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Livelihood Activities, Climate Change and Water Resources Availability in the Lower Cross River State, Nigeria

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Abstract

This study aims to assess how human livelihood activities influence climate change and water resource availability in the Northern part of Cross River State, Nigeria. Majorly, the paper looked at how human livelihoods activities like deforestation for agricultural expansion, carving, and timber, exploitation of non-timber forest products, sand mining, and faulty agricultural practices among others had influenced the removal of forest vegetation cover, how these activities also influenced the reduction in rainfall and subsequent paving of ways for climate change. These activities had contributed greatly to increasing ambient temperature orchestrating carbon accumulation in the surrounding environment and reduction in the amount of rainfall within the study area. Using both soft and hardware computer applications including German 12 handheld GPS, and Integrated Land and Water Information System (ILWIS), were used for data collection. Both quantitative and qualitative data were collected for the study. The GIS information software package was used to manipulate and perform feature identification, recognition, classification, calculation, and ground-truthing. A structured questionnaire was also used to collect data on some livelihood activities, the influence of livelihoods activities on water availability, and climate change among others. Secondary data set include the use of satellite imageries of Bekwarra, this was acquired from the Nigeria Center for Remote Sensing and Nigerian Meteorological Center, Jos for 1987- 2017. After analysis, it was found that the forest vegetation cover is fast disappearing, the built-up area had increased and the forest and water bodies are shrunken. Ambient temperature and carbon accumulation had seriously increased, while rainfall has reduced seriously leading to climate change and reduced water availability. It was recommended among others that tree planting and afforestation, alternative sources of livelihood that are feasible, sustainable, cheap, and practicable should be introduced to reduce pressure on the natural ecosystem.

Keywords: Human livelihoods activities; Deforestation; Water availability; Watershed destruction and climate change.

1. Introduction

The livelihoods activities of most rural forest communities are dependent to a larger extent on the capability of the natural asset base of the community. Some livelihood activities practiced by the people include agriculture to guarantee food security and maintain a healthy balance in their feeding conditions, horticulture for seasonal vegetable cultivation to bridge the gap during food shortage and cash flow, grazing of domesticated animals, fuel wood harvesting, harvesting of both forest and non-forest timber products (NTFPs), for their consumption and sales, carving and molding of wood and earthen wares, infrastructural development including residential houses and other social amenities like schools, markets, roads, stadia or field etc (Elson, 2008 cited in Berger, *et al.* [1]; Eneji, *et al.* [2], Eneji, *et al.* [3]; Ramcilovic-Suominen, et al., 2010 cited Bieler, *et al.* [4]. The exploitation of forest and mineral resources exploitation began in the prehistoric days of human existence.

It is unfortunate that today, the exploitation of forest resources within the rural forest communities has become a regular employment for most rural communities within the forest. Eneji, *et al.* [5] observed that until recently, majority of the rural poor within the forest communities do practice sedentary or peasant agriculture to meet the daily dietary needs of their households, with very little left for the market. During this material time, their impacts on the forest and its resources were very minimal. Man's quest for the improvement of his income for his daily sustenance and the reduction of poverty has seen man in various ways struggling helplessly to get something from the environment irrespective of the climatic, ecological, social and cultural implication of his action [6, 7]. In recent times, there has been increasing discussion about the link between conservation, poverty reduction and human livelihoods, gaining momentum since the Rio Earth Summit in 1992 [8, 9]. The International Union for the Conservation of Nature (IUCN) has intensified its efforts to address questions of ethics, poverty and human livelihoods in its conservation efforts [2, 10-12].

Despite the size of its workforce, agricultural production accounts for less than five percent of the gross world product (an aggregate of all gross domestic products) [10]. Poverty and unemployment are the root causes of most environmental problems. This is because poor people have problems with meeting their daily needs; food, shelter, health and other necessities of live, so they resort to the exploitation of forest resources for their survival because they feel the resources within is their ancestral inheritance. They also see this as their community resources where they can always fall back to for complimenting their sources of livelihoods [13, 14].

In recent times, the activities of man have increasingly impacted on the environment and its resources. This has also affected biodiversity and other species within the ecosystem, altering the ecological balance and functioning of the entire ecosystem [2]. The sum total of these effects are species extinction including specie loss, endangerment, disappearance and ecological problems like shortage in rainfall, climate change, flooding, increased heat, soil fertility loss and food insecurity [15, 16].

Severally, scholars have found that the major causes of forest depletion and other environmental problems are deforestation and agricultural expansion, urbanization, habitat decimation and destruction, forest fragmentation, pollution and natural disaster, unregulated and faulty agricultural practices in their submission, looked at the major problems of the environment to include deforestation for whatever reason, agriculture, urbanization, infrastructural development, poor agricultural practices, peasant agriculture and rotational bush fallowing. Others include mechanized agriculture with the concomitant indiscriminate and unregulated use of agrochemicals (herbicides, insecticides, pesticides, inorganic fertilizer), habitat decimation, pollution from both domestic, industrial and commercial production and consumption processes and above all the unregulated exploitation of both timber and non-timber forest products for their daily livelihood activities [17-19].

Most livelihood activities in the study area are to increase their sources of income and also improve their living standard. These include activities like agriculture, timber exploitation for carving, building, furniture, harvesting of timber and non-timber forest products, mining of sand from the river beach, dry season manual irrigation agriculture, fuel wood collection, animal grazing, harvesting of wild animals for dietary usage and income generations. These livelihoods activities have contributed in no small dimension to destroying the ecosystem [20, 21]. These activities lead to increase in the deterioration of the forest health and biodiversity vis-à-vis climatic conditions of the area. Eneji, *et al.* [5] found out in their study that basically in these study areas, agriculture is still at the traditional level, with the use of local farm implements like hoe and cutlasses for clearing and cultivation of land for agriculture. Bush burning is another method of clearing land for farming activities. All these attempts by man to improve the quality of their lives to guarantee food security and generate income for household use has become detrimental to the forest condition and also contributing to the degradation of the forest [22].

Studies have shown that the rate of forest resources depletion is becoming worrisome in recent times, and this trend is on the increase on daily basis [23-25]. This could be traced to commercial logging, rotational bush fallowing, fuel wood exploitation, exploitation of non-timber forest products, increase in population, road construction and prescribed forest fire or bush burning, opening up of forest land for irrigation agriculture among others. The quest for improved living standard is resulting to forest degradation, watershed destruction and climate variation in this study area, it is on the basis of the foregoing that this research called for empirical examination of livelihood activities and its impact on the forest vegetation, watershed and climate condition of the study area.

These interconnectivities are having debilitating effects on forest land, water resources and watershed, land availability for rain-fed agriculture and reduction in the productive capacities of fisheries due to the emergence of new diseases and other factors. These factors are principally due to the sudden rise in sea-level due to the heat generated from these human activities resulting in the melting of ice at the polar region [26]. Further studies have also shown that these issues are interlinked to land degradation and sustainable land management, [5, 23, 27, 28].

Scholars have shown that the largest known contribution to global climate change and global warming comes from the burning of fossil fuel, including bush burning, deforestation, pesticides and agrochemicals usage and the release of methane and other compounds which releases carbon dioxide gas to the atmosphere. Livelihood activities carried out by humans to meet their basic requirement release greenhouse gases into the atmosphere. Greenhouse gases and aerosols affect climate by altering incoming solar radiation and outgoing infrared (thermal) radiation that are part of Earth's energy balance. Changing the atmospheric abundance or properties of these gases and particles can lead to a warming or cooling of the climate system [5, 27, 28].

From the beginning of the industrial era, the overall effect of human activities on climate has been a warming influence [29, 30]. The human impact on climate during this era greatly exceeded that due to known changes in natural processes, such as solar changes and volcanic eruptions. Yadav, *et al.* [29] quoted ICPC, (2007) that human

activities in pursuit of their livelihoods involving burning of fossil fuel, fuel wood, deforestation and the use of agrochemicals and pesticide and waste dump results in emissions of four principal greenhouse gases: carbon dioxide (CO2), methane (CH_4), nitrous oxide (N_2O) and the halocarbons (a group of gases containing fluorine, chlorine and bromine). These gases accumulate in the atmosphere, causing concentrations to increase with time. Studies have shown that in dry areas where farming activities have removed forest cover almost completely, rainfall is minimal and the upper soil cover has become turgid and dry, that rainwater can no longer infiltrate into the ground.

Here water is accumulated on the surface because it cannot percolate or infiltrate under the ground, hence these results in its evaporating into the atmosphere or causes erosion and flooding and washes away the remaining fertile soil. Arising from the strength of the issues raised by some human livelihood activities, this study was carried out to examine the environmental /ecological implication of human livelihood activities on climate change and water resources availability in the lower parts of Cross River State, Nigeria.

2. Material and Methods

The Expost facto research design, using the survey inferential research approach was adopted for this study, both quantitative and qualitative data were collected for the study. Using a Germin-12 Global Positioning System (GPS) to identify the location of Bekwarra, Bekwarra Local Government Area is located between latitude 5° 34′ 49.63″ North and longitude 8° 44′ 54.16″ East. It has a total landmass of about 3,536sq kilometer (Goggle Map, 2020; Cross River State Ministry of Land and Survey, Calabar, 2018).

Bekwarra Local Government has some notable forest like Agbalu and Inyanya as the two major forests. Others include Afrike forest, Iritem Abuana, Ungwe Ugbe Anibi, Adiebi and Iritem Ebewo. Bekwarra local government is blessed with other forest and cultural features like the Ogolobi pond, the Ukaa ochifu, and the Bewo mystic stone with human finger print among others. The major tribes of the area are Bekwarra and Afrike. Geographically, Bekwarra local government Area is a low lying area with about 80% of the entire area being at less than 300m above sea level, due to the fact that it is part of the Benue valley trough. In fact, areas along the flood plains of River Benue and those of the valley are marshy areas and liable to seasonal flooding [31].

The Bekwarra Local Government Area has an undulating topography from Ukpah to Afrike and Nyanya towards the Aya River. The Aya River, Ulu and Ityem rivers drains Bekwarra. Occasionally, some part of the local government is flooded from Ukpah, Ugboro, Akurinyi, Ukpada, Nyanya and some part of Gakem during the rainy season [5]. The population of the area according to Google population projection, 2020 for Bekwarra at 2.5% growth rate is about 276,885 (those residents at home during the study). The major livelihoods activities carried out include subsistence farming, hunting, palm wine tapping, wood carving, sand and stone mining, harvesting of timber and non -timber forest products, weaving, cane making, trading, artisans, civil and public servants. Most of those engaged in these form of activities depends largely on what the environment can provide for their livelihoods, hence their impacts on the environment.

Both hard and soft ware was used for data collection. The authors used a high speed memory digital electronic Pentium IV computer, compact dick writer/reader, colored printer and flatbed scanner, and Garmin 12 hand held Geographic Positioning System (GPS) for data collection. Software used include an integrated land and water information system (ILWIS) academic version 3.1, this is a GIS information software package used to manipulate and perform feature identification, recognition, classification, calculation and ground trothing. Data generated and used for the study were through primary and secondary sources. Structured questionnaire was also used to collect data on some livelihood activities, influence of livelihoods activities on water availability among others. Secondary data set include the use of satellite imageries of Bekwarra, this was acquired from the Nigeria Center for Remote Sensing and Nigerian Meteorological Center, Jos for 1987- 2017.

3. Results and Discussion

The vegetation cover of Bekwarra was classified under the following titles:

Forest: There were very thick vegetation cover with different canopies, forests at that time (1986) especially Iritem Agbalu, Ishane iritem, Abuana, Bewo, Otukpuru and Ukpada, the forest occupied about 1504.46 km^2 or 41.05% of the total land.

Natural vegetation: as at 1986, natural vegetation covers a total mass of about 2015.56 km^2 or 55.00% of the total land mass of Bekwarra, having the highest percentage because of the less human activities carried out in the area because of the low human population at that time.

Water bodies: this include all the rivers, streams, and other swamp within the study area (Aya River, Uduo River, Ulu River, Ityem, Illa) amongst others. By 1986, water bodies cover an area of about 19.28 km^2 or 0.52% of the total land area.

Bare surface: These are areas where no agricultural activities or infrastructural activities were carried out or noticed. Bare surface occupied about 6.51 km^2 or 0.17% and was seen mostly in areas near water bodies.

Built up Area: These are areas where human habitations are in the community, settlement in general in the study area occupied about 11.23 km^2 or 0.30% then, of the total land area and concentrated in the northwestern part of the study area.

Cultivated Area with other livelihood activities: Farming activities (livelihoods activities) in the 1986 satellite image was not much and mostly concentrated at the north-western and north-eastern part of the study area. The farm land occupied about 108.76 km^2 or 2.96% of the area.

Fig-1. Classified Landsat MSS Image (1987) of the Study Area

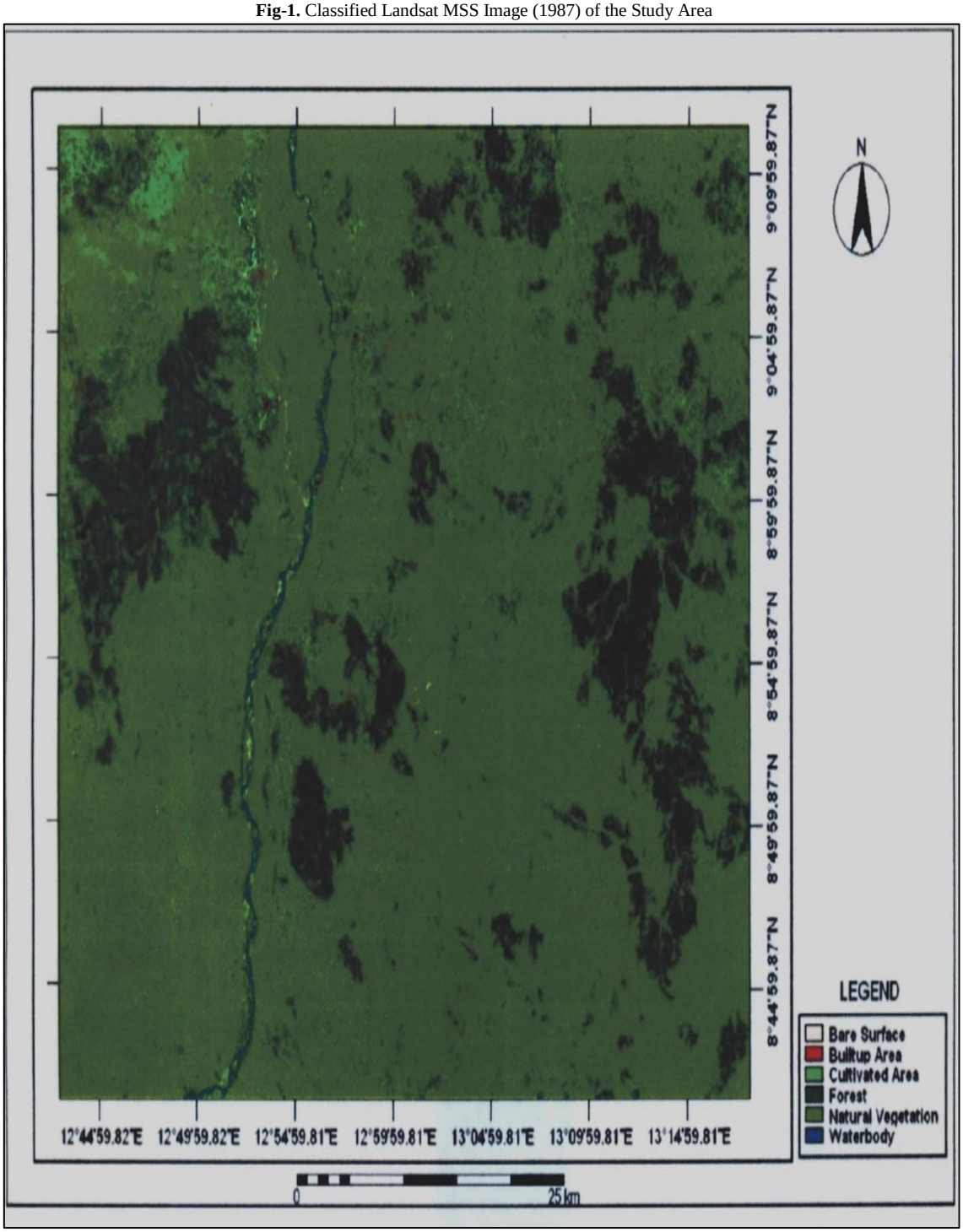

Fig-2. Classified Nigeriasat.1 Image (2007)

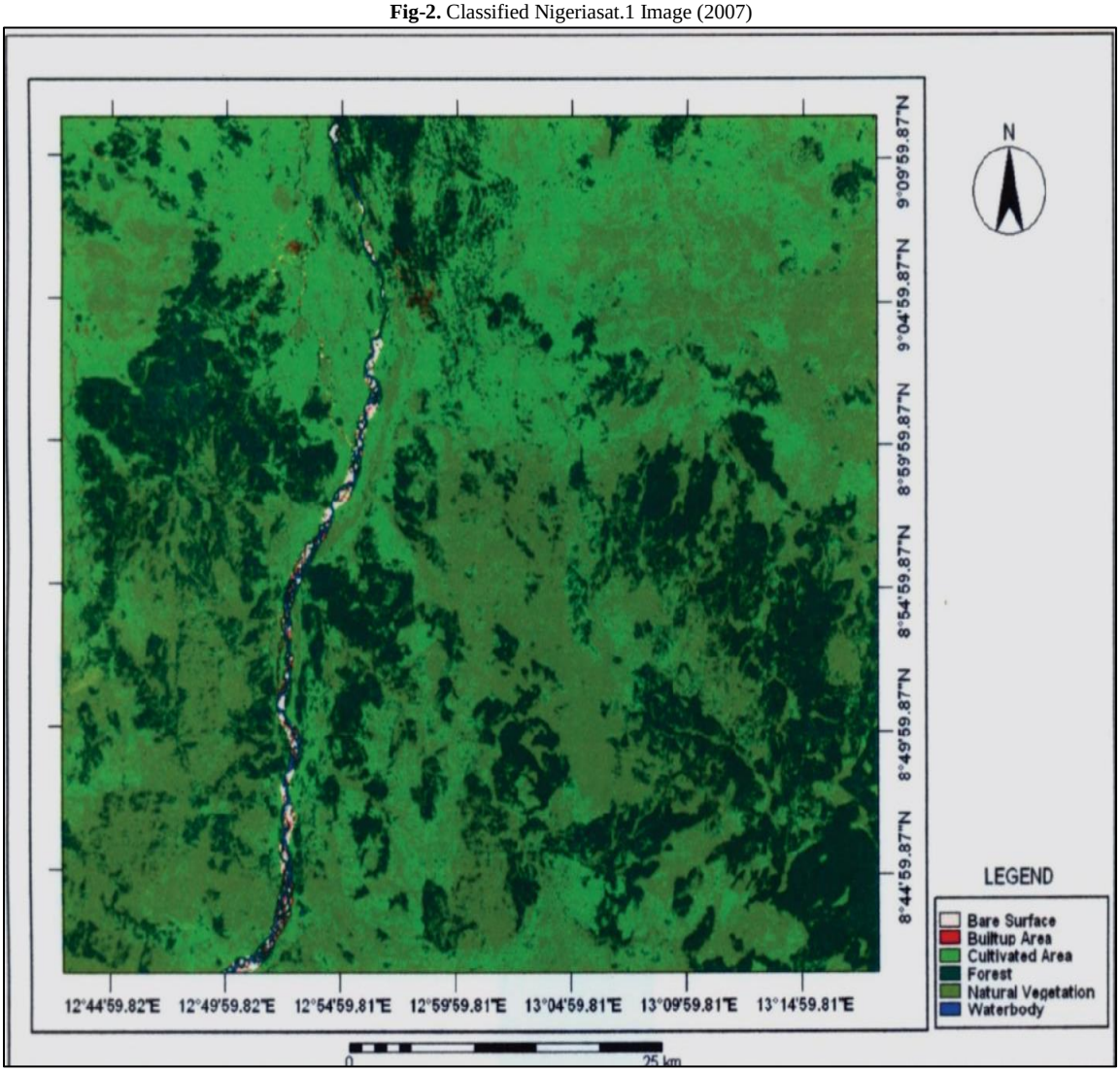

Fig-3. Classified Landsat ETM Image (2017) of the Study Area

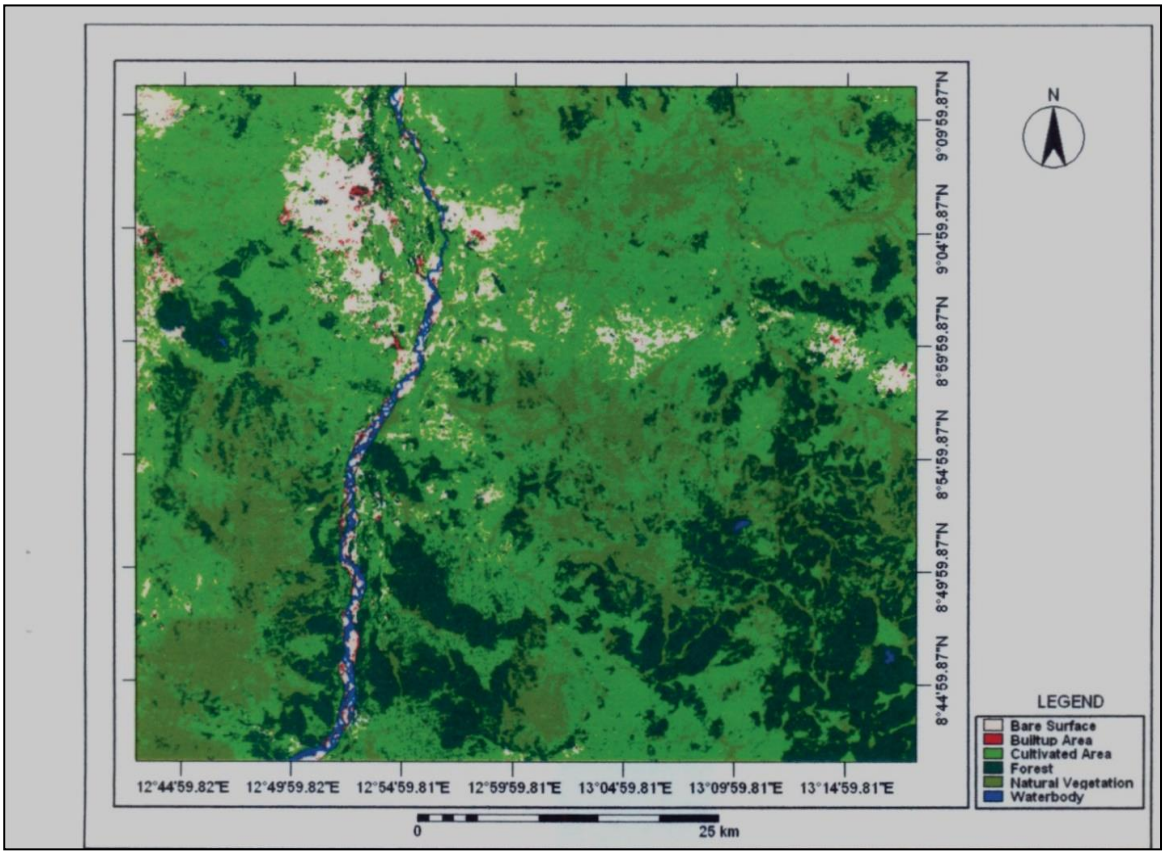

Table-1. Result of LANDSAT MSS 1987 image classification

Class	Area (km^2)	% Area
Bare surface	5.81	0.21
Built up area	23.46	0.84
Cultivated area	168.76	4.44
Forest	1842.46	52.05
Natural vegetation	2116.23	50.20
Water body	19.28	0.52
Total land area	4,176	100

Source: Landsat MSS Data Analysis, 1987

3.1. Change Detection from 1987-2007

Table 1 shows the changes that have taken place between 1987-2007, this was detected by cross-tabulating (super imposing) 1987 image on the 2007 image and a change table was produced using time series analysis.

Table-2. Result of Nigeria Sat -1 2007 image classification

Class	**Area (Sq KM)**	**% Area**
Bare surface	33.87	0.87
Built up area	92.53	1.81
Cultivated area	2564.25	69.68
Forest	405.45	10.13
Natural vegetation	1067.23	17.33
Water body	12.67	0.18
Total land area	4,176	100

Source: Result of Nigeria Sat-1 2007 data analysis

The changes that have taken place were attributed to farming activities, which includes settlement, livelihood activities including hunting, farming, timber and non-timber forest product exploitation including sand mining and fuel wood extraction. The result of the cross-tabulation presented in Table 2 shows the base line data of 1987 and 2007 which other classification and variations were calculated from. It can be observed that farming, logging, hunting, sand mining, collection of timber and non-timber forest exploitation depicting their livelihood activities in the study area in general took the largest share of both the forest and natural vegetation conversion which is 1168.07 km^2 or 48.66% of the total change, followed by buildup areas which is 18.47 'km^2 or 0.76% of the total change. Bare surface accounted for 13.11 km^2 or 0.54% of the total changes in the study area for that period.

Table-3. Result of Nigeria Sat -1 2017 image classification

Class	Area (Sq KM)	% Area
Bare surface	45.55	0.87
Built up area	96.46	1.81
Cultivated area	2554.67	69.68
Forest	481.62	10.13
Natural vegetation	985.23	17.33
Water body	12.47	0.18
Total land area	4,176	100

Source: Result of Nigeria Sat-1 2017 data analysis

Table-4. Change detection from 1987-2017

	1987		**2007**		**2017**		**2017-1987**	
Class	**Area (Sq KM)**	**% Area**	**Area (Sq KM)**	**% Area**	**Area (Sq KM)**	**% Area**	**Variance**	**%**
Bare surface	5.81	0.21	33.87	0.87	45.55	0.87	39.74	0.66
Built up area	23.46	0.84	92.53	1.81	96.46	1.81	73.0	0.97
Cultivated area	168.76	4.44	2564.25	69.68	2554.67	69.68	2385.91	65.24
Forest	1842.46	52.05	405.45	10.13	481.62	10.13	-1360.84	-41.92
Natural vegetation	2116.23	50.20	1067.23	17.33	985.23	17.33	-1131	-32.87
Water body	19.28	0.52	12.67	0.18	12.47	0.18	6.81	0.34
Total land area	4,176	100	4,176	100	4,176	100		

Source: Classified Landsat ETM Image (1987-2017)

3.2. Change Detection from 1987-2007

The change that has taken place between 1987 and 2007 was detected by cross-tabulating the Landsat ETM (1987) image and Nigeria sat-1 (2007) image to produce a change in land use of the area. Reasonable changes were observed and attributed to the increased in cultivation, resources exploitation for other livelihoods activities, expansion of settlements, and exposure of bare surface, which accounted for 48.04%, 1.15% and 0.78% respectively of the total land area over the period (see result on Table 4). A critical look at the land cover of the entire Bekwarra landscape shows that there are marked changes or variations on the land cover, land use- land change (LCLUC) of the area. Table 4 summarized the changes in the land cover land change of Bekwarra.

As at 1987, forest cover of the area covered an area of 1842.46 $km^{2,}$ 52.05% of the entire land mass of Bekwarra, but in 2017, the forest cover has decimated from 1842.46 km^2 to 481.62 km^2, 10.13% of the entire mass. This shows a decrease of forest of about 1360.84 km^2 (41.92%). It was further revealed from the result in Table 4 that natural vegetation cover as at 1987 covered an area of 2116.23 km^2 (50.20%), but by 2017, the total vegetation cover of the area was 985.23 km^2, (17.33%), this shows a decrease of 1131 km^2 (32.87% of the natural vegetation has been lost to man's quest to satisfy his livelihoods). The areas covered by water bodies as at 1987 was 19.28 km^2, 0.52%, but by 2017, the total area covered by water bodies covers only 12.47 km^2 (0.18%), the variance shows that by 2017, 6.81 km^2, (0.34%) of water bodies have been lost due to the activities of man.

The result of cultivated area and built up area in Table 4 further revealed that as at 1987, built up area covered an area of 23.46 km^2, (0.84%), while cultivated area was 168.76 km^2 (4.44%), but by 2017, built up area covered an area of 96.46 km^2 (1.81%), and cultivated area covered 2554.67 km^2, (69.68%). The variance shows an additional area of 2385.91 km^2, (41.1%) has been added to the area cultivated. Bare area increased from 5.81 km^2 (0.21%) to 45.55 km^2 (0.87%), with a variance of 39.74 km^2 0.66%. From the result of these analysis as shown in Table 4, human activities ranging from farming, hunting, logging, sand mining, harvesting of timber and non-timber forest products and other activities carried out by man has drastically reduced the vegetation, forest cover and water bodies thereby increasing the bare surface of Bekwarra environment.

From the result of data analyzed using the satellite images and the land cover land use changes, it is clear that human activities in order to satisfy their livelihoods needs have impacted on the land cover of the environment of Bekwarra and this has impacted not only on the environmental resources like the forest cover, vegetation, water bodies, but has also impacted on the forest cover and watershed. These human activities had grown exponentially in the study area over the years, leading to the increase in bare surface land. Vegetation and forest covers are shrinking daily from bush burning, deforestation, unsustainable agricultural activities including farmland expansion, bush fallowing, logging and exploitation of non-timber forest products and sand mining among others.

3.3. Human Livelihoods Activities and Water Availability in Bekwarra

Table-5. Showing temperature variation in the study areas and the meteorological station

Temp. Variations	**Specific Days**	**Ityem River Ugboro /Ukpah**		**Uduo River / Ungwaodaa Otukpuru**		**Illa Stream Gakem**		**Junction Spring, Abuochiche**		**Kwarikwata Igoli, Ogoja**		**Mean Temp. both season**		**Water Station**
		Dry	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	
2005	01/12/2005	44.9	42.2	44.6	40.1	40.3	40.1	41.9	39.9	45.1	41.0	43.4	40.7	41.0
2006	01/12/2006	44.7	42.6	45.9	43.0	45.0	47.3	42.0	41.0	44.2	40.1	44.4	42.8	41.9
2007	01/12/2007	49.3	40.1	47.9	41.9	46.1	46.6	44.9	41.0	43.9	42.2	46.4	42.4	45.1
2008	01/12/2008	52.9	44.9	50.3	48.9	48.3	43.1	48.0	45.1	49.1	47.0	49.7	45.8	52.1
2009	01/12/2009	55.9	50.0	53.2	47.9	53.2	49.9	55.5	51.1	56.0	52.0	54.8	50.2	58.2
Annual mean temp.	**2005-2009**	**47.7**	**44.0**	**48.3**	**44.4**	**46.6**	**45.6**	**46.5**	**44.0**	**47.7**	**45.6**	**47.4**	**44.7**	**47.7**
Variance of mean	**2005-2009**	**7.8**	**2.0**	**3.8**	**4.3**	**6.3**	**5.5**	**4.6**	**4.1**	**2.6**	**4.6**	**11.4**	**4.0**	**17.2**
2010	1/6/; 1/12/ 2010	57.9	47.9	58.9	55.6	57.8	55.0	58.0	56.9	60.1	56.9	58.5	54.7	56.6
2011	1/6/;01/12/ 2011	56.9	45.1	56.2	53.4	57.9	54.5	58.8	58.0	59.1	57.9	57.8	53.8	55.8
2012	1/6/;1/12/ 2012	52.2	46.4	55.3	52.1	55.2	53.4	57.1	56.7	62.1	60.0	56.4	53.7	55.1
2013	1/6/;01/12/ 2013	56.2	48.5	56.4	54.4	67.1	60.8	68.9	64.2	65.2	67.2	62.8	59.0	60.9
2014	1/6/;1/12/ 2014	64.1	61.1	65.9	63.3	67.1	64.9	66.0	62.2	63.4	63.3	65.3	63.0	64.2
2015	1/6/; 1/12/2015	67.9	65.9	66.8	66.9	67.3	64.4	68.1	65.2	62.3	60.1	66.5	64.5	65.5
2016	1/6/;1/12/ 2016	65.8	65.2	66.3	62.7	65.5	63.9	63.8	62.0	65.9	63.5	65.6	63.5	64.5
Annual variance in temp.	**2011-2016**	**20.9**	**23**	**21.7**	**22.6**	**25.2**	**23.8**	**21.9**	**22.7**	**20.8**	**22.5**	**22.2**	**22.8**	**23.5**

*Data generated from the study are and meteorological station Ogoja, over a ten years' period 2005-2016. *There is significant difference in temperature of the study sites within the five years' period.

The amount of rainfall and annual temperature data of the area were also collected to assess how human livelihoods activities influence the availability of water supply to these rural populaces. Table 5 shows temperature data generated from the field and compared with that from the meteorological station in Ogoja. In 2005-2009, during dry season, the mean temperature for the five spots selected for study were 47.7^{0}C, 48.3^{0}C, 46.6^{0}C, 46.5^{0}c and 47.7^{0}C, while during the rainy season, the mean temperatures are 44.0^{0}C, 44.4^{0}C, 45.5^{0}C, 44.0^{0}C, 45.0^{0}C, and 43.0^{0}C for Ityem/Ugboro/Ukpah, Uduo/Ungwodaa, Illa stream, Junction spring, Abuochiche and Kwarikwata streams respectively.

A visitation was again taken to the study area to collect the same sets of data over another five years (2011-2016) the data generated from the field is as shown in Table 6.

Table-6. Mean annual rainfall in the study sites from 2005-2016

Rainfall variations	Specific days (Measured rainfall)	Ityem River (Amount of rainfall in mm^3)	Uduo River / Ungwaodaa Otukpuru	Illa stream Gakem	Junction Spring, Abuochiche	Kwarikwata Igoli, Ogoja	Mean annual rainfall in all sites (mm^3)	Rainfall Data From Weather Station Ogoja (mm3)
2005	25/06/2005	977	997	987	988	979	984.6	1080
2006	25/06/2006	962	971	978	981	972	974.2	988
2007	25/06/2006	891	901	899	902	911	900.8	901
2008	25/06/2006	791	801	796	896	809	818.6	861
2009	25/06/2006	675	771	699	712	742	719.8	811
Mean annual rainfall	2005 -2009	859.2	887.2	871.8	895.8	882.6	879.6	930.2
Variance in rainfall 2005-2009		-302	-221	-276	-288	-237	-264.8	-269
2010	22/06/2010	933	1001	994	928	899	951	963
2011	25/06/2011	949	991	965	988	898	958.4	948
2012	28/06/2012	1011	899	887	846	812	891	898
2013	20/06/2013	998	877	912	908	922	923.4	930
2014	27/06/2014	850	886	856	867	872	866.2	869
2015	25/06/2015	835	789	800	788	801	802.6	805
2016	23/06/2016	918	900	856	816	867	871.4	875
Mean annual rainfall	**2010-2016**	**927.7**	**906.1**	**895.7**	**877.3**	**867.3**	**894.9**	**898.3**
Variance in rainfall 2010-2016		**-5.3**	**-94.9**	**-98.3**	**-50.7**	**-31.7**	**-56.1**	**-64.7**
Variance in rainfall	**2005-2016**	**-59**	**97**	**-131**	**-172**	**-112**	**-113.2**	**-205**

*From the data collected from the farm sites, the mean variance between 2005-2016 shows that there is a significant difference of -264.8., *This figure is less 269 from the mean average of all the community in 2009.

In terms of rainfall within the study areas, in 2005-2009, mean annual rainfall was recorded as 859.2 mm^3, 887.2 mm^3, 871.2 mm^3, 895.8 mm^3, and 882.6 mm^3 for Ityem, Uduo/Ungwaodaa, Illa, Junction Spring and Kwarikwata stream respectively. Between 2011-2016, another sets of data were again collected for the daily rainfall, an aggregate mean annual rainfall for the 5 years

Between 2011-2016, the following rainfall data were recorded from the field, Ityem/Ugbro/Ukpah, 927.7 mm^3, Uduo/Ungwaodaa, 906.1 mm^3, Illah, (Gakem), 895.7 mm^3, junction spring, Abuochiche, 877.3 mm^3, and Kwarikwata, 894.9 mm^3, while the total average from the meteorological station is 898.3 mm^3. A comparison of these rainfall data between the mean value of between 2005-2009 and between 2011-2016 shows a variance for Ityem (Ukpah/Ugboro), 97 mm^3, (Uduo/Ungwaodaa), -131 mm^3 Illah (Gakem), -172 mm^3 junction spring, Abuochiche) and -112mm^3 (Kwarikwata), while the average rainfall for 5 years between 2005-2009 and 2011-2016 for the meteorological station is – 205mm^3. The analysis of data shows that there are some variations in rainfall which is negative. The negative sign shows that there is reduction in the volume or amount of water received from these study sites. The implication is that during the period under study, from 2005-2016, there are changes in the amount of rainfall, which has reduced drastically from more rain to less rainfall. With these changes in the amount of rainfall and e increase in temperature, it has confirmed the pointer to the fact that these are feasible attributes of climate change. This is a further confirmation of the findings of Adger, *et al.* [32], Armstrong, *et al.* [33], Alan [34] and Bentley, *et al.* [35]

A lot of studies have shown that when there is increased ambient temperature and reduced rainfall, soil moisture is lost, these situation gives room to the accumulation of greenhouse gases, which are direct part ways to global climate change [5, 36]. These are therefore directly proportional signs of climate variation, which if it remains unchecked give rise to global climate change. These situations are caused by human activities, especially during deforestation, expansion of farm holdings, removal of sand from fragile ecosystem like river banks, bush burning

and other deleterious activities carried out daily by humans to meet their daily livelihood activities. All these had been alluded to as causes of global climate change [3, 36, 37].

What explanation could be adduced to these shortages in rainfall and increase in temperature in the study area?

4. Discussion of Findings

This finding has come to uphold the earlier finding of Hayes [38] who posited that the forest communities depend on their resources for their livelihoods. Most rural communities depend on the environment especially forest resources as sources of cheap energy for heating and cooking of their family meal, timber for construction and carving, non-timber forest resources like food, spices, resin, rope, cane, raphia, chewing sticks, cattle stick, medicinal materials, mushroom and others for income generation. Others mined sand and gravels for sales and for their building construction. Others engage in unsustainable agricultural practices including opening up new forest land for expansion of their farm holdings.

This is also a confirmation of what [39] found, that more than 79% of all pharmaceutical products have their raw materials in the forest, because the forest is a store house for all raw materials used in the manufacture of drugs and other medical therapeutics and consumables. Just like the cure for HIV/AIDS, which is found in the plant species call *Ancistocldues korupensis* and *Prunus caribea* cure for prostate cancer, all found in Cross River National Park. Quinine is a plant material used for the production of almost all antimalarial drugs. Within the forest communities, they harvest the forest resources as vegetables and food especially during shortfall in times of food insufficiencies or environmental emergencies [3]. The implication is that most community members still depend on natural drugs from the environment for the treatment of their ailments, most rural community members are herbalist, their major stock in preparing medicine for their clients are from the forest. They depend entirely from roots, herbs, barks, leaves and twines and other non-timber forest products for the preparation of drugs for sick patients. It is true that once there is the harvesting of these raw materials for drug production are done consistently without allowing the rate of regeneration to catch up with the rate of exploitation, there is bound to be the destruction of most forest species and watershed could be affected in the process.

The study also revealed that in Bekwarra and most forest communities, there are six dominant land use pattern and land cover types that are identified and were used during classifications. They include bare surface, built up area, cultivated area, forest, natural vegetation and water body. The study therefore revealed that the rate of deforestation between 1987-2017 stood at about 79.97km^2 per year and between 1999-2007 was about 98.53 km^2 per year, (as in table 2, 3 and 4). It was further revealed that there were decrease in both the natural vegetation and forest throughout the period under study. This has also affirmed the earlier position of Rigg [40] and Eneji, *et al.* [3, 41] who found out respectively that as a result of man's consistent deforestation in whatever guise, has greatly affected the available forest, thereby reducing the quality, health and abundance of the forest and the vegetation cover. This is having very serious environmental implication and exposing the environment to harsh climatic environmental conditions.

In the study, the results show that the forest cover has reduced from 1504.46 km^2 as at 1987 to l038 km^2 in 2007, it then dropped to 898.98 km^2 in 2009, and then to 371.55 km^2 in 2017. The results also show that the natural vegetation also reduced from 2015.S6 km^2 in 1987 to 1290.04 km^2 in 2007, then dropped to 876.75 km^2 in 2009 and then reduced to 635.22 km^2 in 2017 as shown in Table 4. This shows that deforestation in the area is increasing at an alarming rate. This is a confirmation that the majority of the respondents (58%) indicate that the rate of deforestation in the area is high.

Similarly, the results of analysis of the questionnaire administered revealed that about 41.1% of the respondents indicated that the main causes of deforestation in the area is logging, fuel wood extraction, over cultivation of land with 23% and population growth of 14.2%. Other causes indicated by the respondents include sand mining by the river side, bush burning, infrastructural/residential building construction and overgrazing with 8.4%, 6.4% and 6.9% respectively. Eneji, *et al.* [2, 3] had earlier posited that forest resources exploitation is done to satisfy certain purposes, and along gender lines, three strands of exploitation were revealed, timber, non-timber forest products and animal species. The timber is used for wood, fuel wood, carving and other uses, the fodder which include non-timber forest products are used as feed for domestic animals, while other non-timber forest products are used for food, medicine, mulching, grazing and as source of revenue for the forest communities, while the branches of some trees including shrubs are used as sources of energy for heating and cooking the family meal as preventive measures against common community diseases.

The result of the study also shows that most livelihoods activities engaged by the people of Bekwarra include sand mining, agriculture, harvesting of timber and non-timber forest products, logging for timber and for fuelwood collection among others. Others harvest snails, bush meat, bush mango, bitter kola, star apple, native cola, resin, cane and rattan. All these have very negative impacts on the forest ecosystem and watershed. From the data generated and analyzed, there is serious effects of human livelihood activities on the environment of Bekwarra, especially the forest cover, vegetation and natural environment, water bodies and watershed.

The result shows clearly from the satellite images, the variance in land cover land use change that there are reductions in forest cover from 1842.46-841.25 km^2, natural vegetation covers also reduced massively from 2116.23 km^2 in 1987 to 985.23 km^2 in 2017. Likewise, cultivated land increased from 168.76-2554.67km^2, water bodies have shrunken from 19.28 km^2 in 1987 to 12.47 km^2 in 2017, while bare surface areas have increased exponentially from 23.46 km^2 in 1987 to 2554.67 km^2 in 2017. Based on these data, human livelihood activities had taken a serious toll on the forest and vegetation cover including the shrunken water bodies.

Earlier studies have shown that the forest and the vegetation cover provide watershed protecting the water budget available in the ecosystem, these watersheds have a serious environmental role of stabilizing soil water,

making them available to us for consumption and for the growth of plants and animals, but once they are removed, there are increased direct evaporation and reduced rainfall to the earth's atmosphere. The findings also show that the most pressing effect of human livelihoods activities in the area is erosion and desert encroachment with 44.2%, resulting in rill and gullies which in turn leads to loss of nutrient. While 26.4% of the respondents indicated that decrease in vegetal resources is one of the effects of human livelihoods activities in the area, 18.4% believed that increase in temperature is the resultant effects of deforestation for the purpose of meeting their livelihood demands in the area. It was observed that deforestation can also lead to flooding and decrease in rainfall; (see Table 6). Hence dense vegetation can reduce the amount of heat stored in the soil structures through transpiration. Other salient effects of these human activities in the study area include species depreciation, loss and subsequent extinction, reduction in the amount of rainfall and increase in ambient temperature (table 5 and 6).

Others include soil fertility loss, reduction in the size of grazing land among others. Facts from the study show that there are serious and noticeable changes in the volume of water received during rainfall, increased temperature, species endangerment serious sand mining and increase bare surfaces, and shrunken water bodies. This in all honesty has shown that the volume of water body is decreasing at an alarming rate, there is increased temperature and there is very pronounced climate change indicator within the study area, hence there is climate change and there is reduction in the water budget of the rea as a result of deforestation and watershed destruction due to increased human livelihoods activities.

5. Conclusion

In this study, an integrated approach of Remote Sensing, GIS and Questionnaire were adopted in assessing the rate, causes and effects of human activities on the environment, climate change and water availability in the study area. Based on the data sets obtained and analyzed, the study therefore concluded that:

i. The amount of forest and vegetation cover within the study area has decreased seriously over the years as a result of human livelihood activities from 98.53 km^2 per year (1972-2017).
ii. His loss in forest and vegetation cover has resulted to increased bare surface areas with a concomitant increase in infrastructural development as a result of built areas.
iii. The results from the field work revealed that fuel wood gathering and over cultivation are the major causes of disappearance of forest and vegetation cover leading to a total loss of about 64%. This situation in recent times has been exacerbated from the activities of cattle grazing by nomadic cattle Fulani men, and bush burning.
iv. The most resultant effects of forest and vegetation cover disappearance in the area has led to erosion, loss of soil fertility and increase in temperature. However, flooding and decrease in rainfall are also noticed.
v. The study further observed and concluded that the majority of the people in the area are farmers and erk their livelihoods from the environment, hence their over dependence on the environment for everything. It was further stated that majority of the population in the study area (90%) are dependents on fuel wood for their domestic energy. This again implies that more trees are to be consumed hence, aggravating the situation of carbon accumulation in the area.
vi. These unsustainable removals of forest and vegetation cover has affected the ambient temperature, water shortage, carbon accumulation, increased bare surfaces and climate change.
vii. Finally, due to human livelihoods activities, the environment of Bekwarra has been serious affected by these activities, our forest is disappearing at an alarming rates, our water bodies are shrunken and are fast disappearing, our streams are drying up, the ambient temperatures are increased, volume and amount of rainfall decreased; these are all signs of global climate change. This paper therefore concluded that human activities in the study have taken very serious toll on the environment leading to climate change and reduction in water supply in the study area.

6. Recommendation for Policy Directions

Arising from the outcome of this study, the following recommendations were made for policy directions:

a) Alternative sources of livelihoods activities that are feasible, sustainable, cheap attainable should be introduced like fish farming, bee keeping, rabbit keeping, poultry among others that will remove the undue pressure on the natural environment
b) Government should subsidize the cost of borehole construction for individuals to be encouraged to own personal boreholes
c) Selective exploration of forest resources should be encouraged, while plantation should be grown in areas where bare surfaces exist to provide alternative sources of energy and wood for housing construction.
d) Mushroom and other vegetable growing should be encouraged within home garden, while dependence on forest non-timber product can be alternated by growing some that can be grown within the home garden
e) Government and corporate bodies can have encouraged small business development by providing soft loans to individuals to move into business and reduce pressure on the forest land
f) Government, nongovernmental organizations and individuals can engage themselves in tree planting to encourage afforestation. This will go a long way to reduce carbon accumulation.

g) Fast growing and drought resistant saplings or tree species should be provided by government and other treatments to enable farmers and those living in poverty to engage in tree planting as their sources of livelihoods.

h) Mass environmental awareness campaigns should be encouraged. One such idea is through encouraging farmers to use mulching, manual irrigation, green and farm yard manure including animal dungs for their agricultural purposes.

i) Unnecessary cutting down of trees should be stopped. Slash and burnt system of farming should be stopped by the farmers, as this will render the lands helpless and therefore, erosion of all types will set in, hence soils nutrients is washed away. It is paramount to encourage the sustainable development of vegetation resources and wildlife, as the well-being of the people is closely related to the quality of their environment.

j) Legislation: There is a need for stiffer laws concerning cutting down of trees to be made by the government and enforce it and the defaulters should be given penalties. This will go a long way in maintaining the vegetal resources in the area. Hence, there is a need to involve traditional rulers at the grass root level for the enforcement of the laws, as this would in-turn mitigate indiscriminate falling of trees for various purposes in the study area.

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