DESCRIPTIVE ANALYSIS OF CLIMATE VARIABILITY IN OBANLIKU-NIGERIA: RAINFALL AND TEMPERATURE.

*Amuyou, U.A[1], Adie, B[1]. and Maiyanga, E. I.[2]

[1]Department of Geography, Federal College of Education, Obudu Cross River State-Nigeria
[2]School of Geography, University of Leeds, Leeds United Kingdom.
*Correspondent author email: amoyouushuki@gmail.com (Mobile N0: +2348038899982)

ABSTRACT: *There are strong signals that confirmed the argument that changes in global climate is associated with increased greenhouse gases (GHGs) in the atmosphere (IPCC 2014, Baccini et al. 2017; Le Quere et al. 2018; Antonarakis et al. 2018; Curtis et al. 2018). The study investigated climate variability in Obanliku using descriptive statistics. Yearly rainfall and temperature data of the study area for the period 2006 to 2017 were obtained from Nigeria Meteorological Agency (NIMET) office Calabar and subjected to statistical analysis. Annual mean and standard deviation analysis were used to describe the data and to understand the yearly patterns of rainfall and air temperature in the study area. In addition, thirty (30) copies of structured questionnaire were administered to purposively selected household heads in three sampled communities in Obanliku. The results revealed that rainfall did not maintain a consistent trend from 2006 to 2017 however, there was a significant interannual variability and departure of the yearly means from the aggregate average within the study period. However, average annual air temperature in the study area showed no marked interannual variation as a steady index of about 27⁰C was observed for the study periods. In addition, analysis of the responses of the farmers revealed an acknowledgement of the flood events which destroyed their floodplain crops. It was therefore recommended among others that farmers should continue to cultivate cover crops and adopt indigenous technical skills in harvesting of flood waters.*

Keywords: *Climate variability, Cross-State, Obanliku, Rainfall and Temperature.*

1. Introduction

There are strong signals that confirmed the argument that changes in global climate is associated with increased greenhouse gases (GHGs) in the atmosphere (IPCC 2014, Baccini et al. 2017; Le Quere et al. 2018; Antonarakis et al. 2018; Curtis et al. 2018).The increased loading of GHGs in the atmosphere has been linked to fossil fuel burning and high rate of deforestation and degradation especially in tropical biomes (Le Quere et al. 2018). Prominent among these gases that have recorded tremendous increase since the industrial revolution include but not limited to carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO). However, CO_2 is one of the major GHG that is threatening the livability of the environment (IPCC 2014). Estimate indicates that at the initial stage of the industrial era, global atmospheric carbon dioxide was 277 part per million (ppm) but it jumped to 402.8 ± 0.1 by 2016 (Dlugokencky and Tans 2018). This increase was initially fuelled by changes in land use but by 1920 fossil fuel burning became the largest contributor to the loading of CO_2 in the atmosphere (Ciais et al. 2013, Le Quere et al. 2018). It is imperative to note that the astronomical increase in atmospheric CO_2 is energized by increased peopling and the accompanying economic growth (1PCC 2014).

The burning of fossils has maintained the lead in the chart of CO_2 releases since then (Le Quere et al. 2018; Curtis et al. 2018). One remarkable effect of anthropogenic loading of the atmosphere with CO_2 is modification of climate variables like temperature and rainfall, which are the two most crop sensitive weather elements in developing nations (IPCC 2014; Adeleke and Olabode 2017). It is estimated that global temperature has increased on average of 0.74 higher than the preindustrial period (IPCC 2007). Specifically, between 1750 and 2011, about 2040±310 GtCO_2 was emitted into the atmosphere leading to a combined warming of land and ocean surfaces between 0.65°C to 1.06°C (Lequere et al. 2018). Since then, about 880±35GtCO~~s~~s has remain in global terrestrial systems while 60% of these gigatons of carbon dioxide have been sequestered among terrestrial and ocean carbon pools (IPCC 2014). Under present scenario, the observed emissions and increases in temperature is predicted to be sustained unless proactive measures are taken to curb this steady increase.

The AR5 report of the IPCC (2014) further pointed out that the predicted change in climate exposes the most vulnerable societies to high risk. For instance, subsistent farmers in sub Saharan Africa remain most affected and vulnerable to extreme climate events as a result of the lack of access to modern mitigation strategies and the continued reliance on rain fed agriculture. It is on record that 95 % of the crops produced by rural farming populations in Africa depend on rainfed agriculture (World Bank 2017). And forecast indicates that precipitation will most probably decline in arid regions while wet areas will experience either increased storm water or high level of uncertainty with regards to onset and cessation (IPCC 2014; Amogne et al. 2018). This rate of climate variability and uncertainty will impact negatively on the gross domestic product (GDP)of countries in the region. Prognosis further revealed that by 2100, climate change will lead to a reduction in the GDP of African countries by 7% (Amogne et al. 2018).

The ripple effects of climate impacts on the region's agricultural systems visa vice her GDP will be gargantuan as the region's population is projected to reach the 2billion mark by 20100 (UN Department of Economic and Social Affairs 2013), worsening an already bad situation. This is particularly apt in Nigeria which has consistently been classified among low human development index nations of the world (UNDP 2018) and has recently been named as the 'Headquarter of world poverty' with more that 80 million of her population estimated to live on less than 1.90 dollars a day (World Poverty Clock 2018).Nigeria like the rest of African countries continue to depend on rain fed agriculture for the feeding of her large population. These explains the urgency in providing detail analysis of key climate data to guide policy development, as taking no proactive measure may amplify environmental and socioeconomic problems such as tribal wars, herds-men-famers clash over dwindling natural resources with snowballing effects on the nations' gross domestic product (Loughlin et al. 2014). The aim of this study is to examine rainfall and temperature trends using descriptive tools and their rural farmers perspective of their variability, impact and mitigative strategies adopted.

2. MATERIALS AND METHODS

2.1 Study area

The study area is the Obanliku Local Government Area of Cross River State. It lies between longitude $9^0\ 22^1\ 0^{11}$ and $9^0\ 22^1 45^{11}$ E, and latitude $6^0\ 21^1 30^{11}$ and $6^0\ 22^1 30^{11}$ N. The local government is bounded in the north by Benue State, northeast by the Republic of Cameroon, to the southeast by Boki Local Government Area in Cross River State of Nigeria. It is made up of ten political wards.

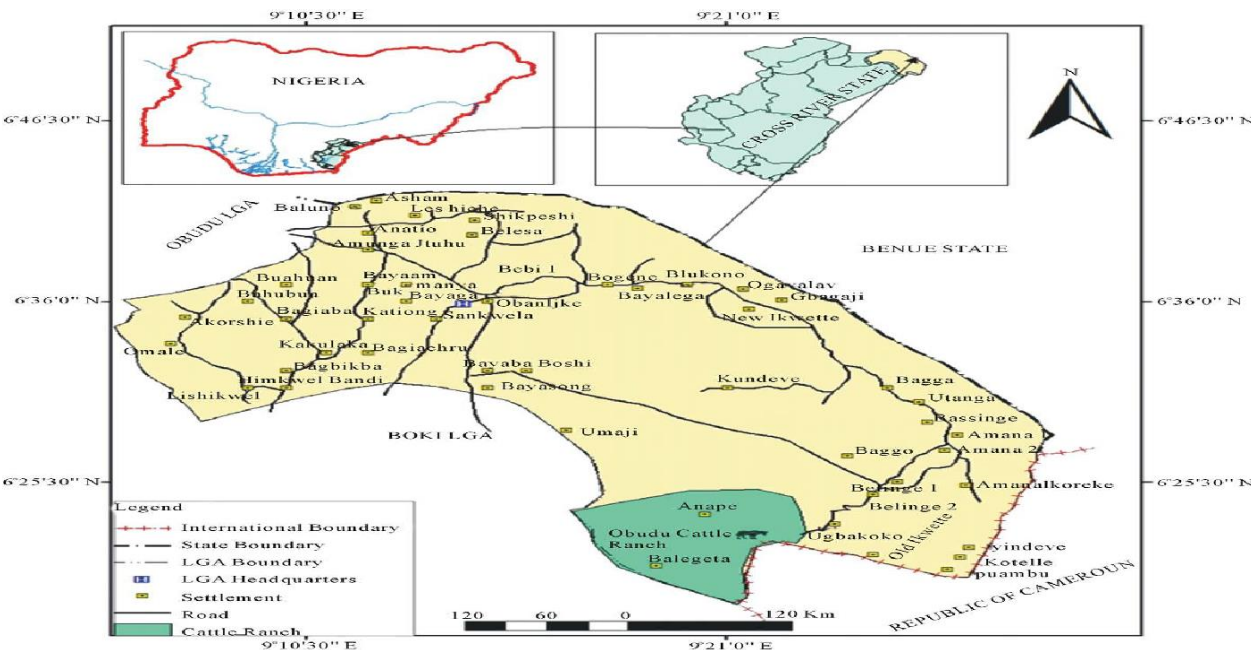

Figure 1: Map of the study area (insert, map of Nigeria and Cross River State)

Source: Akpan-Idiok & Ofem (2014)

The area has a tropical humid climate with wet and dry seasons. Wet season lasts from April to mid-November while the dry season lasts from mid-November to mid-March. The area experiences average annual rainfall of 1300mm – 2000mm, the average temperatures are between 15^{0}C and 16^{0}C (Mabugunje 1983). This climate provides a conducive agricultural environment for cultivation of fruit trees, pulses, cereals and root/tuber crops.

In terms of vegetation, Obanliku is in the southern guinea savanna zone where vegetation is generally a mixture of lower montane grassland and moist forests. It also has some patches of savanna grassland and deciduous forests. The soils are generally sandy loam, while in some locations they range from loam to sandy clay. The soils are generally well drained and range in fertility status from the fertile, to the low fertility soils (Essoka et al. 2008; Amuyou and Kelly 2015). However, at the mountain region of the study area, climatic indices are akin to the Mediterranean conditions.

2.2 Methods and techniques of data analysis

3.2.1 Rainfall and temperature data: The study relied on rainfall measured in millimeters and temperature measured in degree Celsius data covering the period of 2006 to 2017. The data were obtained from the archival records of the Nigerian Meteorological Agency (NIMET) Calabar office, Cross River State Nigeria. The data were subjected to descriptive statistical analysis of mean and standard deviation to decipher patterns in air temperature and yearly rainfall in the study area. The results of the analysis were presented in tables and charts.

2.2.2 Questionnaire administration: Five farming communities were purposively sampled in Obanliku and structured questionnaire named ‘Farmers perception of climate variability, impacts and adaptation’ (FPCVIM-Questionnaire) was then administered to thirty randomly selected head of households in the study area. As the questionnaire name suggest, the content of the instrument covered perception on rainfall and temperature trends, impacts on farming activities, and adaptation measures to mitigate the impacts. Tables, charts and descriptive tools of percentages were used to present and describe the results.

3. Results and discussion

3.1Climate variability (rainfall and temperature)

3.1.1Mean annual rainfall in Obanliku between 2006 and 2017

Table 1 shows the mean annual and standard deviations of rainfall in Obanliku from 2006 to 2017. As revealed in the table, rainfall received in the study area from 2006 to 2017 varies, the least rainfall was experienced in 2013 with 90.6 mm while the highest rainfall was recorded in 2012 with 154.5 mm. In 2006, 2007, 2008, 2009 and 2010 the annual mean rainfall was 130 mm, 140.9 mm, 136.9 mm, 144.1 mm, 118 mm and 126.3 mm respectively while the mean annuals of the years 2012, 2013, 2014, 2015, 2016 and 2017 were 154.5 mm, 90.6 mm, 144.1 mm,124.9 mm, 131.9 mm, and 136.7 mm respectively. The total annual rainfall recorded from 2006 to 2011 was 796.2 mm with a mean and standard deviation of 132.7 mm and 8.9 while from 2012 to 2017, total annual rainfall documented was 782.9 mm, mean of 130.4 mm and standard deviation of 20.1.

Table 1: Mean annual rainfall (mm)

	rainfall (mm)		rainfall (mm)
	130		154.5
	140.9		90.6
	136.9		144.1
	144.1		124.9

	118		131.9
	126.3		136.9
	∑=796.2 $\overline{X}$=*132.7* SD=8.9		∑=782.9 $\overline{X}$=*130.4* SD=20.1

Source: Analysis by authors (2019)

Synoptic analysis of the number of years with mean values above the aggregate mean revealed that between 2006 and 2017, the study area recorded more rainfall as out of the twelve years data were analysed, eight years recorded annual mean values above the general mean for the period examined. This means that, flooding and erosion might have been recorded in those years. Although, number of years with mean rainfall above the aggregate man were more, no significant sustained increase in rainfall was recorded in the region as revealed in figure 2.

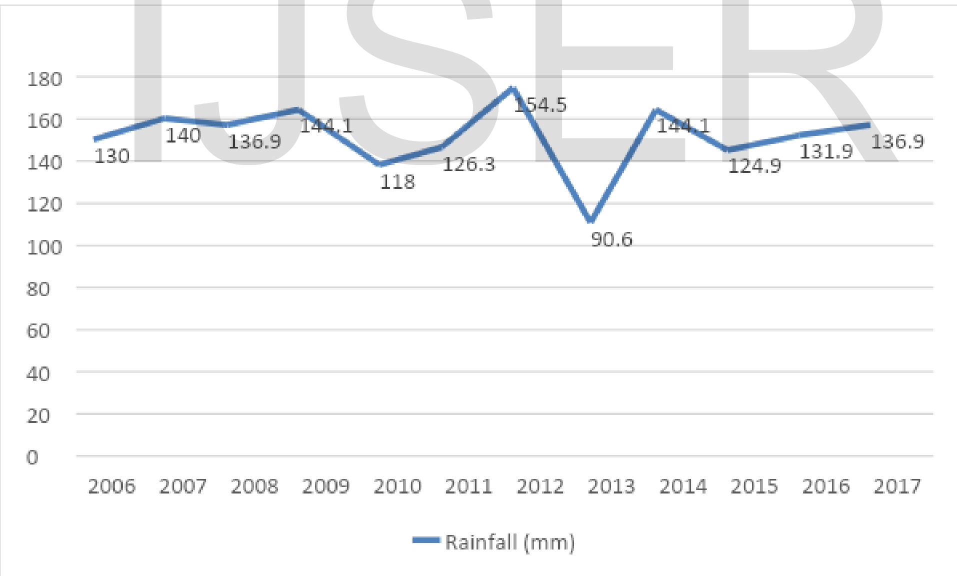

Figure 2: Trend of rainfall 2007-2017.

Source: Analysis by authors (2019)

From Table 1 and Figure 2, it is obvious that regular variability of rainfall was recorded in the study region within the period examined. The variability could be as a result of factors such as the local relief of the area where some areas peaked at about 1600 meters above sea level, the intensity of sunlight, surface of the area, vegetation of the area, wind or rapid rate of land cover change through deforestation and degradation. The intensity of these elements of land has been confirmed to have moderating effect on the rate of evapotranspiration as a high evapotranspiration will correspondingly increase the rainfall amount (Cohn 2017). More so, areas with dense forest cover can have modulating impact on the frequency of local rainfall. Spranklin et al. (2018) noted that modification of the land surface features could mediate the fluxes of energy, moisture, trace gases and aerosols between the landscape and the atmospheric boundary. On a general note, rainfall variability characterized by uncertainty as shown here has significant effects on rural agriculture especially in Nigeria that was recently ranked among the most vulnerable countries in the world to the adverse effects of climate change mainly due to its high dependence on rain fed agriculture by the World Bank last year (World Bank 2017).

3.1.2 Mean annual temperature in Obanliku from 2006 to 217

Table 2 is the mean annual and standard deviations of temperature in Obanliku from 2006 to 2017. From the table, it can be observed that from 2006 to 208, the annual mean temperature was 27.3 per year while the annual mean values in 2009 was 27.4^{o}C, in 2010 annual mean value of 27.6 ^{o}C was observed in the study area. Other years recorded the following annual mean values of temperature for the study years 2011, 27.0^{o}C, 2012 and 2013 recorded 27.4^{o}C, 2014, hard 27.6 ^{o}C, 201527.5 ^{o}C, 2016 and 2017 recorded mean values of 27.70C and 27.9 ^{o}C.

Table 2: Mean and standard deviation of annual temperature in Obanliku 2006 to 2017

	Temp. (0C)		**Temp. (0C)**
	27.3		27.4
	27.3		27.4
	27.3		27.6
	27.4		27.5
	27.6		27.7
	27.0		27.9
	∑=163.9		∑=165.5

	$\bar{X}$=27.3 SD=0.2		$\bar{X}$=27.6 SD=0.2

Source: Analysis by authors (2019)

The yearly distribution of temperature is also shown in Figure 3. From the Figure, it can be observed that the highest annual mean temperature value of 27.9 °C was recorded in 2017 while the smallest values of 27.0°C was observed in 2011. A cursory look at Table 1 again will reveal~~ed~~ that, the annual mean of temperature between 2006 and 2011 was 27.3 °C and from 2012 to 2017 annual mean aggregate temperature was 27.6 °C. This implies that there is no significant deviation from the aggregate annual mean value, that is temperature in the study area maintained a relative steady ratio within the years data were analysed. These trends of temperature are likely to be good for tropical crops as they fall within the minimum and maximum threshold for most staple food crops cultivated in the tropics.

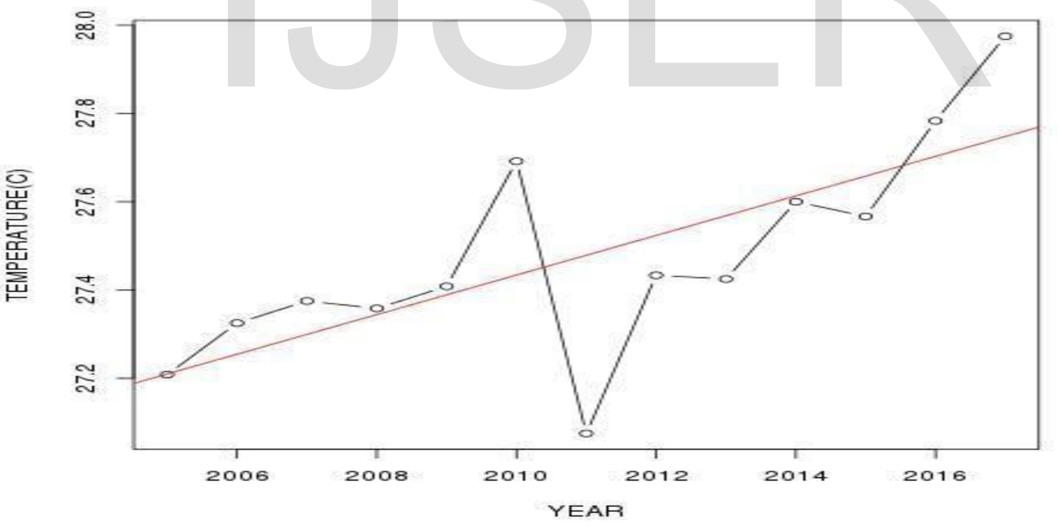

Figure 3: Temperature trend in Obanliku 2006-2017.

Source: Analysis by authors (2019)

3.2 Climate variability impacts on floodplain agriculture

Table 3 is the Likert scale statement on farmers perception of the impacts of climate variability on flood plain agriculture in the study area. From the table, it can be observed that on the statement ‘our stream and river banks are often flooded’, 53.3 percent of the respondents strongly agreed while 33.3 percent agreed to the statement and 6.7 percent of the sample population disagreed and strongly disagreed respectively. The high proportion of those who agreed that most of part of the years flood water inundates their farmlands along flood plains support the results of rainfall data analysed for the area. More so as revealed in figure 3, only rainfall show variability between 2006 and 2017 while temperature shows an almost smooth trend within the study years. This result support an earlier research outcome of Eni et al. (2011) where it was submitted that excessive rainfall in Itigidi has resulted in the loss of valuable farmlands and crops. And when farmers lost their means of livelihood through flash floods, it creates multiplier effects on the society. For instant, students’ fees and upkeep may be impacted negatively, medical bills could surge and become unaffordable to the very low-income earners, wide spread hunger spell could be a common feature among others. These challenges if not nip in the bud will have cascading impacts on the nation economy (Ebele et al., 2016).

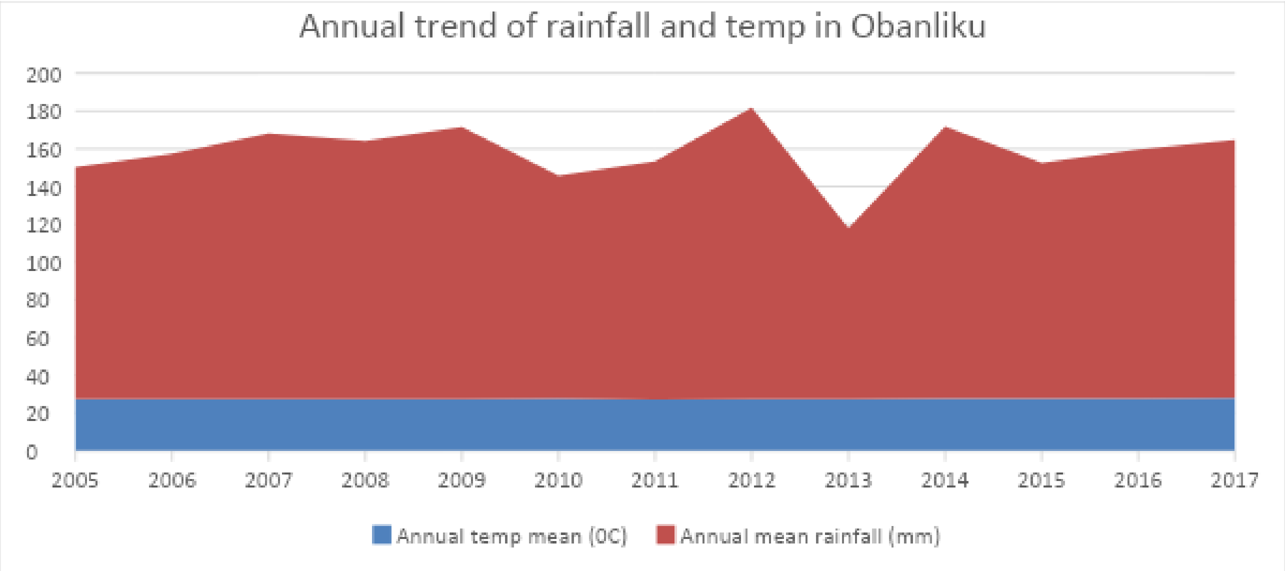

Figure 3: Rainfall and Temperature variability in Obanliku

Source: Analysis by authors (2019)

Table 3 further indicates that the 19 of the respondents which is about 63 percent of the sample population submitted to the statement that ‘crops along flood plains are destroyed’. It also revealed that only 3.3 percent of the sample population strongly opposed the statement. More so, about 53.3 percent of the sampled respondents disagreed to the statement that ‘volume of water in the ponds and streams have remain the same in the last thirty years while 26.7 percent agreed to the statement. This assertion confirmed results from station data with respect to precipitation where variability and yearly mean departure from the aggregate annual mean showed variability.

Table 3: Impacts of climate variability on flood plains agriculture in Obanliku

S/N	STATEMENT	SA (%)	A(%)	D(%)	SD (%)	Total
1	Our streams and river banks are often flooded	16 (53.3)	10(33.3)	02(6.7)	02(6.7)	30 (100)
2	Crops along floodplains are destroyed	19(63.3)	09(30)	01(3.3)	01(3.3)	30 (100)
3	Volume of water in our ponds and streams have remain the same	02(6.7)	08(26.7)	16(53.3)	04(13.3)	30(100)
4	We have adequate water irrespective of the season	03(10)	07(23.3)	08(26.7)	12(40)	30(100)
5	Natural services of floodplains have reduced	03(10)	22(73.3)	01 (3.3)	04(13.3)	30 (100)

Source: Field survey by authors (2019)

It can also be observed from the table that on the statement about the sufficiency of water in the community for agricultural purposes regardless of the season, 10 percent strongly agreed, 23.3 percent agreed, about 26 percent and 40 percent disagreed and strongly disagreed respectively. Despite frequent rainfall events and the flooding of floodplains, farmers still complained of insufficient water. This irony could be likened to the fate of the ‘Rime of Ancient Mariners’ and their famous line ‘Water everywhere but no drop of water to drink’. This is in line with the study of Amah (2015) where it was noted that climate change and hydrological extremes remains to a threat to water utilization in Nigeria.

This outcome is in line with the narratives from other regions of the tropics that climate variability/change and land cover are potent instruments leading to reduction of water volume in streams and ponds of rural areas. Climate change/variability smother crops, makes the area too dry for any form of crops particularly high-water demanding crops to do well (Ayoade 2002). Beside this, Machitteo (2014) submitted that land use modifications and its impacts on land cover through processes such as deforestation, afforestation, agriculture, pasture development, forest management regimes and urban sprawl remains a threat to the livability of the environment. The transformations of natural cover of the landscape into cultural entities has been recognized to having modulating impacts on climate variables (Deng et al. 2013). It is however imperative that farmers who depend on rainfed agriculture as the principal means of livelihood come up with strategies to ameliorate or halt the effects of climate variability.

3.3 Farm-level adaptation to climate variability impacts

Table 4 is the farm-level adaptation strategies in the sampled communities. The result in the table indicates that 30 percent of the respondents said they change the cultivation period based on weather condition. This implies that crops that require enough water for them to thrive, early start of the rain will be a welcome development and vice versa. More so, 6.7 percent of the sampled households submitted that they plant improve crop varieties. These crops are secured either from the agricultural agent or from the open market. Such crops are known to withstand weather stress (Odjugo 2010) but there are not without their side effects. Genetically modified crops are known to threaten the safety of man and the quality of the environment. Water bodies are polluted, soils become acidic, plants biomass get destroyed, the ambient air changes in purity among others (Adeleke & Olabode 2017).

Table 4: Farm-levels adaptation strategies to climate uncertainties

S/N	Strategies	N0 %
1	Changing cultivation time (early or late cultivation)	09 (30)
2	Plant improved crop varieties	02 (6.7)
3	Practice cover cropping to reduce heat burn	11 (36.7)
4	Change occupation	00 (00)
5	Migrate to communities with favorable farming season	01 (3.3)
6	Diversify occupation	05 (16.6)
7	Do nothing	02 (6.7)
10	Total	30 (100)

Source: Survey by authors (2019)

Furthermore, the table revealed that about 36 percent of those interviewed said they plant cover crops to reduce the effect of sunlight on the crops. This is vital to the farmers because the intensity of the sun often kill the crops, dry them up and those that survive the intense heat will subsequent yield very poor outputs (World Bank 2017). Table 4 also shows that no person agreed that the change occupation, this attest to the fact that the rural population have limited alternatives, hence farming remains the mainstay of their economy (Ebong 2011). However, 3.3 percent of the respondents said they move to communities with favorable climate for farming. This is a periodic feature common with some households in the study area who often relocate to neighboring local government of Boki to take advantage of the fertile soils and other economic prospects in the area. About 16 percent of the sampled respondents said they diversify their livelihood portfolio to offset any lost associated with poor crop yields. The other economic activities identified includes petty trading, 'Okada' business, tapping of palming and processing of palm oil more than is required for subsistence, etc. while 6.7 percent say they do nothing. Whatever God decides to come their way, they choose to resign to faith.

The spiralling impacts of human-induced climate change effects on the health of biodiversity and welfare of man informed the decision of the United Nation Framework Convention on Climate Change (UNFCCC) and her sister's organizations to put series of mitigation mechanisms to address both the causes and effects (Adeleke and Olabode 2017).

The various adaptive measures practiced by the local farmers in Obanliku is part of their zeal to fulfil the mandate of UNFCC some years back.

4. Conclusion and policy recommendations

The study investigated the trend of rainfall and temperature and the effects of observed variability on the means of livelihood of the rural population of Obanliku Local Government Area of Cross River State. Secondary data from weather station (rainfall and temperature) for twelve years (2006-2016) were obtained and subjected to descriptive statistical analysis while primary data on impacts of weather variability on floodplain agriculture and common mitigative measures were collected through structured questionnaire. The result revealed variability in rainfall as most of the years' annual mean were above the aggregate annual mean. The implication of this is that more rainfall was recorded in some years', but this was not consistent from 2006 to 2017.

On the impacts of climate variability on floodplain farming, the study observed significant agreement to the fact that rainfall in the area sometimes is heavy and during such periods, streams are overflow their banks leading to the destruction of their crops. Like in other parts of Nigeria and developing economics, extreme weather events are destructive with significant repercussions on the local economy. This is particularly trite these regions that heavily reliant on rainfed agriculture. In view of this, farmers put up measures to manage the aftermath of climate variability or reduce activities that will trigger climate incidences either in the short or long run.

In view of the outcome of this study, it is recommended that climate change and adaptation experts should form a synergy with development practitioners and other relevant stakeholders to feed in research results with policy development and subsequent implementation. Nigeria as a country cannot afford to continue to plan without facts, scientific reports should be collated and sieved for their appropriateness in promoting economic development and mainstreamed into national development plans. This measure will aid in reducing the vagaries of weather and climate on the nations' economy.

More so, farmers on their own should amplify and sustained indigenous practices of climate change/variability management like the cultivation of cover crops, sustenance of mixed cropping, appropriate timing of the planting season and put in place good water harvesting schemes like water collection pots in the agricultural fields among others to reduce flood damage to crops.

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