International Journal of Environmental Chemistry
2026, Vol. 10, No. 2, pp. 34–42
https://doi.org/10.11648/j.ijec.20261002.12

Research Article

Environmental Impact Assessment of Carbon Emissions from Refuse Waste Disposals Along River Niger Bank in Asaba - A Footprint Approach

Godspower Ikechukwu Okolotu[1, *], Romanus Nwadiolu[2], Onoziogie Moses Akwenuke[3], Chineze Glory Okeke[4]

[1]Department Of Agricultural Engineering, Southern Delta University, Ozoro, Nigeria

[2]Department Of Agricultural Economics, Southern Delta University, Ozoro, Nigeria

[3]Department Of Civil and Water Resources Engineering, Southern Delta University, Ozoro, Nigeria

[4]Department Of Agricultural and Bioresource Engineering, Enugu State University of Science and Technology, Enugu, Nigeria

Abstract

Environmental impact assessment is the study of the effects exertible on the environment from a specific action. With respect to refuse waste disposals, the generative actions are mostly from people. Refuse waste disposal means rejected useless materials disposed away. Their unpleasantness extend to unsightliness accompanied bad smell, emissions and climate change contributions, fire outbreaks from contents burning, chemical poisonings upon contacts, pollution from leakages to surrounding soil, groundwater, and surface waters, and others. Wastes are among the top 5 largest generator of total greenhouse gas emissions. Carbon constituent the largest content of the total greenhouse gases, and are mostly deployed in determining such emissions. Refuse waste carbon emissions are generatable from mostly decays and burnings which facilitate carbon emissions movement back to the atmosphere of the environment. This calls for observatories, documentaries, strategies, and others, necessary for effective management. And, healthy management yields remarkable sustainability. This positively benefits agriculture (food production), ecology (good dwelling and interactions), health (good body state), engineered products and services (stable good conditions enable peak functions and services), etc. Thus, "environmental impact assessment of carbon emissions from refuse waste disposals along River Niger bank in Asaba - a footprint approach" was conducted. Results showed that 1,427.85 $kgCO_2e$ and 793 Kg were the carbon emissions and refuse wastes amounts. The carbon emissions and wastes ranged between 730.80 - 3445.20 $KgCO_2e$, and 406 - 1914 Kg respectively, invariably low to moderate. It was concluded that the carbon emissions from the refuse wastes disposals had low impact to the environment.

Keywords

EIA, Refuse Waste Disposal, Carbon Emissions, Footprint

*Correspondence: Godspower Ikechukwu Okolotu (Okolotugodspower@yahoo.com), Godspower Ikechukwu Okolotu (okolotugi@sdu.edu.ng)

Received: 5 June 2026; **Accepted:** 22 June 2026; **Published:** 16 November 2026

Copyright: © The Author(s), 2026. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

1. Introduction

About 75% of global population is projected to live in cities by 2050, and urban growth is of negative effect to the environment [1]. Asaba in Nigeria is a city of growing population, and this reflects on the expectedly rising refuse waste generation. Though most are duly managed, some remain inappropriately disposed, linking some negativity that calls for actions like this work. Existing works relative to this study include [2-6], and others, pointing on the various problems associated to wastes disposing. This work "Environmental impact assessment of carbon emissions from refuse waste disposals along River Niger bank in Asaba - a footprint approach" was conducted to monitor, assess and account the emissions impact on the area environment prior pollution. Monitoring causal actions of pollution for contamination reduction from its source is an effective technique for pollution management as well as environmental awareness creation in people [1].

1.1. Environmental Impact Assessment (EIA)

Environmental impact assessment is the study of the effects exertible on the environment from a specific action. It involves strategic processes of evaluation. Environmental impact assessment refers to the process involving the evaluation of possible environmental impacts from a development or event while considering adverse and beneficial impacts like inter - related socio - economic, human health and cultural impacts [7]. Environmental impact assessment is the examining process of anticipated specific environmental effects from consideration aspect of environmental possible effects, through due consultation, preparation, evaluation, and decision of environmental impact assessment report [8]. Environmental impact assessment involves the evaluation of the effects from private and public actions on the environment [9].

1.2. Refuse Waste Disposal

Refuse waste disposal exist in all countries, visibly extending to even all local areas. Refuse means rejected materials. Waste means useless. Refuse waste disposal refers to rejected useless materials disposed away. They generate from individual sources traceable to household and other activities. If improperly disposed, may be of nuisance due unsightliness accompanied bad smell, result able from the breeding grounds of pathogens and disease vectors [10]. They contribute a huge source of emissions to local pollution as well as climate change [11]. They pollute the surrounding soil, contaminate groundwater as well as surface waters, facilitate physical and fire hazards, as well pose chemical poisoning effects from mostly insecticides and pesticides [10].

1.3. Carbon Emissions

Carbon emissions refer to the rate of carbon emmitably sent out to the environment prior radiation and circulation. Carbon dioxide estimatedly is 53% more dense compare to the dry air, capable of living long, and mixing effectively in the earth atmosphere [12]. Its emissions in natural state are colourless enough not to be significantly seen with the naked eye. Decay and wildfires facilitate carbon emissions movement back to the atmosphere [12]. In addition to decays, carbon dioxide is generated from cellular respiration in form of by - product, organic materials combustion from wood, gas, coal, and natural sources of hydrothermal vents and volcanoes [13]. With respect to this work, refuse waste carbon emissions are generatable from mostly decays and burning. Wastes recorded the fourth largest emissions source sector, producing 3% greenhouse gas total emissions in 2017 [14].

1.4. Footprint

Footprint generally points to marks exertible upon existing presence. It is defined as the impact prior ecology involving activities of humans, other organisms, machines, and others. Human activities influencible by population and utilization rate of earth resources, plays great role in determining environmental damage with respect to land, water, as well as changing climates [15]. The amplitude of climate responsibilities towards human from greenhouse emissions necessitate carbon footprint, as the basic greenhouse work for research advances [16]. Carbon footprint is regarded as the biggest threat attributed to the twenty - first century, inclined long - term temperature variations as well as climate change [17]. Since composting minimizes organic materials emissions above 50%, offering sustainability prior soil amendment especially for agricultural purposes [18], it is a control measure for carbon footprint reduction. Other viable methods include incineration, landfills, waste compaction, vemicomposting, biogas production, and others. Typical examples are presented in Figure 1 below;



Figure 1. *Refuse wastes disposals methods [19].*

2. Materials And Methods

The River Niger bank at Asaba in Nigeria, West Africa was the study site used. Asaba being a capital city in Nigeria is expected to have growing wastes with growing population presently and in future. The major (at least two) trade locations are sited by this bank, contributing their own quarters to refuse waste disposals. The location of this work area (Asaba Nigeria) is presented in the Figure 2 below;



Figure 2. *Global map showing the location of Asaba, Nigeria.*

Additional materials were mechanical weighing machine, digitalized air indicator, mobile digital set, green house gas index, *etc*.

This work methodology involved physical surveys, weight measurements and computations of weekly refuse wastes disposals before final discards from the area, and documentation for the year. Thus, the amounts of the refuse wastes disposals along the bank on weekly bases were deployed upon indexing and classification, for the acquisition of carbon quantities emitted to the environment with respect to footprint.

3. Results

The obtained results are presented in Tables 1-5, and Figures 3 and 4 below;

Table 1. *The results from the first week.*

SN	Month	Amount Of Waste (Kg)	Carbon Footprint Emissions (Kg CO_2 e)	Impact Classification
1	January	918	1652.40	Low
2	February	912	1641.60	Low
3	March	582	1047.60	Low
4	April	869	1564.20	Low
5	May	597	1074.60	Low
6	June	440	792.00	Low
7	July	468	842.40	Low
8	August	698	1256.40	Low
9	September	790	1422.00	Low
10	October	832	1497.60	Low
11	November	890	1602.00	Low
12	December	1,210	2178.00	Moderate
Total	-	9,206	16,570.80	-
Average	-	767	1,380.90	Low

Table 2. *The results from the second week.*

SN	Month	Amount Of Waste (Kg)	Carbon Footprint Emissions (Kg CO_2 e)	Impact Classification
1	January	996	1792.80	Low
2	February	896	1612.80	Low
3	March	691	1243.80	Low
4	April	791	1423.80	Low
5	May	673	1211.40	Low
6	June	709	1276.20	Low
7	July	507	912.60	Low
8	August	631	1135.80	Low
9	September	560	1008.00	Low
10	October	495	891.00	Low
11	November	780	1404.00	Low

SN	Month	Amount Of Waste (Kg)	Carbon Footprint Emissions (Kg CO_2 e)	Impact Classification
12	December	1,730	3114.00	Moderate
Total	-	9,459	17,026.20	-
Average	-	788	1,418.85	Low

Table 3. *The results from the third week.*

SN	Month	Amount Of Waste (Kg)	Carbon Footprint Emissions (Kg CO_2 e)	Impact Classification
1	January	882	1587.60	Low
2	February	815	1467.00	Low
3	March	683	1229.40	Low
4	April	984	1771.20	Low
5	May	882	1587.60	Low
6	June	406	730.80	Low
7	July	610	1098.00	Low
8	August	863	1553.40	Low
9	September	515	927.00	Low
10	October	605	1089.00	Low
11	November	830	1494.00	Low
12	December	690	1242.00	Low
Total	-	8,765	15,777.00	-
Average	-	730	1,314.75	Low

Table 4. *The results from the fourth week.*

SN	Month	Amount Of Waste (Kg)	Carbon Footprint Emissions (Kg CO_2 e)	Impact Classification
1	January	834	1501.20	Low
2	February	937	1686.60	Low
3	March	924	1663.20	Low
4	April	996	1792.80	Low
5	May	968	1742.40	Low
6	June	561	1009.80	Low
7	July	483	869.40	Low
8	August	624	1123.20	Low
9	September	495	891.00	Low
10	October	528	950.40	Low
11	November	1,380	2484.00	Moderate
12	December	1,914	3445.20	Moderate
Total	-	10,644	19,159.20	-

SN	Month	Amount Of Waste (Kg)	Carbon Footprint Emissions (Kg CO_2 e)	Impact Classification
Average	-	887	1,596.60	Low

Table 5. *The results from the Average.*

SN	Month	Amount Of Waste (Kg)	Carbon Footprint Emissions (Kg CO_2 e)	Impact Classification
1	January	908	1634.40	Low
2	February	890	1602.00	Low
3	March	720	1296.00	Low
4	April	910	1638.00	Low
5	May	780	1404.00	Low
6	June	529	952.20	Low
7	July	517	930.60	Low
8	August	704	1267.20	Low
9	September	590	1062.00	Low
10	October	615	1107.00	Low
11	November	970	1746.00	Low
12	December	1386	2494.80	Moderate
Total	-	9,519	17,134.20	-
Average	-	793	1,427.85	Low

The chart of carbon footprint emissions for the weeks (one to four) is presented in Figure 3 below;

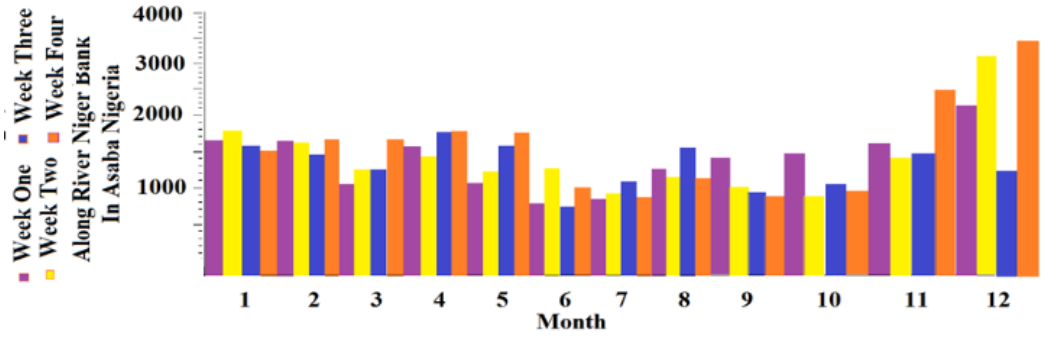


Figure 3. *Carbon footprint emissions along the River Niger bank in Asaba, Nigeria.*

The chart of the refuse wastes and carbon footprint emissions is presented in Figure 4 below;

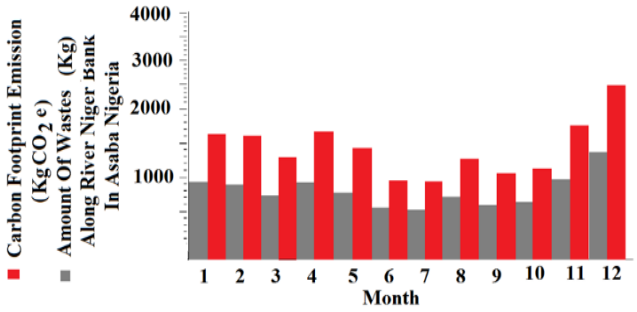


Figure 4. *Wastes and carbon footprint emissions.*

4. Discussion

The minimum carbon emission was 730.80 $KgCO_2e$, which occurred in the third week of June, classify - ably low with 406 Kg of wastes. The maximum was 3445.20 $KgCO_2e$, which occurred in December fourth week, associatedly classified moderate from 1,914 Kg of wastes. These were however high values compared to a carbon footprint assessment which found that, CO_2 emissions from 534 households wastes were below 10 kg of CO_2 equivalent per week reported by Premkumar A. [20]. Daily net carbon emissions ranges of 56.37 to 115.46 $kgCO_2e$ and 139.92 to 254.03 $kgCO_2e$, for residual incinerated wastes of conventional mixed incineration system and sorted waste treatment system were obtained in Hangzhou [21]. Both per week and per day, represent reporting values. The carbon emissions from the refuse wastes disposals in the River Niger bank in Asaba, Nigeria were low on the long run, having 1,427.85 $kgCO_2e$ with 793 Kg. Not disputing its contribution to pollution, it is not of positivity to the environment. This is because if not properly distributed in the atmosphere, concentrates accumulation may exist causing imbalance in the lower atmosphere.

Potential research works prior emissions dim vital and viable from incineration, landfills, waste compaction, vemicomposting, biogas production, and others.

5. Conclusions

From results obtained, it was concluded that in all, carbon emissions were 1,427.85 $kgCO_2e$, associated to 793 Kg of refuse wastes disposals in the area. It was moreso concluded that the carbon emissions from the refuse wastes disposals were of low impact to the environment. And that, this impact was atmospherically good. Also, the area had carbon emissions range of low to moderate (730.80 - 3445.20 $KgCO_2e$) attributive to 406 - 1914 Kg of refuse wastes.

Abbreviations

$KgCO_2e$	Kilogram Carbon Dioxide Equivalent
Kg	Kilogram
CO_2	Carbon Dioxide

Acknowledgments

The author (s) wish to appreciate the understanding from everyone, mostly the unanonimous individual wastes discarders.

Author Contributions

Godspower Ikechukwu Okolotu: Conceptualization, Methodology, Project administration, Validation, Writing – original draft

Romanus Nwadiolu: Visualization, Writing – original draft, Writing – review & editing

Onoziogie Moses Akwenuke: Visualization, Writing – original draft, Writing – review & editing

Chineze Glory Okeke: Visualization, Writing – original draft, Writing – review & editing

Data Availability Statement

All recorded and computed data of relevance from the research site has been reported within this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Salman M. Y., Hasar H. Review On Environmental Aspects In Smart City Concept:Water, Waste, Air Pollution And Transportation Smart Applications Using IoT Techniques. Sustainable Cities And Society. 2023, 92(104567). p 2, & 4. https://doi.org/10.1016/j.scs.2023.104567

[2] Ichipi E. B., Senekane M. F. An Evaluation Of The Impact Of Illegal Dumping Of Solid Waste On Public Health In Nigeria:A Case Study Of Lagos State. International Journal Of Environmental Resources And Public Health. 2023, 20(22), 7069, pp 1 - 19. https://doi.org/10.3390/ijerph20227069

[3] Pudcha T., Phongphiphat A., Towprayoon S. Greenhouse Gas Mitigation And Energy Production Potentials From Municipal Solid Waste Management In Thailand Through 2050. Earth System And Environment. 2023, 7, pp 83 - 97. https://doi.org/10.1007/s41748-022-00323-z

[4] Olaniyan U., Massoud M. A., Alameddine I., Al - Hindi M. Beneath The Surface:Assessing Pollution Levels Near Major Solid Waste Dumpsites In Lagos, Nigeria. Environmental Monitoring And Assessment. 2024, 196(11), pp 1 - 12. https://doi.org/10.1007/s10661-024-13357-9

[5] Raphela T., Manqele N., Erasmus M. The Impact Of Improper Waste Disposal On Human Health And The Environment:A Case Of Umgungundlovu District In KwaZulu Natal Province, South Africa. Frontiers Of Sustainability. 2024, 5(1386047), pp 1 - 13. https://doi.org/10.3389/frsus.2024.1386047

[6] Zhang Z., Chen Z., Zhang J., Liu Y., Chen L., Yang M., Osman A. I., Farghali M., Liu E., Hassan D., Ihara I., Lu K., Rooney D. W., Yap P. S. Municipal Solid Waste Management Challenges In Developing Regions:A Comprehensive Review And Future Perspectives For Asia And Africa. Science Of The Total Environment. 2024, 930(172794), pp 1 - 18. https://doi.org/10.1016/j.scitotenv.2024.172794

[7] World Heritage Convention. WHC:Environmental Impact Assessment. UNESCO World Heritage Centre, Viet Nam, 2025, p 1. Available From:https://whc.unesco.org/en/glossary/239

[8] Environmental Protection Agency. EPA:Environmental Impact Assessment - Overview. Wexford, Republic Of Ireland, 2025, p 1. Available From: https://epa.ie/our-services/monitoring--assessment/assessment/environmental-impact-assessment/

[9] European Commission Of The European Union. EC - EU:Environmental Impact Assessment. Environment - Environmental Assessments, European Union; 2025, p 1. Available From: https://environment.ec.europa.eu/law-and-governance/environmental-assessments/environmental-impact-assessment-eia_en

[10] Khalil E. E., El - Sherif D. M. Innovative Smart Applications For Solid Waste Management (Chapter 17). Smart Cities Policies And Financing Approaches And Solutions. 2022, pp 239 - 247; 239. https://doi.org/10.1016/B978-0-12-819130-9.00015-2

[11] Watson M. Waste Management. International Encyclopedia Of Human Geography (Second Edition). 2020, pp 225 - 231; 225. https://doi.org/10.1016/B978-0-08-102295-5.10761-9

[12] Wikipedia Encyclopedia. W. E:Carbon Dioxide. Wikipedia, 2025, p 7. Available From: https://en.wikipedia.org/wiki/Carbon_dioxide

[13] Myclimate. MC:What Is Carbon Dioxide (CO_2)? Environmental Climate Organisation, 2025, p 2. Available From: https://myclimate.org/en/information/faq/faq-detail/what-is-co2-and-where-does-it-come-from/

[14] Europe Statistics Of European Commission. ES - EC:Greenhouse Gas Emissions From Waste. Eurostat, European Union; 2020, p 4. Available From: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200123-1

[15] Derbyshire E. J., Finnigan T. J. A. Mycoprotein:A Futuristic Portrayal (Chapter 16). Future Foods Global Trends, Opportunities, And Sustainability Challenges. 2022, pp 287 - 303; 289. https://doi.org/10.1016/B978-0-323-91001-9.00037-2

[16] Chen R., Zhang R., Han H. Where Has Carbon Footprint Research Gone? Ecological Indicators. 2021, 120(106882), p 6. https://doi.org/10.1016/j.ecolind.2020.106882

[17] Sarkar S., Garai S., Saha S., Ghosh S., Brahmachari K. Management Of Carbon And Nitrogen Footprints For A Better Environment. Encyclopedia Of Sustainable Technologies (Second Edition). 2024, 2, pp 694 - 709; 697. https://doi.org/10.1016/B978-0-323-90386-8.00096-6

[18] New York State Energy Research And Development Authority. NYSERDA:Steps To Lower Your Carbon Footprint. New York State Government, USA; 2025, p 6. Available From: https://nyserda.ny.gov/Featured-Stories/Steps-to-Lower-Your-Carbon-Footprint#footnote6

[19] Byjus Learning App. BLA:Methods Of Wastes Disposals. Biology, 2025, p 2. Available From: https://byjus.com/biology/waste-disposal/

[20] Premkumar A. Assessment Of Carbon Footprint From Household Solid Waste In Tamil Nadu, India:Pathways For Achieving Low - Carbon Economy. Circular Economy And Sustainability. 2025, 5, pp 483 - 504; 483. https://doi.org/10.1007/s43615-024-00411-4

[21] Yin J., Wang M., Yu X., Wang M., Zhang Y., Chen T., Liu J. Carbon Footprint Impact Of Waste Sorting On The Municipal Household Waste Treatment System:A Mommunity Case Study Of Hangzhou. Circular Economy. 2024, 3(4):100114, p 1. https://doi.org/10.1016/j.cec.2024.100114

Biography



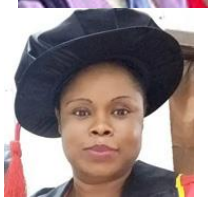
Godspower Ikechukwu Okolotu (B. Eng., M. Eng., M. NSE, PhD, Re-COREN) is an academia of Southern Delta University, Ozoro Nigeria, West Africa, in the department of Agricultural Engineering 2023 to present. He attained the climax of his education in 2021 with a PhD in Soil and water engineering from department of Agricultural and Bioresource Engineering, at the Enugu State University of Science and Technology, Nigeria, upon M. Eng., and B. Eng., (2015 and 2011) in same. He also holds a certificate of practicing from Council for the regulation of Engineering In Nigeria from 2021 to present. Scholarly, he has authored multiple published papers.



Romanus Nwadiolu is an academia of Southern Delta University, Ozoro Nigeria (2021 till date). He holds his PhD, masters degree, and bachelors degree in the area of agricultural economics, faculty of agriculture. He has authored various research works, and has registered a substantial record in academics.



Onoziogie Moses Akwenuke (B. Eng., M. Eng., PhD, Re-COREN), graduated with a B. Eng in Civil Engineering from Bendel State University in 1986, M. Sc in Environmental Resources Management, Lagos State University, Ojo, Lagos, 2000, PhD in Water Resources/ Environmental Health Engineering, University of Benin, 2015, have published a number of international, national and local research articles in reputable journals, have practiced civil engineering over the years both in the private and public sectors that involves design, construction, management and lecturing.



Chineze Glory Okeke (B. Eng., M. Eng., PhD, Re-COREN), an academia of Enugu State University of Science and Technology, Nigeria, holds a PhD (2019) in Bioprocessing Engineering from the department of Agricultural and Bio-resource Engineering at Enugu State University of Science and Technology, Nigeria. She has published various re-search papers in various publishing places.

Research Field

Godspower Ikechukwu Okolotu: soil and water conservation and management, hydro status and health, aquatic environments, sphere water recharges, ecosystem, *etc.*

Romanus Nwadiolu: agriculture, agroresource, agroconservation, agro safe environment, water relative to agriculture, *etc.*

Onoziogie Moses Akwenuke: water resources management and conservation, environment, soil, groundwater, Waterways, *etc.*

Chineze Glory Okeke: bio processing, crop processing, agricultural processing, agroconservation, agroenvironments, *etc.*