



Impacts of variability and change in rainfall on gender of farmers in Anambra, Southeast Nigeria



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ABSTRACT

Men and women farmers experience different impacts of climate variability and change (CVC). Research on the differentiated impacts of variability and change in rainfall on gender is limited in the study area. This study examined perceptions and experience of men and women farmers on the impacts of CVC, using climate data and farmers' perception from a gender perspective. It examined the effect of CVC on annual and seasonal rainfall, number of rain days, onset and cessation of rainfall; perceived impacts of CVC on annual and seasonal rainfall and compared the measured (meteorological) impacts with the perceived impacts across gender. Mixed methods of qualitative and quantitative data collection and participatory rural approaches were used. Household survey of 50% men and 50% women each were conducted in six farming communities. Data analysis involved the use of annual rainfall trends, Annual Rainfall Anomaly (ARA), Standardized Annual Rainfall Anomaly (SARA), regression analysis percentages and chi-square. Results reveal the occurrences of more dry years than wet years (ARA and SARA <0.00) in the three locations. There were wide variability and changes in inter-annual rainfall in Ogbaru ($R^2 = 0.0003$), Anambra East ($R^2 = 0.0071$) and Ayamelum ($R^2 = 0.0014$). Seasonal rainfall was unevenly distributed from 2007-2016. There were wide variations in dates of onset and cessation of rainy season ($R^2 = 0.006$) and number of rain days ($R^2 = 0.009$). Men and women responses revealed that there were statistically significant ($p < 0.005$) changes in the onset of rainy season, early cessation of annual rainfall; alteration of growing seasons; frequent flooding and frequent drought. Women felt more impact of food insecurity, water shortage and had more burden of migration due to changes in rainfall. This study concludes that respondents perceived and experienced impacts of CVC which varied across gender. Hence, it recommends the provision of sustainable water and irrigation system which should encourage women's participation in the construction, maintenance and management among others.

1. Introduction

Global climate variability and change (CVC) are evident with enormous impacts, which vary across gender, locations and socioeconomic features. Empirical observations and climate models indicate that global climate have been changing over the past 100 years and will likely change more rapidly in the future (Adeleke et al., 2018). The impacts of climate change on our ecosystems are already severe and affect food security of humankind (FAO, 2016). Agriculture, which is central to livelihoods in Africa, is considerably vulnerable to CVC (Gebreyes et al., 2017). Climate change has significantly affected global agriculture in the 21st century and future impacts are projected to worsen as the temperature continues to rise and precipitation becomes more unreliable

(Ochieng et al., 2016). The intensity and frequency of heavy precipitation events have increased in the last 50 years and the spatial pattern of the rainfall is likely to change, with rise in number and intensity of extreme rainfall events which adversely impact the natural resources on which majority of the population is dependent (Thakural et al., 2018). Hence, there is need to recognize the enormous impacts of CVC on agriculture.

Impacts of CVC on rainfall affect farmers in many regions, countries and developing countries including Africa. The natural resource base on which men and women farmers depend on are altered, traditional socioeconomic livelihoods stressed and the potential for future agricultural development are affected by CVC (Jost et al., 2016). In India, the meteorological records indicate rise in the mean annual surface air temperature by 0.4 °C with not much variations in absolute rainfall (Thakural

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et al., 2018). Developing countries especially in Africa are highly susceptible to the impacts (IPCC, 2014; Ford et al., 2015; Bryan et al., 2017; Connolly-Boutin and Smit, 2016; Perez et al., 2015; Sonwa et al., 2017) and the poor already struggle to cope (De Souza et al., 2015). The poor in Africa, particularly smallholder farmers, are highly vulnerable to climatic and environmental hazards as their options for diversifying their resources and income sources are limited (Ochieng et al., 2016). Yet in most African countries, men and women farmers do not have equal rights to agricultural resources. Unfortunately, existing gender differences, roles and inequalities increase the impacts of CVC on farmers due to inequalities in access and right to resources. For instance, it has been noted that some chronically poor women farmers are affected more negatively by climate change and seasonal changes than the men in Africa (Nkengla-Asi et al., 2017). Thus, CVC affect agricultural production of farmers and most especially the women in Africa as well as Nigeria.

Nigerian economy from past decades depends on the agricultural sector, which is reputed as the mainstay of the economy and the key driver for growth and development (Sertoglu et al., 2017). Yet, Nigeria is experiencing adverse climate conditions with negative impacts on welfare of millions of people, persistent droughts and flooding, off season rains and dry spells which have sent growing seasons out of track (Ologehi et al., 2018). Farming is also the predominant livelihood activity in the rural areas of Southeast (SE) Nigeria (Ifeanyi-obi and Mathews-Njoku, 2014) yet the region has persistent problems of drought, deforestation, high loss of vegetative cover, erosions and floods. In SE the sex ratio is male-dominated in three (Imo, Anambra and Abia) of the five states but female-dominated in Enugu and Ebonyi states (Wilson and Felix, 2018). For instance, data show a total population of 16,381,729 comprising of 8,306,306 males and 8,075,423 females, making a ratio of 50.70 males to 49.30 females for the zone (Wilson and Felix, 2018). This shows that females constitute a significant proportion of the population that are affected by CVC. Despite the observed erratic nature of both rainfall and dry spells, the location of the zone within the tropical rainforest belt of the country encourages strive to produce most tropical food crops like yam, cassava, vegetables, rice, and livestock production (Nwaiwu et al., 2014). Farmers in SE, who produce mainly food crops like cassava, yam and maize, mostly practice mixed farming (Ifeanyi-obi and Mathews-Njoku, 2014). Among the States in SE zone, Anambra is the main focus because of the significant role they play in agricultural development and production.

Anambra State of the SE region is very important because of their large-scale involvement in agricultural activities and high dependence of other SE States on them for food and goods for their feeding and trading respectively. Also the State experience persistent CVC problems as well as gender related inequalities. The farmers are contending with variations in climate and achievement of optimum yield to secure a suitable farm output for increased food supply (Okeke et al., 2016). For instance, flooding is one of the most serious environmental problems pervasive in Anambra state and over 30% of the inhabitants of Anambra state live along the riverine area and survive mainly on fishing and agriculture (Onwuka et al., 2015). Unfortunately, most of these flood prone areas are places where the inhabitants carryout most of their economic activities like agricultural activities, fishing, industrialization, transportation activities and trading (Onwuka et al., 2015). The inhabitants of the area and even people from distant places who depend on these activities are in serious danger of losing their means of livelihoods (Onwuka et al., 2015). For instance, the State is the major grower and supplier of rice in Southeast Nigeria. Rice farmers have been witnessing heavy downpours due to intense rains as a result of variability in timing and amount of rainfall caused by climate change (Onyegbula and Oladeji, 2017). The cost of rice production in the area is becoming very high as well as the price of rice they distribute to other States likewise other agricultural product. The degree and intensity which rains are experienced in recent times is far beyond what farmers are familiar and can grapple with in order to remain productive (Onyegbula and Oladeji, 2017).

Women play major farming roles in Anambra, but have very limited

decision power and lesser access to production resources. Women farmers are more vulnerable to the changes in weather than men and supply most of the labour needed in the farm in addition to managing their own farms (Okeke et al., 2016) even though available agricultural resources are unevenly distributed across gender. Hence, considerations of the links between prevailing gender and CVC issues, which cause more inequality among farmers, are imperative in Anambra State of the Southeast zone. Few studies (Amusa et al., 2015; Issa et al., 2015) considered gender and climate change in Nigeria. There have been many studies on CVC in Southeast Nigeria (see for example Chikezie et al. (2015), Enete et al. (2015), Okoro et al. (2016) and Munonye (2017)). These studies exposed the effects of CVC on food crop production and indigenous response strategies and practices. However, gender differentiated information to show detailed CVC impacts on men and women were not included. In addition, climate change information used in the studies are more typical of farmers' perception. The perceptions and experiences of farmers combined with meteorological data improve understanding of these situations. Therefore, the trends of CVC over time and their linkages with gendered problems have not been explored sufficiently in SE Nigeria and Anambra State. The prime objective was to examine farming communities' perceptions and experience of impacts of CVC, using climate data and respondents' perception from a gender perspective. Specifically this study sought to first examine impacts of CVC on annual and seasonal rainfall of the farm communities. Secondly, examine the impacts of CVC on number of rain days, onset and cessation of rainfall in the study area. Thirdly, ascertain perceived impacts of CVC on annual and seasonal rainfall from gender perspective. Fourthly, and lastly compare the rainfall (meteorological) data with the perceived impacts (measured across gender). These helped to answer the following research questions:

1. What are the impacts of CVC on annual and seasonal rainfall of the farm communities?
2. What are the impacts of CVC on number of rain days, onset and cessation of rainfall in the area?
3. What are the perceived impacts of CVC on annual and seasonal rainfall from gender perspective?
4. Are there similarities between the rainfall (meteorological) data with the perceived impacts (measured across gender)?

2. Methodology

This study was carried out in SE region of Nigeria with focus on Anambra State (Fig. 1).

The State is situated between Latitudes 5° 32' and 6°45'N and Longitude 6°43' and 7° 22'E (Ezenwaji et al., 2014). The three Local Government Areas (LGAs) (Anambra East, Ogbaru and Ayamelum) are situated very close to water bodies and suffer from many impacts of climate change especially flooding and erosion. Although the three LGAs are located close to river Niger and many water bodies, Ogbaru has more wetlands than the other LGAs. The entire Ogbaru LGA, which constitutes a large wetland zone is located in the south western part of Anambra State (Ekenta et al., 2015). Anambra east LGA is made up of depositional lowlands with pockets of lakes, ponds and levees and the relief is undulating and descends towards the water (Ugoyibo et al., 2017). It also has a variety of land forms despite the fact that they are dominated by flat and low lying land generally less than 120m above sea level (Ugoyibo et al., 2017). Topography of Ayamelum LGA ranges from undulating to flat plains and cuesta landforms (Orakwue et al., 2015). There are several smaller river basins and drainage features of the Anambra-Manu River (Orakwue et al., 2015).

Annually, Anambra State experience two major seasons namely: dry and rainy season. Ejikeme et al. (2017) noted that the "climate of Anambra State has two seasons, the wet and dry, with the wet seasons usually starting in March and ending in October, while the dry season usually begins in November and last till February". The temperature

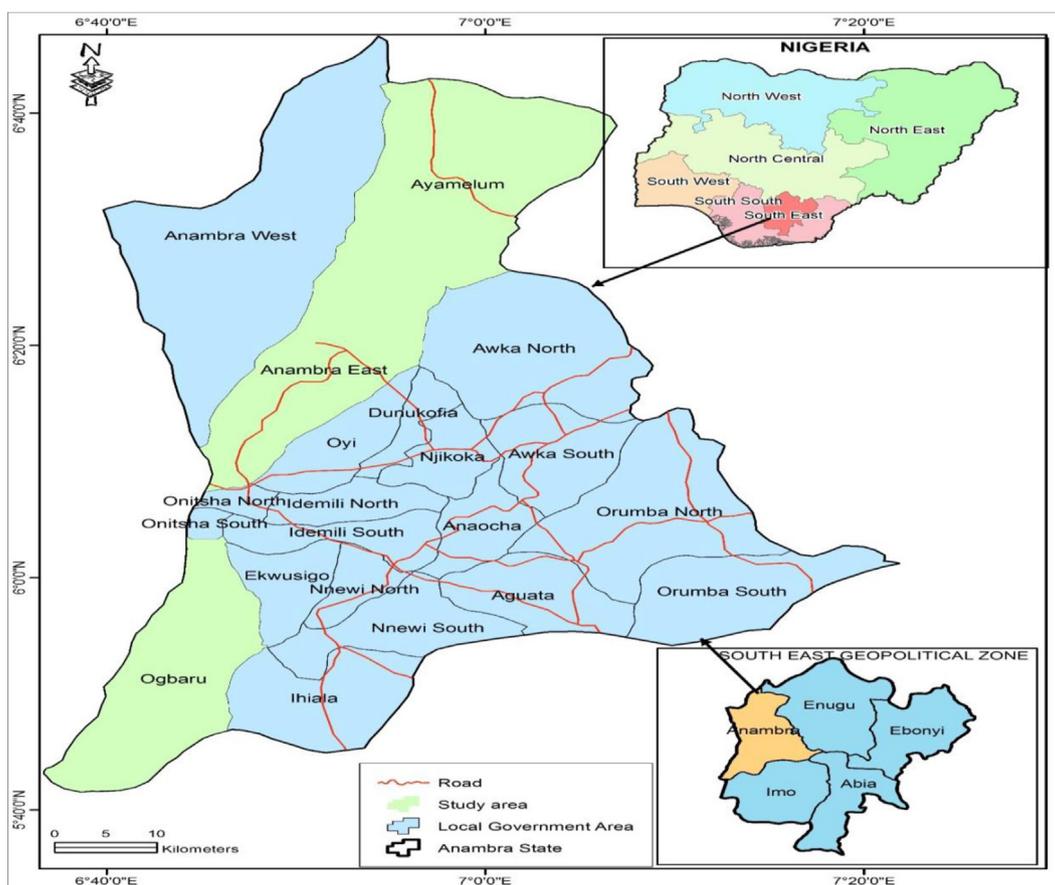


Fig. 1. Map of Nigeria showing study locations (Anambra East, Ogbaru and Ayamelum).
Source: Modified from divagis.org

pattern has mean daily and annual temperatures as 28 °C and 27 °C respectively. “The mean daily temperature can rise to about 32 °C during hot periods of the year usually in the month of February” (Ejikeme et al., 2017). “Humidity is relatively high between 65–80% throughout the year” (Ejikeme et al., 2017). Similarly, according to Ezenwaji et al. (2014) “the climate shows that annual mean minimum temperature is about 23 °C while the annual mean maximum temperature is about 32 °C”. Also according to Ifeka and Akinbobola (2015b), Anambra experiences warm humid tropical climate, with average rainfall between 1520–2020 mm per annum. The rainfall pattern is characterized by a dry season, November to March, with dry continental North-East winds dominating during this period and a long wet season which occurs normally from April to October and dominated by the moist maritime south-west winds (Nzoiwu et al., 2017). In recent times, the onset and cessation periods of the rain in the study area has been observed to vary over time (Nzoiwu et al., 2017). Climate was once considered to be static possibly because of the long period of time it takes for a change to occur in it (Nwagbara and Ibe, 2015).

Mixed methods of research design and approaches were adopted for the collection of qualitative and quantitative data. Mixed method approach employs rigorous quantitative research to assess magnitude of problem and rigorous qualitative research to explore meaning and understanding of the construct and the context (Kaur, 2016). Field observations, Household questionnaire, Focus Group Discussions (FGDs) and Key informants interview methods were used to collect qualitative and quantitative data while meteorological data were also collected from the three LGAs. Key informant interview, FGD and household survey were used to elicit information on the perceived impacts on CVC on annual and seasonal rainfall and the perceptions of respondents on the impacts of varying rainfall on gender. The purpose of using mixed methods research,

of combining qualitative and quantitative research components, was to expand and strengthen a study with heightened knowledge and validity (Schoonenboom and Johnson, 2017). Men and women household heads (150 each) were purposively used in order to get detailed information in the households. Separate FGD session of eight members each (including leaders of farmers' cooperative groups) were organized for men and women farm household heads in each Local government area (LGA). Key informants of men and women included four community leaders with in-depth knowledge of the area. This study complies with all regulation and informed consent was obtained.

Multi-stage sampling technique was used to select the sample for household questionnaire survey. In the first stage, three LGAs in Anambra (Ogbaru, Ayamelum and Anambra East) were purposively selected due to predominance of large scale farmers in the areas. In the second stage, two town communities (Atani, Ogbakuba, Ifite-Ogwari, Anaku, Aguleri and Igbariam) were selected from each LGA. In the third stage, random sampling technique was used to select a ratio of 50:50% men and women household heads (150 each) respectively from a list of registered farmers in the State Ministry of Agriculture. Respondents were asked to tick either Yes/No on existence of different impacts of CVC in 1986 and 2016.

In order to examine impacts of CVC on rainfall, meteorological data of 31 years period was used. The classical period of climate change is 30 years, as defined by the WMO (WMO, 2017). Annual rainfall for 31 years (1986–2016) for Anambra East Local Government Area (LGA), which were measured at Chukwuemeka Odumegwu Ojukwu University, Igbariam were collected from the Synoptic Meteorological Station in Awka (Anambra State capital). Annual rainfall of Ayamelum LGA for 31 years (1986–2016) period, were collected from the Agro-Meteorological Station in Ifite-Ogwari, Ayamelum LGA. Annual rainfall data for 31 years

(1986–2017) were also collected from the Nigerian Meteorological Agency, synoptic station, at Nkwelle in Anambra State, which according to Ezenwaji et al. (2014) is to about 5kms to Ogbaru LGA. To examine seasonal variability and changes in rainfall, this study used only the monthly rainfall of Anambra East LGA due to inability to access monthly rainfall of other LGAs. This was sufficient to explain the seasonal variation in rainfall in the State.

Data were analyzed using statistical measures in IBM-SPSS, Excel and Minitab 18 software. Meteorological data were analyzed using trend or time series analysis to explore the seasonal and annual variability and change. Time series analysis of monthly and annual rainfall values were used to illustrate the trend of rainfall and in estimating seasonal variation (also used in Ekwe et al., 2014). Trend analysis included computation of Annual rainfall trends, Annual Rainfall Anomaly (ARA) and Standardized Annual Rainfall Anomaly (SARA). Based on SARA calculations illustrated in Ekwe et al. (2014) mean, standard errors and standard deviations were used to obtain standardized annual and seasonal rainfall anomalies. Anomaly here is deviation of a mean annual or seasonal rainfall and temperature from a long-term mean (Juma, 2015). Standardized Anomaly Index (SAI) for rainfall was used to group the years based on their standardized anomaly values. The SAI (see also Ifeka and Akinbola, 2015a) were set at normal (0.0); wet (above 0.0) and dry (below 0.0) years. Regression analysis was performed in SPSS version 20 to ascertain effect of changing climate time (years) on rainfall variations. The non-parametric (regression analysis) test is considered better because it is a function of the ranks of observation and it displays much insensitivity to outliers unlike the parametric counterpart (Ifeka and Akinbobola, 2015a). T-test statistics was used to analyze statistical significance level of the variability and change from the sample mean. T-test is usually expressed as deviations of sample means from a population mean (Madukwe, 2015). Statistical tools commonly used to detect significant trends in climatic and hydrological time series are either the non-parametric test such as Mann-Whitney, Wilcoxon, Mann-Kendall or Spearman's rank correlation or the parametric test such as student's t-test (Ifeka and Akinbobola, 2015a). The significance level for the t-test was set at $P < 0.05$ hence the differences in annual rainfall were statistically significant at 95% confidence interval. Field observation was used to improve the validity of information obtained.

Respondents' perceptions were analyzed and compared with findings from the meteorological data on annual rainfall and seasonal rainfall, length of rainy season days. Proportions of the existence of these impacts in 1988 and 2016 were expressed in percentages and the differences between these two periods were analyzed using Pearson chi-square by cross tabulation statistics. The Chi-square applied to this situation with two variables and the contingency table had r row and c columns (Yekinni, 2015). In this case the row was the time before (1986) and after (2016) CVC. The columns were variables on climate change impacts in these periods. The results were compared with the measured impacts obtained for the analysis of the meteorological data.

3. Results and discussion

3.1. Respondents' perceived impacts of CVC on rainfall across gender

Table 1 shows that respondents perceived significant impacts of CVC in rainfall in the area. Data in Table 1 show that from the common trend (pooled data of men and women), there were statistically significant ($p < 0.005$) differences in onset of rainfall, early cessation of annual rainfall; alteration of growing seasons (planting and harvesting calendar); frequent flooding and frequent drought before (1986) and after (2016) CVC. Data also show that the men and women indicated that there were statistically significant ($p < 0.005$) differences in the onset of rainy season, early cessation of annual rainfall; alteration of growing seasons (planting and harvesting calendar); frequent flooding and frequent drought for the selected periods.

The majority of men and women indicated there were more

Table 1

Respondent's perception of impact of CVC on annual and seasonal rainfall.

Pooled Data (men and women) n = 350			
Variable	Before Climate variability/change (1986)	After climate variability/change (2016)	χ^2 -value
Seasonal changes in onset of rainfall	14.3	87.7	377.57*
Early cessation of annual rainfall	19.1	82.0	276.60*
Alteration of growing season, planting and harvesting calendar	9.1	90.9	183.43*
Frequent flooding	13.7	89.4	401.68*
Frequent drought	10.3	82.6	367.64*
Men (n=150)			
Seasonal changes in onset of rainfall	16.9	93.2	208.08*
Early cessation of annual rainfall	22.6	81.4	122.40*
Alteration of growing season, planting and harvesting calendars	13.6	91.5	215.74*
Frequent flooding	13.7	93.8	186.92*
Frequent drought	10.3	79.1	87.7*
Women (n=150)			
Seasonal changes in onset of rainfall	11.6	82.1	172.76*
Early cessation of annual rainfall	15.6	82.7	155.60*
Alteration of growing season, planting and harvesting calendars	4.6	90.2	82.22*
Frequent flooding	5.2	85.0	222.30*
Frequent drought	8.7	86.1	208.15*

Source: field survey (2018); * $p \leq 0.05$

occurrences of these changes in recent times than past thirty years. This agrees with Onyeneke et al. (2018) reports that the changing climatic condition in Southeast Nigeria, which manifest through changes in rainfall pattern is a concern. This implies that there were lesser cases of seasonal changes in onset of rainfall, early cessation of rainfall, alterations in growing seasons, effects of flooding and droughts lately than in the three decades ago. Similarly, Oloukoi et al. (2014) found that perceived changes in the local climate which included delay in the onset of rain, reduction in the total annual rainfall and early cessation of the rainy season which affected the livelihoods of men and women differently. Women in these rural communities practice subsistence farming during the rainy season, their farmlands are submerged during flood events destroying their crops and they are helpless during prolonged dry seasons (Mbajiorgu et al., 2017).

3.2. Empirical evidence of impacts of CVC on rainfall of farm communities

3.2.1. Impacts of CVC on annual rainfall in Ogbaru L.G.A

Findings reveal that CVC resulted to a wide variability and changes of rainfall in Ogbaru LGA as presented in Fig. 2. The curvilinear graph between rainfall in millimeters and time in years (Juma, 2015) shows wide variability in amount of annual rainfall in the Ogbaru LGA.

The trends in the Fig. 2 reveal a wide variability in the inter-annual rainfall ($R^2 = 0.0003$) for the period (1986–2016). The Figure also reveals the anomalies and standardized anomalies of the variability and changes. The long-term mean of the inter-annual rainfall was 1849mm per year from 1986 to 2016. The maximum annual rainfall of 1920mm was recorded in 1989 and 1992 while the minimum of 1776mm was recorded in 1987. The ARA and SARA results (see Fig. 2) reveals the occurrence of 13 wet years, which had annual rainfall that were higher than the long-term annual mean (ARA and SARA >0.00). It also reveals 18 dry years with annual rainfall values lower than the mean (ARA and SARA <0.00). The graphs show existence of more dry years than wet

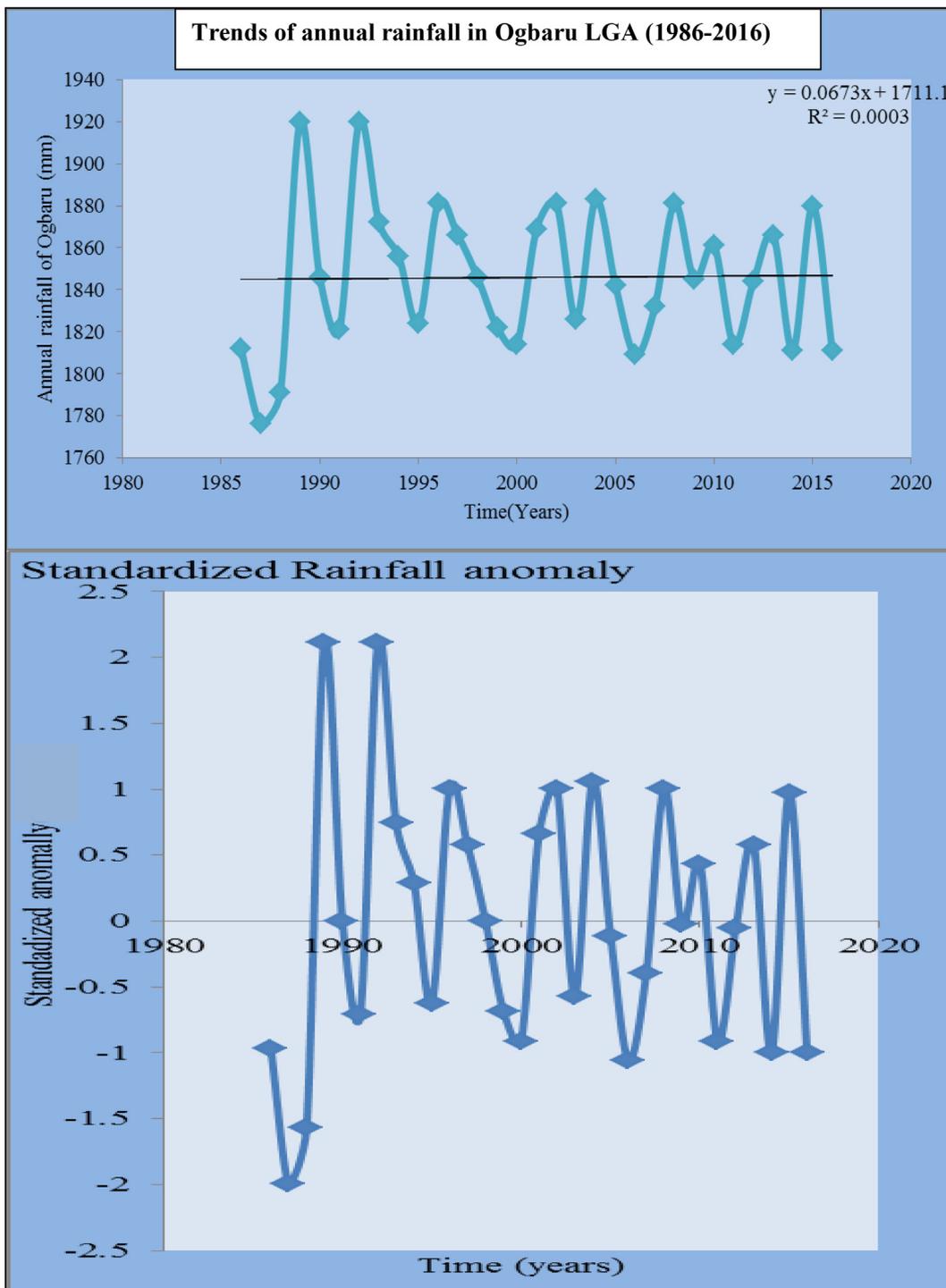


Fig. 2. Trends of annual rainfall variability and change in Ogbaru LGA (1986–2016). Source: Meteorological Station (2018)

years in the area for this period. Field observation revealed that the area is a wetland, which is located close to River Niger (one of the biggest rivers in Nigeria).

During FGD in Ogbaru LGA, participants noted “there are changes in rainfall pattern; sometimes we experience much rainfall leading to floods and sometimes there are little rainfall and much drought”. These implies that there were downward and upward trends in the annual rainfall in the period for Ogbaru LGA. The variability in the trend agrees with the trends in Ifeka and Akinbobola (2015a) in which between 1991 and 2010, there were upwards and downwards trend in the rainfall parameters in Ogbaru

LGA. These variability and changes in pattern of annual rainfall can affect crop and animal production as well and livelihood of farmers since they depend on rainfall for their agricultural production.

3.2.2. Impacts of CVC on annual rainfall in Ayamelum L.G.A

Fig. 3 shows the results of annual rainfall trends analysis and the resultant anomaly and standardized anomaly of rainfall in Ayamelum LGA.

The curvilinear relationship between rainfall in millimeters and time in years (see Fig. 3) was used to show the trend in the inter-annual

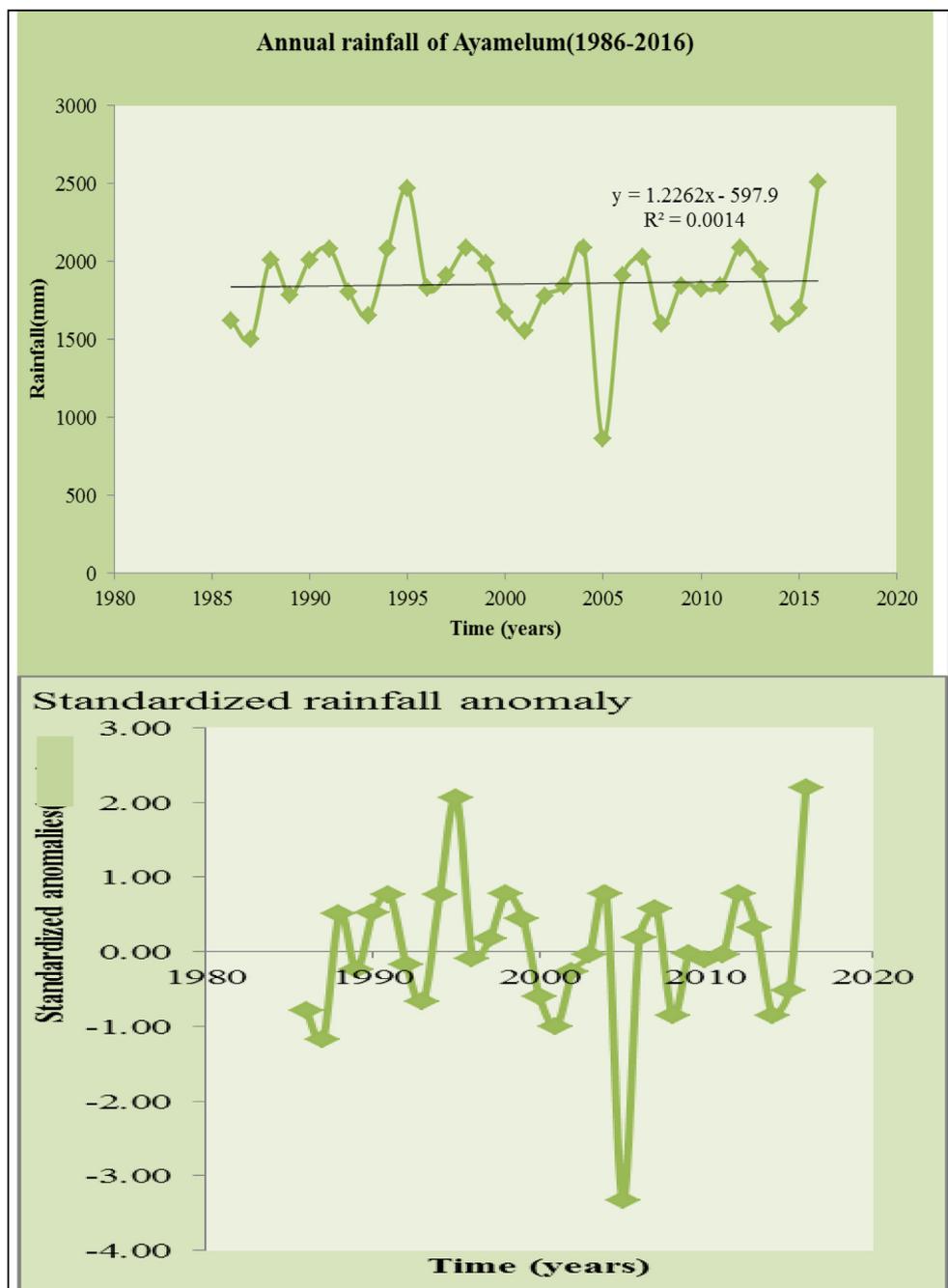


Fig. 3. Trend of annual rainfall variability and change in Ayamelum LGA (1986–2016).
Source: Meteorological station (2018)

rainfall variations. Based on the data, the long-term mean annual rainfall was 1855 mm per year for the period between 1986 and 2016. The trend analysis revealed that there were wide variations of the inter-annual rainfall from the long-term mean ($R^2 = 0.0014$). The highest annual rainfall of 2510mm was recorded in 2016 and the lowest rainfall of 861 was recorded in 2005. The ARA and SARA graphs (Fig. 3) showed that out of the 31 years' period, 14 years had annual rainfall values higher than the long term annual mean (ARA and SA > 0.00). It also revealed that 16 years had annual rainfall values lower than the mean (ARA and SRA < 0.00). Based on the SARA there were more dry years (16 years) within this period. This implies that there were changes and variability in annual rainfall as well as more dry years in the LGA. This is similar to findings of Ifeka and Akinbobola (2015a) which reported that there was downward trend in the total, mean, maximum and minimum rainfall in

the location between 1991 and 2010. Also during the key informant interview in this area, respondents noted that “*there were variations in annual rainfall*”. Information gathered from field observation was that these farmers engage very much in rice production hence they need water. They integrate rain-fed agriculture with irrigation. However, based on available resources, use of irrigation in this area is constrained by land fragmentation and limited irrigation facilities. Hence, they depend mainly on rainfall to produce crops and animals in this area. This implies that there was variability in inter-annual rainfall in this LGA.

3.2.3. Impact of CVC on annual rainfall in Anambra East L.G.A

CVC have impact on annual rainfall in Anambra East LGA as can be seen in Fig. 4. The annual rainfall trend and the resultant ARA and SARA that occurred in Anambra East LGA reveal wide variability and changes

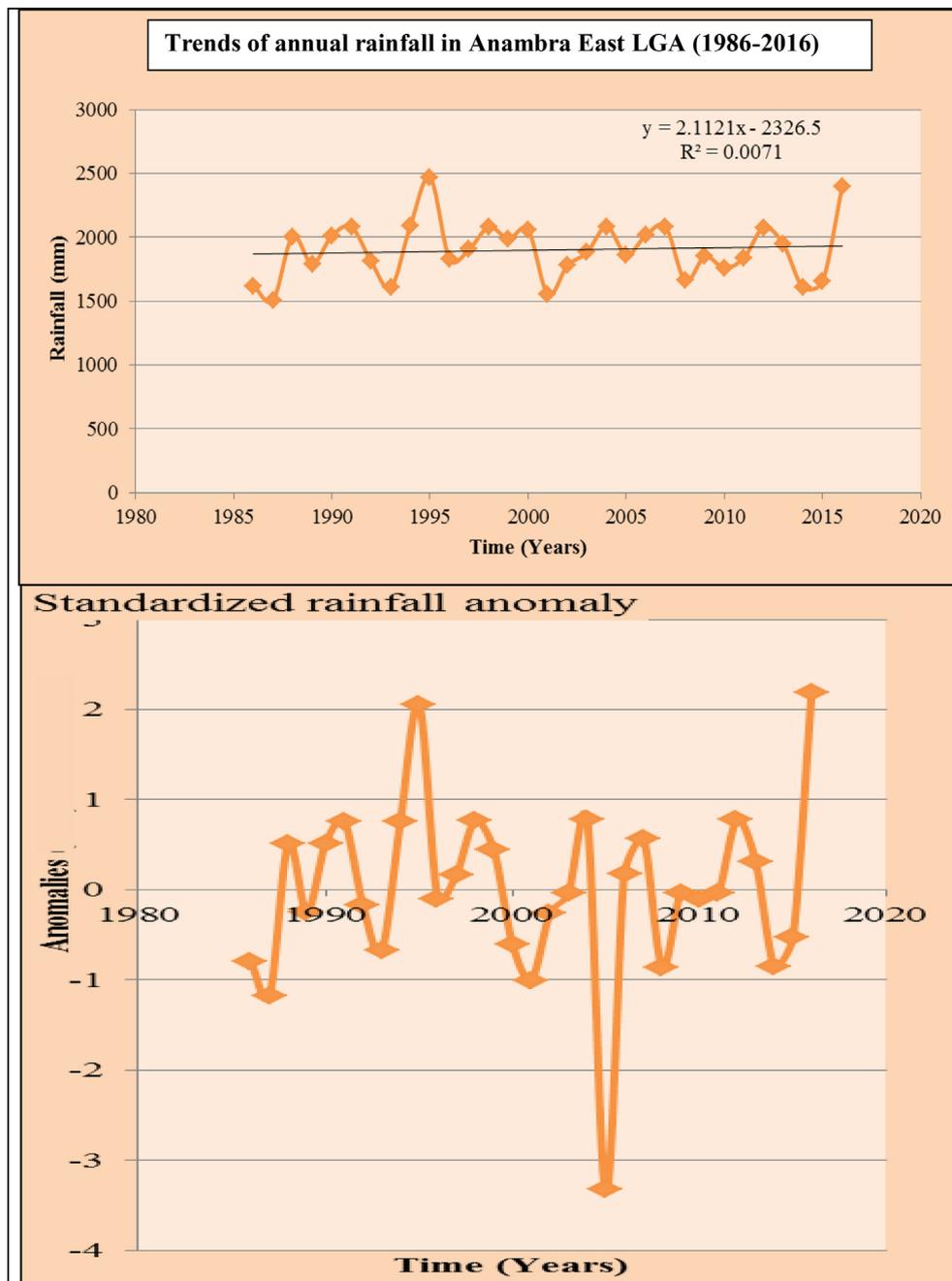


Fig. 4. Trends of annual rainfall variability and change in Anambra East LGA (1986–2016). Source: Meteorological station (2018)

for the period.

The curvilinear relationship between rainfall, in millimeters, and time, in years, show the changes and variability in the inter-annual rainfall in the area. Based on the data, the long-term mean annual rainfall was 1899mm per year for the period (1986–2016). The trend analysis reveals that there were wide deviations of inter-annual rainfall means from the long term mean ($R^2 = 0.0071$). ARA and SARA (see Fig. 3) shows that out of the 31 years' period, 14 years (wet years) had annual rainfall values higher than the long term mean (ARA and SARA >0.00). It also reveals that 17 years (dry years) had annual rainfall mean lower than the long-term mean (ARA and SARA <0.00). The highest annual rainfall of 2469mm was recorded in 1995 and the lowest rainfall of 1507 was recorded in 1987. Although there were series of dry and wet years, there were more dry years in this period.

Participants in FGD and key informant interviews in this LGA

reported that there were variations in amount of annual rainfall within this period. They stated that “rainfall is not sufficient for their agricultural production and household needs”. Field observation also revealed that different household sourced water from streams, as the rainfall was unpredictable and insufficient. This corroborates the findings of Umeh and Nwachukwu (2018) that high sunshine intensity, increased drought, inadequate access to water and crop losses are major changes due to climate change. This implies that there was variability in annual rainfall in the area and annual variations in amount of water for agricultural and household use and decrease or increase in crop and animal production of farmers in this area.

3.2.4. Impact of CVC on seasonal rainfall in Anambra East

Data in Fig. 5 shows the trend of monthly rainfall in Anambra East LGA from 1986–2016.

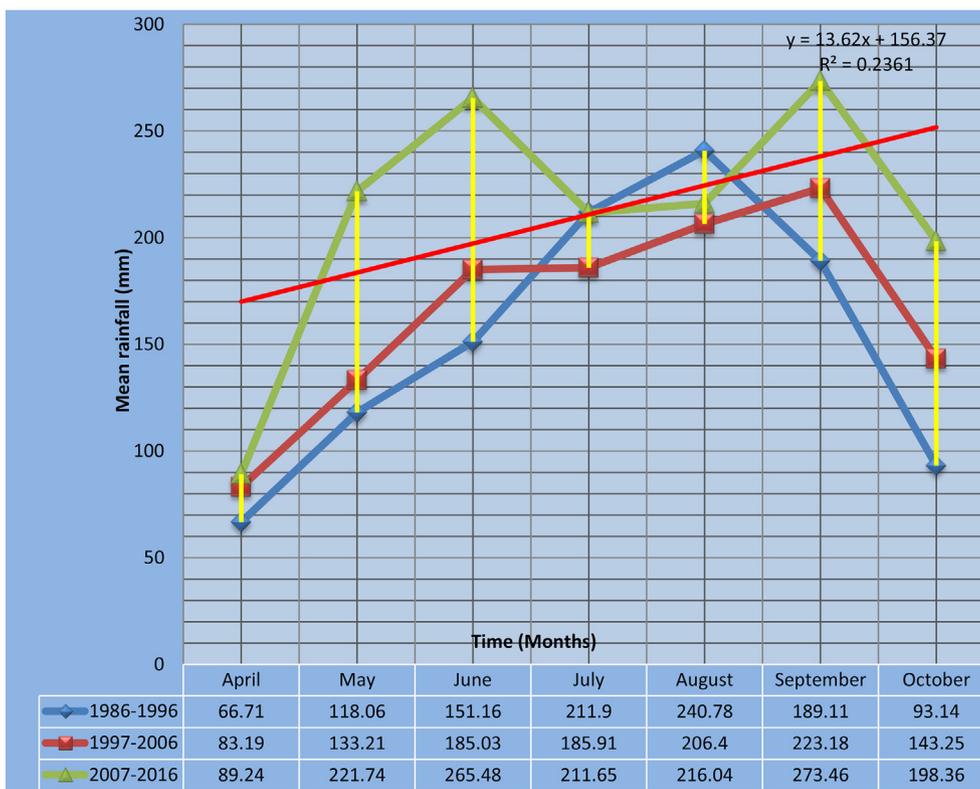


Fig. 5. Trend of variability and change in seasonal monthly rainfall in Anambra East LGA (1986–2016). Source: Meteorological station (2018)

Fig. 5 shows that in April, the amount of rainfall was highest (mean = 89.24) from 2007 to 2016. The differences between mean rainfall in April between 1986–1996, 1997–2006 and 2007 to 2016 were statistically significant at $p = 0.007$ ($t = 11.84$) as presented in Table 2.

Similarly, in May, the amount of rainfall was highest from 2007–2016 with mean rainfall of 221.74mm. The differences between mean rainfall in May between 1986–1996, 1997–2006 and 2007–2016 were statistically significant at $p = 0.040$ ($t = 4.88$) (see Table 2). In June, rainfall was highest from 2007 to 2016 with mean rainfall of 265.48mm. Result of the trend analysis show that there was wide variability in monthly rainfall in the rainy seasons ($R^2 = 0.139$) between 1986–1996, 1997–2006 and 2007–2016. The differences between mean rainfall in June for 1986–1996, 1997–2006 and 2007 to 2016 were statistically significant at $p = 0.027$ ($t = 5.91$). In July and August, the amount of rainfall were highest from 1986–1996 with mean rainfall of 211.9 and 240.78mm respectively. The differences in total monthly rainfall of July and August for 1986–1996, 1997–2006 and 2007 to 2016 were statistically significant at $p = 0.002$ and 0.001 ($t = 23.56$ and 21.59

Table 2 Test of differences in seasonal monthly rainfall in Anambra East (1986–2016).

Months	t-value	df	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
April	11.841*	2	79.713	50.75	108.68
May	4.877*	2	157.670	18.56	296.78
June	5.916*	2	200.557	54.69	346.43
July	23.562*	2	203.153	166.06	240.25
August	21.592*	2	221.073	177.02	265.13
September	9.330*	2	228.583	123.17	333.99
October	4.769*	2	144.917	14.18	275.66

Source: Meteorological stations (2018); *P < 0.05 statistically significant at 95% confidence interval.

respectively). In September and October, the amount of rainfall was highest from 2007–2016 with mean rainfall of 273.5mm and 198.4mm respectively. The differences in the mean rainfall in September and October for 1986–1996, 1997–2006 and 2007 to 2016 were statistically significant. The resultant p-value and t-value were $p = 0.011$ and 0.041 ($t = 9.33$ and 4.76) respectively. This shows the nature of seasonal variability and change within the months in rainy season. This implies that the seasonal rainfall is unevenly distributed from 2007–2016. Amount of precipitation are more in the beginning of rainy season from 2007–2016.

During key informant interview they revealed that they used to have “August Break” because of the wet days in August. In line with this, data show that there was highest rainfall amount in August from 1986 to 2006 only. Similar to this is the findings of Ezeh et al. (2016) which reported that the wettest month was June in Lagos, September in Rivers, and August in Katsina and Borno, respectively. This agrees with the results of Eludoyin et al. (2017) that too early rainfall; late rainfall, prolonged dryness after an initial rainfall, excessive rainfall, and windstorms were the common weather-related causes of low crop yields. Similarly, Matthew et al. (2015) reported that the deviations in annual climate during their validation period (1999–2009) vary from year to year and across the ecological zones in Nigeria. This further agrees with the findings of Okoyeh et al. (2015) that rainfall occurs as violent downpours accompanied by thunderstorms, high runoff and heavy flooding, soil leaching and extensive sheet outwash. This rainfall pattern is not suitable for agricultural production.

During FGD and key informant interview, farmers revealed that, “many days in rainy season had no rainfall while the few days of rainfall have high amount of rainfall”. They also reported that, “some of the years with longer rainfalls favored agricultural production and in some of these years, we double their cultivation by growing late maize and vegetables”. Similarly, the results of Akinsanola & Ogunjobi (2017) estimated an increase for trends in annual and seasonal rainfall over the country. The implication of this finding is that variability and uneven distribution of rainfall in the rainy

seasons might cause a resultant variability (increase or decrease) in agricultural production.

3.2.5. Comparison of measured inter-annual rainfall variability and changes in the three locations

Result show similarity in the impacts of CVC on inter-annual rainfall variability and change in the three LGAs. Data in Table 3 shows that inter-annual rainfall variability and changes in Ogbaru was not statistically significant at 95% confidence interval (P-value = 0.622, $t = -0.498$).

Furthermore, the p-value of 0.984 ($t = 0.020$) in Table 3 shows that the inter-annual rainfall changes and variability in Anambra East were not statistically significant. Similarly, Table 3 shows that the inter-annual rainfall variations in Ayamelum were not statistically significant ($t = 0.013$; $P = 0.990$). This implies that the variability and changes in annual rainfall were not statistically significant in the three locations. This might be due to the disparities in measured and actual rainfall in the area. There might be other attributes of the actual climate in the area that have not been captured in this dataset, which potentially contributed to shape the CVC (Debela et al., 2015). Hence, there were similarities in the impact of CVC on annual rainfall in the three LGAs.

3.2.6. Impacts of CVC on number of rain days, onset and cessation of rainfall

3.2.6.1. Measured impacts of CVC on number of rain days. Fig. 6 shows that there was variability in the length of rainy season (number of rain days) from 1986 to 2016 ($R^2 = 0.009$).

Plot of number of rain days in Ogbaru, Anambra State (1986–2016).

The variability was statistically significant ($p = 0.000$; $t = 48.84$). Based on the SAI, 15 years were slightly below the mean, 9 years were slightly above, 4 years very much above and 2 years were very much below the mean. Length of rainy season was highest in 2012 (287 days) and lowest in 2005 (162 days). The area experienced a major flood in 2012 which caused massive losses of lives and properties. The finding is in line with Nzoiwu et al. (2017), in which a slight increase in the number of rainy days was observed. Hence there were significant impacts of CVC on the number of rain days resulting to more years with lesser number of rain days within this period.

3.2.6.2. Measured impacts of CVC on onset and cessation of rainfall. Data in Fig. 7 show wide change and variability in dates of onset of rainy season from 1986 to 2016 ($R^2 = 0.031$).

Fig. 7 shows that the rainy season mostly started in April but started as early as January (25th January in 1995) and very late in 1987 (5th May) and 2015 (5th May). There was rain in November (11th November) in 1996, which was supposed to be a dry period. Therefore, data shows great fluctuations in the dates of onset of rainfall.

Information gathered from field observations and key informant interview revealed that there were variability and in most cases late onsets of rainfall in the area. According to the informants, “rainy season’s onset is not predictable anymore and the intervals between the first rainfall and the next one can last for weeks or even a month”. “This makes us to be unsure of when to start cultivation as irrigation capacity and resources are constrained by many factors including land fragmentation and limited funds”. This result

Table 3
T-test of differences in annual rainfall in the study locations (1986–2016).

Location	t	df	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Ogbaru Rainfall	-0.498*	30	-3.129	-15.96	9.71
Anambra East rainfall	0.020*	30	0.839	-82.80	84.48
Ayamelum Rainfall	0.013*	30	0.674	-109.01	110.35

*not significant $P \geq 0.05$. Source: (Field survey, 2018).

is in line with other findings on onset of rainfall in Southeast Nigeria. In Chinago (2015), the study shows a delay in onset of rainfall over the study period. This implies that rainfall has shifted from the earliest date to a later onset date (Chinago, 2015). Meteorological data on rainfall in the country show that between 1941 and 1970 most places usually experienced normal onset of the wet season (NIMET, 2011). This pattern in the onset of the wet season changed during the 1971–2000 period to vary from late to normal onset, no part of the country experienced early onset of rains any longer (NIMET, 2011). Date of onset of rainfall is highly important for agriculture and socioeconomic activities. This agrees with Nzoiwu et al. (2017) which noted that precipitation, in all its forms, is an important element of the physical environment and as such constitutes one of the most valuable sources of water, a strategic resource for human survival and social development. The implication of this finding is that agricultural production and other rainfall dependent livelihood activities will be highly affected since onset of rainfall is highly unpredictable and late. Plant preparation and planting calendar, which are dependent on the dates of onset of rainfall, will be difficult to select by farmers. NIMET (2016 and 2017) predicted and confirmed shorter length of season that occurred in 2016.

Data in Fig. 8 show wide variations in dates of cessation of rainy season from 1986 to 2016 ($R^2 = 0.006$).

Fig. 8 shows that rainy season normally ended in October but it ended as early as September in 2002 (28th, September), 2003 (27th, September) and 2004 (29th, September) and 2014 (28th, September). There was wider variability in date of cessation of rainfall from 2000–2016. End of rainfall occurred much earlier in six years (2001–2005 and 2014) and later than normal in 4 years (2011–2013 and 2016) within this period. In a similar study, Chinago (2015) observed that cessation or the end of the rainfall has slightly shifted forward, that is the end of rainfall occurs earlier. Key informants and FGD groups also complained of changes in the cessation of rainy season, which are highly unpredictable and early. According to NIMET (2017), the cessation of the rains over most places in Nigeria tended towards early cessation. Distributions of rainy season help farmers to know planting calendars for different crops based on their water requirement. Implications of these finding is that rains start late and end early hence there is shorter growing periods.

3.2.7. Comparison of measured and perceived impacts of CVC on rainfall

Results from the study show similarities in respondents' perception of impacts of CVC on annual rainfall and meteorological data collected in the area. The perceptions of respondents showed that there were more cases of seasonal changes in onset and cessation of rainfall, alterations in planting calendars, flooding and droughts in 2016 than 1986. Perceptions of respondents on seasonal changes in onset of rainfall and the meteorological data on dates of onset of rainfall show that there were variability and change in onset of rainy season from 1986 to 2016 in the area. This is in agreement with the finding of Ayanlade et al. (2017) that climatic trends confirmed farmers' perceptions that early growing season and late growing season precipitations are oscillating and that rainfall onset is becoming later. Variations in onset and cessation of rainy season affect socio-economic activities, food security and income of farmers. This is due to delays in onset of rainfall which affect crop and animal production and other livelihood activities. Based on respondents' perception and meteorological data, there was changes in cessation of rainfall. According to Okoyeh et al. (2015), variation in the onset and cessation of rainfall in recent times in the study area has raised issues of concern as over 70% of the population depends on rain-fed agriculture for their livelihood. These imply that based on the perceptions and measured data, cessations of rainfall varied and came earlier than normal in most cases.

In addition, comparison of respondents' perception and meteorological data most of the rainy season months had highest amount of rainfall from 2007 to 2016 than other periods as well as higher frequency of floods. High rainfall can be beneficial but when it results to flood, it causes loss of lives, farms and properties. This agrees with Ezeano and

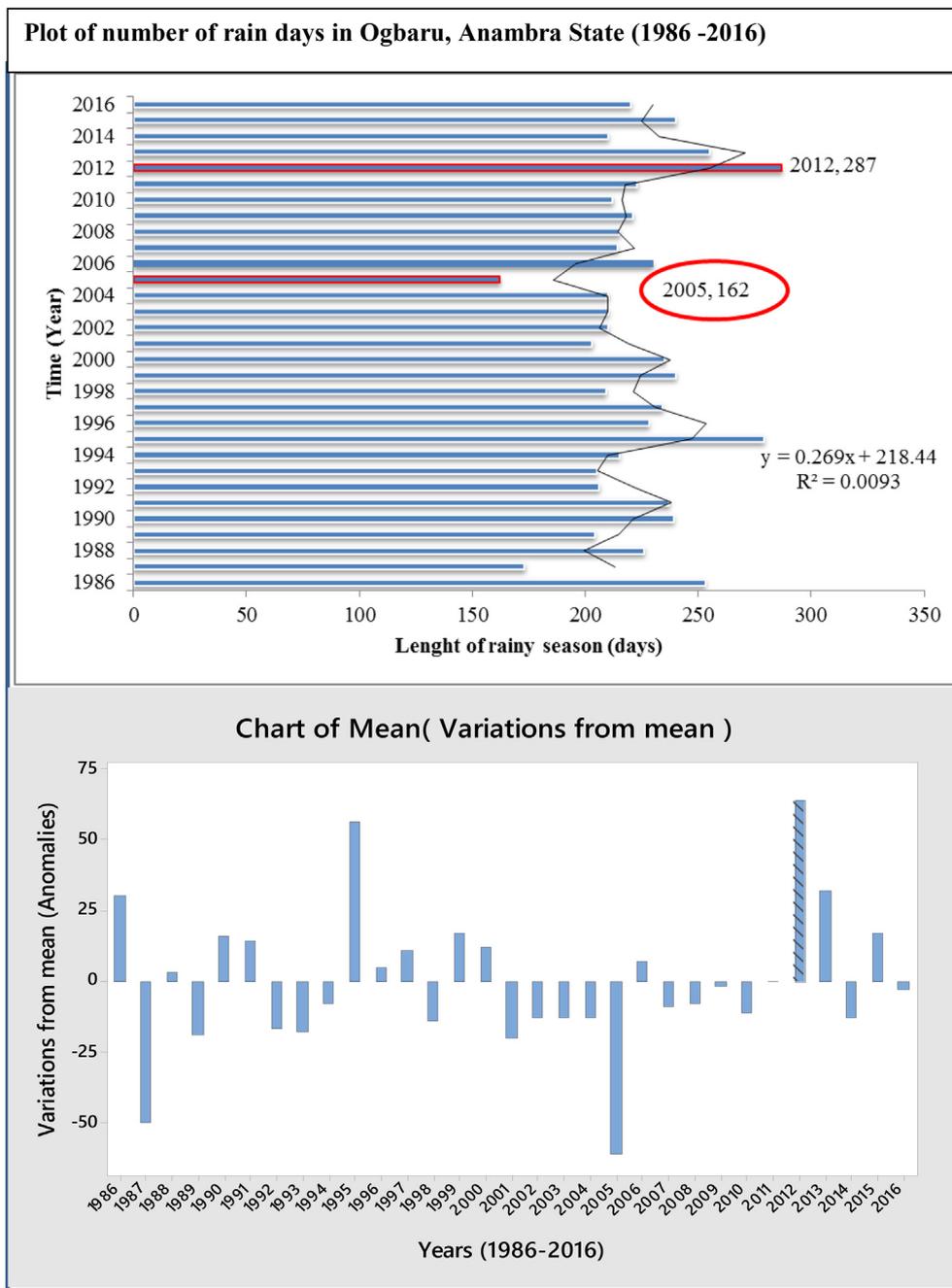


Fig. 6. Trends of number of rain days and the anomalies in Ogbaru, Anambra State (1986–2016). Source: Meteorological Station (2018)

Albert (2012) who reported that above normal rainfall resulted in high fish production in the area. Flooding destroy farms and properties and increase disease conditions. High intensity rainfall, erratic/torrential rainfall, flash flooding, rainstorms and gustiness exacerbated flooding and erosion in the area resulted in landslides and loss of lives and properties (Ezeano and Albert, 2012). This impact is not gender neutral as farmers will have to face so many difficulties and additional responsibility, especially women who are responsible for major house works.

Measured and perceived data on frequency of drought in the area showed that there was more frequent drought in the area. There was uneven distribution of rainfall and respondents noted that the length of dry periods is on the increase. Recent studies have shown that drought is one of the climatic extreme events, which are an insidious natural hazard,

leading to water shortage, with notable adverse impacts on crops, livestock and income of rural farmers (Ayansina et al., 2018). Some of these studies have shown that drought has significant negative impacts on poorer farming communities who have less diversified livelihoods and few economic alternatives (Araujo et al., 2016; Ifeanyi-Obi, 2016; Zhan et al., 2016; Ayansina et al., 2018). The level of impact of drought on agricultural communities varies, and depends on the socio-economic status of the communities, length and intensity of the drought (Ayansina et al., 2018). Although crop and livestock production provides employment and are major sources of income for many people in Nigeria, prolonged dry spells have become much more common in recent years, characterized by low crop yields, poor nutrition and death of livestock (Adegboyega et al., 2016). Multi-year droughts are now common which some scientists perceive to be a transitional phase in climate change

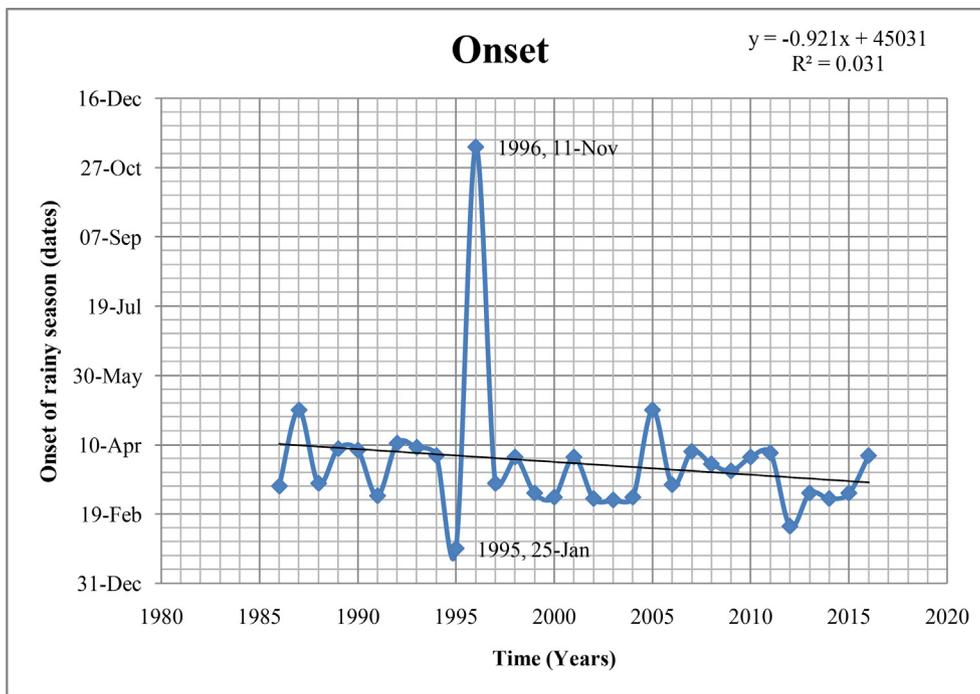


Fig. 7. Trends of variations in onset of rainfall in Ogbaru LGA (1986–2016). Source: Meteorological station (2018)

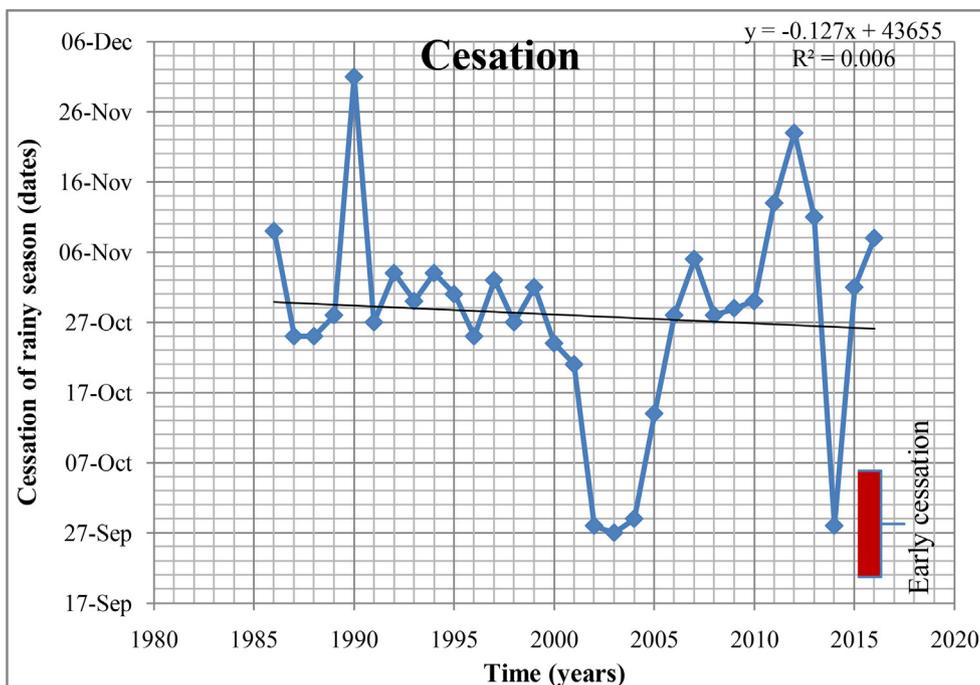


Fig. 8. Trends of variations in onset and cessations of rainfall in Ogbaru LGA (1986–2016). Source: Meteorological station (2018)

(Ezeh et al., 2016; Usman and AbdulKadir, 2014). Previous study concluded that annual rainfall has reduced significantly over 20% of the landscape and the amount of annual rainfall reduced by 50–350 mm in 64% portion of Nigeria (Ogungbenro and Morakinyo, 2014). Drought creates more problems of inequality, poverty and food insecurity and increased gender inequality.

In addition, the findings showed alteration in planting date, growing and harvesting calendar. With alterations in amount, monthly distributions, onset and cessation of rainfall, there was variability in the planting calendar. This irregular pattern of rainfall in the state has negative implication such that farmers experience some difficulty in planning for the suitable time to plant their crops (Igwenagu, 2015). Sometimes they

use the previous year's rainfall pattern as a yards stick; which makes them to run into the problem of miscalculation in some cases thereby having serious negative effect on their yield (Igwenagu, 2015).

3.3. Respondents' perceived impacts of variability and change in rainfall on gender

In addition, Table 4 shows the impact of climate variability or change on gender. It shows that the women felt more impact of food insecurity, had more burden of migration and were affected more by water shortage due to changes in rainfall.

In agreement to this, Mbajorgu et al. (2017); Oloukoi et al. (2014) showed that compared to men, women are more affected by impacts of CVC on annual rainfall. The study of Mbajorgu et al. (2017) found that women are predominantly the providers of food, water and fuel, and CVC has adverse impacts on all three. Findings in Table 2 reveal that women suffer more of the consequences of the resultant food insecurity. This is similar to other studies (Swedish International Development Cooperation Agency, 2015; Owoo, 2017; Nnadi et al., 2012), which have reported that women bear more burden of food insecurity. Owoo (2017) noted the food security is best considered individually, since different members of the same households can experience different outcomes based on gender, age, or other factors. In far too many cases, women and girls are over-represented among those who are food-insecure (SIDA, 2015). Women are more responsible for ensuring that household member eat while they may go hungry when there is inadequate food. Women act as household shock absorbers during times of economic and physical hardship (Nnadi et al., 2012). Cultural traditions and social structures often mean that women are more affected by hunger and poverty than men even though women, and in particular expectant and nursing mothers, often need special or increased intake of food (SIDA, 2015).

Table 4 further shows that women bear more burden of water shortage. During FGD and Key informant interview, participants revealed that women are more affected by variability in rainfall. During field observation and FGDs reported that in cases of water shortage women and their girls resort to going to streams in search of clean water for drinking, cooking and other housework. In agreement, Ogbonna et al. (2017) reported that variation in rainfall threaten people's wellbeing and contributed further to environmental degradation. Freshwater systems are directly threatened by human activities and stand to be further affected by anthropogenic climate change (Idu, 2015). Some of the streams are located in far distance away from their homes. In some rural communities, a journey to fetch water means a round trip of several kilometers taking hours (Ubuoh et al., 2014). This burden on women and children often manifests in poor health and physical exhaustion (Ubuoh et al., 2014). In providing water for cooking, washing, bathing and drinking, at a time when streams have dried up, the water quality in streams has deteriorated, and the streams are not accessible due to landslides, more time and energy is spent in search of water in neighboring communities (Agwu, 2009). Some women have to go in the night and very early in the morning in order to get opportunity to get water in the area.

In addition, women also bear more consequences of migration in the area. Field observation revealed that most of the men farmers move out of the rural communities in search of better livelihood options in the face of CVC. The out-migrations are mostly by people who are educated and eligible for employment in the urban areas. In agreement with this, Chukwuemeka et al. (2013) found that impoverishment of rural areas in Anambra state is partly explainable by out-migration in search of employment in cities. Through the loss of their farmland, the inhabitants of the communities lost their primary, if not only, source of income, this leads to the emigration (Agwu, 2009). The urban areas are over-populated while the rural areas are densely-populated, as young men and women leave the rural areas (Okoli and Gbemudu, 2017). The women, who cannot find skilled jobs, are left to do most of the farm works with limited labor. The social impacts of climate change such as

Table 4
Perceived impacts of variability and change in rainfall on gender.

Pooled Data (men and women) n = 350			
Variables	Before Climate variability/change (1986)	After climate variability/change (2016)	X ² -value
Women feel more impact of food insecurity	17.1	68.0	185.13*
Much burden of migration fall on women	40.0	77.1	99.4*
Women are more affected by water shortage	50.9	80.6	68.58*
Increased burden of care giving in times of sickness	63.4	63.1	1.4
Women perceive hot and dry weather more than men	24.3	24.1	9.59
Women feel more effect of floods	30.6	33.7	1.81
Men (n=150)			
Women feel more impact of food insecurity	20.9	75.1	104.2*
Much burden of migration fall on women	44.6	67.2	18.33*
Women are more affected by water shortage	45.8	68.9	19.41*
Increased burden of care giving in times of sickness	57.7	58.8	0.9
Women perceive hot and dry weather more than men	23.7	23.3	0.70
Women feel more effect of floods	32.3	31.4	1.12
Women (n=150)			
Women feel more impact of food insecurity	23.3	80.7	83.37*
Much burden of migration fall on women	35.3	87.3	98.65*
Women are more affected by water shortage	56.1	92.5	60.03*
Increased burden of care giving in times of sickness	65.4	67.6	4.01
Women perceive hot and dry weather more than men	34.9	32.1	4.01
Women feel more effect of floods	87.9	86.1	208

Source: Field Survey; *p < 0.05

male migration also increase the workload of the women and expose them to physical and sexual abuse as they scramble for depleting commodities and encourage early marriages (Agwu and Okhimamhe, 2009). Also as a result of in-migration of herdsmen in search of pasture for their herds, women's farms are raided and they incur losses. This implies that women mostly bear the burden of out migration because most times, women stay at home while the men migrate in search of better lives.

4. Conclusion

This study concludes that local communities perceived and experienced impacts of CVC on rainfall. Due to variability in rainfall there were changes in onset and cessation of rainfall, planting calendars and

frequent flooding in the area. These impacts of the variability and changes in rainfall varied across gender of the farmers. The variability and changes on rainfall had significant impact on gender in farming communities and women bore more burdens of the impacts of CVC on rainfall, felt more impact of food shortage, migration and water shortage resulting from changes in rainfall in the area. The women also bear more responsibility for provision of household water even in the face of climate change.

In order to help the farming communities to adapt, this study recommends women empowerment as well as a sustainable water and irrigation system which should encourage women's participation in the construction, maintenance and management. This will reduce the impacts of water shortage for agricultural production in the area. It also recommends the use of innovative approaches especially weather forecast in local languages and mediums to enable farm communities to ascertain their planting dates and also prepare for flooding. In addition, it is important to educate farmers to cultivate away from flood prone areas in order to reduce the impacts of flooding in the farms.

Declarations

Author contribution statement

Nnadi O.I, Liwenga E.T, Lyimo J.G, Madukwe M.C: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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