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Flood Disaster Effect on SmallholderFarmers' Food Security inKelantan: An Ordered Logistic Regression Analysis

Abdussalam Adamu Jega[1, 3*], Norsida Man [1, 2], Ismail Abd Latiff [1], Kelly Kai Seng Wong[1]

[1]*Department ofAgribusiness andBioresource Economics University Putra Malaysia, 43400, Serdang, Selangor, Malaysia*
[2]*Department ofAgricultural Technology, University Putra Malaysia, 43400, Serdang, Selangor, Malaysia*
[3]*Department ofAgricultural Economics andExtension, Kebbi State University ofScience andTechnology, Aliero, PMB 1144, Kebbi State, Nigeria*

Abstract:*Food security of smallholder farmers especially those living in the coastal areas and floodplains is becoming increasingly threatened by disaster occurrence globally, since majority of them depends on agriculture as their sole source of food and income. However, flood disaster effect on smallholder farmers was paid little attention in the literature. Hence, understanding flood disaster effect on small-scale farmers' food security is critical for planning and flood disaster management. The aim of this study is to determine the potential effects of 2014/2015 flood disaster on smallholder farmer's food security in the Kelantan state of Malaysia. Data from a sample of 344 affected smallholder farmers was collected and analyzed using ordered logistic regression analysis. Based on the USDA categorization of food security levels, the findings reveal that 44.5% has high level food security after flood disaster, 30.5 % were very low food secured while 17.4% and 7.6% were at marginally and low food secured levels respectively. Additionally, smallholder farmers income (β = 0.987 p = 0.001, marital status (β = 1.130, p = 0.009), sex (β = 0.563, p = 0.012) and recovery resources (β = 1.030, p = 0.002) were all found to be significant and positively related to their food security. The implication of this study help policy makers to facilitate consistent and comprehensive long-term cost-effective strategies for flood management even though smallholder farmer's food security was not adversely affected to avoid cascading effect in the future. In addition this study will further give an insight to the academicians on flood disaster on other smallholder livelihood outcomes in the future research.*

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I. Introduction

Flood is the most common type of disaster causing serious economic losses in various part of the world (G.Ramakrishna et al. 2014; Toubes et al. 2017). The immediate effect of natural disasters and other climatic change variability on smallholder farmers include loss of lives, destruction of crops and farmlands, loss of livestock, damage to properties and infrastructure and food security problem among the affected communities (Alam et al. 2010; Islam & Wong 2017; Okeleye et al. 2016). Therefore and any reduction to agricultural productivity can ultimately have significant effect on smallholder farmers food security, income, and general well-being (Hertel & Rosch 2010; Mcdowell & Hess 2012). The links between natural disasters in rural communities and food security have largely been connected to the effects on crop productivity and hence, food production (Gregory et al. 2005; Islam & Wong 2017). Rural households around the world, both in developing and developed nations like United States of America (USA), suffer the greatest disaster losses (Blaikie et al. 2003; Fothergill & Peek 2004).

Different literatures have studied natural disasters and climate change effect on food security, but so far very little attention has been paid specifically on the flood disaster effect on food security of smallholder farmers. However, there has been little discussion on the influence of flood disaster characteristics, flood agricultural losses, socio economic/demographic factors and recovery resources on food security in the literature. In addition, little validated models were applied in flood disaster effect analysis, hence, this study adopts the disaster impact model to be the main guide of its analysis.

Floods have been generally defined as "a natural event which involves an overflow of water where an area of land that is usually dry gets submerged under water" (Gornall et al. 2010). Similarly (Rayhan 2008) defined flood as the submerging of land by an overflowing water that can damage crops and property, disrupts people's living conditions, economic activities and endanger the lives of people and their livestock.Food security was defined as an access to sufficient food at FAO World food conference in 1974 (UN 1996), but the current definition is that of FAO World food summit (1996) defined food security as a situation, when all

people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Malaysia is a very fast developing country fortunate and relatively free from natural disasters such as volcanic eruptions, earthquakes, strong winds and hurricanes, tropical cyclones and typhoons etc. that periodically occur in its neighboring countries. However, floods remain the only severe type of disaster frequently occurring with increasing intensity in most part of the country in recent decades especially in east coast causing significant socioeconomic impact to the affected population. Kelantan is one of the states of Malaysia, whose major economic activity is primarily farming and very prone to flooding annually due to its geographical location while experiencing a major flood at least once every five years (Lim & Cheong 2015). Floods are the most frequent and severe of all disasters in Malaysia affecting millions of people and causing economic damage costing millions of ringgits annually (Chan 2012). Agricultural production in Malaysia and world over is extremely vulnerable to flood disaster and other extreme climate conditions (Vaghefi et al. 2016; Zhong et al. 2014). The implication is, the likely negative impact of flood on agriculture would automatically have an adverse effect on food production, food prices, farmer's income and potentially disrupts food security (Bandara & Cai 2014; Md. Mahmudul Alam et al. 2016) Kelantan is largely an agricultural state very prone to floods and where a majority of small-scale households depends on agriculture as a source of livelihoods (Syed Hussain & Ismail 2013). The 2014/2015 flood disaster reported to be the largest and severe flood experienced in the history of Kelantan, also referred to a "tsunami-like disaster" by National Security Council (NSC) Malaysia (Hussain et al. 2014; Lim & Cheong 2015) and is greater than those of 1927 and 1967 which were considered as the major devastating flood ever witnessed in Kelantan history where at least 70% of the villages in the state were reportedly affected (Baharuddin et al. 2015). Despite government efforts on flood risk management systems in Malaysia and Kelantan state in particular, flood conspicuously become the most severe natural disaster causing substantial tangible and intangible impact and economic damage/losses (Hussain et al. 2014; Mei et al. 2016), by damaging houses and infrastructures, destroying agricultural lands costing millions of ringgit (Abd. Rashid et al. 2007; Lim & Cheong 2015; Iya et al. 2014).

A clear understanding of the extent to which flood disaster affect agriculture and food security of smallholder farmers is critical to governments, policymakers and other stakeholders to further improve and implement holistic strategies and actions in order to minimize the effect of the disaster.

However, there is information gap in terms of quantitative effect of flood disaster on agriculture and food security in the study area, as very few or none research was carried out on the stated topic, therefore the main purpose of this paper is to fill such gap by examining the effect of flood disaster on agriculture and food security in Kelantan. However the gap of not including various parameters in flood disaster analysis such flood disaster characteristics (occurrence, duration, inundation etc.), socio economic and demographic characteristics, recovery need resources provided by government and other non-governmental organization was also considered in this paper as suggested by Mojtahedi (2015) and Paul et al (2008) that multiple variables must be taken into account including the duration, magnitude and timing of the flood disaster event. In addition to the nature, severity and the extent of the collateral damage on the society, the federal, state and local governments' response to the flood disaster effect was also taken into account.

II. Literature Review

A review on the previous literatures has showed that, flood disaster research in recent decades receive an increasing trend in the world, due to the prevailing discussion and debate on climate change disturbance among scholars. Some of the areas studied includes, natural disasters and their impacts on economic growth (Cavallo et al 2013; Hallegatte and Przyluski, 2010; Hochrainer, 2000; Sardar et al 2016; Sawada and Sothea, 2011; Shabnam, 2014; Syaheera and Shaari, 2017; Toya and Skidmore, 2005). The impact of natural disasters on agriculture and food security and/or livelihoods, in which it was highlighted that, natural disaster impacts on agriculture are negative especially in a large number of smallholder farmers living in a low income societies (Afshin, 2015; Chapagain and Raizada, 2017; FAO, 2016, 2015; Israel and Briones, 2013; Sauer, 2011; Sivakumar et al., 2005; Siwar et al 2009; Zhong et al 2014),. Most of these studies assessed both direct and indirect effects of natural disasters on economic growth using time series data sourced mostly from EM-DAT (Emergency Events Database) maintained by CRED (Centre for Research on the Epidemiology of Disasters) and few on panel and cross sectional data. In addition some of the literatures has traditionally concentrated on management and adaptation of natural disasters using qualitative data rather than social impact on the society.

Although different empirical studies that have studied the impact/effect of natural disasters, however, there has been little discussion that both engages specific type of natural disaster assessment and with the specific community, like smallholder farmers in the literature (Morton, 2007), considering the influence of flood disaster characteristics, flood agricultural losses, socio economic/demographic factors and recovery resources on

food security. However, whilst various flood damage estimation methods exist in urban areas flood losses assessment in agricultural production in rural areas are frequently neglected or measured using rough estimates.

III. Methodology

3.1 Methodological Framework

The methodological framework for this analysis on flood disaster effect on smallholder farmer's food security was developed based on Lindell & Prater (2003) disaster impact model, which was later modified by Israel and Briones (2013) as shown in the Figure 1 below.

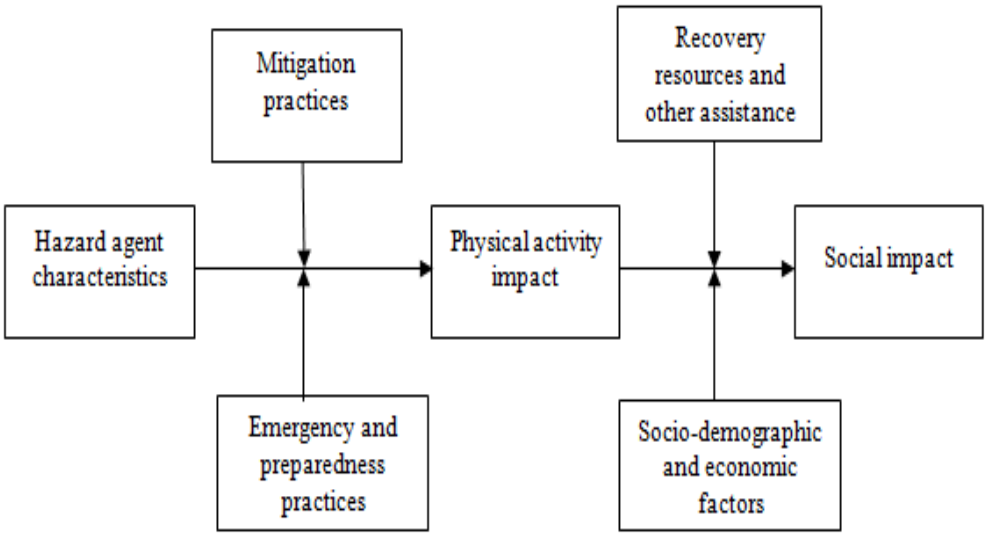

Figure 1: Disaster Impact Model by Lindell &Prater (2003)

In summary the model above depicts that hazard agent characteristics (disaster characteristics) triggered physical impact on an economic activity which consequently results in social impact at the household level in terms of its negative effect on food security and income. The physical impact is expected to be reduced by mitigation strategies and emergency and preparedness practices while social impact can be alleviated by recovery resources, other extra assistance and socio-demographic and economic factors.

3.2 Conceptual Framework

This research work adopted and further modified disaster impact model so as to further identify the how these variables of interest affect food security, as indicated in Figure 2 below, the variables include disaster characteristics (flood occurrence, duration, and inundation depth), activity impact (flood disaster effect on agriculture agricultural production) on social impact (food security). From the framework it is expected that provision of recovery resources as an intervention from government and other nongovernmental organizations would reduce the cascading negative effect on food security of the smallholder farmers. In addition, the socio-economic and demographic characteristics of the victim, such as level of his income, education, marital status, household size among others were also expected to play a vital role in alleviating the flood disaster effect on their food security problem during and after the disaster.

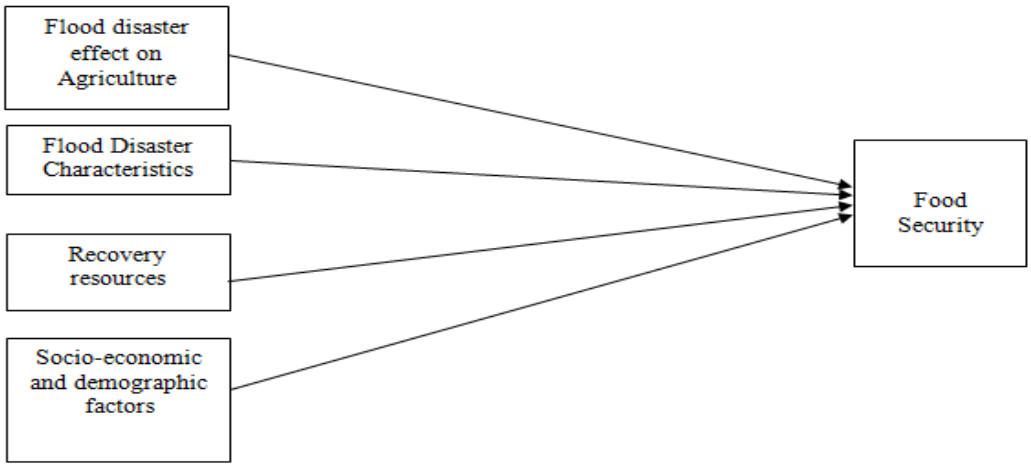

Figure2: Framework of flood disaster effect on food security based on Disaster impact model

3.3 Sampling and Questionnaire

A cross-sectional household survey using structured questionnaire was employed in collecting the required information in the study area. The questionnaire was first drafted in the English language before it was later translated in Malay by independent professionals in those languages, for better understanding on the part of the respondents. The selection of the respondents of the study was determined through the use of multistage sampling technique which ensures that all the target smallholder farmers have an equal chance of being selected for the study. For the purpose of this study 360 questionnaires were distributed disproportionately among the respondents in all the sampled districts. However only 344 questionnaires were found to be valid for the analysis, and the remaining 16 questionnaires were dropped as a result of the problem of uncompleted questionnaires and missing data.

3.4 Method ofAnalysis

Toachieve the objective of this paper, descriptive and ordered logistic regression analysis were used to analyze the data obtained from the questionnaires. Descriptive statistics was employed using SPSS version 21 to describe the socio-demographic characteristics of the respondents while ordered logistic regression analysis was employed to determine the effect of flood disaster together with socio-demographic characteristics on smallholder farmers food security status using STATA 11 tool of analysis, in the study area.

An ordered logistic regression was employed to determine the food security status of the respondents, using the procedure introduced by USDA describing four ranges of food security (1) Very low food security: at times during the year, eating patterns of one or more households were disrupted and food intake reduced. (2) Low food security: household reduced the quality, variety, and desirability of their diets. (3) Marginal food security: Household had problems at times or anxiety about accessing food but food intake was not substantially reduced. (4) High food security: household has no problems or anxiety about consistently accessing Food.

Given that the dependent variable for this study which is food security status was ordered and coded as 1, 2, 3 or 4 (1 = very low; 2 = low; 3 = marginal, and 4 = high), this implies that multiple linear regression techniques is not suitable in this case as the assumption of normality is most likely violated, hence, the most appropriate technique for variable with more than two outcomes is ordinal logistic regression model (Liu 2009)**.**

3.5 Model Specification: Ordinal Logistic Regression

Given the measurement model forOrdinal variables, it is assumed that category $4 > 3 > 2 > 1$

$Y = f(Y^*)$

$Y^* = \alpha j + X\beta + \varepsilon$

Where

Y = is an observed ordinal variable which is a function of Y* = that is unobserved or unmeasured variable.

X = is the vector of independent variables

β = is the vector of regression coefficients to be estimated

ε = s the error term

αj = is the threshold or cut points

Since our Y* is divided into some cut points or thresholds $\alpha 1$, $\alpha 2$, $\alpha 3$, $\alpha 4$, and $\alpha 1 < \alpha 2 < \alpha 3 < \alpha 4$

Considering the observed food security status level as an ordinal outcome, Y ranging from 1 to 4 the category in which each respondent falls is expressed as

$$Y = \begin{cases} 1 & if\ Y^* \leq \alpha_1 \\ 2 & if\ \alpha_1 < Y^* \leq \alpha_2 \\ 3 & if\ \alpha_2 < Y^* \leq \alpha_3 \\ 4 & if\ \alpha_3 < Y^* \leq \infty \end{cases}$$

Where Y = 1, 2, 3, 4 (1 = very low food security to 4 = high food security)
Thereforethe probability of a respondent to be at a particular level of food security can be expressed as

$$Pr[Y \leq j/X_1, X_2, X_3, X_4] = \alpha_j + (-B_1X_1 - B_2X_2 - B_3X_3 - B_4X_4)$$

$$\Pr[\ ^{y \leq j}/_{\chi}\ ] = \beta_0 + \beta_1\chi_{age} + \beta_2\,\chi_{gender} + \beta_3\,\chi_{education} + \beta_4\chi_{marital\ status} + \beta_5\chi_{house\,hold\ size} + \beta_6\chi_{flood\ occurence} + \beta_7\chi_{duration} + \beta_8\chi_{inundation} + \beta_9\,\chi_{\text{harvest failure}} + \beta_{10}\,\chi_{\text{farmer s income}} + \beta_{11}\,\chi_{r\text{ecovery resources}} + \beta_{12}\,\chi_{\text{livestock loss}} + \beta_{13}\,\chi_{\text{food prices}} + e_i$$

3.6Description ofIndependent Variables in the Model

Independent variables are used to explain the variation in the dependent variable. The variables used in this study were selected from previous studies and based on their implications from theory. Table 1 shows the variables used and their expected priori signs which were assumed to influence food security disruption of the respondents. The explanatory variables reported to affect smallholder farmer's food security include both flood disaster characteristics (Paul & Mahmood 2016; Grahn & Nyberg 2014; Ali et al. 2017; Toubes et al. 2017), direct and indirect effect on agriculture (FAO 2015; Israel & Briones 2013) and socioeconomic and demographic characteristics (Paul & Mahmood 2016; Babatunde et al. 2007; Jonkman et al. 2008) recovery needs resources (food aid, cash transfer) provided by government and other non-governmental organizations in order to alleviate the effects of flood disaster (Okuyama & Chang 2004; Devereux 2006).

Table 1: Definition of the Explanatory Variables and their Expected Signs

Variable	Symbol	Definition	Expected Sign
Age	Age	Age of respondent in years	+Ve, -Ve
Gender	Sex	Sex of respondent (1 if male and 0 if female)	+Ve, -Ve
Education	Educ	Education of respondent (years of schooling)	+Ve
Marital Status	Mrs	1 if married and 0 otherwise	+Ve, -Ve
Household Size	Hhs	Household size (number of individuals)	+Ve, -Ve
Flood Occurrence	Occur	Number of times flood occur in a year	-Ve
Flood Duration	Dur	Number of days of submersion	-Ve
Flood Inundation	Inund	Depth in meters	-Ve
Harvest Failure	Hf	1 failure and 0 otherwise	-Ve
Farmers Income	Fincme	Household per capita income	+Ve
Recovery Resources	Rr	1 if received and 0 otherwise	+Ve
Livestock Losses	Livlos	Monetary value of the losses	-Ve
Food Prices	Fp	1 if increased and 0 otherwise	-Ve

IV. Results And Discussion

4.1 Background oftheRespondents

Table 2. Shows the characteristics of the interviewed smallholder farmers with regards to their socioeconomic and demographic profiles, in which 84% of the respondents were reported to be males and only 16% were females and this indicates that farming is predominantly males business who have a greater responsibility of providing food and other basic necessities to the family. 98% of the respondents were Malays, 53.5% fall within the age range of 41-59 years, and about 90.1% were found to be married, moreover, the highest level of education among the respondents is secondary with 56.4%. Majority of the respondents (66%) had income below RM3000.

Table 2: Socioeconomic andDemographic Profile oftheRespondents

Characteristic	Freq.	Percentage
Gender		
Male	289	84.0
Female	55	16.0
Race		
Malay	337	98.0
Chinese	6	1.7
Age Group		
21-40 Years	63	18.3

41-59 Years	184	53.5
60 And Above	97	28.2
Primary Occupation		
Farming	281	81.7
Labor	30	8.7
Handcraft/Trade	15	4.4
Marital Status		
Married	310	90.1
Widowed/Divorced	30	8.8
Single	4	1.2
Level Of Education		
Islamic Education Alone	38	11.0
Primary	97	28.2
Secondary	194	56.4
Household Size		
1-5 Family Members	278	80.8
6-10	61	17.7
>10	5	1.5
Income		
Below 3000	227	66
Above 3000	117	34

Table 3 below described the distribution of food security levels after 2014/2014 flood disaster among the affected smallholder farmers in Kelantan, it is shown that 44% which is the highest percentage among the levels, were high food secured even in the event of that catastrophic flood disaster, and this is attributable to their level of income and prompt government provision of recovery needs resources in terms of food aid and cash transfer as it was found to be significant and positively related to food security in table 5 below. Similarly, 30.5% of the respondents felt very low food secured, 7.6 low food secured and 17.4 % marginally food secured.

Table 3: Description ofFood Security Levels afterFlood

Food Security Levels	Frequency	Percentage	Cumulative
Very Low Food Security	105	30.5	30.5
Low Food Security	26	7.6	38.1
Marginal Food Security	60	17.4	55.5
High Food Security	153	44.5	100
Total	344	100	

3.2 Ordered Logistic Regression Analysis Results

The result of the ordered logistic regression model in table 5 below, revealed that, log likelihood ratio chi-square test LR $\chi 2 = 127.61$. P = 0.000 indicates that the combined effect of all the variables in the model is different from zero, and the model as a whole is statistically significant compared to the null model with no predictors. The four levels of food security status are indicated by three cut point categories, namely, Cut 2 is insecure, Cut 3 less secure and Cut 4 marginally secure, and therefore the standard comparison is the secure level. Assuming all other things being equal (1) the probability of food security level (insecure): Pr insecure $\leq$ 0.113; (2) the probability of food security level (less secure): Pr < 0.113 less secure $\leq$ 1.086; the probability of food security level (marginally secure): Pr < 1.086 marginally secure $\leq$ 1.542; and probability of food security (secure): Pr (secure > 1.542).

Table 4. An Ordered Logistic Regression Analysis Results

Variable	Coefficient	SE	Z-Stat	Prob.	Odds Ratio
Age	-0.003	0.010	-0.03	0.972	0.999
Gender	0.563	0.223	2.52	0.012	1.757
Marital Status	1.130	0.430	0.63	0.009	3.097
Education	0.009	0.047	0.21	0.837	1.009
Household Size	-0.309	0.427	-0.72	0.469	0.734
Farmers Income	0.987	0.285	3.46	0.001	2.685
Recovery Resources	1.030	0.332	3.10	0.002	2.802
Food Prices	-0.130	0.074	-1.69	0.090	0.882
Flood Occurrence	-0.007	0.536	-0.01	0.989	0.993
Flood Duration	-0.629	0.301	-2.09	0.036	0.533
Flood Inundation	-0.074	0.057	-1.30	0.194	0.928
Harvest Failure	-0.710	0.147	-4.82	0.000	0.491
Livestock Losses	-0.002	0.004	-1.43	0.154	0.999
Cut1	0.113	1.225			
Cut2	1.086	1.226			
Cut3	1.542	1.230			
LR Chi 2	= 127.61				

Prob. > Chi2	= 0.000
Pseudo R2	= 0.1517

Based on the results of z statistics it is indicated that smallholder farmers income ($\beta = 0.987$ $p = 0.001$, marital status ($\beta = 1.130$, $p = 0.009$), sex ($\beta = 0.563$, $p = 0.012$) and recovery resources ($\beta = 1.030$, $p = 0.002$) were all found to be significant at 5% and positively related to their food security status, this indicates that, their level of income and prompt response in terms of provision of adequate food aid and cash transfers from government and other non-governmental organization to flood victims make their food security not adversely affected even though, harvest failure ($\beta = -0.710$, $p = 0.000$) and flood duration ($\beta = -0.629$, $p = 0.036$) were found to be significant at 5% and negatively related to food security status of the smallholder farmers which indicated that crop losses as a result of flood disaster would consequently affect the food security of the affected smallholder farmers since it is their major source of livelihood, and this is consistent with the work of (Gichere et al. 2013) who reported that farmers in lake Victoria basin of Kenya incurred crop failure and poor yield as a result of flood disaster.

With regards to proportional odds ratios the results from Table 5 further indicated that respondents' gender (sex), marital status, level of education and recovery resources are all greater than one (>1), meaning that, their odds from being food insecure to secure is greater. For gender, being a male respondent the odds from being food insecure to food secure is 1.757 greater, given that all other variables in the model are held constant. For marital status, being a married respondent the odds from being food insecure to food secure is 3.097 greater, given that all other variables in the model are held constant. Similarly for respondent level of education, for any increase in the level of education of the respondent, the odds from being food insecure to food secure is 1.009 greater, given that all other variables in the model are held constant. For any increase in one of respondent's level of income the odds from being food insecure to food secure is 2.685 greater, given that all other variables in the model are held constant. Looking at the recovery resources (food aid and cash) received by the respondents, for any quantity increase of food aid and cash received by the respondent, the odds from being food insecure to food secure is 2.802 greater, given that all other variables in the model are held constant.

Therefore, the adequate income of smallholder farmer helps in boosting his purchasing power to attain food security during and after flood disaster, similarly adequate provision of recovery resources to the affected farmers will also satisfy their necessary food requirements during and after the event. This result is consistent with the result of the study by (Suharyanto. et al. 2014) which confirms that farming households in Bali were found to be positively and significantly related to food security.

However**,** explanatory variables such as age, food prices, household size, flood occurrence, inundation depth, livestock and farm assets losses were not significant but found to be consistent with the priori expectation of a negative relationship with the dependent variable. Fluctuation of food prices has negative effect on consumer's purchasing power which in turn affect his accessibility of adequate quantity and quality of food he required (Suharyanto. et al. 2014).

V. Conclusion

The global climate change variability highlighted that flood disaster results in disruption of livelihoods, destruction of properties and loss of human lives across the world. This paper examines the potential effects of 2014/2015 flood disaster on smallholder farmer's food security in the Kelantan state of Malaysia using ordered logistic regression analysis. The findings of this study revealed that although smallholder farmers experienced significant harvest failure in terms of crop production losses and yield reduction, their food security has not been adversely affected but there are some short term disruptions, as more 1/3 (one third of the respondents) reported that, they are food insecure during and after the flood disaster, and this also indicates that smallholder farmers in the study area are vulnerable to flood disaster cascading negative effect on their livelihoods in the future if adequate planning were not taken. This is consistent with the work of Mallick et al. (2017) who reported that the livelihoods of the affected communities who were mostly farmers in the southwestern coastal region of Bangladesh were disrupted and are physically vulnerable to cyclone disasters. In addition, it is evident that recovery needs resources plays a vital role on smallholder farmer's food security in the study area. Therefore, provision of adequate recovery resources in terms of food aid and cash transfer, and other proactive measures should greatly be intensified so as to achieve wider and equitable distribution to the future affected communities and individual farmers since flood disaster occurrence is inevitable.

These findings have a number of implication for policy makers, academicians and society. Although this study revealed that majority of the respondents food security was not adversely affected by the flood disaster due prompt and adequate response from government and other stakeholders in terms of recovery resource provisions, policy makers should place more emphasis on proactive measures (structural and non-structural mitigation measures) rather than reactive (response and recovery) that is usually done after the disaster strikes, and this would save lives, cost of damages to the respondent and government expenditure on recovery

resources. Thus, this give an avenue for future research to focus on mitigation strategies and other related variables helps in preventing flood disaster effect on food security in the study area and beyond.

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Author Contributions: Abdussalam Adamu Jega conceptualized the study, analyzed the data, interpreted the result and drafted the paper. Norsida Man conceived the study, facilitated data collection and provided her suggestion for the study. Ismail Abd Latiff and Kelly Wong Kai Sengprovided their critical suggestions on the study.

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