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DETERMINATION OF CARBON EMISSION POTENTIALS IN A SOLID WASTE MANAGEMENT FACILITY IN AKURE, NIGERIA

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ABSTRACT

Emissions emanating from poor solid waste management have increased steadily on a global scale particularly in developing countries including Nigeria. Incidentally, such, emissions in Nigeria have been estimated based on national statistics on waste generation which are neither accurate nor consistent. This study therefore characterized generated Municipal Solid Wastes (MSW) and determined the carbon emission potentials of the open dump in the solid waste management facility in Akure, Ondo State, Nigeria.

Solid wastes brought to the MSW facility from three locations viz: markets, residences and kerbside, were characterised and quantified monthly for a period of one year. The methane emission potential arising from the wastes for the period of study was determined using the Intergovernmental Panel on Climate Change Default Method (DM) and First Order Decay (FOD) method. Carbon-dioxide emissions estimate based on the MSW composition was also determined using the IPCC (2006) guidelines Data were analysed using descriptive statistics and ANOVA at $\alpha_{0.05}$

The total wastes generated from all the sources were 5,834,005.0 + 5,079633.8 and 4,266,871.0 +3,745,337.8 kg;9,159,995.0 + 8,453,005.4 and 6,777,621.3+6,313,977.0 kg and 7,794,894.0 +7,569,909.7 and 5,724,532.0 +5,596,562.0 kg, for paper, plastics and food wastes in the wet and dry seasons respectively. Methane emissions were 80.8 and 42.3 Gg/yr for DM and 2.9 and 1.5 Gg/yr for FOD in the wet and dry seasons respectively. The estimated CO2 emissions was 1.2 Gg/Yr.

The solid waste disposal facility is a significant contributor of methane and carbon dioxide emissions in Akure. Further studies should be carried to provide methane and carbon dioxide specific properties of the solid waste generated in Akure in order to build an inventory of carbon emission parameters.

Keywords: Municipal Solid Wastes, Solid wastes characterization, Carbon Emissions Potentials.

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1. INTRODUCTION

Waste landfills have been recognized as the large source of anthropogenic methane emission and an important contributor to global warming **[1]**. Methane emissions from landfills is estimated to account for 3–19% of the anthropogenic sources in the world **[1]**. The estimation has been made from mere calculation using national statistics on waste generation. In many countries, especially the developing economies of the world, the available data on waste generation are not consistent, leading to a large uncertainty in the estimates.

Municipal solid waste is a significant contributor to greenhouse gas emissions through decomposition and life-cycle activities processes. The majority of these emissions are a result of landfilling, which remains the primary waste disposal strategy internationally **[2]**. In particular, the disposal of waste in landfills generates methane that has high global warming potential. Effective mitigation of greenhouse gas emissions is important and could provide environmental benefits and sustainable development, as well as reduce adverse impacts on public health **[3]**.

In the last few decades, the greenhouse gases produced by human activities have been predominating over those of natural origin **[4]**. The waste sector is a significant contributor to greenhouse gas (GHG) emissions accounting for approximately 5% of the global greenhouse budget (IPCC, 2006). This 5% consists of methane (CH_4) emission from anaerobic decomposition of solid waste and carbon dioxide (CO_2) from wastewater decomposition **[1]**.

According to recent estimates, the waste sector contributes about one-fifth of global anthropogenic methane emissions **[5]** and methane contribution to climate change is about one-third to a half of that of carbon dioxide **[4]**. Waste sector emissions have grown steadily globally and are expected to increase in the forthcoming decades especially in developing countries like Nigeria. This is because of increase in population and GDP **[1]**. In recognition of this, the Clean Development Mechanism (CDM) established by Kyoto Protocol in 1997, recognized waste and its disposal as one of the sectors identified for greenhouse gas reduction.

When solid waste (SW) is disposed in waste dumps and landfills, most of the organic material will be degraded over a longer or shorter period, ranging in a wide span from less than one year to 100 years or more. The majority of this process will be bio-degradation. Strongly depending on conditions in the site where the SW is disposed, this biodegradation will be aerobic or anaerobic. The main degradation products are carbon dioxide (CO_2), water and heat for the aerobic process and methane (CH_4) and CO_2 for the anaerobic process. The CH_4 and CO_2 produced and released to the atmosphere contributes to global warming and the emissions need to be estimated and reported in national greenhouse gas inventories under the United Nations' Framework Convention on Climate Change [6]. Fortunately in Nigeria, some works have been reported about the greenhouse gas emissions contributed by the wastes management sector, but it is imperative to look into the estimation of carbon emission potentials of open dumps which is the major method of disposal of solid wastes in Akure and in many Nigerian cities. The study therefore characterize the solid wastes generated in Akure brought to the Solid Wastes Management Facility into various physical components and chemical composition and estimate the Carbon Emissions Potential of the solid wastes over wet and dry seasons to check if there are seasonal variations in the environmental carbon-dioxide levels emitted at the Solid Wastes Management Facility

2. MATERIALS AND METHODS

2.1. STUDY AREA

Akure is the capital of Ondo State in Nigeria. It is an indigenous African town that lies between latitude 7° 15′ 0″ N and 5° 11′42″ East of prime meridian **[7]**. The present population of the city according to the 2013 Census Projection is more than 387,087 people **[8]**. The majority of the people are "Yoruba" while other ethnic groups constitute a smaller proportion of the population. Most of the people are engaged in petty trading and small-scale business, while others are civil/public servants. Akure has several public, private and social amenities such as the Ondo State Specialist Hospital, banks, industries, post office, higher institutions such as the Federal University of Technology Akure (FUTA), Federal College of Agriculture, Akure, Water Corporation and over 700 schools made up of both public and private nursery, primary and secondary schools.

The Integrated Waste Recycling Plant at Akure was commissioned by one of the former Presidents of Nigeria, Chief Olusegun Obasanjo on the 14th of June, 2006 and began operations on the 1st of December, 2006. The conceptualized capacity of the plant was 25 Tons/day, 5Tons/day and 5Tons/day for Organic Fertilizer, Plastic recycling and Metal Scrap Recycling, respectively. However, the plant was running below the design capacity due to several reasons. The total period of production is 8 hours daily. The Recycling Plant is managed by a Project Manager who is a Research and Development Officer in the State Government and reports to the Director of the Planning, Research and Strategy Department of the Ondo State Waste Management Authority. The recycling plant was designed and installed by Environmental Development Foundation under the supervision of Prof. Sridhar (One of the authors) and his team. The Plant consists of three Units namely; Material Recovery/Quality Control Unit, Material Processing and Production Unit and Marketing Unit. The initial size of the facility is 7 Hectares. That is, 6 Hectares for the Landfill and 1 Hectare for the recycling Plant. Presently, the Landfill has gone beyond the 6 Ha. The plant started with an initial size of 80 Workers but presently, the staff size is about 40 workers. Presently the plant is operated irregularly except the open dumping of waste at the large expanse of land adjacent to the recycling plant.

2.2. STUDY DESIGN

An exploratory study design was adopted. The study involved physical characterization of the solid wastes brought to the plant by wastes disposal vehicles, and estimation of the carbon-emissions at the dumpsite including recycling plant.

2.3. CHARACTERIZATION AND QUANTIFICATION OF SOLID WASTES

2.3.1. DETERMINATION OF PHYSICAL COMPONENTS

A). WEIGHT DETERMINATION

Three major sources of wastes were identified:

- Market: The wastes that emanate mainly from the markets which sell a variety of commodities including food and fancy goods.
- Residential: The wastes are mainly residential wastes which are emanated from 21 zones in Akure city. The wastes generated in the zones were collected through Stratified Random Sampling, on the basis of the type of commodities
- Kerbside (Non-specific wastes): These wastes arise from trade and offices.

The characterization and determination of weights of the waste were carried out for a period of 12 months. The segregation waste was carried out by randomly picking a vehicle coming out of the Residential, the Markets and Kerbside, once in a month. After the segregation at a central facility, the various components of the solid wastes were weighed using a 20kg capacity *Camry* kitchen weighing scale. The results were computed for the number of trucks that bring in the wastes. Some of the wastes which find their way to the open dump and have emission potentials are shown in Figure 1.

Figure 1. Segregation of market wastes into (a) vegetable and food residues, (b) cartons and paper, (c) low and high density plastics, (d) Typical waste disposal vehicle with compactor in use in Akure.

2.4. ESTIMATION OF METHANE EMISSION POTENTIAL AT THE DUMPING SITE

To estimate the Methane Emission Potential of the dump site the Intergovernmental Panel on Climate Change (IPCC) Default Method (DM) and First Order Decay Method (FOD) were used.

2.4.1. THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) DEFAULT METHOD (DM)

This methodology depends on estimating the Degradable Organic Carbon (DOC) content of the solid waste, and using this estimate to calculate the amount of CH_4 generated from the waste. Furthermore, this methodology assumed that all potential of CH_4 was released from waste in the year that the waste is disposed of. The DM methodology is the most widely accessible, easy to apply methodology for calculating country-specific emission of CH_4 from solid waste disposal sites. The annual CH_4 emission estimation for each region or country was calculated from Equation (1)**[1]**. The equation was employed by**[9]** to calculate Methane emissions.

The default method **[1]** is based on the main equation 1:

Equation 1

$$CH_4\ Emission\ Gg\ Yr^{-1} = [\left\{MSW_T\ x\ MSW_F\ x\ MCFx\ DOC\ x\ DOC_F\ x\ F\ x\frac{16}{12} - R\right\}\ \ x\ \{1 - OX\}] \quad (1)$$

Where:

MSW_T: total MSW generated (Gg/yr)

MSW_F: fraction of MSW disposed to solid waste disposal sites

MCF: methane correction factor (fraction)

DOC: degradable organic carbon (fraction) (kg C/ kg SW)

DOC_F: fraction DOC dissimilated (IPCC default is 0.77)

F: fraction of CH4 in landfill gas (IPCC default is 0.5)

16/12: conversion of C to CH_4

R: recovered CH_4 (Gg/yr)

OX: oxidation factor (fraction – IPCC default is 0)

MSW_T= Total municipal solid waste (MSW) generated (Gg yr^{-1}). Total MSWT can be calculated from population (in thousand persons) annual MSW generation rate (Gg 10^{-3} persons yr^{-1})

MSW_F= Fraction of MSW disposed of at the disposal sites. The percentage of 70% is based on field investigative studies. The remaining 30% is assumed to be lost due to recycling, waste burning at source as well as at disposal site, waste thrown into the drains and waste not reaching the landfills due to inefficient solid waste management system

MCF= Methane correction factor (fraction). The fraction depends upon the method of disposal and depth available at landfills. The IPCC document indicated the value of 0.4 for open dumps 0.5m depth and hence used for computation.

Table 1 reflects the Solid Waste Disposal Sites (SWDS) classification and MCF

Table 1 SWDS Classification and MCF

Type of Site	MCF Default Values
Managed	1.0
Unmanaged-deep	(≥5m waste) 0.8
Unmanaged-shallow	(≤5m waste) 0.4
Default value-uncategorized SWDSs	0.6

Source **[1]**

DOC= Degradable organic carbon (fraction). DOC content is essential in computing methane generation. It depends on the composition of waste and varies from city to city. Equation to determine DOC values

0:4A + 0:17B + 0:15C + 0:3D

where

A= paper + textiles

B=leaves + garden trimmings

C=food wastes

D=wood

F: 0.5 is the IPCC default value

R: Rate of Recovery of Methane which is 0 for an open dump.

OX: 0 is the IPCC default value

The minimum national Figs required are:

- National MSW quantities ending up at Solid Wastes Disposal Sites (SWDSs), eventually (in lack of SW statistics) based on the number of urban inhabitants in the country multiplied with a specific national MSW disposal rate Fig, and
- National quantities of landfill gas recovered.

In most developing countries there is no gas extraction and recovery; hence the only Fig needed in the calculation is the number of inhabitants in the country, with clear focus on the urban population.

Determination of Degradable Organic Carbon (DOC) from the recycling plant/open dump for the wet and dry season

The mean weights of the Paper and Textile, Food Wastes, Leaves and Garden Trimmings and Wood for the Market, Residential and Roadside were determined for the four months. The mean weight for each location was then obtained and then multiplied by the number of vehicles for each location and month as recorded by the job card produced for this purpose. This was used to estimate the weight of wastes for each location for each month and ultimately for the year under review. The year was then classified into wet and dry seasons. The wet season was from March to September, 2013 while the dry season was from October to February, 2014.

2.4.2. NATIONALLY ADJUSTED FIRST ORDER DECAY (FOD)-MODEL

Several countries have made adjustments to the presented FOD-model by including supplementary information of the factors Lo and k, and are in the process of using these in their national inventories.

A model implemented in Norway in 1998 **[10]** is proposed as follows:

$$Q_{T,X} = K \ x \ MSW_{T(X)} \ x \ MSW_{F(x)} \ x \ MCF_{(X)} \ x \ L_{0(X)} \ x \ e^{-(T-X)} \ x \ F \quad (2)$$

Where:

$Q_{T,x}$: the amount of methane generated in the current year from waste disposed in the year x

T: the current year (year of the emission estimate) (Gg/yr)

X: the historical year of the disposal of the relevant national MSW quantities

$Lo_{(X)}$: DOC x DOC_F for the year x (Gg CH4/Gg waste)

k: ln (2)/t½. (1/yr) which is between 0.005-0.4, the default value is 0.05 yr^{-1} is to be used as suggested under the Clean Air Act (CAA) in the U.S

t ½: half-life period for the degradation process (yr)

$MSW_{T(x)}$, $MSW_{F(x)}$ and $MCF_{(x)}$ and F are the same factors as in the default method (equation 1), but estimated for the year x.

2.5. ESTIMATION OF CARBON DIOXIDE EMISSION POTENTIAL AT THE DUMPING SITE USING THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), 2006 GUIDELINES

This methodology was based on the Tier 1 method of the **[1]** Guidelines. The Tier 1 method is a simple method used when CO_2 emissions from incineration/open burning are not a *key category*. Data on the amount of waste incinerated/open-burned are necessary [**11]**. The calculation of the CO_2 emissions is based on an estimate of the amount of waste (wet weight) incinerated or open-burned taking into account the dry matter content, the total carbon content, the fraction of fossil carbon and the oxidation factor. The method is based on the MSW composition and for MSW, it is *good practice* to calculate the CO_2 emissions on the basis of waste types/material (such as paper, wood, plastics) in the waste incinerated or open-burned expressed:

$$CO_2 = MSW\ x \sum_j \left[WF_j\ x\ dm_j\ x\ CF_j\ x\ FCF_j\ x\ OF_j \right]\ x \frac{44}{12} \quad (3)$$

Where

CO_2 Emissions= CO_2 emissions in inventory year, Gg/yr

MSW = total amount of municipal solid waste as wet weight incinerated or open-burned, Gg/yr

WF_j = fraction of waste type/material of component *j* in the MSW (as wet weight incinerated or open burned)

Dm_j = dry matter content in the component *j* of the MSW incinerated or open-burned, (fraction)

CF_j = fraction of carbon in the dry matter (i.e., carbon content) of component *j*

FCF_j = fraction of fossil carbon in the total carbon of component *j*

OF_j = oxidation factor, (fraction)

44/12 = conversion factor from C to CO_2

With: $\sum_j WF_j = 1$

j = component of the MSW incinerated/open-burned such as paper/cardboard, textiles, food waste, wood, garden (yard) and park waste, disposable nappies, rubber and leather, plastics, metal, glass, other inert waste.

2.5. DATA ANALYSIS

Data analysis was carried out using descriptive Statistics and ANOVA at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1. CHARACTERIZATION OF GENERATED WASTES

3.1.1. VARIATIONS IN WASTES GENERATION ACROSS SEASONS

Table 2 shows the variations in total wastes generation between the months of March to September, 2013 which represented the wet season and the months of October, 2013 to February 2014 which represented the dry season at the solid wastes' management facility. From the wastes brought from all locations, LDPE and plastic was the most generated component of solid wastes with 9,159,995.0 ± 8,453,005.4 and 6,777,621.3 ± 6,313,977.0 kg in the wet and dry seasons with no significant difference; this was followed by food waste, paper and textiles with 7,794,894.0 ± 7,569,909.7 and 5,724,532.0 ± 5,596,562.0 kg; 5,834,005.0 ± 5,079,633.8 and 4,266,871.0 ± 3,745,337.8 kg and 1,785,388.8 ± 1,394,407.0 and 1,320,720.2 ± 1,026,759.0 kg in the wet and dry seasons respectively and all with no significant difference.

Table 2 Variations in waste generation across seasons

Component	Wet Season		Dry Season		P- Value (<0.05)
	Weight (kg)		Weight (kg)		
Paper	5,834,005.0		4,266,871.0		0.69
LDPE & Plastics	9,159,995.0		6,777,621.3		0.67
Food Waste	7,794,894.0		5,724,532.0		0.72
Leaves and Hay	869,107.0		638,293.0		0.72
Textiles	1,785,388.8		1,320,720.2		0.79
Wood	300,476.5		220,366.3		0.72
Metal	22,426.3		16,518.5		0.80
Can and Tins	129,212.0		93,641.0		0.68
Bottles	265,680.6		191,959.4		0.67
Tyres	93,920.1		69,380.4		0.84
Battery	24,500.9		18,099.2		0.84
Wire	12,498.5		8,876.8		0.83
POP	28,336.0		25,120.0		0.83

*The period of wet season was from March to September, 2013 while that of Dry season was from October 2013 to February, 2014

3.2. ESTIMATION OF THE CARBON EMISSIONS POTENTIAL

3.2.1. WASTE COLLECTION TRUCKS COMING TO THE WASTE MANAGEMENT FACILITY

The number of trucks coming to the Waste Facility from the three locations is reflected in Figure 2. The highest number of trucks that came to the Facility was 837 in the month of August with 50, 250 and 572 for market, roadside and residential respectively. While the lowest number of trucks were 704 in the month of March with 31, 256 and 417 for market, roadside and residential respectively.

3.2.2. Comparison of Degradable Organic Carbon components per season for a year

Figure 3 reflects the components of the degradable organic carbon generated in the facility per season for a year in kilograms for the three locations. The total weights generated for paper and textile, food waste, leaves and garden trimmings and wood were 21,685,236, 23,384,682, 2,607,321 and 901,430kg; 15,880,890, 17,173,596, 1,914,879 and 661,099kg for the wet season and dry season respectively.

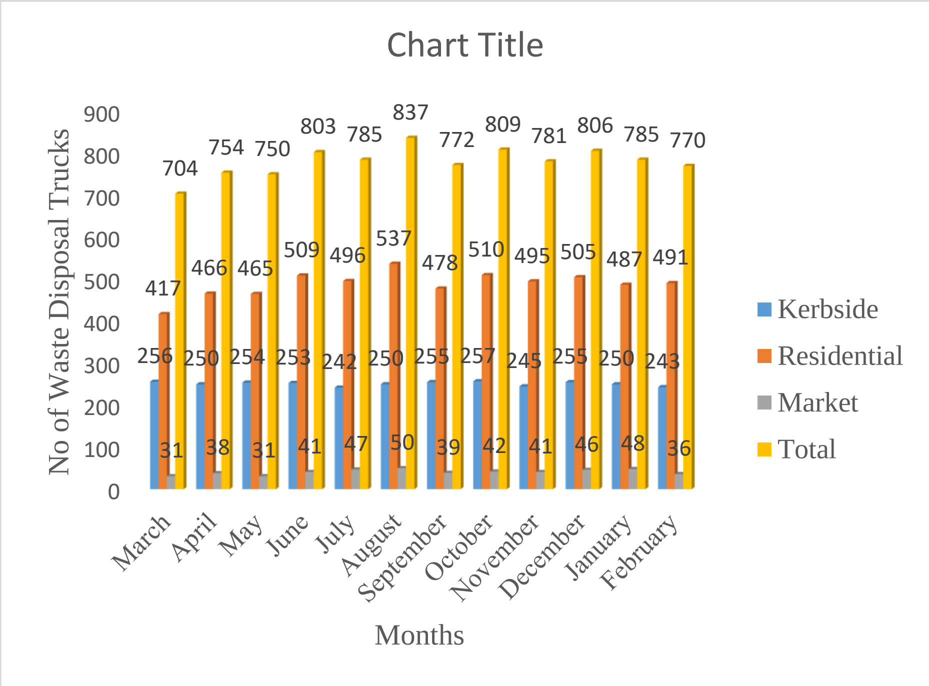

Figure 2 Number of waste collection trucks coming to waste facility by location for a Year

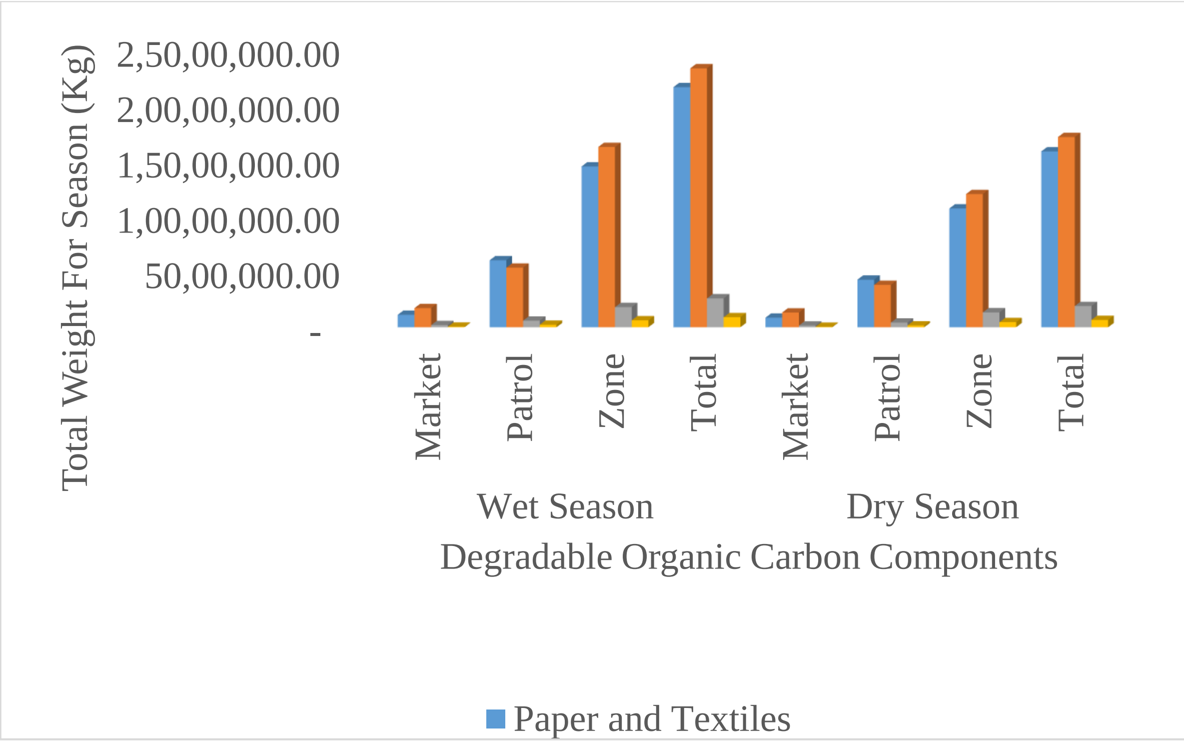

Figure 3 Total Degradable Organic Carbon components generated at the waste Facility per seasons for a year

3.2.3. ESTIMATION OF METHANE EMISSION FROM THE WASTE FACILITY

ESTIMATION OF METHANE EMISSION USING IPCC DEFAULT METHOD AND NATIONAL FOD METHOD

In most developing countries, the dominant disposal method is open dumping compared to the extensive use of sanitary landfills in the western countries. This is due to lack of finances of the government, rapid population growth, and increasing urbanization **[12] [13]**. The situation is not different in Nigeria as evidenced in the waste disposal method of open dumping in the study area.

The amount of methane emitted from a certain site is dependent on several factors including non-chemical properties e.g. size of population whose solid waste is disposed of, quantity and type of waste as well as chemical parameters such as composition and fraction of degradable organic carbon of waste, moisture, pH-value, temperature at the site **[14]**.

Various studies have been carried out to quantify methane emission from open dumps, especially in India and Thailand, but scanty information exist in Nigeria on the subject matter. The methane emission from the study area as shown by Tables 4 and 5 revealed that the calculation by the default method was 80.8 and 42.3 Gg/yr in the wet and dry seasons respectively, whereas using the National First Order Decay (FOD) method, the methane emission was 2.9 and 1.5 Gg/yr in the wet and dry seasons respectively, which reflects a seasonal variation in the estimated methane emissions.

As reflected in the results the estimations by the empirical methods were not different. This was in agreement with **[15]** who argued that the values of the default method were higher due to the assumption that all potential methane is emitted in the same year in which the solid wastes were disposed of. Therefore, the values estimated by the FOD method are more realistic. This method Kumar **[15]** proposed assumes that the decomposition of organic matter takes place in two phases.

Large differences of methane estimations from open dumps from developing countries are found in the literature. The estimations have to be handled with care as lot of uncertainties exist because regarding open dumps, there are several factors which have to be considered such as the specific microorganisms which hinders or enhances the anaerobic decomposition of organic waste. Furthermore, climatic conditions, age, and gas migration lead to wide variation of measurement results. Thus uncertainties are associated with the degree of factors affecting the methane emission estimation **[16].**

Table 4 Estimation of seasonal variation of methane emission from the solid waste facility using default IPCC methodology

Season	Methane Emissions (Gg/Yr)	MSW_T	MSW_F	MCF	DOC	DOC_F	F	16/12-R	OX
Wet Season	80.8	43,903	0.7	0.4	0.0128	0.77	0.5	1.333	1
Dry Season	42.3	30,979	0.7	0.4	0.0095	0.77	0.5	1.333	1

- **Methane emissions** $(\mathbf{Gg\ Yr^{-1}}) = \left\{\mathbf{MSW_T\ x\ MSW_F\ x\ MCF\ x\ DOC\ x\ DOC_F\ x\ F\ x}\frac{\mathbf{16}}{\mathbf{12}} - \mathbf{R}\right\}\mathbf{x}\{\mathbf{1 - O_x}\}$
- **MSW_T =** 387,087 X 0.53Kg/Person/Day X 214/1000 (Wet Season)
- **MSW_T =** 387,087 X 0.53Kg/Person/Day X 151/1000 (Dry Season)
    - **Approximate Population of Akure** = 387,087

- **Wastes Generation Rate for Akure =** 0.53Kg/Person/Day
  (Data from Ondo State Waste Management Agency)

- **DOC=** (0.4(37,566,126.00)+0.17(40,558,278.00)+0.15(4,522,200.00)+0.3(1,562,528.40))X 10^{-9}

Table 5 Estimation of seasonal variation of methane emission from the solid waste facility using the Nationally Adjusted FOD-model

Season	Methane Emissions (Gg/Yr)	K	MSW_T	MSW_F	MCF	DOC	DOC_F	F	$e^{-0.05(2013-2012)}$
Wet Season	2.9	0.05	43,903	0.7	0.4	0.0128	0.77	0.5	0.9512
Dry Season	1.5	0.05	30,979	0.7	0.4	0.0095	0.77	0.5	0.9512

- $\mathbf{Methane\ emissions\ (Gg\ Yr^{-1}) =}$
  $\mathbf{K \times MSW_{T(2013)} \times MSW_{F\,(2013)} \times \mathit{MCF}_{(2013)} \times DOC_{(2013)} \times DOC_{F(2013)} \times F \times e^{-K(2013-2012)}}$
- $\mathbf{MSW_T}$ **=** 387,087 X 0.53Kg/Person/Day X 214/1000 (Wet Season)
- $\mathbf{MSW_T}$ **=** 387,087 X 0.53Kg/Person/Day X 151/1000 (Dry Season)
  - **Approximate Population of Akure** = 387,087
  - **Wastes Generation Rate for Akure =** 0.53Kg/Person/Day
    (Data from Ondo State Waste Management Agency)

DOC=(0.4(37,566,126.00)+0.17(40,558,278.00)+0.15(4,522,200.00)+0.3(1,562,528.40))X 10^{-9}

3.2.4. ESTIMATION OF CARBON DIOXIDE EMISSION POTENTIAL AT THE DUMPING SITE USING THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), 2006 GUIDELINES

The carbon-dioxide emission potential estimated from the study area was 1.2 Gg/yr as shown by Table 6. The value was not in agreement with that of **[17]** who estimated 33.2 Gg/yr. In general, the total generation of CO_2 based on the current data for Nigeria is low when compared to emissions from the United States and other developed economies. However, Nigeria's gross emissions may approach those of these countries if its population continues to grow at the current rate of 3.5% per annum since per capita emissions is also likely to increase and nothing is done with respect to mitigating the emissions emanating from the solid wastes sector.

Table 6 Estimation of carbon dioxide emissions from the solid waste facility using default IPCC methodology

Carbon-dioxide Emissions (Gg/Yr)	Component of Waste	MSW (Gg)	WF_j	dm_j	CF_j	FCF_j	OF_j	(WF_j * dm_j * CFj *FCFj *OF_j)		44/12
	Paper	30.30	0.1747	0.90	0.44	0.01	0.58	0.000401238		
	Nylon + Plastic + Battery	47.70	0.2750	1.00	0.00	0.00	0.58	0.000000000		
	Biodegradable Waste	40.56	0.2338	0.40	0.38	0.00	0.58	0.000000000		
	Garden Trimmings	4.52	0.0261	0.40	0.49	0.00	0.58	0.000000000		
	Textiles	7.26	0.0419	0.80	0.30	0.20	0.58	0.001165772		
	Wood	1.56	0.0090	0.85	0.50	0.00	0.58	0.000000000		
	Metal + Cans/Tins/Wire	0.79	0.0046	1.00	0.00	0.00	0.58	0.000000000		
	Sand	36.18	0.2086	0.90	0.00	0.00	0.58	0.000000000		
	Ash	2.53	0.0146	0.90	0.00	0.00	0.58	0.000000000		
	Bottles	1.37	0.0079	1.00	0.00	0.00	0.58	0.000000000		
	Rubber/Tyre	0.28	0.0016	0.84	0.47	0.67	0.58	0.000250165		
	Bones	0.26	0.0015	0.90	0.00	0.00	0.58	0.000000000		
	POP	0.15	0.0008	0.90	0.00	0.00	0.58	0.000000000		
1.2		173.46	1.0000					0.001817176		3.6667

4. CONCLUSION AND RECOMMENDATIONS

A large volume of 40,558,278 kg per year for organic waste and 37,560.126 kg per year for paper and textiles generated in Akure provide a good source of raw materials for the establishment of a recycling plant. The emission estimates calculated with the two methods of IPCC default method and first order decay method are not comparable. The values of 80.8 Gg/year and 42.3 Gg/year and 2.9 Gg/year and 1.5 Gg/year were estimated for the wet and dry seasons respectively reflecting a variation and thus making the solid waste disposal facility a significant source of methane in Akure. The carbon-dioxide emission potential estimated at the Facility was 1.2 Gg/Yr which is quite high. Further studies should be carried out to extend the characterization of solid waste generated in Akure beyond one year to verify the seasonal variation of solid waste. Further studies should be carried to provide methane and carbon dioxide specific properties of the solid waste generated in Akure in order to build an inventory of carbon emission parameters.

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