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ASSESSING VULNERABILITY OF RURAL FARMING HOUSEHOLDS TO ENVIRONMENTAL PROBLEMS IN OGUN STATE SOUTH WEST NIGERIA

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ABSTRACT
The study examined the vulnerability level of the rural farming households to environmental problems in two selected agricultural zones of Ogun State Nigeria**.** A cross sectional sample of 160 farming households was drawn using multistage sampling techniques. Data were analyzed using descriptive statistics and principal component analysis. The study revealed that majority of the households' head were males with mean of 48 years, (88.8%) With households sizes of between 5and 9 persons. Household vulnerability indices for environmental problems were negative for the two zones studied The study concluded that most of the farming households were vulnerable to environmental problems and crop yield decreased drastically over the years with unfavorable environmental conditions. The study therefore recommends that Farmers, should diversify farm land by planting crops in different locations as the environmental degradation induced hazards do not equally harm everywhere in a region.

Keywords: *Vulnerability, PCA, Environmental Problems, and Farm Household*

INTRODUCTION

Human vulnerability to drought appears to be due to high poverty levels, high population growth rates, insufficient sensitization on values of wetlands and politically instigated pressures and interference. However, severe effects of drought are exacerbated by human activities such as deforestation, overgrazing and poor farming methods. (IPCC, 2001). Floods are also a common phenomenon in Nigeria, with the country among the nations affected in the world causing havoc and destroying livelihoods (Gadain *et al*., 2006). Floods are the most dominant in Nigeria and mostly occur along flood plains as a result of exceeded stream flow capacity, leading to spillover of the natural banks or artificial embankments (Smith and Ward, 1998). Over dependence on the agricultural sector which is directly impacted by climate change increases the vulnerability level of the farmers inhabitants, while the low economic development and low institutional capacity makes most developing countries within the Africa highly vulnerable to environmental problems (IPCC, 2001). Other factors such as widespread poverty, human diseases and high population density also magnify the negative impacts of climatic events particularly on the agricultural sector. High population growth rate is expected to double the demand for food, water, and livestock forage within the next 30 years, making the poor even more vulnerable to the effects of climate change. However, farmers tend to rely more on rainfed crop farming, which increases vulnerability to climatic factors. The impact of crop failure on rural households is very severe communities is usually high as it is often the main source of livelihood. Many studies have shown that the magnitude of a disaster depends on the characteristics and intensity of the negative impact and the susceptibility of the affected communities based on the prevailing social, physical and environmental conditions (Osbahr and Viner, 2006).

The current study will therefore analyze the vulnerability level of rural farming households to environmental problems. Specifically, the study will:

1. Describe the socio-economic characteristics of rural farmers in the study area?
2. Determine the vulnerability level of the rural farming households in the study area to environmental problems?
3. evaluate the results of this study compare with other studies across Nigeria in terms of identified the vulnerability level of the rural farming households

METHODOLOGY

Study Area

The study was carried out in Ogun State, Nigeria. The state was carved out of the defunct western state on the 3rd February, 1976, and it has total land area of 16,409.26sqkm. It falls within the southwest region of the country. It is bounded in the North by Oyo and Osun states, in the east by Ondo state, in the South by Lagos state, and in the west by Republic of Benin. It lies within latitudes 6^0N and 8^0N and longitude 2^0E and 5^0E. The estimated population is 3, 728,098 (NPC, 2006)The climate of Ogun state follows a tropical pattern with the raining season starting about March and ending in November, followed by dry season. The state is made up of 20 Local Government Areas. The majority of the people of the state belong to the Yoruba ethnic group. The greater proportion of the state lies in the tropical rain forest zone with a sizeable feature of guinea savannah in the far Northern area of the state. The main occupation of the population of the state is subsistence farming.

Method of Data Collection and Sampling Technique

The data used for this study was collected through the use of structured questionnaire administered to farming households in the study area. The data collected include socioeconomic characteristics such as age of the household head, gender, level of education of the household head, farmland size, years of farming experience, vulnerability of rural farming households to environmental problems such flood, drought, erosion etc as well as coping strategies to environmental problems in the study area.

Multistage-sampling technique was used to select 120 respondents for the study. The first stage involved the purposive selection of two zones (Ijebu and Ilaro) which are prone to environmental issues like flood, drought etc from the four OGADEP zones. The second stage involved a random selection of 50% of the number of blocks in each of these two zones (three and two respectively), using the list of blocks in the two zones as sampling frame. The third stage involved the random selection of four cells from each of the five blocks to give a total of 20 cells. Lastly eight farming households were randomly selected from each cell to arrive at the sample size for the study.

Method of Data Analysis

Descriptive statistics and principal component analysis were used for data analysis.

Principal component Analysis (PCA)

Principal component analysis is a technique of extracting from a set of variables the few orthogonal linear combinations of variables that most successfully capture the common information. Intuitively, the first principal component of a set of variables is a linear index of all the variables that captures the largest amount of information common to all the variables. For example, suppose we have a Z-variables (a^*_{1j} to a^*zj) that represents the Z-variables (attributes) of each region j. PCA starts by specifying each variable normalized by its mean and standard deviation. For instance, $a_{1j} = (a^*_{1j} - a^*_1)/s^*_1$, where a^*1 is the mean of a^*_{1j} across agro ecological zones and s^*_1 is its standard deviation. The selected variables are expressed as linear combinations of a set of underlying components for each region j:

$$a_{1j} = y_{11}W_{1j} + y_{12}W_{2j} + \ldots + y_{1z}W_{zj} \quad \ldots \quad j = 1 \ldots J$$
$$a_{z1j} = y_{z1}W_{1j} + y_{z2}W_{2j} + \ldots + y_{zz}W_{zj}$$

Where the 'W's are the components and the 'y's are the coefficients on each component for each variable (and do not vary across agro ecological zones). Because only the left side of each line is observed, the solution to the problem is indeterminate. PCA overcomes this indeterminacy by finding the linear combination of the variables with maximum variance (usually the first principal component W_{1j}), then finding a second linear combination of the variables orthogonal to the first and with maximal remaining variance, and so on. Technically, the procedure solves the equations (R-λI) vn = 0 for λ_n and v_n, where R is the matrix of correlation between the scaled variables (the a's) and v_n is the vector of coefficients on the nth component for each variable. Solving the equation yields the characteristic roots of R, λ_n (also known as eigen values), and their associated eigenvectors, v_n. The final set of estimates is produced by scaling the 'v_n's so that the sum of their squares sums to the total variance – another restriction imposed to achieve determinacy of the problem.

The scoring factors from the model are recovered by inverting the system implied by the equation below. This yields a set of estimates for each of the Z-principal components:

$$W_{1j} = b_{11}a_{1j} + b_{12}a_{2j} + \ldots + b_{1z}a_{zj} \quad \ldots \quad j = 1 \ldots J$$
$$a_{z1j} = b_{z1}a_{1j} + b_{z2}a_{2j} + \ldots + b_{zz}a_{zj}$$

Where the 'b's are the factor scores. Following Filmer and Pritchett (2001), the first principal component, expressed in terms of the original (unnormalised) variables is an index of each agro ecological zone in Oyo state based on the following expression:

$$W_{1j} = b_{11}(a^*_{1j} - a^*_1)/(s^*_1) + \ldots + b_{1z}(a^*_{zj} - a^*_z)/(s^*_z)$$

Vulnerability is calculated as the net effect of adaptive capacity, sensitivity and exposure. Vulnerability = (adaptive capacity) – (sensitivity + exposure)

It is however necessary to attach weights to the indices and this was accomplished using the principal component analysis (PCA). PCA is frequently used in research that is based on constructing indices for which there are no well-defined weights.

The use of asset-based indices for measurements of wealth across different social groups is a good example (Filmer and Pritchett 2001; Langyintuo 2005; Sumarto, Suryadarma, and Suryahadi 2006; Vyas and Kumaranayake 2006). As with the asset based indices for wealth comparism, there are no well-defined weights assigned to the vulnerability indices chosen for this research work therefore a statistical method (PCA) was employed to generate the weights.

Table 1: Vulnerability indicators, units of measurement, and expected direction with respect to vulnerability.Source: Derressa *et al.* , 2008b

Determinants of Vulnerability	**Vulnerability Indicators**	**Description of Each Indicator Selected for Analysis**	**Unit of Measurement**	**Hypothesized Functional Relationship Between Indicator and Vulnerability**
Adaptive capacity	Wealth	Livestock ownership Ownership of radio Quality of residential home Non-farm income	Percentage of total population who own or have access to	The higher the percentage of total population with asset ownership, and access to these income sources the lesser the vulnerability.
	Technology	Insecticide and pesticide supply Fertilizer supply Improved seeds supply	Percentage of total population within 1–4 kilometers of supply sources	The higher the percentage of total population within 1–4 kilometers, the lesser the vulnerability.
	Infrastructures and institutions	All-weather roads Health services Telephone services Primary and secondary schools Food market Microfinance	Percentage of total population within 1–4 kilometers of these infrastructures and institutions	The higher the percentage of total population within 1–4 kilometers, the lesser the vulnerability.
	Literacy rate	Literacy rate age 10 years and older	Percentage of total population	The higher the literacy rate, the lesser the vulnerability.
Sensitivity	Extreme climate	Frequency of droughts and floods	Number of occurrences (counts of the occurrences of drought and flood in different parts of the study area)	The higher the frequency, the more the vulnerability.
Exposure	Change in climate	Change in temperature Change in precipitation	Change (delta T) in degrees from base value (2012) Percentage change from base value (2012)	Increasing temperature and decreasing precipitation increase vulnerability.

Source: Derressaetal.2008b

RESULTS AND DISCUSSION

Socio-economic characteristics of the Farming Households

Respondents' socio-economic characteristics are presented in Table 2. Male household heads constituted majority (88.8%) of the sampled respondents. The bimodal age was between 31 and 40 years, indicating that a typical farmer interviewed was economically active. There were more married household heads (94.4%) than those divorced (5%), and single (0.6%). The study revealed that majority (81%) of households surveyed had more than four (4) members implying that the average farming households in the study area had a large household size which indicate that

Table 2: Household distribution by Socio-economic Characteristics

Household characteristic	Frequency	Percentage
Gender		
Male	142	88.8
Female	18	12.2
Age		
25-30	2	1.25
31-40	69	43.1
41-50	56	35
51-60	27	16.9
Above 60	6	3.75
Marital status		
Married	151	94.4
Single	1	0.6
Divorced	8	5.0
Household size (Number)		
1-4	56	35.0
5-9	83	51.9
10-14	21	13.1
Educational Level		
No formal Education	72	45.0
Primary Education	67	41.0
Secondary Education	14	8.7
Tertiary Education	7	4.4
Farm size (Hectare)		
1.0-1.5	24	15.0
1.6-2.0	57	35.6
2.1-2.5	32	20.0
2.6-3.0	47	29.4
Total	**160**	**100**

Source: Field Survey 2017

Vulnerability Assessment

For the analysis, principal component analysis (PCA) was run on the indicators listed in table 1 using (SPSS). The PCA of the data set on vulnerability indicators revealed two components with eigen values greater than 1. These two components explain 100 percent of the total variation in the data set. The first principal component explained most of the variation (78.33 percent) and the second principal component explained 21.67 percent. Based on earlier argument for the use of PCA, in constructing indices, the first principal, which explained the majority of the variation in the dataset was chosen. It was observed from the factor scores that the first PCA (the vulnerability index, in this case) was positively associated with the majority of the indicators identified under adaptive capacity and negatively associated with the indicator for sensitivity. It is however not negatively associated with the indicators categorised under exposure because the two districts have similar temperature and rainfall amount. Thus for the construction of the vulnerability indices, the indicators of adaptive capacity which are positively associated with the first PCA and the indicator of sensitivity which was negatively related were selected, this reduced the indices remaining to just thirteen.

Table 3: Factor score of the first Principal Component for the two Zones

Vulnerability	**Factor Scores**
Ownership of livestock	-0.045
Ownership of radio	0.061
Quality of house	0.061
Non-Agricultural income	-0.047
Insecticide and pesticide supply	0.061
Fertilizer supply	0.042
Improved seeds supply	0.061
All weather roads	0.061
Health services	0.059
Telephone services	0.060
Primary and secondary school	0.061
Food market	0.060
Microfinance	0.060
Literacy rate	-0.052
Farm association	0.057
Extension service	0.050
Frequency of extreme climates	-0.035
Change in Temperature	0.055
Change in precipitation	0.058
Eigen value	16.450
Proportion of variance	78.332
Cummulative proportion	78.332

Source: Data analysis

Table 4: Normalized values of the original data by their respective means and standard deviation

Zone	Ownership of radio	Quality of house	Insecticide and pesticide	Fertilizer supply	Improved seeds supply	All weather roads	Health service	Telephone service	Primary and secondary	Food market	Farm association	Extension service	Drought and Flood	Increasing Temperature	% change in rainfall
Ijebu	0.55	0.54	0.55	0.29	0.69	0.56	0.32	-8.0	0.53	0.46	0.23	-1.06	0.46	0.97	0.87
Ilaro	-1.16	-1.16	-1.16	0.83	-1.15	-1	-1.12	-0.49	-1.15	1.15	1.10	0.93	0.19	1.03	1.09

Source: Own Computation

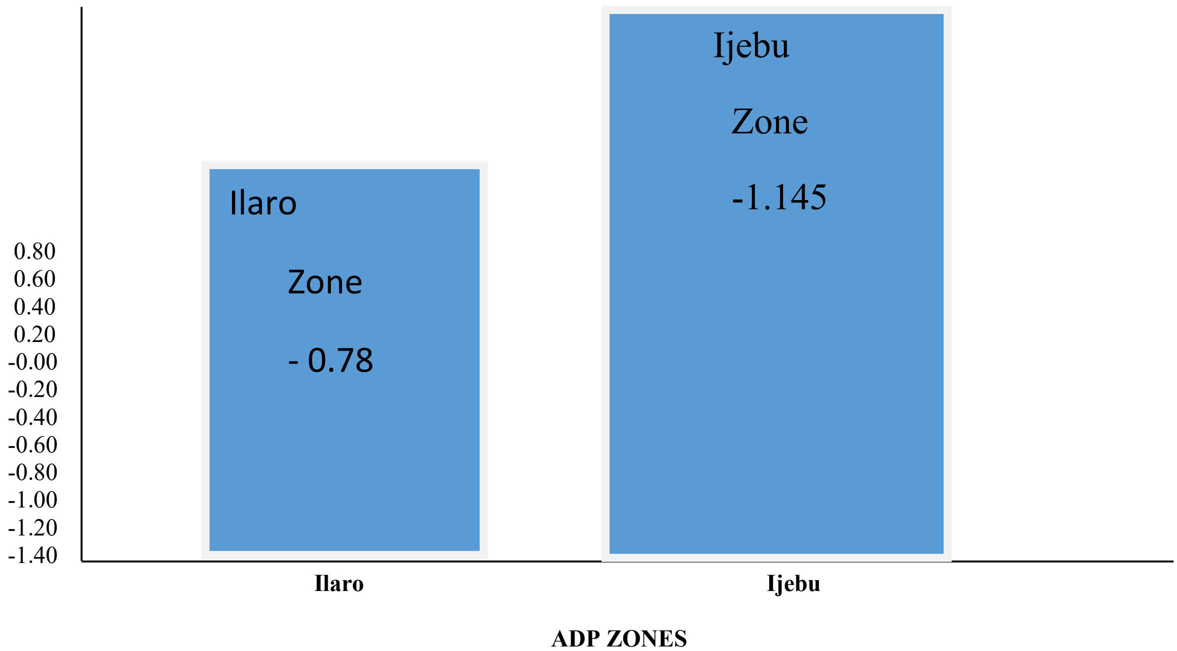

Figure 1: Vulnerability index of the two zones in Ogun state

The figure above shows that the overall effect of adaptive capacity, sensitivity and exposure are negative between Ijebu and Ilaro zones respectively (-1.145 and -0.78 respectively) This implies that farmers in this area are relatively vulnerable to this environmental problems. Vulnerability of Ijebu and Ilaro to environmental problems is mainly attributed with lower levels of regional development, poor quality of home, high frequency of flood and lower access to technology and infrastructure such as health care services, portable water, food market, telephone services, and electricity. However, the level of vulnerability of ilaro zone is higher compared with ijebu zone

CONCLUSION AND RECOMMENDATION

Farming households in the two zones are relatively more vulnerable to environmental problems which may be attributed to low level of regional development and poor adaptive capacity in terms of access to basic infrastructure, lower access to technology, institutions and extreme poverty. Based on the findings the study recommended that:

1. Government must ensure that the different, relevant research institutions are developing new varieties of crops that can easily adapt to environmental factors and extension agents should also encourage household farmers to adopt the new crop varieties for optimal productivity.
2. A tireless effort must be made to enact and enforce laws and regulations to control such activities that can induce or cause environmental problems which can eventually lead to loss of crops or loss of crop outputs.
3. Researchers should direct efforts towards research in this area of study as environmental problems are a continuous natural phenomenon, also both government and non-governmental organizations must invest in this field of study by providing drainage across the villages in the study area in order to reduce flood problem and also provide irrigation system when there is drought.

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