Carbon Footprint Perception Among Residents of Bukuru Area of Jos South, Plateau State, Nigeria

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Abstract

The environment has been undergoing significant alterations, attributable to increased human population and their activities, which in turn is exacerbating carbon dioxide emissions. Carbon-dioxide is one of the major greenhouse gases (GHGs) warming up the Earth to cause global climate change. This study investigates carbon footprint perception among the residents of Bukuru area of Jos South using quantitative survey method. Bukuru was purposely divided into urban and suburbs for the study, while simple random sampling technique was used in selecting 150 respondents who were administered with questionnaire. Descriptive statistics were used to analyse the raw data collected and results presented in Tables. Results showed that majority of the respondents are aware of the concept of carbon footprint, its causes and threats. The respondents frequently cited causes of the menace to include open dumping of waste (82%) and bush clearance/burning (59%). Findings of the study revealed that residents perceived daily use of fossil-based cooking fuels (100%), daily use of automobile vehicles (100%), frequent use of refrigerators/freezers (81%), and intermittent use of insecticides/pesticides (78%) as the major causes of carbon footprints. From the findings, residents perceived that the problem of carbon footprint could be mitigated through: reduction in petrol-powered generators (23%), proper waste disposal methods (15.6%), practicing of climate-friendly agriculture (15%), afforestation (11.8%), and reduction in aerosol-releasing activities (11.0%), among others. Based on the findings, study recommended the need for government to implement all agreements on climate change, increase publicity among the general public about the menace, and environmental curricula be taught to students at all levels and disciplines.

Keywords: Carbon footprint, climate change, global warming, greenhouse gas.

Introduction

The earth offers diverse resources such as arable lands, forests and minerals necessary for human survival and development. However, uncontrolled human activities are directly and indirectly impacting the environment negatively in recent times (Gutschow et al., 2019). The environment has been undergoing significant changes attributable to increased human population and their multifarious activities which in turn is exacerbating greenhouse gas (GHG) emissions, with consequent Earth warming and global climate change (Ryu et al., 2022). Besides, the increased carbon dioxide build-up causing global warming and global change, GHGs are leading to decrease water availability for human beings and their economic activities, environmental pollution, melting of ice caps and rise in ocean water level, degradation of the ozone layer, extreme weather events, drought, desertification, biodiversity loss and mass extinctions, among others. It is widely accepted that the GHG emissions caused by humans are

having negative impacts on the environment and the most important GHGs are carbon dioxide (65%), methane (16%), forestry and other land-use types (11%), nitrous oxide (6%) and fluorinated gases (2%) (IPCC, 2007a; 2014b).

The concept carbon footprint is derived from the concept of ecological footprint, raised by Wackernagel and Rees in 1996 to refer to the land area needed to sequester carbon dioxide (CO_2) emitted from burning fossil fuel and can be measured to estimate the land requirement for energy use (Wackernagel & Rees, 1996). Although, many other scholars (Wang et al. 2022) define the concept variously, but in this study, the concept is regarded as the measure of the total GHGs being released into the atmosphere due to activities of individuals or group of persons. It can be interchangeably taken as global warming and, or greenhouse effect (GHE), where if the gases occur in the right proportions, the effect will help in regulating the internal heat of the earth for comfort and optimal ecosystem processes.

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007b) has emphasized that anthropogenic activities of all the world's nations are generating GHG emissions with consequent climate change. The report adds that it is due to alterations taking place in the atmosphere that worsening the problem of rising average global temperature since mid-20th Century which leads to rising temperatures. The IPCC (2014a) report has revealed global GHG emissions by economic sectors thus: electricity and heat production emitted 25%, followed by agriculture, forestry and other land-use (AFOLU) (24%), industry (21%) transportation (14%), and other energy, such as fuel extraction, refining and conveyance (10%). The report further indicated that the agriculture, forestry and other land-use sector emitted GHGs through cultivation and rearing of livestock and deforestation, but excluded the carbon dioxide removed by ecosystems through sequestering carbon in biomass, dead organic materials in the soil, that help to offset about 20% of emissions from this sector. The global carbon emissions from fossil fuel combustion have increased by 90% since 1970, with the combustion and industrial processes alone contributing 78% of the total global emissions (Ang & Zhang, 2000).

This astronomical rise in carbon footprint is substantially attributable to the increase burning of fossil fuels in transportation, industrial processes, electricity generation and mining, among others. This implies that the less the anthropogenic activities, the less the carbon footprint, hence the safer the ecosystem functioning and well-being. The 2014 global carbon dioxide emissions from fossil fuel combustion and some industrial processes by country has indicated the top emitting nations to include: China (30%), the United States (15%), the European Union (9%), India (7%), the Russian Federation (5%) and Japan (4%), while the rest of the countries, including Nigeria accounted for 30% (Zhang et al., 2019).

The carbon footprint in Nigeria has been increasing significantly. According to Worldometer (2016), the population of Nigeria as at 1971 was 57,296,983 people who emitted 38,183,651 tons of carbon dioxide, with per capita CO_2 emissions of 0.67 ton per year. This rose to 75,098,160 tons with per capita emissions of 0.77 ton per year when the population increased to 97,667,632 people in 1991. About twenty years later (2011), when the population rose to 162,805,077 people, the carbon dioxide emissions level reached 86,986,580 tons but with per capita emissions of 0.53 ton per year (ibid). The World Resources Institute Climate Analysis Indicators Tool (WRICAIT) (cited in Nigeria Numbers At A Glance, 2014) reported that Nigeria's 2014 carbon footprint came primarily from land-use change and forestry (LUCF) (38.2%), energy sector (32.6%), agriculture (14.0%), waste (13.0%) and industrial processes (2.1%) of total GHG emissions. The GHGs emanating from human activities which are contributing immensely to greenhouse effect (GHE) are majorly carbon dioxide ($C0_2$), methane (CH_4), nitrous oxide (N_2O) and tropospheric ozone (O_3).

Global warming as an aspect of climate change is a fact, and has evolved into a full range of political, economic, societal, technological, environmental and ecological issues on a global scale prompting series of international conventions like the United Nations Framework Convention on Climate Change (UNFCCC, 1992), the Kyoto Protocol (1997), Bali roadmap (2007), Copenhagen Agreement (2009). Signing of these agreements reflects the determination and efforts by Governments in response to global warming (Liu, Wang & Lu, 2013). Despite these efforts, the global carbon footprint is still on the increase. It was against this backdrop that this study set to investigate people's perception of this phenomenon adversely affecting the world presently. It is hoped that the results will guide relevant authorities in making policy decisions to mitigate this global warming.

This study is guided by thought-provoking questions, thus:

i. To what extent are the residents of Bukuru aware of carbon footprint?

ii. What anthropogenic activities are precipitating carbon footprint?

iii. What is residents' perception of the sources of greenhouse gas emissions?

iv. How can carbon footprint be mitigated at individual and group levels?

Description of Study Area

Bukuru Area is located between latitudes 9º 44'0'' to 9º49'30''N, and between longitudes 8° 50'0'' to 8º55'30'' E (figure 1). Bukuru is the headquarters of Jos South Local Government Area (LGA), but the entire LGA covers an area of 1,037km². The area is made up of younger granite formed during the Jurassic Period, underlain by crystalline rocks of the Africa shield. The landscape of the Bukuru area has been divided into physiographic units, hills dissected terrain and undulating terrain (Badiru et al, 2015). The general height of the area is 1,237 metres above mean sea level (AMSL), drained by numberous streams, including the Karami, Kaduna and N'gell which feed the Niger River and Shimankar which flow into the River Benue, the Lere, Maijuju and Bagel, suppling the Gongola, and the Kano, Delimi, Bunga and Masau which nourish the Lake Chad. Some rivers particularly River Kaduna cascades to forms waterfalls for generating hydro- electricity.

It is the second most populated area in the state after Jos North with, a population of 171,672 (National Population Commission-NPC, 2006). Bukuru area comprises parts of Bukuru stadium, Kugiya, Yelwa, Bukuru central, Bwandang, Zongo Kara, Kerana, Sabon Layi, Railway station, Tatangi Estate, Nesco quarters, Angwan Miyango/Chala, B division. The geology of the Bukuru area consists of crystalline rocks of the African shield. Sedimentary strata dating from various periods overlay the older rocks in many areas. The sedimentary areas are typically consisting of flat-topped ridges and dissected plateau and characteristic landscape of extensive plains and no major rocky outcrops.

The study area has a Tropical Savanna climate classified as ''Aw'', with two distinct seasons of equal duration. The rainy season starts from early April and ends October has annual rainfall, ranging from 1,317mm to 1,460mm while dry season of rainless months sets in from November to March. The climate is characterized by cool climate temperatures, ranging from 15°C and 24°C in cold and warm periods respectively. This climatic condition supports montane vegetation, consisting mainly of Tropical Savannah Woodland of mahogany, locust bean tree and shea butter tree, well supported by the Jos Plateau soils that developed on the basaltic and granitic rocks (Olowolafe, 2002).

The combined climatic, pedological and ecological conditions of the study area have given a medium for food crop and temperate crop production, including apple, strawberry and Irish potato. This explains in part why the population of Jos South LGA is growing at an

unprecedented rate. Jos South is the second most populated area in Plateau State, with a population of 171,672 (NPC, 2006). The town is made up of nearly all the ethnic groups of Nigeria, living in communities including: CTM Stadium, Kugiya, Yelwa, Bukuru central, Bwandang, Zongo Kara, Kerana, Sabon Layi, Railway station, Tetangi Estate, Nesco quarters, Angwan Daba, Angwan Doki, Angwan Miyango/Chala, B Division. Bukuru town has experienced large influx of people since the early days of commercial tin mining in 1904 which has boosted the growth of the area through urban sprawl. A substantial number of the residents are engaged in different economic activities like trading, teaching, public service, in Government Departments, Agencies and industrial processes, with few others engaged in cultivation of fruits and vegetables crops such as carrots, cucumber, okra, tomatoes, among others. The Yakubu Gowon dam is one of the biggest dams in the Northern part of Nigeria with a capacity of more than 90,000 cubic metres of water, providing potable water for domestic and agricultural activities within and outside the State. The presence of educational institutions is leading to the rapid economic activities in the area, leading to daily vehicular traffic that is fast exacerbating carbon footprint, hence the need to investigate people's perception of this environmental problem, with a view to getting the involvement of the residents in mitigating the problem.

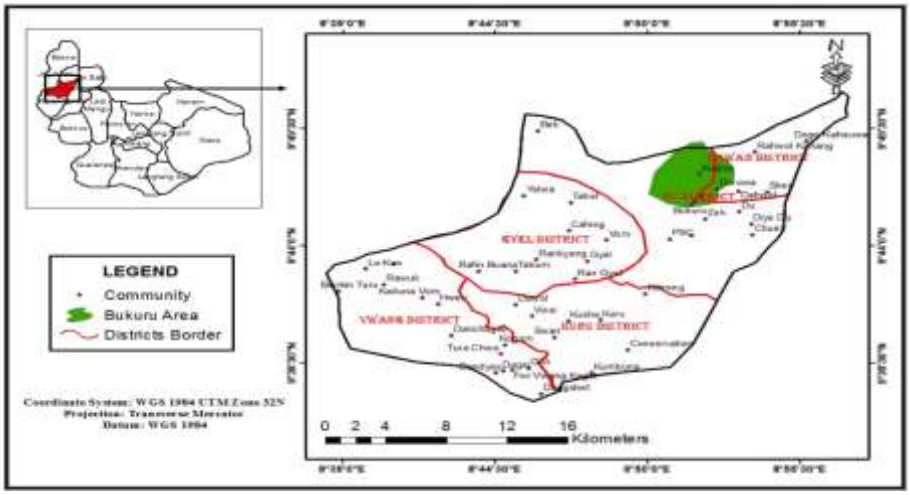

Figure 1: Study area

Materials and Methods

In this study, qualitative data was used. Data needed for the study were obtained from both the primary and secondary sources. Primary data were obtained through the design and administration of questionnaire to respondents, while archival sources such as reports, textbooks, journals and online resources were used in the study. Questionnaire was administered to people in houses, offices, shops and clinics/hospitals with questions which were relevant and in line with the aim and objectives of the study. Also, a field observation was carried out to identify other anthropogenic activities found in the area. A purposive sampling technique was used to select respondents from the urban and suburbs of Bukuru LGA. Thereafter, a simple random sampling technique was used to select the respondents in the study area which was grouped into urban and the suburbs. A sample frame of 150 was selected randomly with 100 from the urban area because it is more populated due to urbanization and industrialization, and the 50 from suburban settlements because it has less activities and population.

Result of the findings:

Extent of knowledge of carbon footprint

Table presented here shows the extent to which respondents have knowledge of carbon footprints and its threat on the environment they live.

Table 1: Extent of Knowledge of Carbon Footprint/Global Warming (Respondents=150)

Question		Frequency	Percentage(%)
1. Have you heard of global warming?			
	Yes	132	88
	No	18	12
2. Do you think global warming is a threat?			
	Yes	126	84
	No	24	16
3. What contributes to global warming?			
	It is man-made	114	86
	It is natural	36	14

Source: Researchers' Fieldwork, 2023.

Public participation in any of environmental programme is determined by the extent of knowledge of the intensity of the problem. Table 1 shows respondents' extent of understanding of the concept of global warming perpetuated by increased carbon footprint. Findings of the study in Table 1 reveal that 88% of the respondents are aware of the what global warming is, and that, 84% of them acknowledged the global threat of global warming, which 86% of the respondents attributed this environmental problem to man-made. It is likely that the people have learned about carbon footprints from school or such media as radio and television sets or read it from the print media.

Human activities causing carbon footprints

Uncontrolled human activities are known to enhance loading of heat-trapping greenhouse gases into the atmosphere to cause global warming. Table 2 contains respondents' views of such anthropogenic activities worsening carbon footprint in the study area. The findings of the study on human activities causing carbon footprint is presented in Table 2.

Table 2: Human Activities Causing Carbon Footprint (Respondents= 150)

Causal Factor	Activity	Frequency	Percentage (%)
1. Waste Disposal	Burning	27	18
	Burying	0	0
	Open dump	123	82
Frequency of disposal	Hourly	0	0
	Daily	89	59
	Weekly	60	40
	Monthly	1	1
2. Pesticides/Insecticide use			
	Yes	83	55
	No	67	45
3. Bush clearance & burning			
	Yes	88	59
	No	62	41

Source: Researchers' Fieldwork, 2023.

Results in Table 2 revealed that the major activities perpetuating high carbon footprint according to the respondents are daily dumping of waste (82%), clearance and burning of bush for farming (59%) and the applications of pesticides/insecticides (55%). Burning of waste (incineration) indicates the emission of carbon dioxide (CO_2), sulphur dioxide (SO_2), methane (CH_4) and oxides of nitrogen (NOx) while the dumping of waste indicates emissions of CH_4 and CO_2. Also included in small amounts of nitrogen (N_2), oxygen (O_2), ammonia (NH_3), hydrogen sulphide (H_2S), hydrogen (H_2), carbon monoxide (CO), and non-methane organic compounds (NMOCs) such as trichloroethylene, benzene, vinyl chloride, which are all associated with agro-chemicals and burning of solid waste (Saral, Demir & Yıldız, 2009), all contributing to carbon footprints and global warming of the environment. A report from the IPCC (2007c) finds that about 30% of global emissions leading to climate change are attributable to agricultural activities, including pesticide use.

Perceived Source of Carbon Footprint Emissions

There are many uncontrolled human activities involving combustion of fossil fuels that are currently exacerbating carbon footprint, as evident by global warming. Table 3 contains respondents' views of such anthropogenic activities exacerbating carbon footprint in the study area.

Table 3: Perceived Sources of Carbon Footprint Emissions (Respondents=150)

Variable	Yes	%	No	%
Daily use of fossil-powered cooking energy	150	100	0	00.0
Daily use of automobile vehicles	150	100	0	00.0
Frequent use of refrigerators/freezers	122	81.0	28	19.0
Intermittent use of insecticides/pesticides	117	78.0	33	22.0
Frequent use of generators	96	64.0	54	36.0
Daily use of air conditioning system	50	33.0	100	67.0
Mean	114	76.0	36	24.0

Source: Fieldwork, 2023.

Results in Table 3 revealed that the major sources of carbon footprint in the study area as refrigerators (81%), insecticides (78%), transportation using cars (65%), power generating devices (64%), and domestic cooking gas (33%) while air conditioners are not known as another source. Ogbuador and Egechukwu (2017) in their work have stated that over 90% of the fuel used for transportation is petroleum based, which includes primarily gasoline and diesel. IPCC (2007b) also asserted that gasoline releases 19.6 pounds of CO_2 per gallon when burned, compared to 22.4 pounds per gallon for diesel; this is coupled with the fact that Nigeria is an oil (petroleum) producing country with massive importation of cars that use Liquefied Petroleum Gas (LPG).

Global Warming/Carbon Footprint Mitigation

Global warming and carbon footprints can be mitigated through different ways, Table 4 presents different mitigation measures in which global warming and carbon footprints can be reduced.

Table 4: Global Warming/Carbon Footprint Mitigation (Responses=525)

Mitigation	**Frequency**	**Percentage**
Minimize car transport	51	9.7
Climate-friendly agriculture	78	14.9
Afforestation/reforestation	62	11.8
Proper waste disposal	82	15.6
Use less air conditioner	21	4.0
Control use of electricity	17	3.2
Reduce aimless driving	36	6.9
Reduction in aerosol-releasing activity	58	11.0
Reducing the frequent use of petrol-powered generator	120	22.9
Total	525	100

Source: Researchers' Fieldwork, 2023.

Table 4 shows the distribution of respondents by ways of mitigating global warming/carbon footprint at individual and group levels. Some of the popular mitigation measures listed include: reducing use of generators (22.9%), proper waste disposal (15.6%), climate-friendly agriculture (14.9%), afforestation (11.8%), minimizing aerosol production (11.0%) and minimization of car use (9.7%). The respondents are right to some large extent, because IPCC (2007b) reported that burning of fossil fuels is contributing to carbon emissions, meaning reduction of it could help in global warming mitigation. However, it seems many respondents in the study area are not aware that controlling electricity consumption could mitigate global warming, as only 3.2% are very much aware of it. The Federal Ministry of Environment, FMEN (2020), averred that the use of electricity contributes 37% of total carbon emissions to the atmosphere therefore; controlling electricity consumption could mitigate global warming significantly.

Conclusion

The study has investigated residents' perception of carbon footprint in Bukuru area of Jos South Local Government. The results revealed high awareness level of awareness of the concept, causes and threats of carbon footprint among the residents. The study findings revealed that daily open dumping of untreated waste and bush clearance and burning are the major anthropogenic activities aggravating carbon footprint in the study area, while the perceived sources of carbon footprint according to the residents are combustion of petrol-powered devices such as generators, automobile cars and weekly use of insecticides in homes and fields. However, the study findings revealed that, at individual and group levels, carbon footprint can be mitigated to a significant level by curtailing combustion, proper waste disposal and practicing climate-friendly agriculture, among others.

Recommendations

Sequel to these findings, the following are recommended:

i. There is need for more research on carbon footprint- generating activities so that both the short-term and long-term solutions could be sought.
ii. There is need to increase publicity among the general public in market and worship centres, while environmental education should be included in school curricula and taught to students of all levels and disciplines.
iii. People should invest more in energy-efficient appliances especially for their households and the Government should adjust from fossil fuel and invest in renewable energy projects.
iv. Government should be committed to implementing all agreements and treaties including the Kyoto Protocol (2008) and the Climate Change, code-named COP26 of the 2022 in order to curtail carbon footprint emissions as early as possible in order to save humanity and the environment from further degradation.

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