world class locally fabricated incinerator (although designed for special waste) at the Bayelsa Medical University, Yenagoa on Friday 12th February, 2021 is operating at a capacity of about 0.6 tonnes per hour, at a temperature of about 1,200°C to 1,500°C, is beyond doubt that waste in Yenagoa and its environs can be managed properly putting all machinery in the right perspectives and right directions while its residue (ashes) can be treated for agricultural used. Furthermore, the functional Bayelsa state Plastic Industry of recent is toeing towards plastic waste recycling through the buying of plastic nylons (plain and customized) and other High Density Polyethylene materials for its production. This will further steam down the quantum of plastic waste in the state and the region at large. Hence, they should be encouraged to steam down the quantum of plastic waste in the state and the region at large.



Figure 3: Fishing activities at Abanigele Lake



Figure 4: Farming Activities around the Dumpsite



Figure 5: Open Dumping, Burning and Residue



Figure 6: Bovine and Porcine Feeding at Dumpsite



Figure 7: Effluent Discharged and Water Source contamination



Figure 8: Recovered Waste Materials at the Dumpsite



Figure 9: Retrieved expired foods back into the market



Figure 10: Activities in the dumpsite



Figure 11: Waste Collection Centre



Figure 12: Waste Collection

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