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VULNERABILITY AND ADAPTATION STRATEGIES OF RURAL FARMERS TO CLIMATE VARIABILITY IN OYO STATE, NIGERIA

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Abstract
Adaptation is crucial to combating the adverse effect of climate variability thus reducing farmers' vulnerability. This study was carried out to investigate the vulnerability and adaptation strategies of rural farmers to climate variability in Oyo State, Nigeria. A multi-stage sampling procedure was used and 160 respondents were selected across the four agriculture zones in the State. Data were analyzed using descriptive statistics, livelihood vulnerability index, and correlation analysis. Vulnerability assessment of the respondents showed that Oyo zone had the highest vulnerability index (0.72). The major components contributing to households' vulnerability to climate variability in the four zones were lack of financial capital (63.23%) and lack of physical assets (20.3%). Result further showed that the most practiced adaptation strategies by the respondents across the four zones include mulching (85.13%), preparation of ridges and furrow (80%) and changing of planting dates to suitable time (83.75%). However, climate mitigation practices such as agro-forestry (1.6%), organic fertilizer use (21.66%) and irrigation (0.83) were not common in Saki, Oyo and Ogbomoso zones. The study revealed that climatic variables significantly affected the total farm income realized in the study area and that most of the farm households were vulnerable to climate variability and were food insecure. It is therefore recommended that, adaptive strategies such as irrigation, organic fertilizer use and agro-forestry should be encouraged among farmers in order to mitigate climatic variations and enhance higher productivity.

Key Words: *Climate variability, Vulnerability, Adaptation, Rural Farmers, Oyo State, Nigeria*

Introduction

According to climate variability is defined as ups and downs in climatic conditions on time scales of months, years, decades, centuries, and millennia which also include droughts and floods (Derek, 2007) .Climate change has become topical because of its effects on human lives and the future of the world. Agriculture is the sector most vulnerable to climate variability due to its high dependence on climate and weather (Mahendra, 2012). Extreme weather events such as droughts, floods, thunderstorms heavy winds and shift in rainfall patterns as a result of climate variability has led to unpredictable yields, crop failures, reduced agricultural productivity, increased hunger and malnutrition and diseases thereby making farmers more vulnerable. Other devastating impacts of

climate variation in Nigeria include increased infestation of crops by pests and diseases, depletion of household assets, increased rural-urban migration, increased biodiversity loss, reduction of wildlife and other natural resources, changes in vegetation type, decline in forest resources, decrease in soil moisture and nutrient, increased health risk and spread of infectious diseases, and changing livelihood systems (Abaje and Giwa, 2007). Climate variation also affects food security, livelihoods and social safety very adversely and in so many ways (Akudugu *et al*., 2012). In order to enhance food production, it is very imperative to adopt adaptation measures against variation in climate especially since agriculture is highly sensitive to climatic condition.

Adaptation methods are those strategies that enable the individual or the community to cope with or adjust to the impact of climate in the local areas (Jones, 2010 and Nyong *et al.*, 2007). As adaptation contributes to reducing the negative risks of climate change and provides opportunities to use the climate for positive effects, it plays an important role in mitigating the impacts of climate change and variability (Kim, 2011). According to Collier *et al*. (2008), increasing climate variability is already affecting crops, livestock, water resources, land, forests and biodiversity. Nigeria's agricultural sector is more vulnerable to climate variation because it is dominated by landless, undernourished, poor, uneducated farmers, with low technological know-how and evidently ill-equipped to adequately adapt to climate variation (Ademola and Oyesola, 2012).

Several studies have been conducted on climate variability, adaptation strategies and vulnerability of farming households. Ajumebon *et al* 2014 in his study examine the vulnerability and adaptation of crop farmers to climate change and concluded that farmers are still vulnerable to the effect of climate change even with the adoption of one or more adaptation techniques. Nwosu *et al.,* 2014 also analysed Farmers perception and local adaptation practices employed by the farmers and optioned that farmers perceive climate change and they have adopted adaptive measures to counteract its negative impacts. Studies show that without adaptation, climate change is generally detrimental to the agriculture sector; but with adaptation, vulnerability can largely be reduced. (Easterling *et al.*. 1993: Smit *et al.* 2002)

Some efforts have been made in analysing adaptation measures to climate change in Nigeria (Nwajiuba *et al*., 2008; Onyeneke, 2010; Nwosu *et al*., 2012) however, none of these studies attempted to calculate and compare the vulnerability index in the study area.

Therefore, assessing household vulnerability to climate change and the adaptive measures put in place to palliate the negative effect of climatic variations will provide useful insights that will reduce the vulnerability level of the farming household and the adoptions adaptive options that can address household vulnerability to climatic conditions. Hence this study will specifically assess the respondents' perception of the threats posed by climate variability and the pattern in the variation of climatic variables. In addition Households' livelihood vulnerability to climate variation and the adaptive strategies used by rural farmers in Oyo State will also be assessed.

Methodology

Study Area

The study area is Oyo State, Nigeria and it is located between 2° 38′ and 4°0 35′ east of the Greenwich meridian. It has area coverage of 28,454 square kilometres and a population of 5,591,585 people (Wikipedia, 2019). Oyo Sate ecological zones are rain forest to the south and guinea savannah to the north. The state is grouped into four agricultural zones by the Agricultural Development Programs (ADP). These are Ibadan/Ibarapa, Oyo, Ogbomoso and Saki agricultural zones. Large proportion of people in Oyo state engage in agriculture as means of livelihood and small scale traditional farming system predominates in the area. The bulk of agricultural produce comes from annually cultivated rain–fed farms. The major crops grown are yam, cassava and maize. The minor ones are cowpea, sorghum, melon, millet, groundnut and vegetables. The study population consist of farmers involved in maize, cassava and yam farming only.

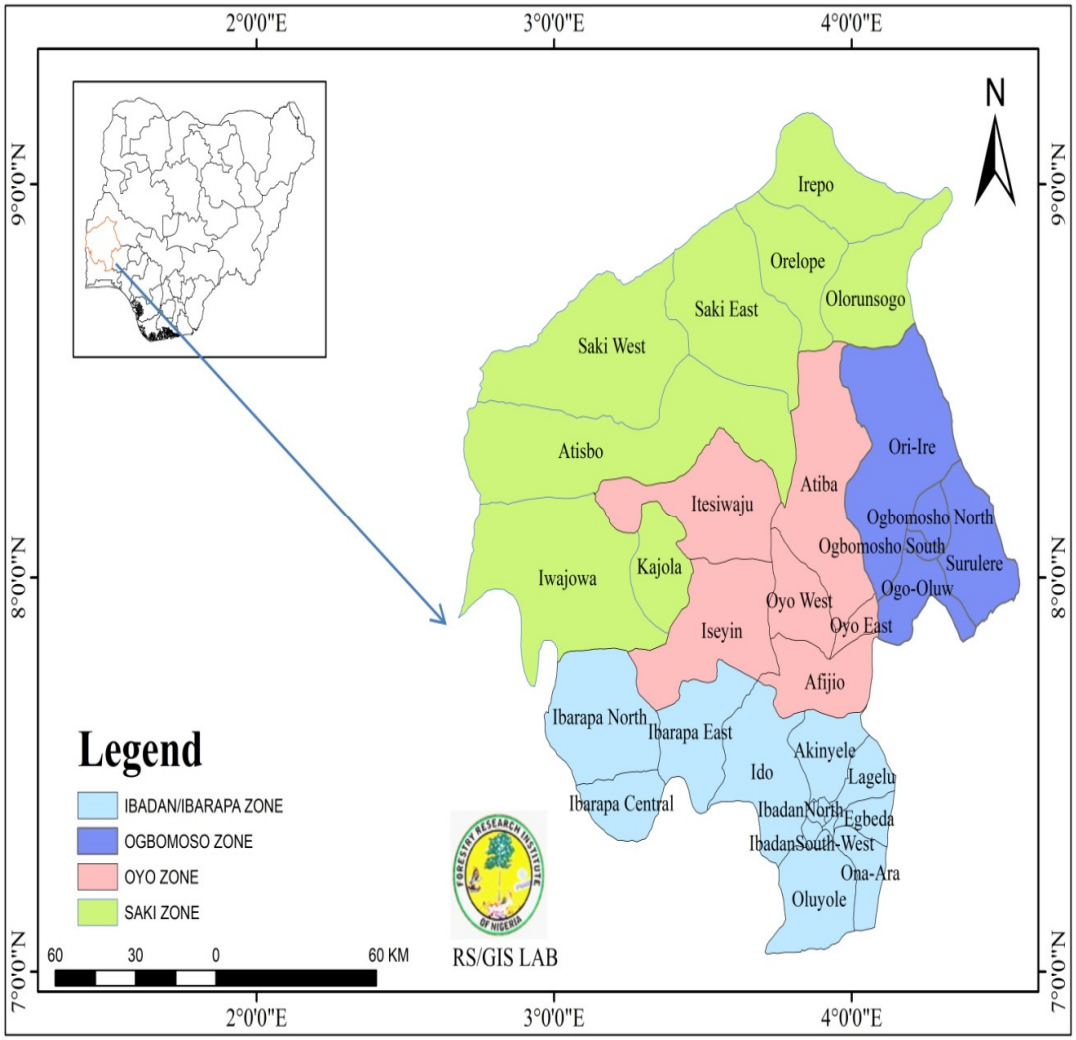

Fig. 1: Map of the Study Area

Data Sources and Collection

Primary and Secondary data was employed in the course of study. The primary data was collected through personal interview in administering a well-structured questionnaire on respondents in the study area. For the secondary data, on climatic variables such as annual mean temperature, rainfall, humidity and number of rain days were collected from Nigerian Meteorological Centre for the period of 10 years (2001 - 2011).

Sampling Procedure and Size

Multi-stage sampling technique was used to select household respondents in the farmers groups across the study area. Each farmers group consist of an average of 25 members. The divisions of the local government into zones, blocks and cells by Oyo State Agricultural Development Programme were used for the purpose of this study. The local government in Oyo State were grouped into 4 zones The first stage involved a random selection of 2 blocks in each zone in the state making a total of 8 blocks out of 29 blocks . In the second stage, 2 cells were selected from each block out of the 8 blocks making a total of sixteen cells were randomly selected out of the 52 cells in the study area. Finally, 10 household heads were randomly selected from each cell making a total of 160 household respondents from whom data were collected.

Analytical Technique

Descriptive statistics comprising of frequencies, means and percentage distributions were used to describe the socio-economic characteristics of the respondents, their perception on climate variability and also used to assess the adaptive strategy in place in the study area.

Household Livelihood Vulnerability Index was used to assess the vulnerability status of each household's respondent to climatic variability by examining the five types of household assets (i.e. human, financial, natural, physical and social capital) using Sustainable Livelihood Approach (SLA) following Vincent (2004). A five-point Likert scale was used to rank the five most important aspects of livelihood that were considered to influence vulnerability to climate variability of each household's response to climate variability. Each indicator was scored and was standardized following the UNDP (2007) procedure of standardizing indicators for life expectancy index (equation 1). This ensures that all indicators were normalised to have a relative position between 0 and 1 (Vincent, 2004; Hahn *et al*., 2009).

$$Standardizedvalue \text{ (livelihood asset)} = \frac{Actualvalue - minimumvalue}{Maximumvalue - minimumvluae} \quad \ldots. (1)$$

Having standardized the indicators, an unequal weighting system, based on relative importance was attached to each indicator of vulnerability by household. The number of times a particular indicator is cited was used to generate the weighting system and the weights were assigned in percentages. The household livelihood vulnerability index for a household was then calculated using the following model (equation 4) (Vincent, 2004).

$$HLVI=(Ssvi*Wi)+(Hsvi*Wii)+(Nsvi*Wiii)+(Fsvi*Wiv)+(Psvi*Wv)+(Lsvi*Wvi)..\ (2)$$

Where;

HLVI = household livelihood vulnerability index,
Ssvi = standardized value of social asset sub-index,
Hsvi = standardized value of human asset sub-index,
Nsvi = standardized value of natural asset sub-index,
Fsvi = standardized value of financial asset sub-index,
Psvi = standardized value of physical asset sub-index, and
Lsvi = standardized value of livelihood asset sub-index.

The Wi terms refer to the weighting that would be applied to each standardized value. The line of reasoning here is that low vulnerability indices reflect lower vulnerability of a particular household (Antwi-Agyei *et al.,* 2012).

The household communities were classified into three major clusters which are low, medium and high vulnerability clusters (Antwi-Agyei *et al.,* 2012). Quantitative data were transcribed and analysed using SPSS statistical software. One-way ANOVA was computed to compare the relative vulnerability among the four zones.

Results

Socio-economic Characteristics of the Farming Households

Table 1 below shows the socio-economic characteristics of respondents. The characteristics of the farmers considered were gender, age, income and educational level, farm size and experience. Majority of the farmers in the study area are predominantly male (84.4%) while 15.6% are female (Table 1). Most of the farmers (63.1%) are within the ages of 30-50 years with the mean age of the respondents as 46 years. This implies that the respondents are in their middle and active age bracket and are therefore expected to be economically productive to enhance the well-being.

The respondents' distribution with respect to education shows that, 28.8% had no formal education, 36.2% of the respondents had only primary education, 23.1% had secondary education and 11.9% were educated up to tertiary institution level such as colleges, polytechnics and universities. Since majority (71.2%) of the household head had at least primary education it implies that they will have access to information that can reduce the effect of climate variability on their farms which in turn boost their productivity. This agrees with Maddison (2006) findings that access to information on climate change creates awareness and favorable condition for adoption of farming practices that are suitable under climate change.

With respect to the gross farm income, majority earned below ₦50,000 (51.9%), approximately 43% earned between ₦50,000 -₦100,000 while 5.6% earned above ₦100,000. This implies that household with gross income below ₦50,000 tends to have limited access to resources that will reduce their vulnerability to climate variability.

The result from the respondents' farm size distribution revealed that the highest percentage of the farmer had farm size between 1-5 hectares (53.1%), 40.6% had between 6 - 10 hectares of farmland and 6.3% of the farmers had more than 10

hectare of farmland. The mean farm size among the respondents is 6 hectares. The larger a farm size is the more the adaptive measures and larger level of investment that a farmer need to put in place to palliate the effect of climate change.

The distribution of the respondents with respect to their farm experience revealed that 3.1% of the respondent had 1-5 years farming experience, 7.5% had between 6-10years farming experience and 89.4% of the respondent had more than 11 years farming experience. This implies that majority of the respondents must have experienced changes in climate variations over time.

Table 1: Socio-economic characteristics of respondents

Personal characteristics	Frequency	Percentages	Mean
Gender:			
Male	135	84.4	
Female	25	15.6	
Age (years):			
Below 30	7	4.4	46
31-50	58	32.5	
Educational level:			
No former education	46	28.8	
Primary education	58	36.2	
Secondary education	37	23.1	
Tertiary education	19	11.9	
Total income per planting season:			
Below 50,000	83	51.9	
50,000-100,000	68	42.5	
Above 100,000	9	5.6	
Farm size (hectare):			
1-5	85	53.1	6
6-10	65	40.6	
Above 10	10	6.3	
Farming experience (years)			
1-5	5	3.1	
6-10	12	7.5	
Above 11	143	89.4	

Respondents' Perception and Awareness of the Threats of Climate Variability

The respondents that perceived variations in climate were 97.5% while 2.5% claimed to be ignorant of the climate variability in the study area (Table 2). This result shows that majority of the respondents perceived changes in climatic variables in the study area.

Table 2: Respondents Perception of Climate Variability

Awareness	Frequency	Percentage
Yes	156	97.5
No	4	2.5
Total	160	100

Climate Variability Threats Perceived by the Respondents in the Last Three Seasons

Table 3 presents the list of some climate variability related threats experienced by the farmers in the study area. The result shows that 70.6%, 78.1% and 52.5% of the respondents experienced erosion and flood in the year 2010, 2011 and 2012 respectively. This result shows that majority of the respondent in the study area experienced higher incidence of flood and erosion in the year 2011. Approximately 52%, 41% and 68% of the respondents experienced witting of young crop in 2010 2011 and 2012 respectively.

The result also shows that there is high reduction of crop yield in 2012 among majority (61.9%) of the respondents as compared to year 2010 (58.3%) and 2011 (56.3%). However, minority of the respondents in the year 2010 (41.9%), 2011 (31.9%) and 2012 (49.4%) experienced crop diseases. However, incidence of fire outbreak is not common in the study area as only few farmers claimed to have experienced it in the last three seasons (28.1%, 21.3% and 18.8% in 2010, 2011and 2012 respectively). Also, about 35.0%, 53.1% and 41.4% in the year 2010, 2011 and 2012 respectively experienced pest infestation with the highest percentage recorded in 2011. In addition, ineffective spraying of herbicides or insecticides due to excess rainfall was experienced by 51.3% respondents in 2010, 56.9% respondents in 2011 and among 63.1% respondents in 2012.

Table 3: Distribution of Respondent by Climate Variability Threats Experienced

Threats	2010	Frequency %	2011	Frequency %	2012	Frequency %
Flood/Erosion	113	70.6	125	78.1	84	52.5
Witting of young crops	83	51.9	65	40.6	109	68.1
Reduction in food crop yield	94	58.8	90	56.2	99	61.9
Crop diseases	67	41.9	51	31.9	79	49.4
Fire outbreak	45	28.1	34	21.3	30	18.8
Pest infestation	56	35.0	85	53.1	67	41.9
Ineffective spraying	82	51.3	91	56.9	101	63.1

Variations in Climate Variables over Time

Variation of climatic variables with over in Oyo State of Nigeria between 2002 and 2011 is as represented in Figure 2. The value of the highest volume of rainfall which was recorded in 2003 was 1937.60mm while the lowest volume was 1226.20mm recorded in 2005. The mean and standard deviation of the rainfall data in the state from 2002 – 2011 were 1512.70mm and 245.30 respectively. This indicates slight variability in the amount of rainfall from year to year. The coefficient of correlation between rainfall and time was found to be 0.152. This implies a very weak positive and significant ($P<0.10$) relationship or co-movement between rainfall and time further justifying the slight variability in this variable over time.

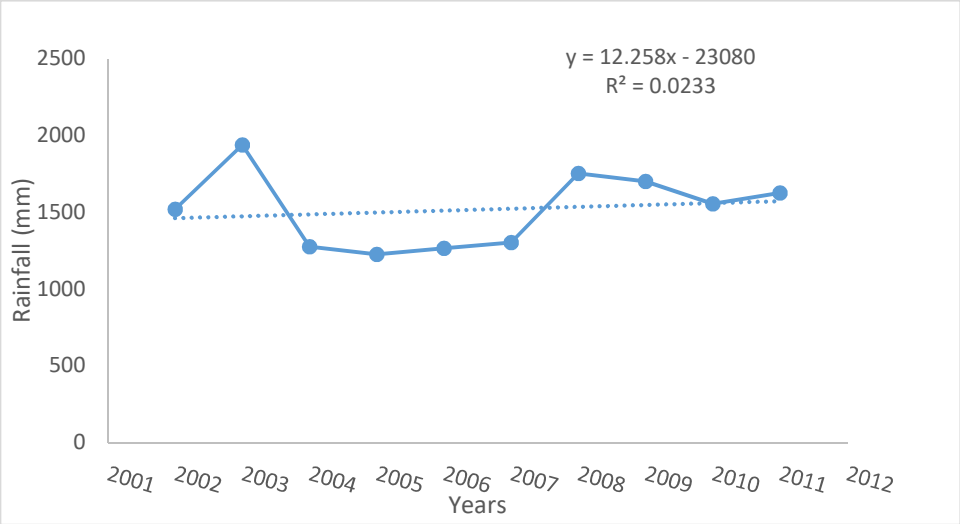

Fig. 2: Pattern of Rainfall Data from 2002-2011 in Oyo State

The temperature from 2002-2011 shows an increasing pattern with the maximum temperature of 31.35 °C recorded in 2011 and minimum temperature of 26.36 °C recorded in 2008 (Figure 3). The mean value of temperature and its standard deviation over this period were 27.91°C and 1.41 indicating very slight variability in temperature values from one year to the other. The coefficient of correlation of temperature over the period was 0.56. This is positive and significant ($p<0.1$) implying that temperature significantly changed with time (Figure 3).

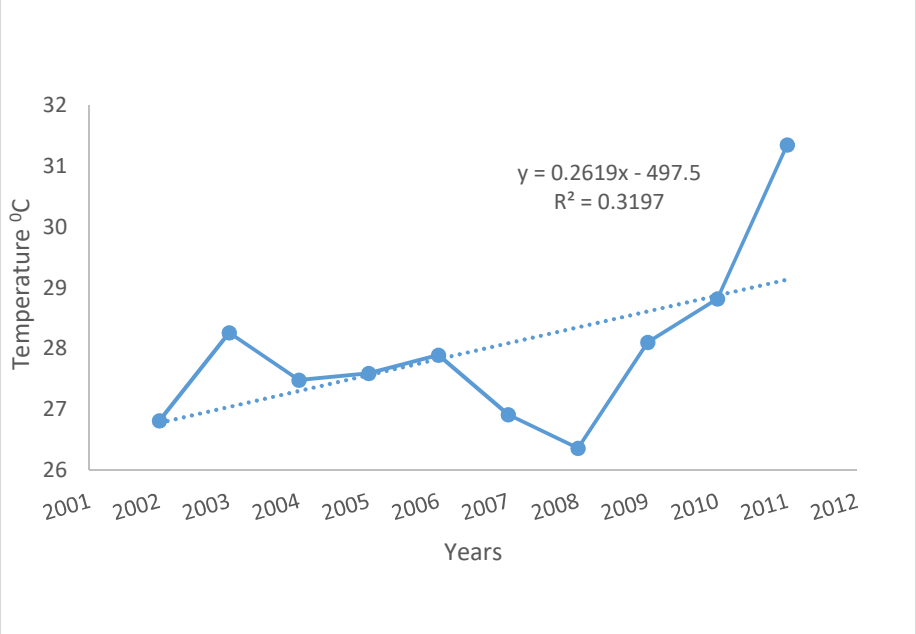

Fig. 3: Pattern of Temperature Data from 2002-2011 in Oyo State

The relative humidity from 2002-2011 shows an irregular pattern with highest value as 81.42% recorded in 2003 and lowest as 76.17% recorded in 2008 (Figure 4). The mean and standard deviation of this variable over this period were 79.31% and 1.82 respectively implying that relative humidity showed little or no variability on annual basis. The coefficient of correlation was -0.05 showing a negative and non-significant relationship between relative humidity and time.

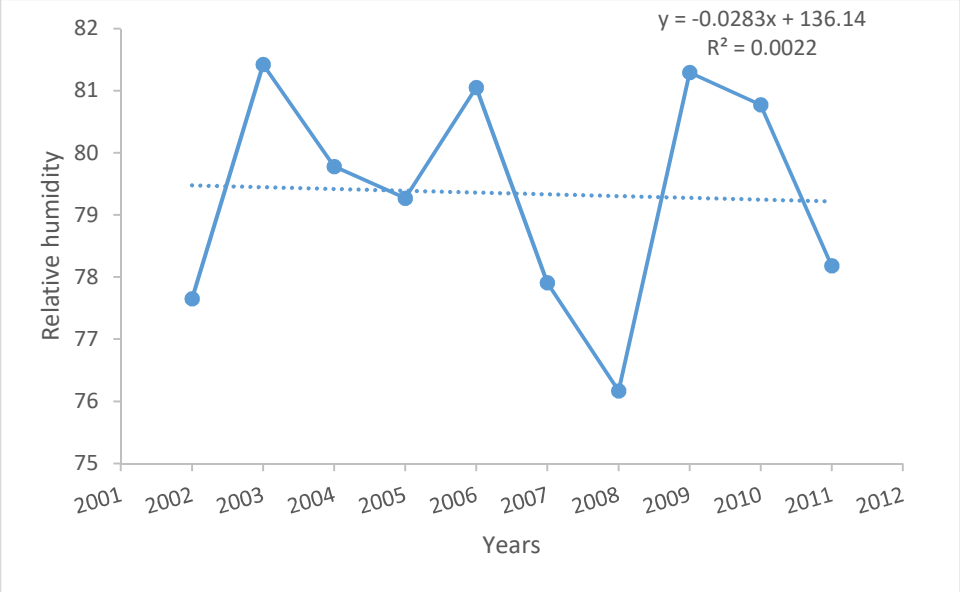

Fig. 4: Pattern of Relative Humidity Data from 2002-2011 in Oyo

The number of rain days from 2002-2011 shows an increasing pattern with minimum (87days) recorded in 2005 and maximum (126 days) in 2010 (Figure 5). The mean and standard deviation of the data are 106 days and 10.24 respectively. This indicates that there is a small variability in number of rain days on annual basis over the period time. The correlation coefficient between the number of rain days and time was 0.33, this imply a positive and significant relationship ($p<0.1$) indicating number of rain days increased on annual basis with time.

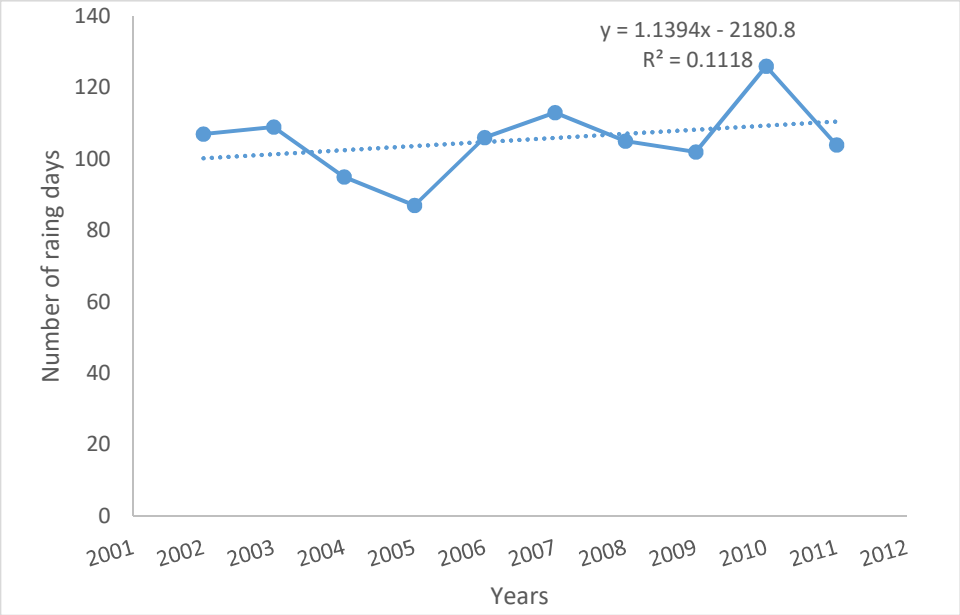

Fig. 5: Pattern of Number of Rain Days Data from 2002-2011 in Oyo State

Assessment of livelihood Vulnerability

The farming households were grouped into low (0.1-0.4), medium (>0.4- 0.6) and high (>0.6-1.0) vulnerability clusters based on their vulnerability indices. The study revealed that Oyo had the highest vulnerability index (0.72) (Figure 6) and the highest percentage (70%) of household within the high vulnerability clusters (Figure 8), while Ibadan which recorded the lowest vulnerability index (0.36) (Figure 6) had the highest percentage of households within the low vulnerability cluster (47.5%) (Figure 8). Ogbomoso zone, had the same percentage (42.5%) of households within the low and medium vulnerability cluster, while 15% of household members were within the high vulnerability clusters. Furthermore, Saki zone recorded the highest (62.5%) number of households within the medium vulnerability clusters.

The major components contributing to households' vulnerability to climate variability in the four zones are lack of financial capital and lack of physical asset (Fig 7). The impact of lack of financial capital is more pronounced in Saki (74.3%), Oyo (65.4%) and Ibadan (76.1%) zones. However, in Ogbomosho zone, physical asset (44.9%) is the major contributor influencing household vulnerability to climate variability (Figure 7).

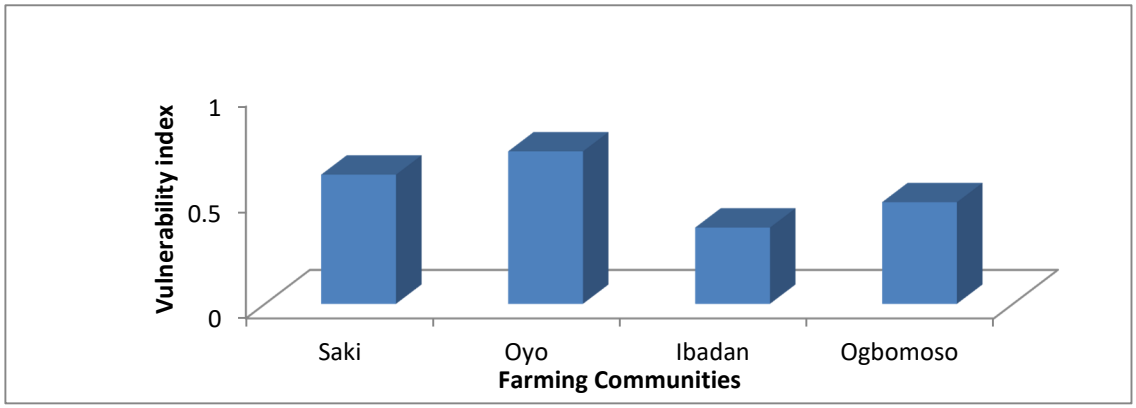

Fig. 6: Vulnerability of the farming communities

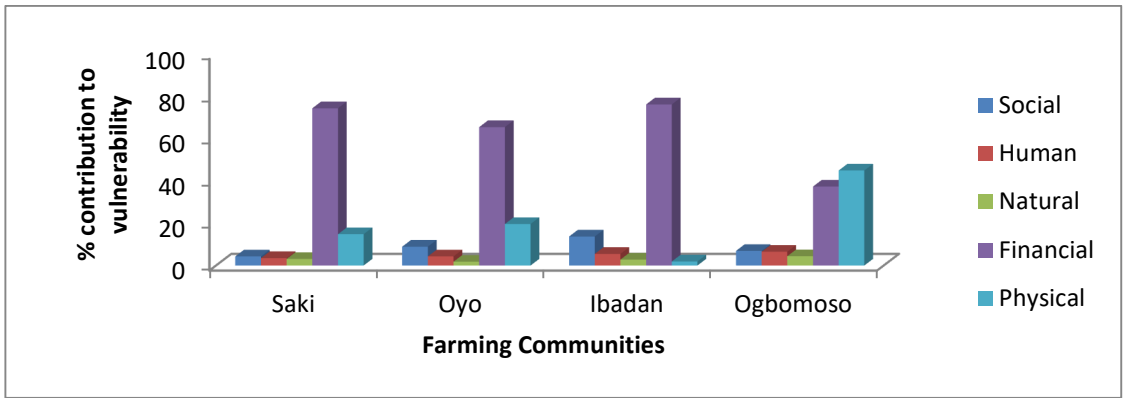

Fig. 7: Components contributing to vulnerability of farming communities

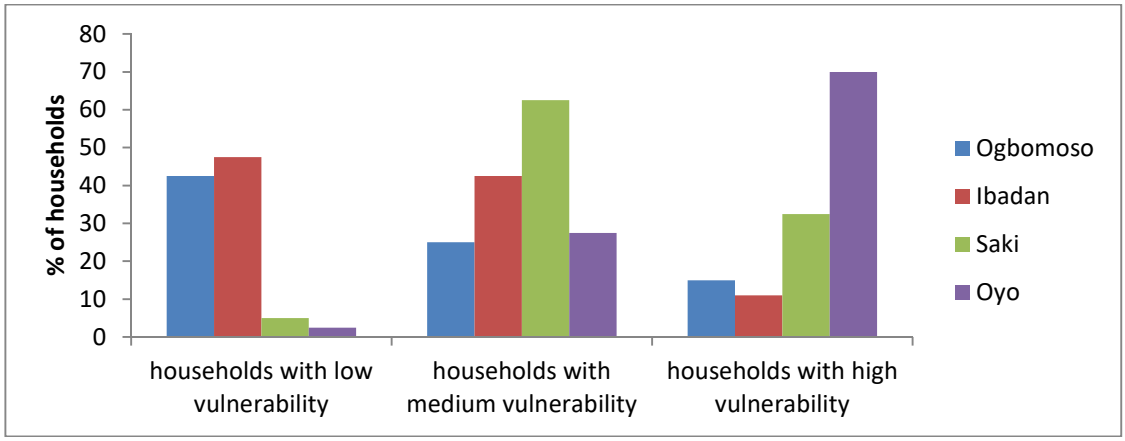

Fig. 8: Proportion of households in different vulnerability cluster in study communities

Assessment of adaptation Strategies to Climatic Variability among the Respondents

The most practiced adaptation strategies by the respondents across the four zones include mulching, planting of resistant varieties, preparation of ridges and furrow, crop rotation, mixed farming and changing of planting dates to suitable time. These practices vary in term of the

percentage of the respondents who used them as adaptation strategy. The result presented in table 4 below shows that majority of the respondents from Oyo, Ogbomoso, Saki and Ibadan respectively used mulching, ridge and furrow and changing planting dates as adaptive strategy. (Table 4)**.**This in line with Ajumebon *et al* 2014 findings that, farmers view changing of planting date and irrigation as a solution to the climate change. Nwosu *et al*., 2012 also affirms that, adaptation measures used by farmers include agroforestry, changing planting dates, mulching, crop rotation, digging ridges across slope and minimum tillage.

The study revealed that the most common adaptation strategies identified in the study area were adopted mostly by respondents in Ibadan zone. Adaptation practices such as Agroforestry, irrigation and organic fertilizer which were not common in other zones were adopted by the respondents in Ibadan. This implies that Ibadan zone had higher adaptive capacity to climate variability as a result of the adaptive measures put in place by the respondents as compared to other zones. This also explained the low vulnerability index of the households' respondents. (Figure 6).

Table 4: Distribution of respondents' adaptation strategies used in the study area

	Oyo	Ogbomoso	Saki	Ibadan
Mulching	82.5	85.5	85.0	87.5
Agroforestry	-	5.0	-	60.0
Resistance varieties	57.5	67.5	62.5	72.5
Ridge and furrow	77.5	62.5	87.5	92.5
Crop rotation	55.0	77.5	62.5	62.5
Mixed farming	55.0	62.5	77.5	85.0
Irrigation	-	2.5	-	10.0
Organic fertilizer	15.0	27.5	22.5	42.5
Changing planting dates	85.0	72.5	90.0	87.5

Conclusion

Adaptation is important to combating the adverse effect of variation in climatic variables on agricultural production and reducing household vulnerability. The paper established that there is a relationship between climate variability with time. This indicates the erratic and unpredictable nature of rainfall on annual basis. Temperature values varies from one year to the other this establish the present of global warming. Relative humidity reduces with time whereas number of rainy days showed a strong positive and significant relationship ($p<0.1$) indicating number of rain days increased on annual basis with time. From the vulnerability assessment of the four zones in the study area Oyo showed the highest vulnerability index (0.72). The major components contributing to households' vulnerability to climate variability in these zones are lack of financial capital and lack of physical asset. Households were further grouped into low, medium and high vulnerability clusters. The study revealed that Ibadan zone recorded the highest percentage of households within the low vulnerability cluster (47.5%), while Oyo which showed the highest vulnerability index, recorded the highest percentage (70%) of household within the high

vulnerability clusters and the lowest percentage (2.5%) of households within the low vulnerability clusters.

The most practiced adaptation strategies by the respondents across the four zones include mulching, planting of resistant varieties, preparation of ridges and furrow, crop rotation, mixed farming and changing of planting dates. These adaptation strategies were adopted mostly by respondents in Ibadan zone. However, adaptation practices such as Agro forestry, irrigation and organic fertilizer which were not common in other zones were adopted by the respondents in Ibadan. This implies that Ibadan zone had higher adaptive capacity to climate variability as a result of the adaptive measures put in place by the respondents as compared to other zones. This also explained the low vulnerability index of the households' respondents.

Educating the farmers and making provisions for effective adaptation methods will help in reducing farmers' vulnerability to climate variation and increase their productivity and income. Also, governments should encourage farmers to adopt adaptive strategies such as Agro forestry and discourage deforestation in order to reduce greenhouse gas emissions, conserve biodiversity.

There is no doubt if these unsustainable practices are regulated, a stable climatic environment will be created for farmers to maximize their income earnings in food crop production.

References

Abaje, I.B. and Giwa, P.N. (2007). Urban flooding and environmental safety: a case study of Kafanchan town in Kaduna State. Paper presented at the golden jubilee/150th anniversary and 49th annual conference of the Association of Nigerian Geographers (ANG) held on 15th-19th October, 2007 at the Department of Geography, University of Abuja, Gwagwalada–Abuja.

Ademola, A.O. and Oyesola, O.B. (2010). Adaptation Strategies of Selected Tree Crop Farmers to Climate Variation in Oyo State, Nigeria. *Journal of Agricultural Extension and Rural Development*, 4(19): 522-527.

Ajumebon-Freeman, A. and Salman, K.K. (2014). Vulnerability and Adaptation of Crop Farmers to Climate Change in Ondo State, Nigeria. *Proceedings of Annual National Conferences of the Nigerian Association of Agricultural Economists. Held at Federal University of Technology, Akure, Nigeria, 24th-27th, February, 2014*.

Akudugu, M.A., Dittoh, S. and Mahama, E.S. (2012). The Implications of Climate Change on Food Security and Rural Livelihoods: Experience from Northern Ghana. *Journal Environment and Earth Science,* www.iiste.org ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online) Vol 2, No.3, 2012

Antwi-Agyei, P., Fraser, E. D.G., Dougill A.J., Stringer L.C. and Simelton, E. (2011). Mapping the Vulnerability of Crop Production to Drought in Ghana using Rainfall, Yield and Socioeconomic Data, Centre for Climate Change Economics and Policy Working Paper No. 55 Sustainability Research Institute Paper No. 25

Collier, P., Conway, G. and Venables T. (2008). Climate change and Africa. *Oxford Review of Economic Policy*, 2(2): 337–353.

Easterling, W.E. Crosson, P.R. Rosenberg, N.J. McKenney, M.S. Katz, L.A. and. Lemon, K.M . (1993). Agricultural impacts of and responses to climate change in the Missouri Iowa-Nebraska region," *Climatic Change,* 24: 23–62.

FAO. (2010).The State of Food Insecurity in the World. Addressing food insecurity in protracted crises. Food and Agriculture Organization of the United Nations Rome, 2010

Hahn, B.M., Riederer, A.M. and Foster, S.O. (2009). The Livelihood Vulnerability Index: A Pragmatic Approach to Assessing Risks from Climate Variability and Change—A Case Study in Mozambique, Journal of Global Environmental Change, 15pp.

Jones, L. (2010). Overcoming Social Barriers to Adaptation. Overseas Development Institute, (ODI) Background Note, www.odi.org.uk/50 years. Accessed January, 2011.

Kim Chang-gil, (2011). The Impact of Climate Change on the Agricultural Sector: Implications of the Agro-Industry for Low Carbon, Green Growth Strategy and Roadmap for the East Asian Region

Maddison, D. (2006).The perception of and adaptation to climate change in Africa. Discussion Paper No. 10. Centre for environmental economics and policy in Africa. Pretoria, South Africa: University of Pretoria, 2006.

Mahendra Dev S. (2012). Climate change, rural livelihoods and agriculture (focus on food security) in Asia-Pacific region

Nwajiuba, C.U., Onyeneke, R. and Munonye, (2008). Climate Change: Perception and Adaptation by Poultry Farmers in Imo State. In; Nwajiuba C. (ed), Climate Change and Adaptation in Nigeria, Farming and Rural System Economics by Doppler W. and Bauer S., Volume 95, Pp; 53-63, Margraf Publisers, Hohenheim, Germany.

Nwosu, C.S., Onyeneke, R.U., Joshua, B.N., Mmagu, C.J. and Nwaodu, K.T. (2014). Perception on Adaptation to Climate Change by Farming Households in Etim Ekpo Local Government Area of Akwa Ibon State, Nigeria. Proceedings of Annual National Conferences of the Nigerian Association of Agricultural Economists. Held at Federal University of Technology, Akure , Nigeria, 24th-27th, February, 2014.

Ogunniyi, L.T.and Ajao, A.O. (2010). Gender and Cost Efficiency in Maize Production in Oyo State of Nigeria. *Journal of Tropical and Subtropical Agroecosystems*, 12: 333-338.

Onyeneke, R.U. (2010). Climate change and crop Farmers' Adaptation Measures in the Southeast Rainforest of Nigeria. M.Sc, thesis submitted to the Department of Agricultural Economics, Extension and Rural Development, Imo Stae University, Owerri.

Smit, B. and Skinner, M.W. (2005). "Adaptations options in agriculture to climate change: A typology," *Mitigation and Adaptation Strategies for Global Change*, 7: 85–114, 2002.

United Nations Development Programme (2007). Human Development Report 2007/2008: Fighting climate change: human solidarity in a divided world. New York, USA.

Vincent, K. (2004). Creating an index of social vulnerability to climate change for Africa. Technical Report 56, Tyndall Center for Climate Change Research, University of East Anglia, Norwich, Uk.

Wikipedia (2019): "List of Nigerian States by Population" last modified December 16, 2019. https://en.wikipedia.org/wiki/List_of_Nigerian_states_by_population.