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The Impact of Solid Waste Management on Green House Gases in Nigeria

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ABSTRACT

Consumption and production activities often lead to the generation of by-products and in some cases end products that can be termed waste. This waste can be gaseous, liquid or solid in nature and they need to be properly and safely discarded and managed in order to ensure protection of man and the environment. This work concerns itself with solid waste, its management and how it is impacting greenhouse gases. The study is qualitative and does not attempt to measure the amount of emission from this region of the state.Data for this study was gottenfrom Primary and secondary sources; Primary data from on-site visits to various waste disposal location within the study area and Secondary data from a wide range of literature and research findings on Municipal Solid Waste and Solid Waste Management systems.The findingshowever show that the dire effect of the poor management of solid waste through its entire life cycle leaves a lot to be desired. The system of open disposal, burning and decomposition obtainable in Port Harcourt is greatly increasing the level of GHG emissions in the country Nigeria. The work recommendsurgent need to step up the Municipal waste management systems to ensure recycling and recovery are key parts of the Port Harcourt waste management system.

Keywords: Disposal, Dumpsite, Green House Gases (GHGs), Municipal Solid Waste (MSW), Rivers Waste Management Agency (RIWAMA),Solid Waste, Solid Waste Management (SWM).

INTRODUCTION

[1] defined solid wasteas any form of solid material which is no longer of use to its producer, owner or user and is hence discarded. He also regards solid waste as left-over arising from human, animal, or plant activities that are normally discarded as useless and not having any consumer value to the person abandoning them [2,3,4,5]. Wastes have also been defined as any product or material which is useless to the producer [6,7,8]. These useless, unwanted or discarded materials results from the consumption or production lifestyles of commercial, agricultural, communal and industrial activities. Municipal solid waste however is defined as waste collected by the municipality or disposed of at the municipal site and includes residential, industrial, institutional, commercial, municipal, and construction and demolition waste [9,10]. [11,12] pointed out that, wastes are materials that people would want to dispose of even when payments are required for their disposal.Solid waste, however, does not imply that such material cannot be of use after being discarded by its user therefore, Solid waste may also include materials that may have the potential to be reused, recycled, and composted [13,14]. Generally, a society based on how developed it is, can be a consumer society or a producer society even though every society is a combination of both [15,16]. Consumption and production activities lead to the generation of by-products and in some cases end products that can be termed waste [17]. This waste can be gaseous, liquid or solid in nature. Naturally, it is observed that the volume of generated waste in a society is proportional to the level of development of such a society [18,19]. One good example of a lifestyle that promotes increase in thegeneration

of waste is urban areas where the daily activities of people involve buying of things that are in disposable bags and other such items which require discarding of its containers after consumption [20]. Waste generation cuts across every sector of our society from the food sector to the production companies and also to manufacturing companies etc. All of such activities are more prevalent in urban areas as compared to rural areas and with the continuous influx of people from rural to urban areas, the reality of a more mounting increase in solid waste generation dawns [21,22,23]. The proliferation of solid urban waste in Africa and Nigeria to be specific isof grave concern, as in the last two decades,management of solid urban waste has been on the front burner [24,25].

STATEMENT OF THE PROBLEM

Presently, the Port Harcourt Metropolis of Rivers state is experiencing a major increase in the amount of waste disposal on major roads. This has been caused partially as a result of the perceived increase in the influx of people into the state as well as the government policy of disposing waste for the inhabitants of the state. Furthermore, it appears that the waste management body of the state; (RIWAMA) is ineffective in ensuring timely transportation of the waste from the approved dump receptacles to the dumpsites which are far off from the people. This is alongside the challenge of people dumping their waste along the median of major roads in the state as against the approved receptacles. Thesehave led to most of the garbage littering the roads in the city and causing pollution/harm to human health and the environment.

AIM OF WORK

This works aims to reveal the existing challenge of managing Municipal solid waste in Port Harcourt metropolis of Rivers State and proffer possible solutions that can change the existing trend while ensuring the reduction in greenhouse gases from waste disposal.

LITERATURE REVIEW

Concept of Solid Waste

There are various types of waste ranging from gaseous, liquid to solid waste, however, this work focuses on solid waste generated especially from urban areas. Management of Solid waste is known to be a source of concern all over the world especially because of the possible harmful effects it has both on the environment and human health. These effects are generated through thecontributions of solid waste to the ever increasing level of greenhouse gas (GHG) emissions. Solid waste has been looked into in this study with particular attention to Municipal solid waste and the management practices prevalent in Port Harcourt Metropolis of Rivers State. Solid waste, however, can bedefined into two categories namely: Municipal Solid waste and Non-Municipal Solid waste. Municipal solid waste refers to any non-solidwaste generated from an individual, household, small business or institution like a hospital, school etc. This type of waste is often referred to as trash or garbage and is usually composed of everyday items that are either spoilt, broken, leftovers or no longer wanted items that are discarded. Non-Municipal solid waste on the other hand produces a larger quantity of waste because these are solid waste generated from the production of products by companies. It is waste generated as a result of the processes involved in production before the items reach the final consumer. So, while it has the capability to be large in volume the quantity generated often varies according to the demand level from consumers [8]. There are various categorization and classifications of waste in literature, in this paper the focus is on Municipal solid waste, therefore the classifications that will aid in x-raying the topic of solid waste management and its impact on Greenhouse gases shall be used. Waste can be classified according to the type of waste produced, source and by generation/composition. Furthermore,

classifying solid waste can be narrowed down along the lines of the composition of such waste as this reveals the level and type of pollution that it will produce. The classification of solid waste according to their sources, include the following:

1.) Municipal Solid Waste (MSW): These are solid wastes which are discarded as by products or leftover of residential and commercial activities. They include waste such as garbage, combustible and non-combustible waste,ashes, street waste,bulky waste, dead animals, vehicles, construction wastes etc.

2.) Hazardous wastes: These are solid wastes that can cause some harm to human beings and the environment. They are regarded as hazardous when they exhibit chemical or physical properties of reactivity, toxicity, corrosively and ignitability.

3.) Industrial wastes: They mostly possess toxic content and therefore require some form of special treatment. They are derived from the activities of industries, metallurgical, chemical and pharmaceutical units, breweries, and pesticide and fertilizer industries e.t.c.

4.) Agricultural wastes: These are waste generated from Agricultural related activities. It includes waste from crops and livestock.

5.) Bio-Medical wastes: Bio-medical waste refers to any wastewhich is generated during the diagnosis/treatment/immunization of human beings or animals or as a result of research activities regarding the aforementioned or involved in the production of biological drugs or materials.*Source: (www.yourarticlelibrary.com).*

According to [12] solid waste can also be classified as Organic and inorganic waste. Examples of items that fallinto the category of inorganic waste are Glass, Metal, Paper, Plastic and others while organic waste are mostly from food related materials. The table below clearly lists out examples of such waste based on its type and sources

Table 1.0: Classification of Organic and Inorganic Waste

Type	Source
Organic	Process residues, food scraps, wood, yard waste (grass, leaves, brush)
Glass (Inorganic)	Bottles, light bulbs, and shattered glassware are among the items found.
Metal (Inorganic)	Foils, Cans, non-hazardous aerosol cans, tins, railings, and white goods (appliances)
Paper (Inorganic)	Newspapers, cardboard, magazines, bags, cartons, wrapping paper, shredded paper, and beverage paper cups are all examples of paper scraps.
Plastic (Inorganic)	Bottles, packing, caps, containers, bags, and cups are just a few of the items available.
Other (Inorganic)	Textiles, rubber, multi-laminates, leather, appliances, ash, e-waste, and other inert materials are all examples of inert materials.

Source: [15]

Management of Solid Waste

The procedures for Solid waste management vary significantlybetween countries, states, and even within localities.Modern waste management systems advocate trash reduction practices such as safe landfill disposal, composting, reuse, recycling even though these procedures are rarely followed (Abdhalah K. Ziraba*, TilahunNigatuHaregu& Blessing Mberu, 2016a). A huge part of garbage in developing nations like Nigeria is known not be recycled. Also, waste sorting is uncommon in Nigeria and this makes recycling and composting a challenging feat. These challenges have resulted in a considerable part of solid trash in Nigeria being dumped openly and frequently burned. In Nigeria, as well as countries where the standard waste management practices are unavailable, the managers of waste have resorted to improvisation. This is a direct reflection of the existence of poor waste management policies and laws, low enforcement level of existing laws, lack of adequate financing, and the type and quantity of trash created. In most countries that are developed, the responsibility of solid waste managementis shared to both the government and private companies/suppliers. The system of managing waste also entails that the majority of waste is collected from a source or a provisional dumping site and permanent disposal of such takes place on the outskirts of the main town, at open designated dumpsites. These grounds are usually massive open spaces where trucks offload garbage. Dumped rubbish is frequently dug up for useful items and recyclable products, and it is frequently burned to decrease bulk [11]. It is not always easy to screen solid waste at every level hence the complex composition of solid waste. Waste may include pharmaceutical, human, industrial, and electrical rubbish and they all get to be deposited in the same space as other municipal waste. Some of the recurring components of most solid waste management hierarchyas identified byMohd et al, 2020are;

a. Source, reuse and reduction
b. Recycling and composting
c. Incineration and land filling

It is expected that one should do whatever is feasible to ensure adequate reduction of the amount of garbage that is created or directly utilized. It is also essential that if garbage cannot be totally avoided or re-used, it should be recycled or composted when possible in order to limit the negative effects that it can cause to health or the environment. At this point, the unavoidable garbage should be considered for reuse, recycling, or composted (with the recovery of energy) or land filled if it cannot be avoided.

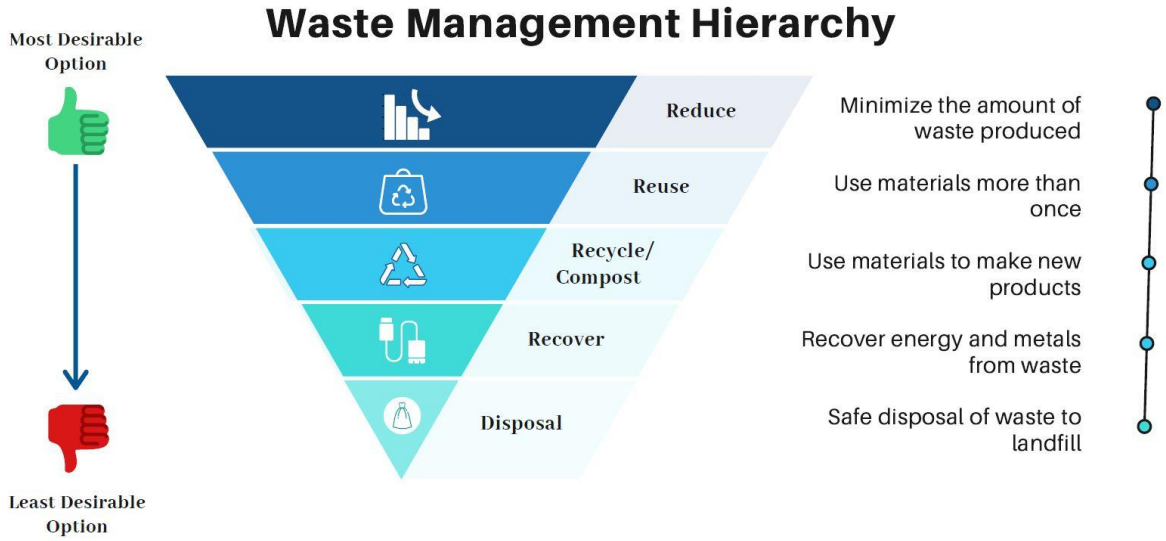

Fig 1.0:Source: colliercountyfl.gov

If everything else is equal, source reduction and reuse are of more value than recycling and composting, which are more valuable than land filling and incineration just in that particular order. The hierarchy shown above does not suggest that every means of reduction and reuse should be exhausted before contemplating recycling and composting. The European Union according to their legislation aims at recycling, source reduction, reuse, incineration with the recovery of energy, and land filling [15].

Inventory of Green House Gases (GHGs) in Nigeria

Article 4 of the United Nations Framework Convention on Climate Change [9] requires each Party to periodically report the emissions of greenhouse gases (GHGs) including CO2, CH4, N2O and non-methane volatile organic compounds (NMVOC) in their National Communication. According to the inventory, Nigeria's gross carbon emissions from energy, land use change, industry, solvents use, agriculture and waste management in 1994 was 52.5 Tg-CO_2-C, while the net uptake, principally from land use change, was 10.4 Tg-CO_2-C.In fulfilment of the article, Nigeria's national communication based on emission per unit human population (based on gross population of 96.7 million for the year 1994) indicates a gross per capita CO_2 emission of 0.5 t C/cap. Per capita, non-CO_2 GHG and precursor gases are between 2 to 4 orders of magnitude lower than CO_2 per capita emissions. An overview of gross carbon emissions by sources and removal by sinks indicates gas flaring, transportation, and electricity generation as the most significant energy consumption processes leading to GHG emissions. Energy and land use change sectors were the main contributors to CO_2 emissions, while energy, agriculture and solid waste are the main contributors to CH_4 emissions. The total methane emission in Nigeria is 5.9 Tg CH_4. The energy production and consumption sector with a total emission of 1.48 Tg-CH_4 contributed 25% of gross national emissions with agriculture contributing the rest. Municipal solid wastes and wastewater treatment contributed 0.21 and 1.88 Tg CH_4. These respectively represent 4 and 32% of gross national emissions. The gross emission of nitrous oxide was 11.95 Gg N_2O. The energy sector (principally petroleum refining, small combustion and transport sub-sectors generated 7.47 Gg N_2O representing 63% of gross national emissions for the year. This was closely followed by emissions from savannah burning (28%), field burning of agricultural wastes (6%), burning of solid wastes (2%) and on-site biomass burning from forest conversion (1%).

The total generation of GHGs based on the current data for Nigeria is low when compared to emissions from the United States and developed economies. However, Nigeria's gross emissions may approach those of these countries if its population continues to grow at the current rate of 2.5% per annum since per capita emissions is also likely to increase. The current population of Nigeria is put at 140 million, representing 20% of the entire population of Africa. The United Nations project a population of 289 million for the Nigeria by 2050. Apart from population growth, Nigeria has been experiencing increased urbanization over the last five decades. The proportion of the population living in the urban centres has risen from 15% in 1960 to 43.3% in 2000 and was projected to rise to 60% by 2015 [14]. Furthermore, current economic growth of 7% per annum since 2005 has been projected to continue andwould invariably fuel increase in the generation of solid waste.

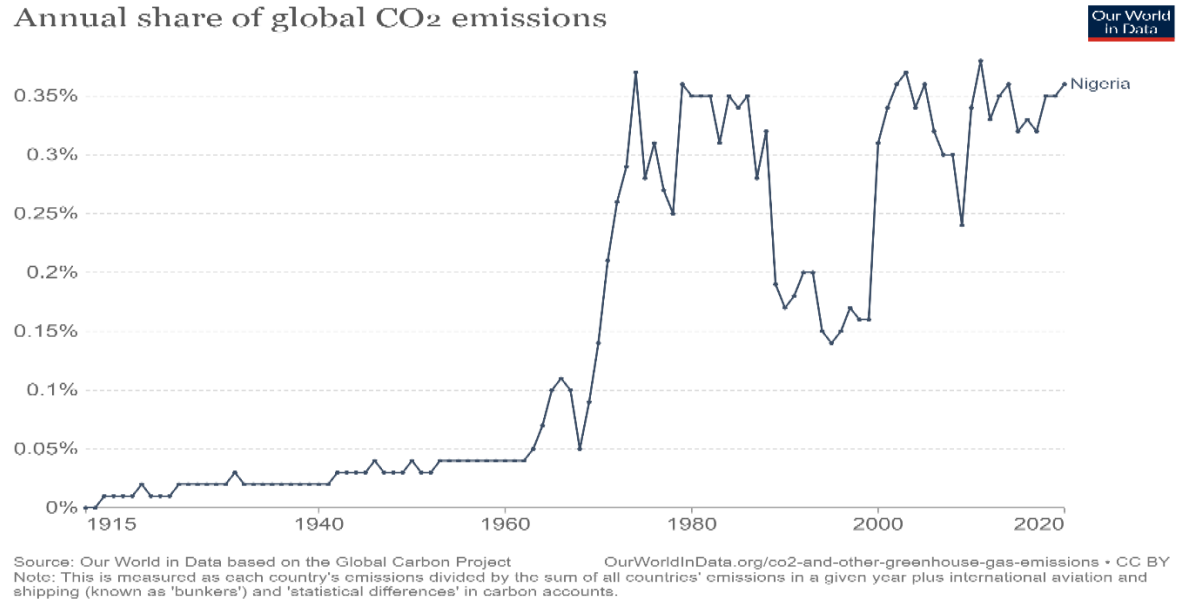

Fig. 2; Cumulative CO_2 emissions

When we only look at emissions produced today, we fail to recognise historical responsibility for emissions in recent decades or centuries.

This interactive chart shows *cumulative* CO_2 emissions – the sum of emissions produced since 1915 to the given year. This allows us to understand how much of the total CO_2 emissions to date has been emitted by a given country and the progression in emission.Source: [14].

RESEARCH METHODOLOGY

The study location Port Harcourt lies within urban areas of Latitude and longitude coordinates: 4.824167, 7.033611 respectively and GPS coordinates of 4° 49' 27.0012" N and 7° 2' 0.9996" E. [16]. The study is aimed at identifying the impact of solid waste management on greenhouse gases in Nigeria; case study Port Harcourt, Rivers State.Rivers State, Nigeria is a city in the southern part of Nigeria which was created in 1967 and it forms one of the six states in that region. What was formerly known as Rivers State was made up of the present Rivers State and a relatively new state called Bayelsa State which was coined out in 1996. To the south is the Atlantic Ocean, Imo state in the north, Abia and Anambra States, to the east and AkwaIbom State to the west. The capital of Rivers State is Port Harcourt and the state has a population of 5,955,153 according to the 2010 summary statistics of Rivers State [13]. The population census carried out in 2006 shows an expected growth rate of 2.553% and a projected population by 2012 of 6,202,042.

Rivers State is divided into 23 local government areas (LGAs), 319 political wards and has a land mass of 1,077 square kilometres. The inland part of the state is made up of the tropical rainforest while moving towards the coastal regions brings you to the typical river delta environment which has lots of mangrove swamps. Port Harcourt the state capital is the hub of the Oil and Gas industry in Nigeria and it also has several other industries. Port Harcourt is also known to have the country's second largest sea port with another sea port at the Onne Port Complex [14].

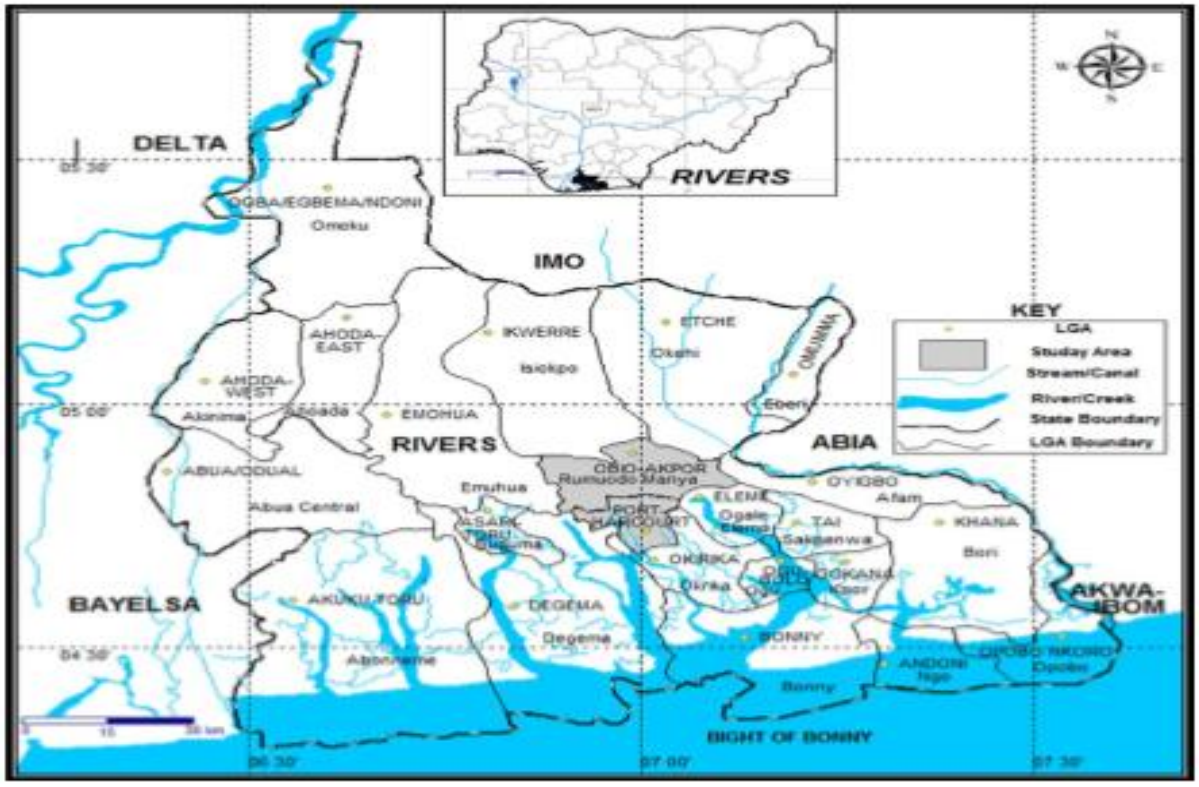

Fig 3.0:Map showing River's state and the coastal states around
Source: [21]

Another large local government in the state is ObioAkpor LGA which is also located in the heart of the state and is a very active business hub. It is one of the 23 local government areas in the state and has the 2nd highest population of all the Local government areas with a figure of 535,800 people only just behind Port Harcourt Local government area with a population of 618,456 people according to the 2010 statistics taken in the Journal of Agriculture and Social Research, 2011 [4]. Data for this study was gottenfrom Primary and secondary sources. Primary data from on-site visit to various waste disposal location within the urban locations in ObioAkporand Port Harcourt Local Government Area of Rivers state; dumpsites where indiscriminate dumping occurs regularlyanddumpsites placed by the State's Environmental waste Management Agency, RIWAMA. Secondary datawas gotten from a wide range of literature and research findings on Municipal Solid Waste and Solid Waste Management inandoutside Nigeria. These data were intensively studied to obtain the required data to clearly depict the impact that Solid waste management system in Port Harcourt has on the continuously increasing rate of greenhouse gases in Nigeria. The key information fished out from literature regardingthis work is the prevailing practices of MSW management, emissions, best international practices as well as the existing state of MSW management in Port Harcourt and Nigeria at large.

FINDINGS AND DISCUSSION

Practices of MSW management in Port Harcourt, rivers state.

The various steps of the waste management observed in Port Harcourt include the following:

- Collection and transportation: Collection is the first step of the waste management. It aims at gathering waste before transfer for sorting, treatment or recovery for instance. Collection can be

done door-to-door, using dedicated vehicles, or after preliminary voluntary drop-off in specific containers (packaging, paper, and glass). In Port Harcourt, the prevalent disposal pattern of waste disposal is by dropping on the road side and the centre median of main roads from where the RIWAMA collectors come to pick it up. However, the disposal of waste is mostly done in exposed bags that are not sealed and, in some cases, the waste is offloaded directly on the road without any form of bagging.

Fig. 4.0:Dumpsite alongMgbuoba axis of NTA road, Fig. 5: Dumpsite along Ada George Road (28th April, 2022, 8.00am)Port Harcourt (28thApril, 2022, 7.43am)

❖ Transfer: Waste that is collected from communities, individuals or companies can be directly transported to a treatment or material recovery facility or be firstly consolidated in a transfer centre in order to optimise its transport to a treatment or material recovery facility. The transfer system for waste management obtainable in Port Harcourt is by the waste management Agency's trucks and mobile hand trucks which are operated by individuals that collect a little fee to move these waste directly from the primary waste source to a disposal location or dump which is either approved by government and in some cases illegal dump sites.

Fig. 6:A compactor truck in Rukpokwu road, Port Harcourt packing trash to send to dumpsite/landfill. (4th May, 2022, 5.17pm)

- Mechanical/Physio-chemical/Thermal/Biological treatment (composting, anaerobic digestion) treatment:Waste can undergo several methods of mechanical pre-treatment to facilitate its recovery or recycling. For example, Electrical Waste and Electronic Equipment (WEEE) can be dismantled. However, studies do not show that waste in our area of study is pre-treated in preparation for any form of treatment.
- Sorting, recycling and material recovery: Waste can be sorted to separate the different materials fractions. Recyclable materials are then recycled by introducing them in the production cycle as a partial or total substitution (paper, glass, steel, etc.). This also is not applicable in the Port Harcourt waste management system.
- Landfilling: Landfilling refers to the more modern sites where waste is placed in lined disposal areas which are environmentally isolated, and where waste is naturally degraded. Within best practices, emissions produced by decaying waste (gas and leachate) are recovered through drainage systems and treated. The amount and quality of these emissions are variable in time and depend on the composition of the stored waste. Organic waste decomposition produces landfill gas (comprised of methane and carbon dioxide in nearly the same amounts). The captured landfill gas is either combusted in flares or recovered to produce thermal and/or electric energy.

What is obtainable in Port Harcourt Metropolis of Rivers state are open dumpsites where solid waste is disposed/deposited and left to decompose gradually.

Fig. 7: A dumpsite located at New Airport road, Port Harcourt (7th May, 2022, 5.30pm)

Subsequently, some form open thermal treatment (burning) of some of the waste is done and the rest is left to decompose in the open thereby creating massive emission of greenhouse gases over time especially methane. The largest contributor to global warming from MSWM sector is landfill due to emission of landfill gas. Landfill gas (LFG) mainly consists of methane (CH4) and carbon dioxide (CO2), with small fraction of hydrogen sulfide (H2S), nitrogen (N2) and volatile organic compound (VOCs). Due to high emission of CH4 among these GHGs, landfill has been ranked as the third largest anthropogenic CH4 emission sources (DaneshandAbubokor, 2018).

Almost every waste management step generates greenhouse gas (GHG) emissions; hence, it is imperative to design appropriate treatment methods from sources to disposal sites for reducing their environmental impact [7]. Improper MSW disposal and management causes all types of pollution: air, soil, and water. Some of the accesses through which poor management of solid waste can result in pollution and affect the environment include the following;

1.) Surface and ground water supplies can easily get polluted by indiscriminate dumping of wastes.

2.) Also, in urban areas, MSW clogs drains, creating stagnant water for insect breeding and floods during rainy seasons.

3.) Uncontrolled burning of MSW and improper incineration contributes significantly to urban air pollution.

4.) Greenhouse gases are generated from the decomposition of organic wastes in landfills, and untreated leachate which pollutes surrounding soil and water bodies.

According to recent estimates the waste sector contribute about one-fifth of global anthropogenic methane emissions and methane contribution to climate change is about one- third to a half of that of carbon dioxide. Waste sector emissions have grown steadily globally and are expected to increase in the forthcoming decades especially in developing countries such as Nigeria because of the increase in population and GDP and in recognition of this, the Clean Development Mechanism (CDM) established by Kyoto Protocol in 1997, recognized waste processing and disposal as one of the sectors identified for greenhouse gas reduction [5].

Waste management processes and climate change operate at similar timescales. There is a need to understand what the potential climate change impacts may be on waste management in order to begin the process of identifying what changes may be needed in waste management operations, regulations, strategy, planning, and policy Climate change is a serious, international, environmental concern and the subject of much research [7].

Table 2.0:Findings from 2 Major landfill sites in Port Harcourt.

S/N	ISSUES/SITE	ENEKA	NEW AIRPORT ROAD OFF EAST WEST ROAD
1	Landfill Liner	NIL	NIL
2	Leachate Pipe	NIL	NIL
3	Landfill Gas pipe	NIL	NIL
4	Landfill Top Cover	No top covering	No top covering
5	Waste Compaction	waste are just so spread by bulldozers	waste are just so spread by bulldozers
6	Fence	No fence	No fence
7	Nearness to major access road	100 Meters	10 Meters
8	Distance from residential buildings	200 Meters	800 Meters
9	Odour	Offensive	Offensive
10	Water quality around the facility	Not affected	Not affected
11	Treatment and recycling of waste	No treatment/No recycling	No treatment/No recycling
12	Landfill supervision	No supervision	No supervision
13	Environmental status evaluation	NIL	NIL
14	Operational compliance with standards	No compliance	No compliance
15	Wash racks	None	None

Source; Iyeneomie T., Valentine B. O, Igbani G. N., (2012)

Table 3.0: Population distribution and waste generation in Port Harcourt area

ZONE	AREA COVERED	POPULATION ESTIMATE	GENERATION RATE (KG/DAY)
1	Old Port Harcourt township up to UTC junction	170,367	210,477
2	Diobu miles 1,234 up to Wimpey Junction	303,946	384,130
3	Port Harcourt expressway/GRA 123 up to Rumuokuta Junction	210,441	262,573
4	Elekahia village/Rumomasi up to Woji/Elelenwo villages	130,290	158,382
5	Ogbunabali/Nkpogu villages up to Abuloma/Oginiba villages	103,578	123,651
6	Rumuokoro/Igwuruta villages up to Eleme/Oyibo town	120,200	148,630
7	Waterlines/Presidential Estate up to Artillery/Mgbuoba village	76,863	106,287
	TOTAL	1,115,685	1,393,880 (Approximately 1.25kg/person/day)

Source; [12]

CONCLUSION

The solid waste management systems in place in our area of study, Port Harcourt shows that Municipal Solid waste is being disposed in ways that expose the waste thus leading to the effects of degradation that eventually results in the emission of large amounts of Greenhouse gases especially CH_4. Also observed is that the emissions start from the initial collection point because dirt is left on the road sides/government approved receptacle for too long before it is eventually relocated to the final dumpsites where the final degradation takes place leading to further increase in the emission figures. This research being qualitative has shown the impacts of the existing solid waste management methods on this increase in GHG emissions but does not go into the specific analysis of the exact figures on emission levels. This open dumping system of collected MSW in unmanaged sanitary landfills used alongside open burning without any modern inclusion of recycling or recovery is what is obtainable and needs to be addressed in order to fully comply with the United Nations Framework Convention on Climate Change (UNFCCC) and the IPCC approved standards.

RECOMMENDATION

This work recommends the following;

1.) Urgent intervention of the Rivers state and Federal government to enforce laws against such archaic systems of waste disposal prevalent in Port Harcourt Metropolis of Rivers State.

2.) Private partners should be encouraged to invest in recycling and recovery of waste so as to avert the increase in GHG emissions and create an economic value chain for the state and the country at large.

3.) Residents should be stopped from disposing waste along the roadside and home pick up disposal system should be encouraged with adequate waste sorting used in packing the waste.

4.) Regular enlightenment campaigns should be run on all media outlets to teach citizens on the dangers for poor waste management systems and how it affects the environment and human health.

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