

CARBON FOOTPRINT ASSESSMENT OF RESIDENTS IN BENIN CITY, NIGERIA

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Abstract

Over the past few years, the term individual carbon footprint has gained enormous popularity. Carbon footprint calculations are in great demand since climate change is a major concern to individuals. Growing atmospheric concentrations of greenhouse gases are upsetting the ecosystem and resulting in severe global warming and related effects. This study determines carbon footprint among individuals in Benin city Nigeria. The carbon emissions of the individuals, awareness of greenhouse gases and efforts taken by the individuals to reduce the emission rate were obtained through a questionnaire designed in Likert scale. 180 of these questionnaires were distributed to the respondents. The carbon footprint was calculated using ISO 14064 model. Other data were analyzed used descriptive statistics such as mean and standard deviation. The result showed that the range of the carbon footprint is between 0.1 and 57.2 tonnes of CO₂ per household most of which were within the ideal carbon footprint, as defined by ISO 14064 (2.72 and 7.26 tCO₂). The result also showed that there was low awareness of greenhouse gas and efforts taken by the respondents to reduce their carbon emission are low. The carbon footprint of the residents is generally low. More efforts should be done by relevant agencies to increase awareness of greenhouse gas and other climate change related to the study area

Key Words: Carbon, Footprint, Greenhouse gas, Individual, Awareness

Introduction

Measuring direct and indirect greenhouse gas (GHG) emissions during production and consumption is now commonly done using Carbon Footprint (CF), an integrated and unified environmental management and evaluation indicator (Pandey *et al.*, 2011). Depletion of energy resources and changes in climate have persisted as global environmental challenges over time (Day and Rybczyk, 2019). In comparison to other nations and regions,

Nigeria and Africa may experience some of the most insensitive effects of climate change, and they are also among the least equipped to deal with these effects (Olaniyi *et al.*, 2013). Carbon footprint is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product (Wiedmann and Minx, 2007). Carbon footprints assessment is one way of determining the contribution an emission source has to climate change.

Heat released into our atmosphere by carbon dioxide is trapped and released from the sun and the Earth's surface. Elevated quantities of greenhouse gases, particularly carbon dioxide, from the burning of fossil fuels and deforestation pose a threat to life, as they can raise the planet's average surface temperature to unmanageable levels and have several adverse effects. Climate scientists believe that present atmospheric carbon dioxide levels are the highest in approximately 14 million years. The levels have increased by more than 40% since the middle of the 18th century. Since the 1980s, when the transition phase began due to the emergence of climate change challenges and diminishing energy supplies, the global energy landscape has been changing quickly. But according to Davidson (2019), CO₂ emissions are the main factor causing environmental deterioration. According to projections, the world's energy consumption will rise by 37% over the next 20 years due to growing demand and an expanding worldwide population. According to the benchmark study, fossil fuels will continue to supply two thirds of the rise in energy demand, even though renewable energy will make up 8% of the energy mix, up from its current percentage of 3%. However, the world will not be able to lower greenhouse gas concentrations in the atmosphere to roughly 450 parts per million of CO₂, also known as the "450 Scenario," which is considered essential to limiting the increase in global temperature by 2°C, according to the International Energy Agency (Quadrelli and Peterson, 2007). This is because of continued demand for fossil fuels.

An individual's GHG emissions are measured by their own carbon footprint.

There are differences in the specific composition of it. According to Kenny and Grey (2009), it is made up of the direct, also known as the primary footprint, and the indirect, also known as the secondary footprint. Over the past few months and years, it has become much more visible in the public and is now a term that is frequently used in the business, government, and media sectors. Nigeria is recognized globally as one of the top producers and consumers of fossil fuels. Therefore, in the past, present, and near future, Nigerian citizens have been at risk due to fossil fuel resources (Alege *et al.*, 2016). Thus, the nation is set to experience a shock unless policies for environmental sustainability and the reduction of greenhouse gas emissions (GHGE) are implemented. Sadly, there is not enough information to feasibly support the specific causes of GHGE in sub-Saharan Africa.

Higher income groups have the highest carbon footprints as a result of travel and mobile use. However, Food preparation and cooking are the main sources of carbon emission of low income households. In order to meet the needs of their existence and development in a given socioeconomic situation, people or their families must emit carbon, which can include both direct and indirect emissions. This definition applies to household carbon emissions (Qu *et al.*, 2016). More specifically, GHG emissions from domestic sources like heating and electricity, as well as transportation sources like private vehicles, plane trips, buses, and trains, make up the majority of the direct footprint (Kenny and Grey, 2009). According to Wang *et al.* (2015), indirect emissions are those that are produced along with all other household

consumer goods. Examples of these emissions include those produced during the production of clothing, food, furniture, services, and so on. The strain that a growing household population places on natural resources is one way that it impacts the environment. The choice of energy demand by households is also influenced by household income. It is obvious that human activities like cooking, heating, transportation, and other energy-intensive activities could increase carbon footprints and lead to ecological disasters, which could have a negative impact.

The difference in social emissions from energy consumption between households in urban and rural areas becomes negligible. Income and population size in urban areas have a positive impact on overall energy consumption as well as the environmental effects of coal and electricity, whereas in rural areas, income and population density have a favourable influence on biomass and electricity Mohammed *et al.* (2013). Basically, people's awareness of their accountability for contributing to greenhouse gas emissions has increased dramatically. This has caused a boom in the availability of online calculators and consulting services for measuring one's personal carbon footprint (Kenny and Grey, 2009). According to Murray and Dey (2009), after calculating the footprint, they offer to offset it by planting trees, promoting forests, and using renewable energy sources. As a result, there has been a notable increase in the voluntary carbon market since 1989 (Hamilton *et al.*, 2009). Individuals' inclination to walk and ride bicycles can contribute to a decrease in fossil fuel-fueled transportation systems (Frank *et al.*, 2010).

Study Area

This study was conducted in Benin City, the capital of Edo State, Nigeria, as shown in Fig 1 below with the Lat. 6° 17' to 7° 12'N and Long. 5° 15' to 5° 41'E. The city is located in the northwest of the Niger Delta, to the west of the plains and mountains that make up the southwest and lower Niger valley. A slanted plain that slopes southwesterly makes up the city region. Around the Ishan Plateau and Asaba Plateau is where it reaches its maximum altitude. The majority of the city region is very level, with the exception of the Ikpoba hill, which is a portion of the plateau in the northwest corner of the Ete and Aduwawa districts. The soil is lateritic, meaning it contains clay particles and is primarily red or reddish brown in appearance. The Ikpoba River drains the eastern section of the city, while the Ogba River drains the western part. These two major river systems drain the city (Ogbonna *et al.*, 2011). Places visited within the city include Ugbowo and Uselu in Egor LGA, Costain, Ogba and Oko in Oredo LGA, Ikpoba Hill in Ikpoba Okha LGA and Iguosa in Ovia Northeast LGA.

The climate in Benin City is hot and humid. March through October is the wet season, and November through February is the dry season. Benin City has an average daily temperature of 28°C during the dry season and 24°C during the wet season. The mean temperature of Benin-city is 27.7°C (Odiana and Idahosa-Ohio, 2023). The temperature range in the research area is low. Intense rainfall is common in Benin City and the surrounding areas, particularly during the rainy or wet season. There is rainfall every month of roughly 180 mm and an annual total of 2000–2300 mm (Cirella *et al.*, 2019).

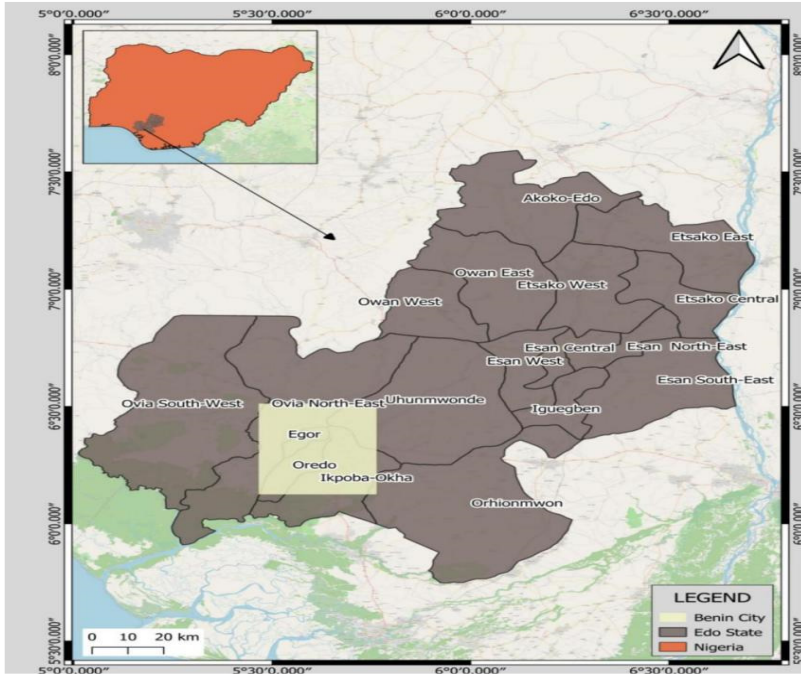


Fig 1: Map of the study area

Methodology

Source of Data

This study used primary source of data, which involves questionnaire designed in Likert-scale to gather Information about energy consumption, awareness of greenhouse gases and measures taken to reduce greenhouse gas emission among residences in Benin-City. 180 respondents were used for this study. Each respondent was asked to complete a questionnaire to find out what energy source and quantity used, what activities increased their carbon footprint and how aware they are of their carbon footprint.

Data Collection Method and Analysis

The questionnaires were distributed to the respondent by the researcher and research assistant who were trained prior to the research. The questionnaires were promptly collected from the respondent

after they had completed them on the spot. This was done to make it possible for the researcher to gather information on the carbon footprints of residences in Benin-City. The questions centered on the amount of carbon released directly and indirectly, the assessment of awareness, and the steps people have done to cut back on greenhouse gas emissions at home.

Descriptive statistics such as mean and standard deviation were used to analyse the acquired data. The International Organisation for Standardization's carbon footprint formula (ISO 14064) was used to calculate each respondent's carbon footprint. The following is the ISO 14064 formula used to determine carbon footprint: Individuals who answered questionnaire items with a mean score of 2.5 or higher were considered to be in the affirmation category.

Results

Demographic Characteristics of the Respondents

The gender, age, occupation, marital status and educational level of the respondents in the study area are shown in Table 1 below. There were 58.9% male and 40.6% female which means that most of the respondents were male. In terms of age, 58.1% were between 20-30 years, 24.0% were between 31-40 years, 11.2% were between 41-50 years and 6.7% were above 50 years. This showed that most of the respondents are young and in their economically productive age. This implies that they have high tendency of continually getting involved in carbon emitting activities for sometimes and

consequently increasing their carbon footprint. As shown in the table, most of the respondent (55%) are working and 45% are students who are also engaged in carbon emitting activities. This implies that carbon emission is likely to take place by each of the respondents. The result also revealed that 2.8% had only primary school education, 15.0% had secondary education, 76.7% had tertiary education and 5.6% had no formal education signifying that most of the respondents are literate. Being mostly literate connotes that accepting innovations and best practices that could help in reducing carbon footprint would not be a much problem in the study area

Table 1: Demographic characteristics of the respondents

Characteristics	Components	Frequency	Percentage (%)
Gender	Male	106	58.9
	Female	73	40.6
	Total	180	100.0
Age	20-30	104	58.1
	31-40	43	24.0
	41-50	20	11.2
	50 AND ABOVE	12	6.7
	Total	180	100.0
Occupation	student	81	45.0
	civil/public service	28	15.6
	business	62	34.4
	Artisan	9	5.0
	Total	180	100.0
Educational Level	Primary	5	2.8
	Secondary	27	15.0
	Tertiary	138	76.7
	No formal education	10	5.6
	Total	180	100.0
Marital Status	single	118	65.6
	married	49	27.2
	divorced	3	1.7
	widow/widower	10	5.6
	Total	180	100.0

Determining the Carbon Footprint of the Respondents

The carbon footprint of the respondents in the study area is as shown in the table 2

below. The carbon footprint ranges between 0.1tCO₂ and 57.2tCO₂ per household. According to ISO 14064, ideal carbon footprint is between 2.72 and 7.26tCO₂; Average carbon footprint is between 7.26 and 9.98 tCO₂. Over 9.98 tCO₂ is in the excess while below 2.72 is said to be too low. 92.22% of the respondents had their carbon footprint not exceeding the maximum limit for ideal carbon footprint. Less than 1% had their carbon footprint exceeding acceptable limit. It can therefore be deduced that most of the carbon footprint within normal range.

Table 2: Carbon Footprint of the Respondent

Range	Frequency	Percentage (%)
0-5	166	92.22
5-10	12	6.67
10-15	01	0.55
>15	01	0.55

To Assess the Level of Awareness of Green House Gas Emission by the Respondent

The mean of the result on awareness of greenhouse gases as shown in Figure 2 below revealed that the respondents were not in agreement with the items analysed. Therefore, from the result, it can be inferred that the level of awareness of greenhouse gases by the residents is poor.

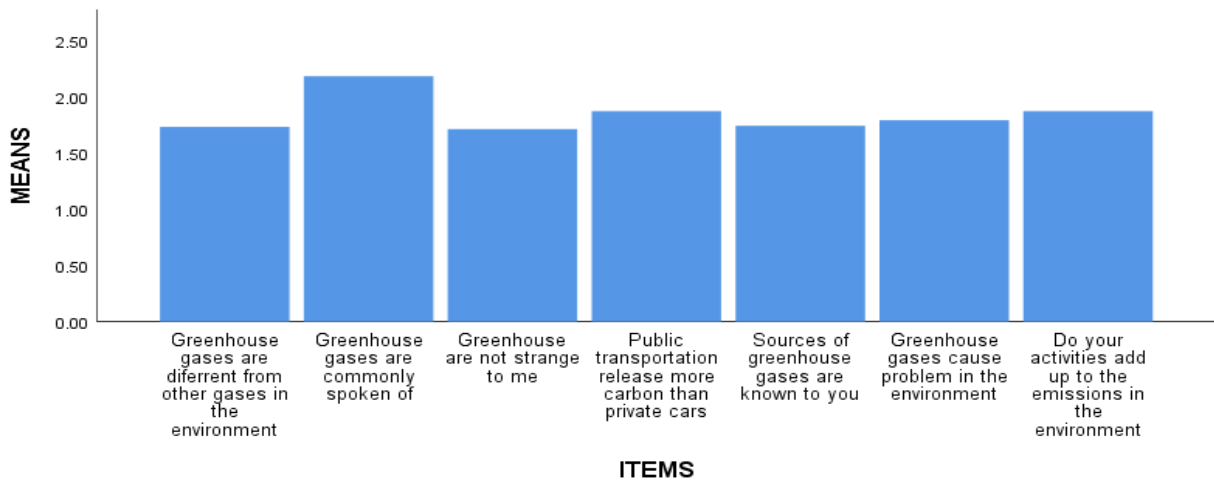


Fig 2: Level of awareness of greenhouse gas by residents

Measures Taken to Reduce Carbon Footprint by Respondents

The mean of the result on measures taken to reduce greenhouse gas emission by the residents in the study area as shown in Figure 3 below revealed that the respondents were not in agreement with

all the items analysed except the one that has to do with the use of firewood. Therefore, it can be deduced that little or nothing are done to reduce carbon emission and consequently carbon footprint in the study area.

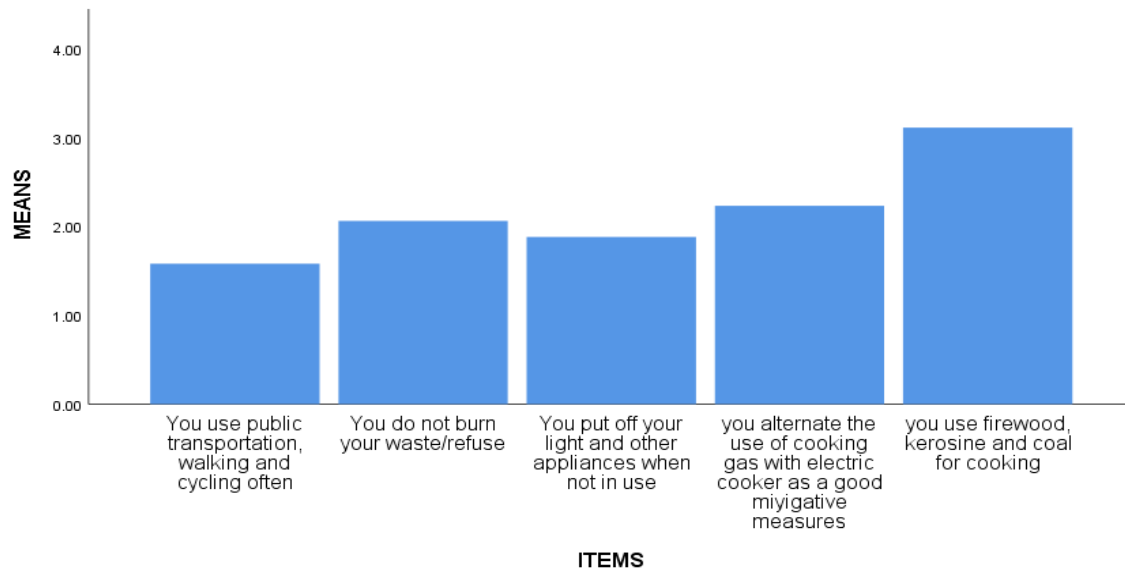


Fig 3: Efforts made by residence to reduce carbon footprint

Determining the Challenges Faced by Respondents in Minimizing Carbon Footprints

The mean of the result on challenges faced by respondents in minimizing carbon footprints in the study area as shown in Figure 4 below revealed that the

respondents were not in agreement with all the items analyzed. It can be deduced that the respondents appeared not to have experience any challenges. This may not be unconnected to their poor awareness of what greenhouse gases are.

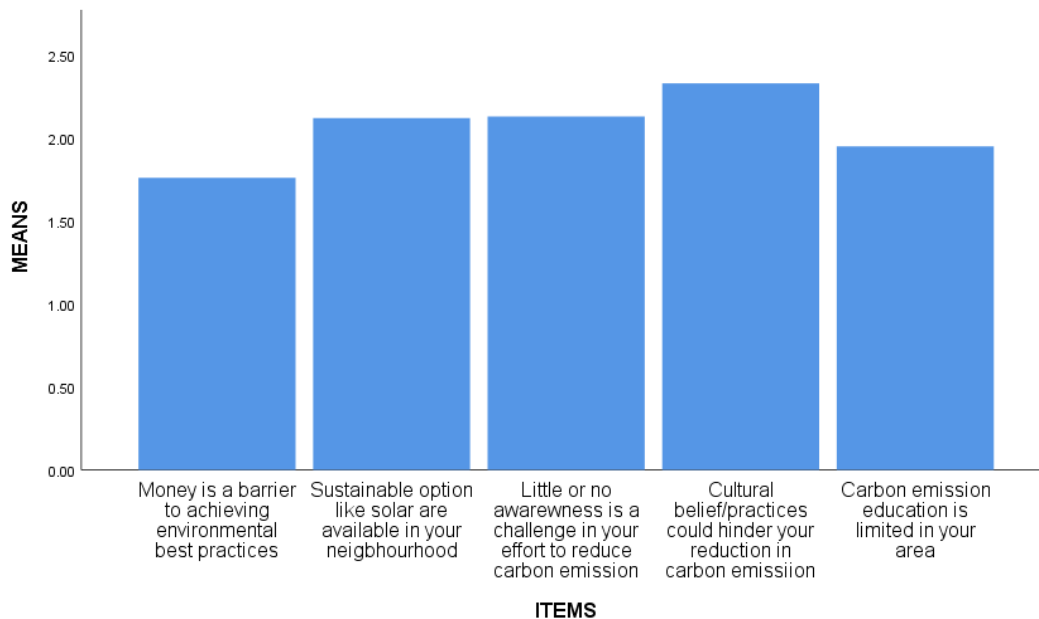


Fig. 4: Challenges faced by residence in minimizing carbon footprint

Discussion

This study indicated that individual data indicated 40.6% of respondents were female and 58.9% of respondents were male, indicating that most respondents were from the male population as opposed to a study carried out by NwaJesus *et al.* (2019) in a study in Enugu which revealed that 66.7 percent were female and just 33.3% were male. This suggests that the neighborhood has a higher proportion of families led by women. Since the majority of respondents are young and in economically productive age groups and engage in carbon-emitting activities in Benin-city, there is a strong likelihood that they will continue to be involved in carbon emitting activities which will increase their carbon footprint. This agrees with Long *et al.* (2023), which showed that older adults have a smaller carbon footprint than other age groups. These individual activities could include agricultural activities, bush burning, deforestation, an increase in the number of cars, using generator sets more frequently because of an epileptic power supply, etc.

The finding of this study reviewed that less than two percent of the respondents had their carbon footprint exceeding ISO14064, however most (92.22%) were within the ISO 14064, ideal range in accordance to ISO14064. Therefore, the contribution of respondents in the study area to global warming and consequently climate change is low or insignificant. The relatively low carbon footprint of the respondents could be attributed to the fact that they were more of young people in this study. This could mean that their consumption of carbon emitting sources was low as against the older people, who could have more money, income, and more people to carter for. This could result

to increased dependence on more carbon emitting sources and consequently emission of more carbon resulting to increasing carbon footprint. In this study, it also showed that there were more of students which could infer lesser dependance on carbon emitting sources and consequently lesser emissions. Similarly, there were more of single and unmarried persons in this study, which could mean lesser dependence of carbon emitting sources as such lower carbon footprint. The low carbon footprint obtained in this study agrees with that of Huang *et al.* (2022)

This study shows that the awareness level of the respondent in the study area is low which is in line with the findings of Yusoff *et al.* (2021). In their studies, they found out that respondents' knowledge of carbon footprint is rather low. However, it disagrees with Lee *et al.* (2015) and Yusoff *et al.* (2020) and Sharifah *et al.* (2017) who reported high awareness. This study reveals that in the study area the literacy level is high, therefore achieving awareness to climate change related matters among the individuals, will not be a big problem. Awareness of the climate change related matters like carbon footprint can be achieved through print, electronic and social media. This is consistent with the study done by Yusoff *et al.* (2020), where they found out that 16% of respondents said they learned about carbon footprint from print media and 8.5 percent from social media, the remaining respondents learned about it from other sources including friends and family. Whitmarsh (2009), reported that only minority knew nothing about climate change and the rise of carbon footprint. But the findings of Wang and Watson (2007) reported majority of their

respondent had high knowledge about carbon footprint.

The results indicated that the respondent's efforts to reduce their carbon footprint were minimal, which is consistent with Stiff *et al.* (2019) who opined that, people were mostly uninterested in participating in climate change mitigation. It agrees with the findings of Sharifah *et al.* (2017) whose respondents despite having good knowledge and attitude recorded, a majority (58.4%) of poor practices in reducing carbon emission. It also agrees with the findings of Hu *et al.*, (2017), who evaluated the maturity and operational performance of individual in the carbon trading pilot programme for climate mitigation. According to the study, respondents had little motivation to invest in reducing their carbon footprint. Hassan *et al.* (2011), also reported that level of individual involvement in the activities of environmental protection were at low level even though the need to maintain the environment issues and the need to maintain the environment had increased among the society. The low efforts could be attributed to poor awareness on carbon footprint and climate change related matters in the study area. Therefore, it can be deduced that with the low effort put in place to minimize carbon footprint, more carbon will continuously be emitted and climate change related problems will be on the increase.

The findings of this study show that the respondent experiences no challenge in mitigating and reducing their carbon footprint. It is true that when people have little awareness or are unaware of a problem, their ability to find solutions may be limited or nonexistent. This agrees with the study of Abbasi and Nawaz

(2020) that found that farmers are more likely to use appropriate adaptation measures to deal with challenges brought on by climate change when their level of awareness is higher. This scenario could pose serious problem to climate change mitigation, because the respondents tend not to do much in reducing their carbon footprint thereby exacerbating climate change problem. Which is in line with the findings of Lo and Chow (2015) that stated that climate change is a serious environmental issue.

Conclusion

This study evaluates the Carbon footprint among individuals in Benin-city, as well as public's awareness in greenhouse gases, efforts made in mitigating carbon footprint and challenges faced by the respondents. The result showed that there were 58.9% male and 40.6% female which means that most of the respondents were male and more of students who engage in carbon emitting activities. The carbon footprint of the respondents in the study area showed that the carbon footprint ranges between 0.1tCO₂ and 57.2tCO₂. In accordance with ISO14064, the ideal carbon is between 2.72 and 7.26tCO₂. This study revealed that most of the respondent had their carbon footprints within the ISO14064 Standard with only two of the respondents had their carbon footprint exceeding the standards. The study showed that the awareness level of the respondent in the study area is low and the literacy level is high, therefore achieving awareness to climate change related matters among the individuals, will not be a big problem. The study also showed that level of individual involvement in the activities of reducing carbon footprint is at low level, which

could be attributed to poor awareness on carbon footprint and climate change related matters in the study area. Therefore, relevant agencies should intensify effort to increase awareness of climate change related matters in the study area.

Recommendation

1. People's knowledge of energy efficiency and sustainability should be increased. Also there should be informational efforts aimed at educating the public about the effects of energy resources and the notion of carbon footprint.
2. Public institutions use a lot of electricity, thus it's important to lessen their carbon footprint there. Research on energy efficiency lowers energy prices and helps people lessen their carbon footprint. Urge staff members to use energy-efficient computers, office supplies, and lights. Easy steps like shutting off unwanted gadgets, placing them in sleep mode, or putting them in power saving mode can be taken.
3. Motivate individuals to choose eco-friendly forms of transportation. Encouragement of low-carbon modes of mobility such as public transportation, walking, and cycling. If at all feasible, provide infrastructure to support the use of these options by businesses, such as showers, bicycle parking places, and electric vehicle charging stations.
4. Policies for waste management and recycling should be established to motivate people to recycle, conserve paper, and use fewer throwaway items. In addition, the government can guarantee proper recycling of

electronic trash by providing the necessary facilities.

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