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Do floods affect food security? A before-and-after comparative study of flood-affected households' food security status in South-Eastern Nigeria

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Abstract. A comparative study of pre- and post-flood households' food security statuses in South-Eastern Nigeria was performed to answer the question "Do floods affect food security?" Data were generated via a survey of 400 households in eight communities using stratified and random sampling methods. Households' food security statuses were assessed using the Household Food Security Survey Module (HFSSM) and computed using a Rasch analysis, where households were divided into four categories, namely: food secure, food insecure without hunger, moderately food insecure with hunger and severely food insecure with hunger. The results show that flooding affects food security negatively by increasing the number of food insecure households to 92.8%, and the regression coefficient of -0.798 indicates a very strong negative effect of flooding on household food security. An odds ratio of 2.221 implies that households that have experienced flooding are 2.221 times more probable to be food insecure than households that have not. The implication of the findings is that flooding is capable of turning communities into food insecurity hotspots that would need long-term assistance to cope, and flooding is capable of hampering the achievement of Goal 2 of the SDGs.

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1. Introduction

Food security as defined by FAO (1996:4; 2008a:9) "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Food security can be classified under four components, namely; food accessibility, availability, utilisation and stability. In recent decades, food security has been investigated with the availability and accessibility components emphasised as the core of food security (Bashir and Schilizzi, 2013).

There has been no single method or technique for measuring food security statuses, as scholars have proposed a variety of methods that measure one component or another of food security (availability, accessibility, utilisation, stability). This makes food security a complex and multidimensional phenomenon, with Ogundari (2017) proposing a harmonisation of the various techniques used in measuring food security statuses to tackle or take into cognisance the multidimensional nature of food security.

> Globally, scholars had adopted different methods to measure household food security status using various indicators. These indicators include; food consumption score/dietary diversity score, per capita expenditure on food, per capita food consumption (such as protein, per capita nutrient intakes of calorie, and fat), share of dietary intake,anthropometry measures, food insecurity access scale (self-report/assessment) and coping strategy index among others. (Ogundari, 2017:1)

These indicators are usually in the form of questions and according to Castell et al. (2015), the food insecurity questionnaires usually employ a series of retrospective questions that detect the level of concern and the inadequate access to, variety and/or quantity of food, which often reflect three different domains of food insecurity namely; uncertainty or anxiety; insufficient quality and insufficient quantity. (Akukwe, 2019:54)

However, an attempt was made to categorise research works based on the indicators used. Coates et al. (2007), Knueppel et al. (2009), Battersby (2011) and Sekhampu (2017) used the Household Food Insecurity Access Scale (HFIAS), while Ndakaza et al. (2016) used the Food Consumption Score (FCS). The *per capita* food expenditure method had been applied by Omonona and Agoi (2007), Adepoju and Olawuyi (2012) and Ibok, Bassey et al. (2014), while Ojogho (2010), Asogwa and Umeh (2012), Olagunju et al. (2012), Welderufael (2014), Yusuf et al. (2015) and Dawit and Zeray (2017) applied the cost-of-calorie method. The Household Food Security Survey Module (HFSSM), which classifies households using a constructed linear food security scale was employed by Sanusi et al. (2006), Fakayode et al. (2009), Ibok, Idiong et al. (2014) and Coleman-Jensen et al. (2015).

Despite the extant literature on food security indicators, there is a lack of any universally acceptable and applicable indicator(s) to measure and examine household food security at small and macro levels (Carletto et al., 2013 in Ogundari, 2017), as these indicators only resolve around one dimension at a time (Bashir and Schilizzi, 2013). To minimise the gap of studying a single aspect of food security, the United States Department of Agriculture (USDA) approach has been adopted in this study for a comprehensive household food security assessment before and after flood events, as the questions in the Household Food Security Survey Module (HFSSM) cover most components of food security.

Several studies have shown that social, economic and environmental factors affect food security. Socio-economic factors such as income, household size, credit access, livestock ownership, level of education, farm size, sex, age of head of household, marital status (Ahmed and Dotti, 2014; Djangmah, 2016; Goshu, 2016; Ajaero, 2017; Dawit and Zeray, 2017) and environmental factors such as climate change, soil fertility, drought and flooding (Nzeadibe et al., 2011; Emaziye et al., 2013; Yaro, 2013) all define level of food security. Flooding as an environmental factor affecting food security has not been extensively studied in South-eastern Nigeria, even though Ramakrishna et al. (2014) and Zakari et al. (2014) found flooding to have negative impacts on food security in India and Niger Republic, respectively.

"Floods have been noted to be the most recurring, widespread, disastrous and frequent natural hazards of the world" (Odufuwa et al., 2012:70), making only a few countries immune to floods. As shown by empirical studies, the increased intensity and frequency of flooding, storms and drought undeniably has implications for food security and agricultural production (FAO, 2007; Ngoh et al., 2011; Yaro, 2013; Pacetti et al., 2017).

Nigeria is not immune to flooding and has recorded several flood incidences, but the most devastating of all was that of August–October 2012, which pushed rivers over their banks and submerged hundreds of kilometres of urban and rural lands (Ojigi et al., 2013) and has been noted as the worst flood experienced in Nigeria in the past 40 years (UN-OCHA, 2012). Over 7,705,378 Nigerians were affected by the floods, with 2,157,419 internally displaced persons (IDPs), with 363 deaths and more than 618,000 damaged houses (UN-OCHA, 2012), thereby affecting their food security status. The findings of UN-OCHA (2012) were supported by FEWS NET (2012; 2013), which reported massive destruction of farmlands owing to the 2012 flooding, with a resultant food insecurity in parts of the country (including the south-eastern region) as a significant proportion of farmland was affected.

In other words, flooding is capable of weakening efforts to achieve Goal 2 of the Sustainable Development Goals (SDGs) that lays emphasis on ending hunger, achieving food security and improving nutrition and promoting sustainable agriculture by 2030.

South-eastern Nigeria is in the Niger Delta region, which is known for its vulnerability to flooding due to its location – its proximity to the River Niger. The region is generally agrarian and has a comparative advantage for the production of crops such as yams, maize, potatoes and cassava that form the staples in Nigeria (FEWS NET, 2012). Unfortunately, there is a dearth of literature on the effects of flooding on food security in the flood-vulnerable and agrarian south-eastern communities, though studies have associated food insecurity with flood incidences (Ramakrishna et al., 2014; Zakari et al., 2014). According to Ajaero (2017:3), "responses to floods in Nigeria have generally been reactive and no assessment study on the food security status of people who were affected by, or migrated due to, floods has been undertaken".

The extent to which flooding affects household food security statuses either positively or negatively in South-eastern Nigeria, seems a relatively novel study, as there exists a paucity of literature as regards the topic, and this study had been undertaken to fill that gap. To show the extent to which flooding affects household food security statuses, the before-flood food security statuses and after-flood food security statuses of households were measured using the Household Food Security Survey Module (HFSSM) developed by the USDA, and a comparative analysis performed.

The research question therefore is: "Does flood affect household food security status and, if it does, to what extent?" The findings of this study will contribute to emergency planning in terms of distribution of relief materials to flood victims, and will strengthen the achievement of the Goal 2 of SDGs by 2030, and would serve as a baseline for comparative studies as regards before-flood and after-flood household food security statuses.

2. Theoretical framework

The Food and Agricultural Organisation – Food Insecurity and Vulnerability Information Management Systems (FAO-FIVIMS) and the climate change and food security theoretical frameworks (Figs 1 and 2) have been adopted in this study. The FAO-FIVIMS framework was adopted as a useful tool for conducting food security analysis as it provides a basis for responding to questions such as who is food insecure, where the food insecurity is located, and why people are food insecure (Verduijn, 2005). The linkages between the four food security dimensions and factors influencing them are explained in the FAO-FIVIMS framework at the individual, household, community, sub-national and national levels. Food insecurity is a complex phenomenon caused by factors that vary across households, communities, social groups and countries over time (Fig. 1). These factors of food insecurity have been grouped into four clusters, namely: socio-economic and political environment; the performance of the food economy; care practices; and health and sanitation, and the four collectively represent potential vulnerability. "Most importantly, the FAO-FIVIMS framework shows a common understanding of possible causes of low food consumption and poor nutritional status" (Verduijn, 2005:12).

However, it shows how climate variables (such as changes in weather events with associated flooding) affect the natural environment (e.g. houses, marketing and storage infrastructure, productive assets, roads, human health and electricity grids) where food components exist and indirectly affect the four dimensions of food security (FAO, 2008b). When there is a change in any dimension of food security (food availability, accessibility, utilisation or stability), the resultant effect is food insecurity that indirectly affects individual and household consumption and health status. Finally, the effective and efficient utilisation of food by the body depends principally on a person's health status, which is dependent on overall sanitation and health conditions (Figs 1 and 2).

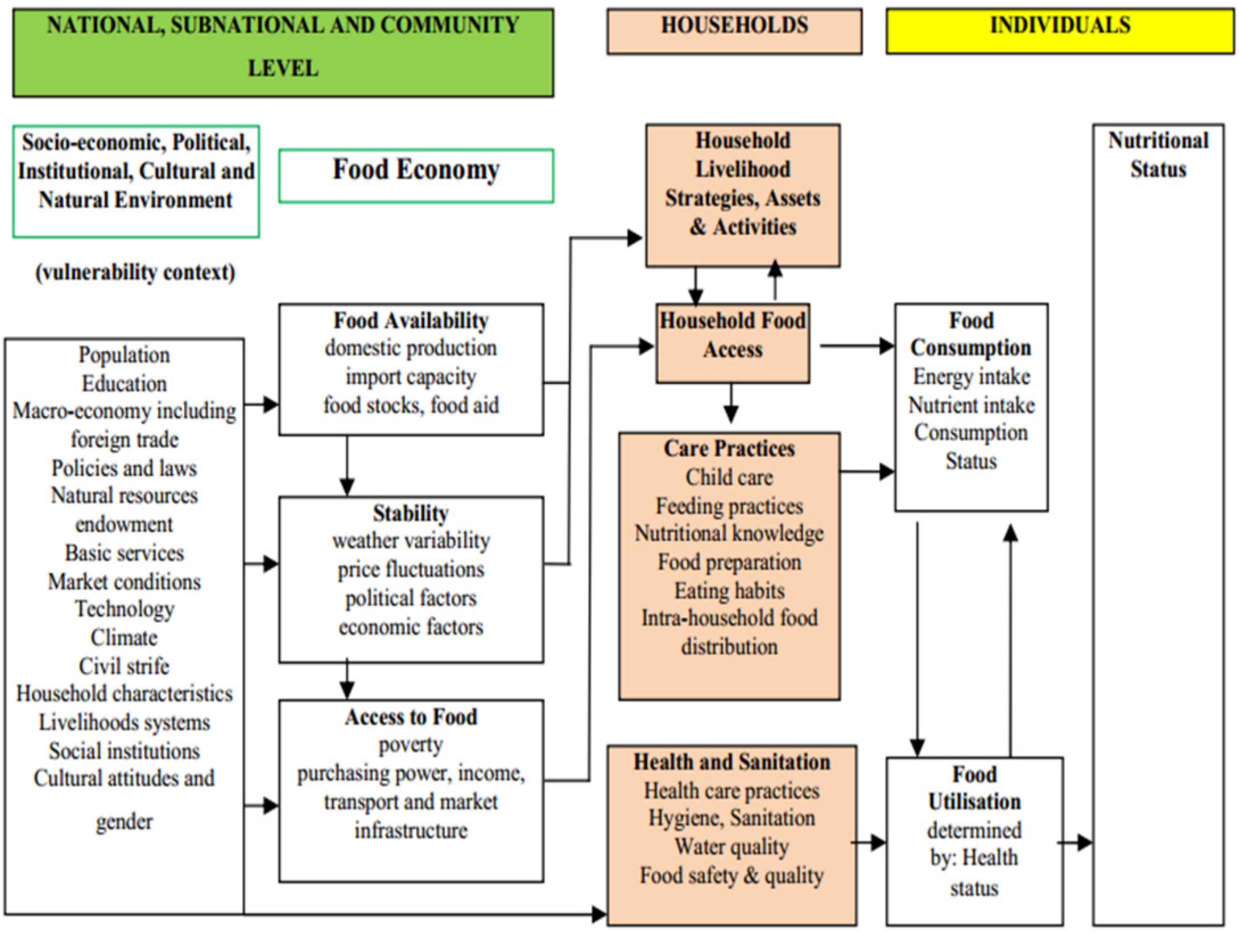

Fig. 1. Food Insecurity and Vulnerability Information Management Systems Framework
Source: FAO, 2008a

3. Materials and research methods

3.1. Sample size and sampling method

South-eastern Nigeria comprises of five states, namely: Abia, Anambra, Ebonyi, Enugu and Imo. The region is a land size of 28,983 km^2 located between latitudes 4°20′ and 7°10′ north of the equator and longitudes 6°35′ and 8°25′ east of the Greenwich Meridian (Fig. 3). Owing to the high susceptibility, vulnerability and flood experience as reported by UN-OCHA (2012), Anambra and Imo States have been purposively selected for this study. Of the states, two Local Government Areas (LGAs) (Fig. 4), namely: Oguta and Ohaji/Egbema (in Imo State) and Anambra East and Ogbaru (in Anambra State) were purposively selected for equal representation. Agricultural livelihood, access roads and flood incidence were the criteria considered in the selection of the LGAs, since the target population was mainly agrarian households that had experienced flooding.

The population of the four selected Local Government Areas (LGAs) according to the National Population Commission (2010) are shown in Table 1. The projected population figures were calculated using the equation below:

$$P_2 = P_1 (1+r)^n \quad (1)$$

where: P_2 – projected population; P_1 – known population (2006 in this case); R – rate of natural increase – 2.8% as noted by the United Nations, 2013; n – the number of years between P_1 and P_2 (interval) – 11 years in our case.

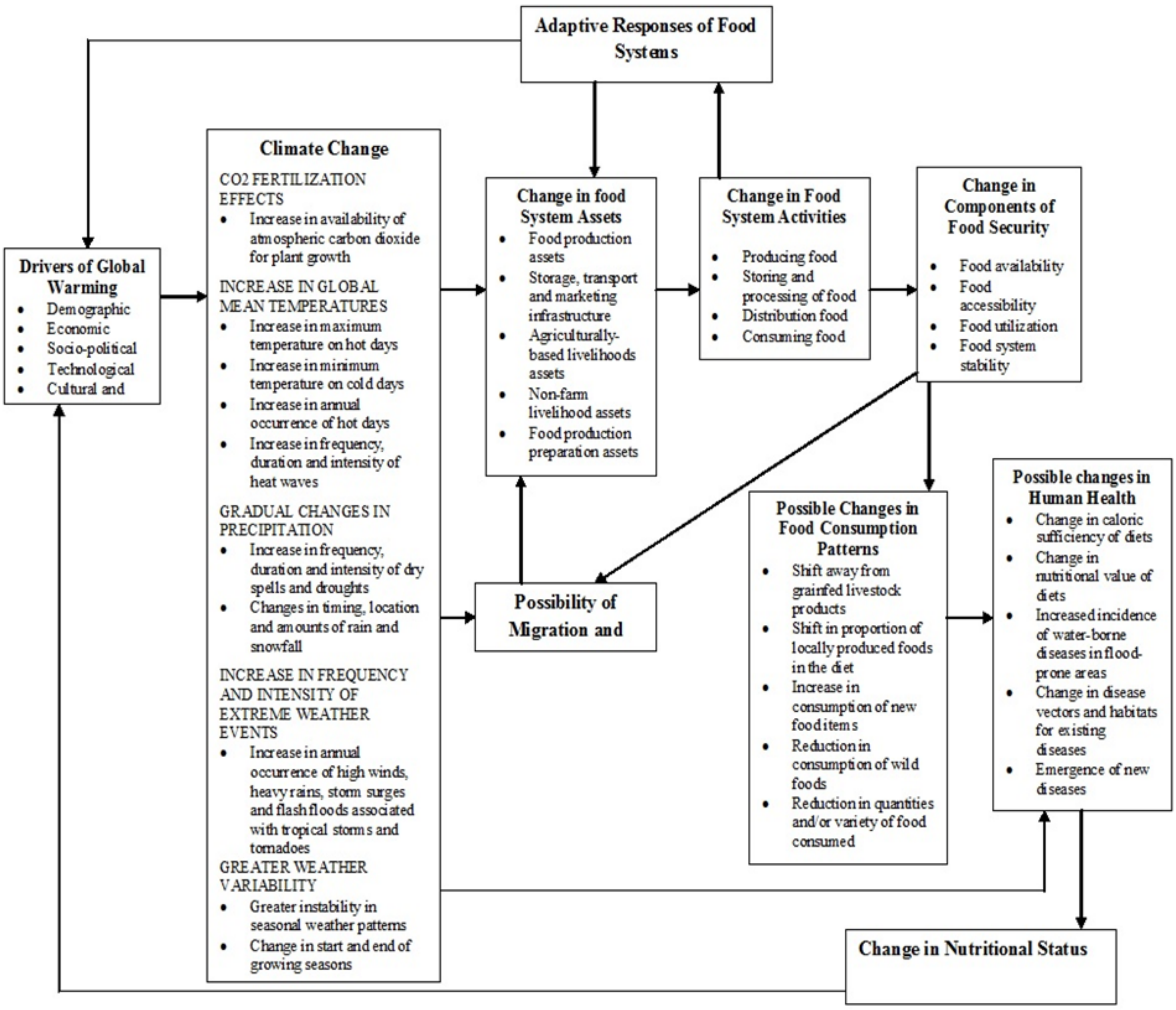

Fig. 2. Climate Change and Food Security Concept
Source: FAO, 2008b

Table 1. Projected 2016 population for the study area

Local Government Area	2006 population (persons)	Projected 2016* population (persons)
Anambra East	152,149	205,401
Ogbaru	223,317	301,478
Oguta	142,340	192,159
Ohaji/Egbema	182,891	246,903

Source: *Researcher's computation, 2016

National Population Commission (2010)

The sample size was calculated using Yamane's (1967) equation given below:

$$n = N/1+N(e^2) \qquad (2)$$

where: n – sample size; N – the population of Anambra East, Ogbaru, Oguta and Ohaji/Egbema LGAs; e – the level of precision/sampling error i.e. 0.05 (at +/-5% level of precision)

$n = (205,401+301,478+192,159+246,903)/(1+ (205,401+301,478+192,159+246,903)(0.05)^2)$

n = 400 households

From the sampled LGA, using multi-stage purposive sampling technique, two (2) communities (one being the LGA headquarters) were purposively selected based on the same criteria used in selecting the LGAs, giving a total of four (4) communities per state and eight (8) communities in total (Fig. 4). Furthermore, a stratified sampling method was used to determine the number of households sampled in each LGA and community, and a random sampling method was employed in administering the 400 copies of the questionnaire (Table 2).

3.2. Data collection and data analysis

Data were collected through a structured questionnaire in which the respondents were requested to respond with a tick to a set of eighteen questions as regards their food security situations before and af-

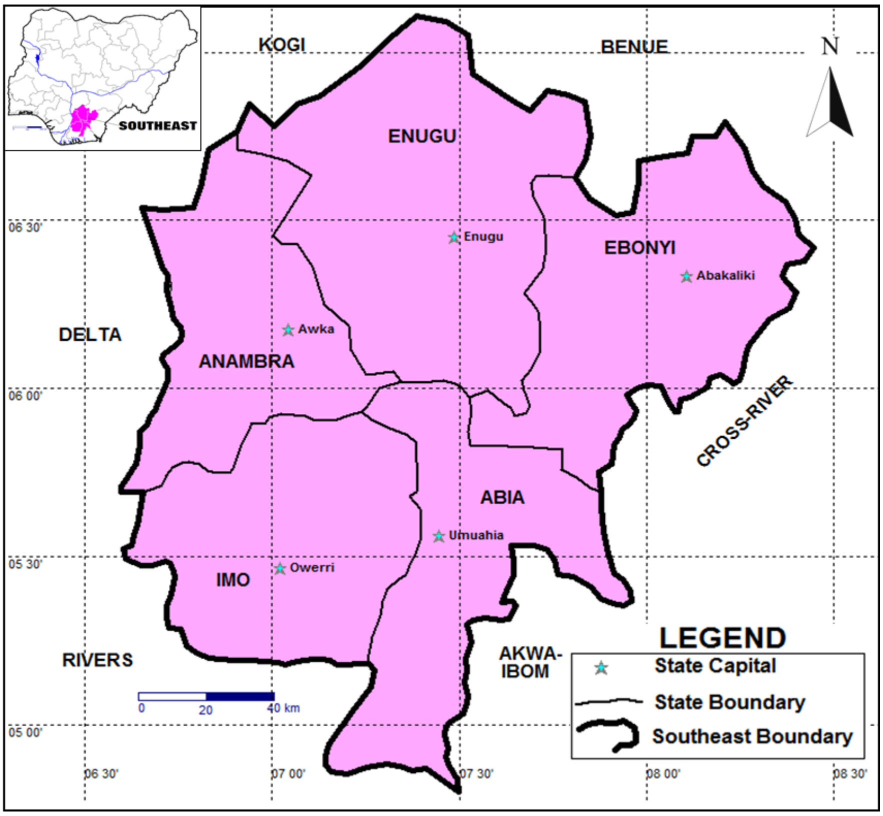

Fig. 3. Map of the Study Area
Source: GIS Lab., Department of Geography, University of Nigeria, Nsukka, 2016

Table 2. Sample size of the study

State	Local Government Area (LGA)	Sampling size	Community / Household sampled
Anambra	Anambra East	(205,401 / 945,941) × 400 = 87	2 communities (44 for one community and 43 for the other) = 44 + 43 households
	Ogbaru	(301,478 / 945,941) × 400 = 128	2 communities (64 for each community) = 2 × 64 households
Imo	Oguta	(192,159 / 945,941) × 400 = 81	2 communities (41 for one community and 40 for the other) = 41 + 40 households
	Ohaji/Egbema	(246,903 / 945,941) × 400 = 104	2 communities (52 for each community) = 2 × 52 households
Total		400	400

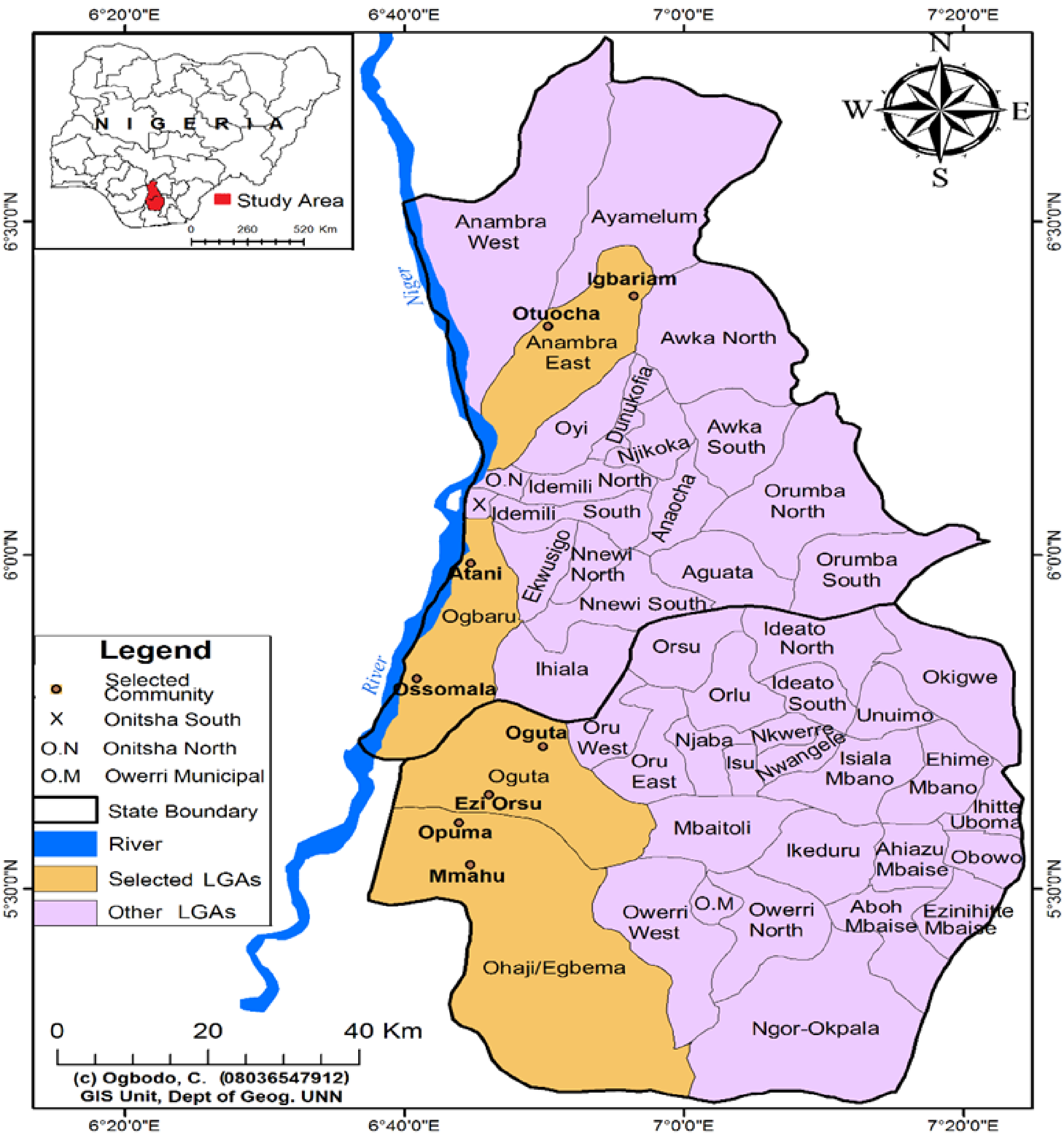

Fig. 4. Map of the study area showing the sampled LGAs/Communities
Source: GIS Lab., Department of Geography, University of Nigeria, Nsukka, 2016

ter flooding, and their responses were analysed. The respondents consisted of household heads (mostly farmers) in agrarian communities whose households had experienced flooding and its associated effects between 2012 and 2017.

3.2.1. Comprehensive household food security status/level measurement: a USDA approach

The Household Food Security Survey Module (HFSSM) developed by the United States Department of Agriculture (USDA), in which households are categorised using a constructed food security scale, was adopted for assessing households' food security statuses. The scale measures diverse food security conditions and severity of food insecurity ranging from 0 to 10. A scale value of zero (0) represents households with the absence of the measured condition, whereas a scale value of near ten (10) represents households with the presence of all the available indicators; that is, experiencing the most severe condition (Bickel et al., 2000). Figure 5 shows the indicators and measured conditions which are the eighteen (18) questions.

3.2.2. Coding survey responses for the food security scale

Responses to the set of eighteen (18) questions regarding households' food needs as shown in Fig. 5 were used to determine where a household falls on the food security continuum. Analysing households' food security status on the food security scale required, firstly, coding responses to each question as either "yes" or "no". There are three response categories of the 18 questions, namely "often true", "sometimes true" and "never true". "Often true" and "sometimes true" were coded as "1" because they were considered "yes" responses, while "never true" was coded as "0" because it showed the condition never occurred before or after flood events. Secondly, a Rasch analysis was used to compute the households' food security status scores (food security indices; FSI) and these scores were further classified into four, *viz*; food secure, food insecure without hunger, moderately food insecure with hunger, and severely food insecure with hunger (Fig. 6) on the basis of the calculated values positions on the scale. Households with "food secure" status have scores ranging from 0 to 2.32, while "food insecure without hunger" households are located between 2.33 to 4.56 on the scale. The "moderately food insecure with hunger" households have scores between 4.57 and 6.53, whereas households with the "severely food insecure with hunger" status are located between 6.54 and 10 on the food security scale.

3.2.3. Rasch Analysis

Rasch analysis is a kind of single-parameter logistic item response theory model that serves as a statistical tool that provides a theoretical base to assess the suitability of a set of survey items for scale construction, and it has been broadly used as the statistical foundation for survey-based experiential food security measurement (Bickel et al., 2000; Nord, 2014). Generally, "the model can be used to assess the location of an individual or household along a continuum—in the present case, a continuum of the severity of deprivation in the basic need for food—by combining information from multiple dichotomous (yes/no) items (questions) that vary as to the point on the continuum that each item uniquely reflects. This corresponds exactly to the character of the food insecurity/hunger measurement construct" (Nord, 2014:3).

The model posits that the probability of a specific household affirming a specific item (question) depends on the difference between the severity-level of the household and the severity of the item. So, there is an assumption that the log-odds of a household affirming an item is proportional to the difference between the "true" severity level of the household and the "true" severity level of the item (Bickel et al., 2000).

Thus, the odds that a household at severity-level "x" will affirm an item at severity-level "y" is:

$$P/Q = e(x-y) \quad (3)$$

where: P is the probability of affirming the item, Q is 1 minus P, that is, the probability of denying the item (thus, P/Q is the odds of affirming the item), and e is the base of the natural logarithms.

Solving equation (2) for P, the probability that the household affirms the item, can be expressed as:

$$P = e(x-y)/(1+e(x-y)) \quad (4)$$

Equation 4 could be simplified as:

$$P = 1/(1+1/e(x-y)) \quad (5)$$

Question	Responses: Often true	Sometimes true	Never true
•Do you always have enough food to eat? •Do you always have the kinds of food you want? •Do you worry if your food stock will run out before you get another to eat? •Do you have enough resources to acquire enough food? •Could you afford to eat balanced meals? •Do you supplement your children's feed with low cost foods? •Can you afford to feed your children balance meals? •Were your children not eating enough, because you couldn't afford enough food? •Do adults in your household skip meal or cut the size of their usual meals? •Do you eat less than what you feel, you should? •Were you ever hungry, but didn't eat? •Did you lose weight, because there wasn't enough food to eat? •Did you or other adults in your household ever not eat for a whole day because there wasn't enough money for food? •How often did this happen? •Did you ever cut the size of your children's meal because there wasn't enough money for food? •Did any of the children ever skip meals, because there wasn't enough food to eat? •Did any of the children ever not eat for a whole day? •Were the children ever hungry but you just couldn't afford more food?			

Fig. 5. Structured survey questions on household food security

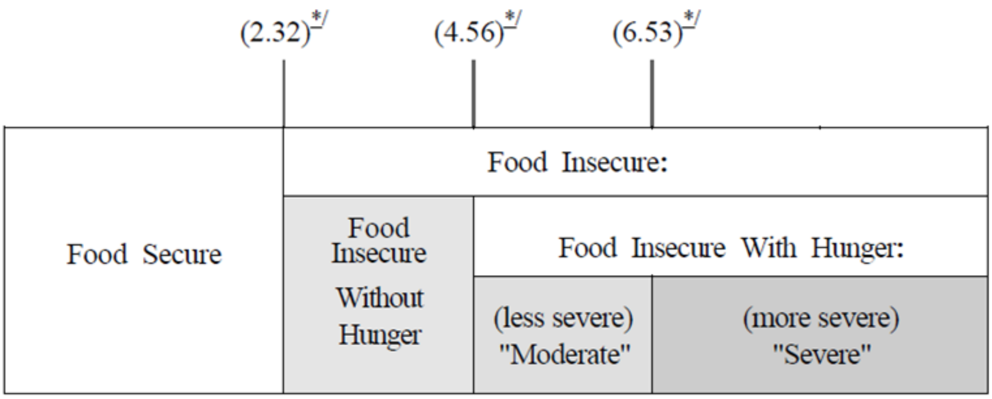

Fig. 6. Household food security status: categorical measure
Source: Bickel et al., 2000:31
*/ located at midpoint between the two adjacent household scale values

The severity of an item, then, is the severity-level of households that are just at the threshold of affirming or denying that item. The odds that a household will affirm an item right at the severity level of the household is 1, corresponding to a probability of 0.5. The odds that a household will affirm an item with a severity parameter one unit lower than that of the household is e1, or about 2.7, corresponding to a probability of 0.73 [i.e., 1/(1+1/2.7)]. The probability that the household will affirm an item two units lower than its own severity measure is 0.88, and for an item three units lower, it is 0.95. (Nord, 2014:4)

The Rasch-based scale is not a ratio measure, but an interval measure, implying that the zero point is not meaningful but the relative size of the intervals is. Since what determines the probability of affirmation in the Rasch model is the difference between the household and item parameters, the metric of the scale was transformed without altering the character of the scaleby adding a constant to both household and item parameters (Bickel et al., 2000; Nord, 2014).

Mathematically, this scale adjustment is equivalent to fitting the Rasch model as in (3) above, with the addition of a discrimination parameter, k, as follows:

$$Px,y/Qx,y=e(k(x-y)) \qquad (6)$$

The discrimination parameter, k, is inversely proportional to the standard deviation of the parameters of the items in the scale based on a given set of data.

4. Research Results and Discussion

4.1. Differential household food security status/levels prior to flooding

The score position of households on the food security scale is based on the overall pattern of response to the complete set of indicators by the households (Bickel et al., 2000). Table 3 shows that a large proportion of households' position on the scale was between 2.33 and 10, implying a high level of food insecurity. Generally, prior to flooding, one third of households in South-eastern Nigeria were food secure, with 40.2% households being food insecure without hunger. Additionally, 13% were moderately food insecure with hunger, while 13.5% were severely food insecure with hunger. This implies that about two third of households in the study were food insecure, while the remaining third were food secure before any flood events.

4.1.1. "Food secure" households

Households in this category were reported to have very limited or no food insecurity or hunger experiences, as reflected in their very low scores (0–2.32) on the food security scale. This is as a result of fewer "yes" responses to the 18 structured food security questions.

Mmahu community had the highest percentage (44.2%) of food secure households and was followed by Otuocha community with 43.2% food secure households, while Ossomala community recorded the lowest (25%) food secure households. Atani, Opuoma and Ezi-Orsu communities, in decreasing order, consisted of households with the "food secure" status of ≥30%, while more than a quarter of households in Oguta and Igbariam communities were food secure. This implies that Mmahu, Otuocha, Atani and Opuoma communities recorded a larger proportion of households that had minimal evidence of food insecurity than did Ezi-Orsu, Oguta, Igbariam and Ossomala (Table 3).

4.1.2. "Food insecure without hunger" households

Household members in this category experienced either little or no reduced food intake. Households in this category had concerns regarding food supply adequacy and household food management, as well as feeling anxious about the sufficiency of their food to meet basic needs (Bickel et al., 2000; Ibok, Idiong et al., 2014) with no presence of hunger among their members. The implication is that little or no reduced food intake was recorded among their members.

More than one third of households in each community across the eight communities fell into this category, with Ossomala, Opuoma, Oguta and Otuocha having more than 40% households, while Ezi-Orsu, Atani, Igbariam and Mmahu each accounted for over 30% of households in this category. Generally on average, 40.2% of households in agrarian communities of South-eastern Nigeria felt the anxiety of having insufficient food and had inadequacy in food supplies and food budget, and these were experienced most and least in Opuoma and Mmahu communities, respectively (Table 3).

4.1.3. "Moderately food insecure with hunger" households

Reduction in adults' food intake is the basis for classification of households in this category. Households in this category have "yes" responses to at least three adult hunger questions, and had adults (children being excepted) who had reduced food intake and thereby repeatedly experienced the physical sensation of hunger. Households in Ossomala, Igbariam, Ezi-Orsu communities had ≥20% adults who had experienced hunger, while Otuocha community had only 13.6% in this category. Similarly, households in Oguta, Atani, Mmahu and Opuoma

Table 3. Differential household food security status/levels before flooding

Community	Category of food security status/level				Total
	Food secure	Food insecure without hunger	Moderately food insecure with hunger	Severely food insecure with hunger	
Atani	24(37.5%)	24(37.5%)	6(9.4%)	10(15.6%)	64
Ossomala	16(25.0%)	29(45.3%)	13(20.3%)	6(9.4%)	64
Otuocha	19(43.2%)	18(40.9%)	6(13.6%)	1(2.3%)	44
Igbariam	11(25.6%)	15(34.9%)	9(20.9%)	8(18.6%)	43
Oguta	11(26.8%)	18(43.9%)	4(9.8%)	8(19.5%)	41
Ezi-Orsu	12(30.0%)	14(35.0%)	10(20.0%)	4(10.0%)	40
Mmahu	23(44.2%)	18(34.6%)	2(3.9%)	9(17.3%)	52
Opuoma	17(32.8%)	25(48.1%)	2(3.9%)	8(15.4%)	52
Total	**133(33.3%)**	**161(40.2%)**	**52(13.0%)**	**54(13.5%)**	**400**

Source: Researcher's computation, 2017

communities recorded the least number of adults with reduced food intake emanating from insufficient food supply and inadequate funds to acquire more (Table 3).

4.1.4. "Severely food insecure with hunger" households

Households in this category had repeatedly reduced food intake for both children and adults and the implication is that all members (adults and children) had experienced hunger. This is the most extreme of all the categories showing households that have given "yes" responses to a large number of the severe conditions. In general, only 13.5% households in the agrarian communities of South-eastern Nigeria had experienced hunger due to reduced food intake for all their members. Respectively, Otuocha and Oguta communities had the smallest number (2.3%) and the largest number (19.5%) of severely food insecure households where both their children and adults repeatedly reduced their food intake as a result of inadequate food supply, insufficient food, and no resources to acquire more food (Table 3). Households in this category are the *food insecurity hotspots* that would need some assistance for them to cope.

4.2. Effects of flooding on household food security status

A comparative analysis of the food security situations before and after flooding was carried out in order to show whether flooding has a negative or positive effect on households' food security in South-eastern Nigeria using the same HFSSM developed by the United States Department of Agriculture (USDA) that categorises households using a constructed food security scale adopted for assessing the food security status of households after a flood event.

The food security status of households after a flooding event is shown in Table 3. The table reveals that the general food security levels of households were drastically affected by flooding, as only 7.2% of households were food secure after flooding, as opposed to the 33.3% of households that were food secure before flooding (Table 4). This implies that flooding has a 26.1% reduction in the number of food secure households.

Consequently, 39.3% of households became food insecure without hunger after flood incidences, which is a bit lower than the 40.2% households that were food insecure without hunger before flooding.

With respect to households that experienced extreme food insecurity after flooding, 15.7% were

Table 4. Differential household food security status/levels after flooding event

Community	Category of food security status/level				Total
	Food secure	Food insecure without hunger	Moderately food insecure with hunger	Severely food insecure with hunger	
Atani	4(6.2%)	25(39.1%)	9 (14.1%)	26(40.6%)	64
Ossomala	1(1.6%)	29(45.3%)	8(12.5%)	26(40.6%)	64
Otuocha	4(9.1%)	26(59.1%)	9(20.4%)	5(11.4%)	44
Igbariam	0(0.0%)	9(20.9%)	3(7.0%)	31(72.1%)	43
Oguta	9(22.0%)	8(19.5%)	18(43.9%)	6(14.6%)	41
Ezi-Orsu	3(7.5%)	16(40.0%)	5(12.5%)	16(40.0%)	40
Mmahu	4(7.7%)	21(40.4%)	7(13.4%)	20(38.5%)	52
Opuoma	4(7.7%)	23(44.2%)	4(7.7%)	21(40.4%)	52
Total	29 (7.2%)	157(39.3%)	63(15.7%)	151(37.8%)	400

Source: Researcher's computation, 2017

moderately food insecure with hunger, whereas 37.8% were severely food insecure with hunger. In other words, flooding forced a larger proportion of households to go into extreme food insecurity, as there were 2.7% and 24.3% increases in the number of households that were moderately food insecure with hunger and severely food insecure with hunger, respectively (Tables 3 and 4). This implies that flooding caused a decrease in the number of households that normally had sufficient food to eat and drastically increased the number of household with repeatedly reduced food intake for both children and adults, thereby putting these households in need of some assistance to cope in times of flooding.

Generally, in South-eastern Nigeria, flooding reduced food security by increasing the number of food insecure households to 92.8%, indicating a 26.5% increase in food insecure households above normal, and this has a possibility of causing migration and conflict as shown in Fig. 2.

The most affected in terms of flood-induced food insecurity was Igbariam community, where all the households became food insecure after flooding, with 72.1% experiencing extreme food insecurity with hunger. The second most affected was Ossomala community, which recorded only 1.6% food secure households after flooding. The negative effects of flooding on household food security are seen in Atani, Ezi-Orsu, Mmahu, Opuoma, where <8% were food secure, with more than 90% becoming food insecure after flooding. Oguta community was the least affected by flooding because 22% of its households were food secure after flooding, which is just 4.8% lower than the number recorded before flooding.

Conversely, the number of households that experienced severe food insecurity in Oguta community after flooding also reduced to 14.6% from the normal 19.5% before flooding. However, flooding forced a majority of households to move from "food insecure without hunger" status to either "moderately food insecure with hunger" status or "severely food insecure with hunger" status (with the exception of households in Oguta community), thereby increasing the number of *food insecurity hotspots*. The implication is that, more households would be needing food assistance to help them cope with the flood-induced food insecurity.

The reasons for the high percentage of extreme food insecurity recorded by households were the decrease in household food supply with associated reduction in children's and adults' food intake as a result of inadequate resources to acquire food. It was also revealed that flooding induced hunger; for example, more than 80% of households indicated having been hungry but never having eaten during a flood event, while more than 90% of them either cut the usual size of children's and adults' meals, or skipped meals, as well as supplementing with low-quality food because of inadequate resources to acquire more.

The study has been able to demonstrate that flooding induces food insecurity leading to changes in food consumption patterns that would hamper the achievement of Goal 2 of the SDGS emphasising ending hunger, achieving food security and improving nutrition and promoting sustainable agriculture by 2030. The reasons for the flood-induced food insecurity as gathered from the respondents were the destruction of farmland, the disruption of sources of livelihoods, a rise in food prices, and seasonal migration to safer land, which significantly affect food availability, accessibility and utilisation over time. However, knowledge of the food insecurity hotspots would aid in the distribution of relief materials to flood victims.

4.3. Assessment of the extent of the relationship between flooding and food security

Ordinal regression analysis was used to analyse the extent to which flooding affects households' food security status because of the ordered nature of the households' food security levels. The value of 0 was assigned to "food secure" households; households with "food insecure without hunger" status were assigned 1; "moderately food insecure with hunger" households were assigned 2; and "severely food insecure with hunger" households were assigned 3. These codes, 0 to 3, formed the codes for the dependent variable (food security), Y. The independent variable (flooding), X, was coded as 1 for "Yes" and 2 for "No".

The estimated coefficients for the model are shown in Table 4. The estimates labelled "Threshold" are the intercept. The estimates labelled "Location" are the coefficients for the independent variable (predictor). The coefficient for the independent variable, FloodExp, (households that had experienced flooding) in the model, is -0.798. The negative coefficient indicates a very strong negative effect of flooding on household food security. Firstly, this shows that households that experienced flooding are more likely to be food insecure. Secondly, the negative value means that the odds of being food secure declines for households with flood experience, making flood a limiting factor, holding other factors constant.

The extent to which flooding affects food security was analysed using the odds ratio. An odds ratio (OR) is a measure of association between an exposure and an outcome. The OR represents the odds of an outcome occurring given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. It is simply the exponential function of the regression coefficient (e^{b1}) associated with a one-unit increase in the exposure (Szumilas, 2010). When OR=1, there is no association between the response and predictorand this serves as the baseline for comparison, and an OR>1, shows the odds of success are higher for higher levels of theindependent variable (in this case, flooding).An OR<1 implies that the odds of success are less for higher levels of a predictor whileOR with values farther from 1 represent stronger degrees of association ("Logistic regression", 2018). (Akukwe, 2019:144)

The odds ratio of flooding (the predicting variable), is 2.221, and this shows a strong degree of association between flooding and food security, since OR>1 (Table 4), implying that households that experienced flooding are 2.221 times more likely to be food insecure than households that did not.

Table 4. Relationship between flooding and food security parameter estimates

Variable		Estimate	Std. Error	Wald	Df	OR	Sig.
Threshold	[Food Security = 0]	-3.339	.888	14.147	1	28.191	.000
	[Food Security = 1]	-.925	.870	1.132	1	2.522	.287
	[Food Security = 2]	-.283	.869	.106	1	1.327	.744
Location	[FloodExp=1]	-.798	.874	.834	1	2.221	.361
	[FloodExp=2]	0[a]	.	.	0		.

Link function: Logit

a. This parameter is set to zero because it is redundant

5. Conclusion and recommendation

The study set out to assess the effect of flooding on household food security status by comparatively measuring before-flood and after-flood households' food security statuses in eight agrarian communities in South-eastern Nigeria. The Household Food Security Survey Module (HFSSM) was used to measure the household security status, where the score position of households on the food security scale is based on the overall pattern of the households' responses to the complete set of indicators. The scale scores were computed using Rasch analysis, and these were used to produce the Food Security Indices (FSI), dividing households into four categories, namely: food secure; food insecure without hunger; moderately food insecure with hunger; and severely food insecure with hunger – before and after flood events.

Food security statuses differ across households as well as within and across communities, as our findings revealed. The most affected in terms of flood-induced food insecurity was Igbariam community, where all the households became food insecure after flooding, with 72.1% experiencing extreme food insecurity with hunger, while Oguta community was the least affected by flooding because 22% of its households were still food secure after flooding, which is just 4.8% lower than the number recorded before flooding.

Generally, households' food security was drastically affected by flooding as only 7.2% of households were food secure after flooding as opposed to the 33.3% of households that were food secure before flooding, implying that flooding caused a 26.1% reduction in the number of food secure households. Consequently, flooding reduced food security statuses by increasing the number of food insecure households to 92.8%, indicating a 26.5% increase in food insecure households above normal in the study area. In addition, flooding forced the majority of households to move from "food insecure without hunger" status to either "moderately food insecure with hunger" status or "severely food insecure with hunger" status (with the exception of households in Oguta community), thereby increasing the number of *food insecurity hotspots*. The implication of this finding is that more households in Igbariam, Ossomala, Atani, Ezi-Orsu, Mmahu and Opuma communities would be needing food assistance to help them cope with the flood-induced food insecurity.

The ordinal regression analysis used to show the relationship between flooding and food security produced a coefficient of -0.798, indicating a very strong negative effect of flooding on household food security. The odds ratio was 2.221, showing a strong degree of association between flooding and food security, implying that households that have experienced flooding are 2.221 times more likely to be food insecure than households that have not.

The answer to the research question "Does flood affect household food security status, and if it does, to what extent?" is that flooding negatively affects food security, and with an ordinal regression coefficient of -0.798 it means a unit increase in flooding would lead to a 0.798 decrease in food security, holding other factors constant. Generally, the findings reveal that flooding further exacerbated food insecurity by increasing the number of already food insecure households recorded before flood incidence in the south-eastern region of Nigeria. Conclusively, flooding induces *food insecurity hotspots* and is capable of weakening the effort to achieving Goal 2 of the Sustainable Development Goals (SDGs), which lays emphasis on ending hunger, achieving food security and improving nutrition, and promoting sustainable agriculture by 2030.

Since the findings of this study hope to contribute to emergency planning in terms of distribution of relief materials to flood victims, and to strengthening the achievement of the Goal 2 of SDGs by 2030, and serves as a baseline for comparative studies as regards before-flood and after-flood household food security statuses, the recommendations below have been made in addition.

It is recommended that flood waters be harvested and put into use during the dry season to encourage off-season planting and harvesting, since the communities are largely agrarian. Seasonal migration to uplands during flooding is encouraged as this is also a form of adaptation. Flood-induced food insecurity has been linked to the destruction of farmlands and the associated disruption of sources of livelihoods; hence, there is need to construct storage facilities at the community level to enable farmers to store their harvested produce and to prevent food wastage in the flood-prone areas. Moreover, policy measures such as access to social protection funds and safety nets geared towards maintaining or improving households' food security statuses during or after flood incidence are recommended.

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