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Research Article

Quantifying CO_2 Green House Gas Emissions from Soil Dredging in Drainage Basin of River Niger at Otu Ogwu Asaba

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Abstract

CO_2 otherwise carbon-dioxide, is a gas of colourless form comprising of a single carbon and two atoms of oxygen, bonded through reaction. Carbon dioxide status obtainable through appropriate quantification is of importance to agriculture, climate change, human health concerns, etc. Objectively, this work summarily point on "Quantifying CO_2 green house gas emissions from soil dredging in drainage basin of River Niger at Otu Ogwu Asaba". In this work, a one year measurement involving field survey, data generation, computations and documentation, with respect to energy consumption by aquatic equipment operations relative to soil dredging which requires burning of diesel and petrol fuels, potentially contributing to atmospheric emittable greenhouse gases of which carbon dioxide (CO_2) was primarily focused on. Conclusively, 3,736.03 Kg CO_2e, and 44,832.32 Kg CO_2e, of average and total CO_2 otherwise carbon - dioxid emissions were attributed to the area in general. Also, 1403.64 Kg CO_2e, and, 5565.54 Kg CO_2e, of minimal and maximal CO_2 emissions occurred at the area, in the months of July (medium) and December (high) respectively. Moreso, the diesel energy consumption outweighed petrol with respect to their contribution to CO_2 emissions to the environment. While balance in environmental emissions were maintained by changing yieldings of low, medium and high CO_2 input from human activities as well as atmospheric air mixtures.

Keywords

CO_2, Green House Gas, Emissions, Soil Dredging, Drainage Basin

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1. Introduction

Quantification of carbon - dioxide (CO_2) provides the status of occurrence of the greenhouse gas emissions into the atmospheric environment. It is of concern to agriculture (plants respirate it as its air), climate change (emissions at high range may alter natural balance in air components capable of affecting weather and climate with respect to change in temperature for instance), human health concerns (high concentration pose health effects especially to humans), *etc*. The effects had led existing works of [1-4], *etc*. Objectively, this work intended to obtain the emission levels in the area mostly in respect of overall total CO_2 with possible classification, identify the intensification of carbon dioxide with respective to periods and class of emissions, observe CO_2 response to energy consumption of deployed fuels, *etc*. This work fills the gap of providing Information relative to the above stated tasks which were unavailably documentable for the area.

1.1. CO_2

CO_2 is the formulative symbol of carbon dioxide. The emission products from CO_2 are through natural and anthropogenic sources. Natural sources are mostly from wildfires and volcanic outgassing [2]. Anthropogenic sources are from burning of any fossil fuels [3]. Fossil fuels include natural gas, petroleum, coal, *etc*. [5], added gasoline, wood, and oil burning to its production. Fossil fuels of oil and coal contents of carbon are from photosynthesis occurrence in some million years of existence [1]. Photosynthesis being the bio - process plants and certain microbes extract carbon dioxide from atmosphere for food generation, play major role in cycling CO_2. Photosynthetic living organisms inhale carbon dioxide (CO_2), combine it with water (H_2O), to manufacture carbohydrates (sugar for instance) and exhale the by - product as oxygen [2]. Humans and some other organisms inhale the oxygen (O_2) and exhale carbon dioxide (CO_2) as by - product in breathing. Prior nature, CO_2 equivalent of 203 gigatons are cycled annually [4]. Presently, CO_2 in the atmosphere is 50% more than previous [1]. Fossil fuels consumption by human acts produce above 30 gigatons of more CO_2 annually, un - accommodative to carbon natural cycle [4]. CO_2 cycles with respect to this work to and from the environment. From renewable energy (through reduction of CO_2) to various fuels (through procurement) to dredgers (through consumption) to environment (through emissions) to atmosphere (through renewable process of recovery), it revolves the cycle. CO_2 intake can amount to notable health issues, especially at concentrated rates. Many hours exposure to CO_2 levels above 5000 ppm can result to nausea, dizziness, headache, and some other symptoms, if higher, the carbon dioxide can replace blood oxygen causing asphyxiation, while within 40000 ppm endengerment of life upon immediate contact is occurrable [5]. A typical example of carbon dioxide in the carbon cycling is presented in Figure 1 below;

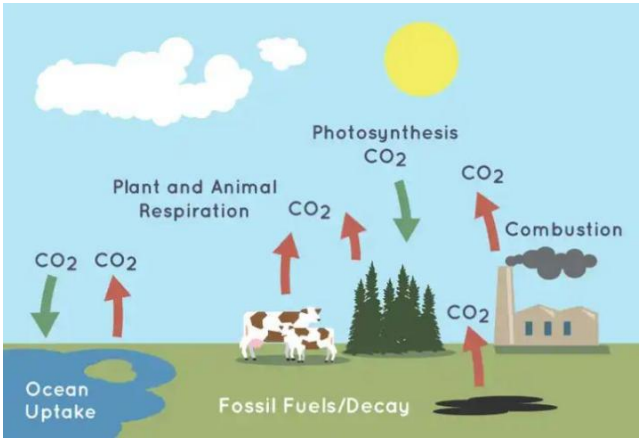


Figure 1. *Carbon cycle [6].*

1.2. Green House Gas

Green house gas is an emittable gas to the atmosphere capable of influencing directly on the greenhouse effect. This effect of greenhouse reflects on climate change which concerns the environment and the people. For instance, a global warming will affect temperature and others which is vital to both man, other animals, and plants. Basically, green house gas examples are carbon dioxide symboled CO_2, nitrous oxide symboled N_2O, water vapor symboled H_2O, sulfur hexafluoride symboled SF6, hydroflourocarbons symboled HFCs, methane symboled CH_4, and perfluorocarbons symboled PFCs [7]. Carbon dioxide forms the major quantity of the entire green house gases existing in the environment. It forms over half and quarter percentage of all component greenhouse gas emissions in the atmosphere. Emissions from GHG are mostly represented by that of CO_2 due to its hugeness [8].

1.3. Emissions

Emissions refers to matter component release, as well as radiables given out. Emissions are measurable in ppm (parts per million), or by their level of concentrations [7]. Matter component of carbon atom release in the form of carbon dioxide and the rest are depositable to the environment upon emitting from various sources. The major worldwide emission sources are of energy consumption and industrial production, seconded by agriculture [7]. The intensifying of these human emission sources which are undeniable due demand, impact on the world climate status. A faster warming of the earth than any recorded past, presently exist, triggered by solar heat trapping due to earth coverage by green house gas emissions in form of atmospheric blanket [9].

1.4. Soil Dredging

Soil dredging is the unearthing of soil sediments and materials from the beds of a river, watercourse, harbour, channels, *etc*. It involves digging and drawing up particles from beds of waterbodies to surface reach. Excavating, vertical transportation towards surface, horizontal conveyance, and utilization of acquired materials, are the phases of a dredging process [10]. Dredging is of mechanical and hydraulic forms [11]. The types are mostly associable to dredging excavation processes, equipment and soil properties. Mechanical involves cohesive soils extraction prior mechanical processes like scoops (cutter heads), buckets, grabs and the rest, while hydraulic extraction involves non - cohesive soils (sands, gravel, silt, and others) excavation using specially made water jests [12].

1.5. Drainage Basins

Drainage basins are depressed surfaces upon which draining of water manifest. The depression formed naturally or artificially, or the combination of both provides storage for receivable materials, including soils of diverse kinds. The term basin ident from the latin late bacchinon, a known french old bacin (1200 to 1300) [13]. Drainage basin refers to any land area serving as a converging point of different flowing surface water, also known as the river mouth upon which water find their way to the ocean [14]. A drainage basin accompanied with soil dredging provide improved water management influencing effective draining, controlling waterlogging, flooding, erosion, and others.

2. Materials

Otu - Ogwu river Niger in Asaba, Nigeria of west Africa, was the study area for attainment of this work. The location of this area is presented in Figure 2 below.



Figure 2. *Location of Otu - Ogwu river Niger in Asaba Nigeria in global map.*

Not excluding other materials of digital air indicating equipment, Green house gas index, mobile digital set, *etc*.

3. Methods

Upon field survey, CO_2 was measured using greenhouse gas index, deploying the energy consumption prior burning by the aquatic equipment during operation in the aquatic environment, emittable to the atmosphere.

4. Results

The obtained results are presented in Tables 1 to 6, and Figures 3 and 4, below;

Table 1. *The results of vessel propelled aquatic barges.*

Month	Total Active Vessel Propelled Barges Per Day	Daily Energy (Petrol) Consumption Per Vessel (In Litre)	Overall Energy (Petrol) Consumption Per Day (In Litre)	CO_2 Daily Emissions Level Per Vessel (Kg CO_2e)	Emissions Classification	CO_2 Overall Daily Emissions Level For All Vessels (Kg CO_2e)	Emissions Classification
January	9	18	162	41.58	Low	374.22	Low
February	7	18	126	41.58	Low	291.06	Low
March	8	17	136	39.27	Low	314.16	Low
April	7	16	112	36.96	Low	258.72	Low
May	7	18	126	41.58	Low	291.06	Low
June	5	15	75	34.65	Low	173.25	Low
July	6	16	96	36.96	Low	221.76	Low
August	7	16	112	36.96	Low	258.72	Low

Month	Total Active Vessel Propelled Barges Per Day	Daily Energy (Petrol) Consumption Per Vessel (In Litre)	Overall Energy (Petrol) Consumption Per Day (In Litre)	CO_2 Daily Emissions Level Per Vessel (Kg CO_2e)	Emissions Classification	CO_2 Overall Daily Emissions Level For All Vessels (Kg CO_2e)	Emissions Classification
September	7	18	126	41.58	Low	291.06	Low
October	11	17	187	39.27	Low	431.97	Low
November	10	17	170	39.27	Low	392.70	Low
December	13	18	234	41.58	Low	540.54	Low
Total	97	204	1,662	471.24	Low	3,839.22	Medium
Average	8	17	139	39.27	Low	319.94	Low

Table 2. *The results of self propelled aquatic barges.*

Month	Total Active Vessels	Daily Energy (Diesel) Consumption Per Vessel (In Litre)	Overall Daily Energy (Diesel) Consumption (In Litre)	CO_2 Daily Emissions Level Per Vessel (Kg CO_2e)	Emissions Classification	CO_2 Overall Daily Emissions Level For All Vessels (Kg CO_2e)	Emissions Classification
January	11	125	1,375	335.00	Low	3685.00	Medium
February	12	125	1,500	335.00	Low	4020.00	Medium
March	11	125	1,375	335.00	Low	3685.00	Medium
April	11	113	1,243	302.84	Low	3331.24	Medium
May	11	120	1,320	321.60	Low	3537.60	Medium
June	8	113	904	302.84	Low	2422.72	Medium
July	7	63	441	168.84	Low	1181.88	Medium
August	9	88	792	235.84	Low	2122.56	Medium
September	11	113	1,243	302.84	Low	3331.24	Medium
October	12	120	1,440	321.60	Low	3859.20	Medium
November	15	120	1,800	321.60	Low	4824.00	Medium
December	15	125	1875	335.00	Low	5025.00	High
Total	133	1,350	15,308	3,618	Medium	41,025.44	High
Average	11	113	1,276	301.50	Low	3,418.79	Medium

Table 3. *Results of overall energy consumptions per vessel.*

Month	Total Active Vessels	Energy Consumption (Diesel) Per Vessel (In Litre)	Energy Consumption (Petrol) Per Vessel (In Litre)
January	20	125	18
February	19	125	18
March	19	125	17
April	18	113	16
May	18	120	18

Month	Total Active Vessels	Energy Consumption (Diesel) Per Vessel (In Litre)	Energy Consumption (Petrol) Per Vessel (In Litre)
June	13	113	15
July	13	63	16
August	16	88	16
September	18	113	18
October	23	120	17
November	25	120	17
December	28	125	18
Total	230	1,350	204
Average	19	113	17

Table 4. *Results of CO_2 emissions from overall energy consumptions per vessel.*

Month	CO_2 Daily Emissions Level (Kg CO_2e)	Emissions Classification
January	376.58	Low
February	376.58	Low
March	374.27	Low
April	339.80	Low
May	363.18	Low
June	337.49	Low
July	205.80	Low
August	272.80	Low
September	344.42	Low
October	360.87	Low
November	360.87	Low
December	376.58	Low
Total	4,089.24	Medium
Average	340.77	Low

Table 5. *Results of overall energy consumption from all active vessels.*

Month	Total Active Vessels	Overall Energy (Diesel) Consumption (In litre)	Overall Energy (Petrol) Consumption (In litre)
January	20	1,375	162
February	19	1,500	126
March	19	1,375	136
April	18	1,243	112
May	18	1,320	126
June	13	904	75

Month	Total Active Vessels	Overall Energy (Diesel) Consumption (In litre)	Overall Energy (Petrol) Consumption (In litre)
July	13	441	96
August	16	792	112
September	18	1,243	112
October	23	1,440	187
November	25	1,800	170
December	28	1875	234
Total	230	15,308	1,648
Average	19	1,276	137

Table 6. *Results of overall CO_2 emissions from all active vessels in the area.*

Month	CO_2 Daily Emissions Level (Kg CO_2e)	Emissions Classification
January	4059.22	Medium
February	4311.06	Medium
March	3999.16	Medium
April	3589.96	Medium
May	3828.66	Medium
June	2595.97	Medium
July	1403.64	Medium
August	2381.28	Medium
September	3589.96	Medium
October	4291.17	Medium
November	5216.70	High
December	5565.54	High
Total	44,832.32	High
Average	3,736.03	Medium

The chart of CO_2 emissions from soil dredging in the area (Otu - Ogwu River Niger in Asaba Nigeria) is presented in Figure 3 below.

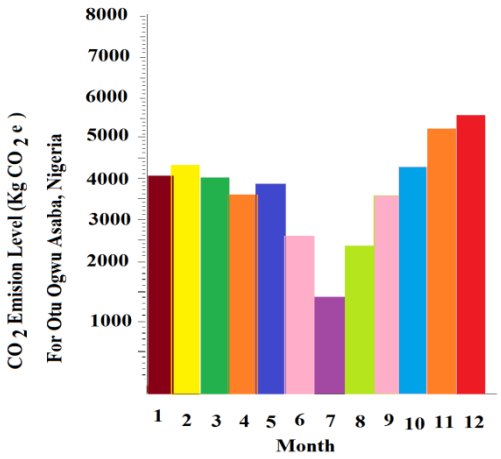


Figure 3. *CO_2 emissions from soil dredging in Otu - Ogwu in Asaba Nigeria.*

The chart of CO_2 emissions from vessel and self propelled aquatic barges is presented in Figure 4 below;

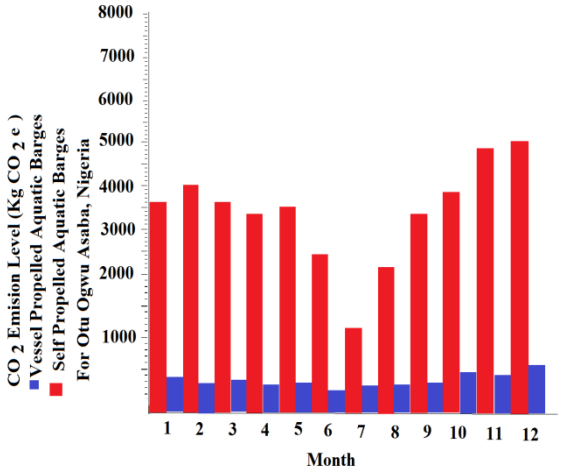


Figure 4. *CO_2 emissions from vessel and self propelled aquatic barges.*

5. Discussion

From results obtained, December recorded the most concentrated. This was associated with 1875 litres of overall energy (diesel) consumption as well as 234 litres of petrol consumption, both with CO_2 daily emissions level of 5565.54 Kg CO_2e, which was in all ramification considered high. In fact the diesel energy contribution alone was high with 5025.00 Kg CO_2e. November was also high on the long run with 5216.70 Kg CO_2e, from combined energy fuels consumptions of 1,800 litres and 170 litres. This November case was however medium and low independently with respect to the energy consumptions yieldings of 4824.00 Kg CO_2e, and 360.87 Kg CO_2e. Emissions of high sort posse negative effects on the aquatic environment and others. However, other months showed medium emissions, pointing to a balance avenue for the emissions. On the other hand, the vessel propelled aquatic barges contributed less emissions. Though their consumption were relatively low due functions. Also, the values of CO_2 used in this work were in kilogram concentrated equivalent. For instance, [5], reported their CO_2 values in parts per million. The units usage were inline with [7], which pointed that level of concentrations or ppm are both ideal for emissions measurement. The two units are also convertible. [15], identified CO_2-e as a standardized GHG comon unit for carbon dioxide emissions.

6. Conclusions

It was concluded that:

The area had an overall medium average carbon - dioxide (CO_2) emissions of 3,736.03 Kg CO_2e, with total of 44,832.32 Kg CO_2e.

Minimal and maximal CO_2 emissions were 1403.64 Kg CO_2e, and, 5565.54 Kg CO_2e, in July (medium) and December (high) respectively in the area.

Energy consumption from diesel outweighs petrol with respect to their contribution to CO_2 emissions to the environment.

Emissions balance was occurrable prior variabling yieldings of low, medium, and high, spaned within the day outputs prior atmospheric air mixture.

Abbreviations

CO_2	Carbon Dioxide
GHG	Green House Gas
Kg CO_2e	Kilogram carbon dioxide equivalent

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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

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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 hereby declare this research work to be of no existing conflict of any interest.

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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 Bioresource Engineering at Enugu State University of Science and Technology, Nigeria. She has published various research 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.*