The Impacts of Climatic and Non-climatic Factors on Household Food Security: A Study on the Poor Living in the Malaysian East Coast Economic Region

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Abstract

Sustainable food security at household level is a national concern in many countries. The reasons for household food insecurity include social, economic, political, and personal factors as well as climatic changes and its outcomes. This research aims at finding out the linkage of the factors of climatic changes, non-climatic factors and household resiliencies with the level of household food security among the poor and low income households in Malaysia. This study is based on primary data that were collected in Jul-Oct 2012 through a questionnaire survey on 460 poor and low income households from the Pahang, Kelantan, and Terengganu States of Malaysia. The sample was selected from *E-Kasih* poor household database based on cluster random sampling technique. Initially the study measures household food security according to the USAID-HFIA model, and ran ordinal regressions under the logit and probit models. This study finds that household food insecurity is not only linked with social and economic factors, but also significantly linked with the climatic factors. Therefore, the food security programs need to be integrated with the adaption programs for climatic change.

Key words: *Climatic Changes, Household Food Security, Poverty, Ordinal Regression, Resilience, East Coast Economic Region, Malaysia*

JEL Code: I32, Q54, P48

1. Introduction

The 2008 global food crisis serves as a prelude to a more acute food crisis in the future. As a result, food security is now a national issue for many countries. The major food security concern is about making agricultural production sufficient for domestic consumption and capability for making food available and accessible from international markets.

Sustainable food security at the household level is also equally important because national food security is not enough to ensure sustainable food security at the household level. The drivers of household food security are in fact more crucial than national level because while food security is defined in its most basic form as access by all people at all times to foods needed for a healthy life (FAO 2003:28). As such, the focus of food security should be on the household as the basic unit in the society. This distinction is important because activities directed towards improving household food security may be quite different from those aimed at improving food security in general.

There are many factors that drive household food insecurity. According to Lovendal and Knowles (2006), these factors include political, economic, environment, natural, social, infrastructural, and health issues. Frankenberge (1992) puts forward that assets, community inequalities, risk-minimizing strategies, and coping strategy are also important drivers. Nyariki and Wiggins (1997) gives utilization of physical, natural, and human resources, availability of technology, and off-farm jobs as factors that drives household to food insecurity. Workneh (2006) mentions that the major drivers are capability to produce own food, growth of purchasing power. Iram and Butt (2004), ECA (2004), Cristofar and Basiotis

(1992), and Olson et al. (1997) and Rose et al. (1995) adds household's demography, access to land, land tenure system, ability to utilize the land productively, and savings to the list of factors. Other researchers, such as Fartahun et al. (2007), Hindin (2006), Myntti (1993), Pfeiffer et al. (2001) Piaseu (2006) and Workneh (2006), widens the list to include women with income-earning capability, women education, sufficient income, number of children, social support, accessibility to productive resources, educational level, land holdings, accessibility to transport, livestock productivity, awareness of suitable interventions, storage technology, and unemployment level.

Changes in the climatic factors and its outcomes would also affect household food security. According to IPCC (Intergovernmental Panel on Climate Change) and Fourth Assessment Report, food security and malnutrition will be severely affected by climate change and variability (IPCC 2007a). FAO (2008 and 2007) has also stressed that climate change affects the availability of food, food supply stability, accessibility to food and utilization of food. This in turn results in negative impacts on nutrition and food security. Water scarcity and droughts reduce the nutritional diversity and decrease the general food consumption, which would cause malnutrition such as micronutrient deficiencies, protein-energy malnutrition, and under nutrition (IPCC 2007). The increase in rainfall, temperature, sea levels, salinity give rise to flooding in human settlement areas. (Cruz et al. 2007Mimura et al. 2007). It may also causescarcity of freshwater (Kundzewicz et al. 2007), increase diarrhea and other contagious diseases (Checkley et al. 2000; Kovats et al. 2004; Zimmerman et al. 2007). Climatic changes also have impacts on food distribution, influencing people's access to markets to sell or purchase food (Abdulai and CroleRees 2001), increase food prices (Cline 2007; von Braun 2007), and reduce real income (Thomsen & Metz 1998).

Malaysia is a fast developing country with a fairly diversified economy. According to EIA (2005), carbon dioxide (CO₂) emissions in Malaysia have increased by 221% during the period from 1990 to 2004 and is included in the list of 30 biggest greenhouse gas emitters. Global warming is expected to elevated temperature by 0.3-4.5°C. Warmer temperature will cause sea level rise by about 95cm over a hundred-year period and changes in rainfall between -30% to +30%. It reduces crop yield and cause drought in many areas so that cultivation of some crops will not be possible (MOSTE 2001). Moreover, projections on maximum monthly precipitation to increase by 51% over Pahang, Kelantan and Terengganu, while minimum precipitation decreases between 32% and 61% for the whole of Peninsular Malaysia. Consequently, annual rainfall may increase up to 10% in Kelantan, Terengganu, Pahang and North West Coast, and decrease up to 5% in Selangor and Johor (NAHRIM 2006). Tisdell finds that rainfall variability increases the level of environmental stress that affects the capability of the system to maintain productivity (Tisdell 1996).

Under the current climate change scenario, temperatures above 25°C may reduce grain mass at 4.4% per 1°C rise (Tashiro 1989), and grain yield may decline as much as 9.6%-10.0% per 1°C rise (Baker 1993). Singh et al. (1996) reveals that the actual farm yields of rice in Malaysia vary from 3-5 tons per hectare, where potential yield is 7.2 tons. The study also unfolds that there is a decline in rice yield between 4.6%-6.1% per 1°C temperature increase and that doubling of CO₂ concentration (from present level of 340ppm to 680ppm) which may offset the detrimental effect of 4°C temperature increase on rice production in Malaysia. Overall, based on the analysis of minimum and maximum yield of the last 28 years, the macro cases of the national data from 1980 to 2008 of Malaysia show that the yield of paddy would decrease between 43% and 61% if there is a 1°C temperature and 1 millimeter (mm) rainfall increase (Ali and Ali 2009). In a recent study, based on the

micro data on paddy field of Integrated Agricultural Development Area (IADA), it was found that in North-West Selangor, temperature increased by 1% which might lead to 3.44% decrease in current paddy yield and 0.03% decrease in paddy yield in the following season; and rainfall increased by 1% which might lead to 0.12% decrease in current paddy yield and 0.12% decrease in paddy yield in the following season (Alam et al. 2014).

Malaysia joined 185 other nations in signing the Declaration of Rome at the 1996 International Food Summit, pledging to reduce the prevalence of hunger by at least 50%, within its own jurisdiction, by a target date some time in the early 21st century. However, in Malaysia, the food security has been embedded into the theme of self-sufficiency level that referred to paddy or rice sector only (Arshad et al. 1999; Alam et al. 2011; 2012a), instead of having a specific or special policy on overall food security. To ensure food security in Malaysia, the government adopts two strategies, such as establishing self-sufficiency level and building rice stocks both domestically and internationally. However, Malaysia has never met the food self-sufficiency level. About 10% to 35% of total required rice is imported from neighboring countries, such as Thailand, Vietnam, Myanmar, India, and Pakistan. The highest food self-sufficiency level for the country was 95% and the lowest was 65%, which were recorded in 1975 and 1990 respectively.

As climate change is one of the major potential threats to national food security in Malaysia, there is a strong possibility that climatic change is linked with household food security of the country. To ensure food security and proper policy options in Malaysia, it is very important to study the current situation of household food security and the linkage between the changes in climatic factors and sustainable food security at household level. Very few works have been conducted on the impacts of changes in climatic factors and its' outcomes on household food security in Malaysia (Alam et al., 2016a; 2016b). Hence, this paper is an attempt to conduct an in depth study on this issue. The findings of this study will be helpful for the policy makers to achieve the *Vision 2020* – to become a fully developed nation by the year of 2020 – and setting targets in national development plans on food security, socioeconomic betterment, and poverty alleviation.

2. Data, Model and Methodology

2.1 Data Collection

For the empirical assessment, this study mostly relies on primary data that are collected through an extensive questionnaire survey at household level in East Coast Economic Region (ECER) in Malaysia. This study has selected ECER as the study area because ECER is more than half of the Peninsular Malaysia with the area of about 66,000 sq kilometer that covers the states Kelantan, Terengganu, Pahang, and the district of Mersing in Johor (Figure 1). ECER is very crucial for two major reasons; (a) ECER is the most vulnerable area in Malaysia due to climatic changes and (b) the income level of this region is low and poverty rate is high that is a hindrance to achieve vision 2020 (Alam et al., 2012b; ECER Master Plan. 2007, 2008). The population of ECER was about 3.95 million, which represents 14.8% of the total population of Malaysia in 2005. In 2004 the incidences of poverty were 10.6%, 4%, and 15.4% in Kelantan, Pahang, and Terengganu respectively, whereas for overall Malaysia it was 5.7%, and the incidences of hardcore poverty were 1.3%, 1.0%, and 4.4% in Kelantan, Pahang, and Terengganu respectively, whereas for overall Malaysia it was 1.2%. At that time, there were about 45,000 paddy farmers in the ECER, and

the average productivity per worker was RM 11,915 whereas the national agriculture productivity per worker was RM 15,355.

ECER is mainly an agricultural region. In 2004, all crops production covered a total area of 2.22 million ha in the ECER (34.8% of Peninsular Malaysia). However, in 2008 government officially launched a very large development project to develop five key areas – manufacturing, oil, gas & petrochemicals, tourism, agriculture and human capital development. With the objective of fast-forwarding the inflow of FDI and industrialization in the region, ECER Special Economic Zone (ECER SEZ) and Malaysia-China Kuantan Industrial Park were initiated in this area. Therefore, ECER is expected to implement projects worth an estimated RM 112 billion in value by year 2020. The ECER Special Economic Zone (SEZ) is expected to generate up to RM 90 billion in investments and contribute RM 23 billion to the national GDP, as well as create 220,000 new jobs out of the 560,000 jobs identified.

Figure 1: Location of the Study Area (ECER-Malaysia)

Source: Alam et al., 2012b

The study follows two-stage cluster random sampling technique. Initially the samples are clustered by location and then by poverty category. Finally, from each category, samples are picked randomly from the *E-Kasih* database – which is an integrated database system that enlisted poor households at the national level to plan, implement and monitor poverty programs. The urban area of Kuantan and rural area of Pekan is selected from Pahang state. The urban area of Kota Bharu and rural area of Tumpat is selected from Kelantan state. The urban area of Kuala Terengganu and rural area of Marang is selected from Terengganu state.

Based on the formula of required size of samples (Yamane, 1967: 886), first, 400 households were selected according to the proportion of population distribution. However, to ensure a good number of observations for each group, which was needed for sound statistical analysis for any particular group, another 100 households were added to the sample. However, while targeting the sample size to be 500, after collecting and validating the data, finally, 460 households remained in the sample. The final distribution of the collected sample is given in the Table 1.

Table 1: Distribution of the Sample of the Study

	Pahang		Kelantan		Terengganu		Total		All
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Total
Hard core Poor	2	15	33	22	6	32	41	69	110
Poor	12	14	21	34	27	46	60	94	154
Recently Marginally Non-poor	11	9	15	16	4	16	30	41	71
Marginally Non-poor	18	30	32	25	4	16	54	71	125
Total Target Group	43	68	101	97	41	110	185	275	460
State Total		111		198		151		460	

* In the *E-Kasih* system, the rural poverty data were categorized as monthly income per person up to RM110 is hard-core poor, up to RM185 is poor, and up to RM227 is marginally non-poor, and for urban area up to RM120 is hard-core poor, up to RM200 is poor, and up to RM340 is marginally non-poor.

A face-to-face interview based on structured questionnaire is used to collect data, where the respondents provide the answers and the enumerators filled-up the questionnaire. The survey is conducted by the regular enumerators of the Implementation Coordination Unit (ICU) agency from Pahang, Kelantan, and Terengganu in Jul-Oct 2012.

2.2 Model Specification

To measure the relationship between household status of food security and the climatic and general factors affecting on food security, the following *ordered dependent regression* or *ordinal regression* is conducted based on *logit* and *probit* models:

$$\begin{aligned}
 Z_i &= (Y1, Y2) \\
 X_i &= (X1, \dots, X63) \\
 Z_i &= f(X_i)
 \end{aligned} \tag{1}$$

In this study, the two dependent variables, the household status of food accessibility and household food availability, are considered as the measurements of household food security. Household food availability is based on measurement on the direct perception of the household, where household status of food accessibility measurement was based on the frequency of calculation. To measure the status of household food availability, households have been asked about their food status in last one month (see Table 2), and to measure the status of household food accessibility, this study follows direct measuring questionnaire-based techniques developed by Coates et al. (2007) for USAID which is known as Household Food Insecurity Access (HFIA) (Table 3).

The list of the independent variables of the study consists of different resilience factors of household (X1-X18), non-climatic factors (X18-X44), and climatic factors (X45-X63). These variables are considered from all of the four dimensions of food security – availability of food, stability of supply, accessibility to food, and utilization of food (FAO, 2005, 2008). The availability of food means sufficient quantities of quality food available at household level. The accessibility of food means household's access to sufficient resources, including a set of all commodity bundles that an individual can gain access based on the legal, economic, political, and social arrangement of a community in which they live, for getting quality foods for a nutritious meal. Food utilization shows the significance of non-food inputs in food security such as proper diet, clean water, healthcare, and sanitation to gain

nutritional well-being where all physiological requirements are met. Food system stability refers to a households having access to sufficient food at all times so that they should not risk losing access to food as a result of sudden crisis such as an economic or climatic crisis or cyclical occurrence such as seasonal food insecurities. Here, the resilience refers to the households' capacity or strength to cope with stress and hardship in case of actual or expected food insecurity which are categorized as socioeconomic, physical assets, and livelihood strategy and behavior. The measurements of all of the variables are given in the appendix.

To check the best fit model and robustness, this study reports both the probit and logit model, but for analysis it mostly focuses on the logit model. Logit and probit model looks like a sigmoid function with a domain between 0 and 1, which makes them both quantile functions based on the assumption that logit model that follows logistic distribution and probit model follows normal distribution. Normally, logit model is used when every observation has equal probability. Furthermore, a correlation analysis is undertaken in order to find out the relationship among the relevant variables and to check the multicollinearity problem. Finally, this study also justifies how the endogeneity and causality problems are considered under the study.

3. Results and Discussion

3.1 Measurement of Household Food Security

In terms of household food availability, 14.8% say they have enough food what they like, but majority (41.1%) of the households mention that always they don't have enough kind of food they like. 9.1% of the households mention that they frequently stay hungry (Table 2).

Table 2: Family Food Status in Last One Month

Food Status in the Family	No of Households	% of Total
Enough of the kinds of food you want to eat	68	14.8%
Enough but not always the kinds of food you want	189	41.1%
Sometimes not enough to eat	100	21.7%
Often not enough to eat	61	13.3%
Frequently stay hungry	42	9.1%
Total	460	100%

Household Food Insecurity Access (HFIA) is calculated for each household by assigning a code 1-4, where 1=Food Secure Access, 2=Mildly Food Insecure Access, 3=Moderately Food Insecure Access, 4=Severely Food Insecure Access. Initially the data are coded frequency-of-occurrence as 0 for all cases where the answer to the corresponding occurrence question is "no" (i.e., if Q1=0 then Q1a=0, etc.). Then the intensities of the occurrence of nine questions are measured in three frequencies – rarely (1-2 times per month) or sometimes (3-10 times) or often (10+ times per month) – which indicate by Q1a to Q9a (Table 3). Finally, the four food accessibility categories are created sequentially, to ensure that households are classified according to their most severe response.

- Category = 1 if [(Q1=0 or Q1=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]

- Category = 2 if [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]
- Category = 3 if [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or cQ6a=2) and Q7=0 and Q8=0 and Q9=0]
- Category = 4 if [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3]

The following table illustrates the above four categorizations, where every household is placed in a single, unique category based on the set of the responses (Table 3).

Table 3: Measurement of Household Food Insecurity Access Scale

HFIA Measurement Issues	Category of food insecurity (access)		
	Rarely (1-2 times per month)	Sometimes (3-10 times)	Often (10+ times per month)
Q1 Worry about food			
Q2 Unable to eat prefer food			
Q3 Eat just a few kinds of foods			
Q4 Eat foods they really do not want eat			
Q5 Eat a smaller meal			
Q6 Eat fewer meals in a day			
Q7 No food of any kinds in the household			
Q8 Go to sleep hungry			
Q9 Go to whole day and night without eating			
Food Secure Access		Mildly Food Insecure	Moderately Food Insecure
			Severely Food Insecure

Source: Coates et al. 2007; Alam et al. 2016a

Based on the survey, this study finds that 52.8% of the households are under the category of “food secure access”. Among the surveyed households, 23.3% are facing mildly food insecurity (access) who are worried about not having enough food sometimes or often, and/or unable to eat preferred foods, and/or rarely eat a more monotonous diet than desired and/or also rarely eat some undesirable foods (Table 4).

Table 4: Distribution of Household Food Insecurity Access (HFIA)

HFIA Category	HFIA Prevalence	% of HFIA Prevalence
1= Food secure Access	243	52.8%
2= Mildly Food Insecure Access	107	23.3%
3= Moderately Food Insecure Access	66	14.3%
4= Severely Food Insecure Access	44	9.6%
Total	460	100.0%

Among the households, 14.3% are moderately food insecure. These households frequently sacrifice quality of food by eating a monotonous diet or undesirable foods sometimes or often, and/or reduce eating the quantity of food rarely or sometimes. There are 9.6% of households that are severely food insecure who has graduated to cutting back on meal size or number of meals often, and/or experiences any of the three most severe conditions – running out of food, going to bed hungry, or going a whole day and night without eating – even as infrequently as rarely or at least once in the previous month (see details in Alam et al. 2016a).

3.2 Household Status of Food Security and Relevant Factors

The regression models based on Equation 1 show that some of the resilience factors have statistically significant relationship with household food availability and food accessibility (Table 5). The P-values of the likelihood ratio (LR) statistics for both models are shown below 0.0000001 that suggest a very good fit of the models. The pseudo R-squares are 0.354 for food availability and 0.305 for the food accessibility models.

Results for household food availability (Y1) models indicate that the climatic impacts on kitchen environment (X58) and sanitation system (X60) are statistically significant. Among the non-climatic/general factors, competition for common resources (X31), common resources dependency for cattle or livestock feeding (X30), incidences of disease like dengue, malaria, heat stretch, cold, skin disease (X44), having knowledge about taking precaution against dengue, malaria (X17), buying bulk amount of food (X12), household poverty/economic status (X3), earning ratio (X6), and number of school going children (X2) are statistically significant.

Table 5: Relationship between Household Status of Food Security and Relevant Climatic and Non-climatic/General Factors

Variable	Dependent variable Y1				Dependent variable Y2			
	Ordered Probit		Ordered Logit		Ordered Probit		Ordered Logit	
	Odds Ratio	Prob.	Odds Ratio	Prob.	Odds Ratio	Prob.	Odds Ratio	Prob.
<i>Household resilience factors: socioeconomic</i>								
X1	1.114	0.449	1.302	0.318	0.994	0.956	1.004	0.981
X2	0.722*	0.007	0.528*	0.005	0.652*	0.000	0.486*	0.000
X3	0.739*	0.002	0.590*	0.003	0.821*	0.004	0.719*	0.005
X4	1.264	0.467	1.822	0.306	2.315*	0.002	4.191*	0.002
X5	0.982	0.964	0.846	0.828	0.865	0.558	0.760	0.521
X6	1.181	0.136	1.412~	0.092	1.385*	0.001	1.800*	0.001
X7	1.193	0.542	1.404	0.521	1.489~	0.093	1.811	0.146
<i>Household resilience factors: physical assets</i>								
X8	0.830	0.467	0.690	0.430	1.275	0.195	1.473	0.222
X9	1.065	0.825	1.017	0.974	1.289	0.210	1.466	0.278
X10	0.857	0.294	0.741	0.263	1.044	0.684	1.104	0.592
X11	1.445	0.176	1.801	0.232	1.797*	0.002	2.769*	0.001
<i>Household resilience factors: livelihood strategy and behavior</i>								
X12	2.098*	0.006	4.046*	0.006	1.057	0.754	1.080	0.796
X13	1.074	0.623	1.144	0.631	1.051	0.634	1.091	0.624
X14	1.220	0.221	1.444	0.220	1.194	0.153	1.333	0.182
X15	0.782	0.269	0.632	0.274	1.119	0.456	1.202	0.478
X16	1.085	0.616	1.139	0.665	1.049	0.683	1.074	0.724

X17	1.673^	0.039	2.602^	0.035	1.026	0.851	1.058	0.809
<i>Non-climatic factors</i>								
X18	0.839	0.318	0.657	0.182	1.035	0.775	1.028	0.892
X19	1.212	0.201	1.475	0.165	1.022	0.851	1.041	0.836
X20	1.222	0.228	1.500	0.194	0.992	0.944	0.994	0.977
X21	1.079	0.677	1.144	0.688	1.051	0.675	1.109	0.603
X22	0.828	0.299	0.676	0.234	0.791~	0.079	0.663~	0.073
X23	1.114	0.495	1.246	0.444	0.760^	0.018	0.630^	0.019
X24	1.087	0.485	1.169	0.473	0.947	0.543	0.936	0.660
X25	1.168	0.301	1.417	0.219	1.038	0.740	1.077	0.697
X26	0.873	0.290	0.772	0.268	0.809^	0.022	0.682^	0.016
X27	1.075	0.657	1.155	0.624	1.100	0.385	1.183	0.365
X28	0.933	0.649	0.876	0.645	0.945	0.617	0.913	0.631
X29	1.235	0.123	1.355	0.221	0.917	0.401	0.846	0.349
X30	1.343^	0.041	1.823^	0.025	0.967	0.751	0.927	0.674
X31	0.803~	0.092	0.662~	0.076	1.127	0.227	1.246	0.199
X32	1.084	0.526	1.133	0.600	1.023	0.830	1.046	0.807
X33	0.855	0.302	0.710	0.226	1.062	0.598	1.140	0.504
X34	0.820	0.252	0.693	0.245	0.840	0.211	0.763	0.259
X35	1.121	0.527	1.288	0.451	0.877	0.369	0.755	0.268
X36	0.935	0.680	0.877	0.661	0.833	0.130	0.731	0.127
X37	0.959	0.786	0.919	0.764	1.175	0.177	1.328	0.164
X38	1.148	0.418	1.200	0.565	1.180	0.190	1.319	0.197
X39	1.084	0.530	1.240	0.371	1.068	0.463	1.124	0.447
X40	0.803	0.186	0.661	0.166	0.909	0.407	0.872	0.482
X41	0.833	0.130	0.708	0.124	1.140	0.214	1.267	0.184
X42	0.983	0.881	0.960	0.843	1.131	0.136	1.253	0.109
X43	0.761	0.166	0.591	0.145	1.503*	0.001	2.024*	0.001
X44	1.817*	0.001	3.179*	0.001	0.839~	0.102	0.741~	0.098
<i>Climatic factors</i>								
X45	0.866	0.311	0.797	0.385	0.844~	0.098	0.747~	0.094
X46	0.688	0.152	0.465	0.126	0.489*	0.000	0.303*	0.000
X47	0.868	0.338	0.752	0.297	0.847	0.137	0.757	0.142
X48	1.308	0.221	1.450	0.344	1.631*	0.001	2.269*	0.001
X49	0.981	0.924	1.104	0.794	0.806	0.153	0.695	0.160
X50	1.061	0.722	1.046	0.888	0.980	0.873	0.979	0.919
X51	0.946	0.682	0.899	0.675	1.059	0.565	1.129	0.487
X52	1.060	0.648	1.150	0.537	0.996	0.968	0.983	0.917
X53	1.003	0.983	1.035	0.888	1.114	0.303	1.195	0.313
X54	0.906	0.471	0.840	0.498	0.906	0.325	0.855	0.366
X55	1.212	0.213	1.483	0.154	1.061	0.626	1.109	0.616
X56	0.857	0.344	0.757	0.337	1.055	0.665	1.075	0.728
X57	0.985	0.926	0.972	0.921	0.935	0.591	0.892	0.595
X58	0.564*	0.002	0.329*	0.001	0.832	0.150	0.718	0.132
X59	1.358	0.100	1.690	0.114	1.032	0.823	1.073	0.770
X60	1.357^	0.046	1.828^	0.035	1.210	0.104	1.403~	0.099
X61	0.811	0.153	0.680	0.147	0.876	0.218	0.787	0.192
X62	0.802	0.152	0.692	0.192	0.837	0.104	0.731~	0.091
X63	0.889	0.331	0.801	0.305	1.113	0.266	1.189	0.291
Pseudo R-squared	0.350		0.354		0.306		0.305	
Prob (LR statistic)	<0.0000001		<0.0000001		<0.0000001		<0.0000001	
Sample Size	460		460		460		460	

*, ^, ~ indicates significant at 1%, 5%, 10% significance level, respectively

In terms of odds ratios, results from the availability of food at household (Y1) logit model indicates that holding other things constant, for a unit increase in the common resources dependency for cattle or livestock feeding (X30), the odds in favor of availability

of food at household (Y1) increases by 1.823 or about 82.3%. Similarly, there is a 160.2% increase of odds of availability of food in the household (Y1) for a one-unit increase in knowledge about taking precaution against dengue, malaria (X17). The odds of household food availability (Y1) for household buying bulk amount of food (X12) is 304.6% higher than the odds of household food availability (Y1) for household without buying bulk amount of food. For a unit increase in the earning ratio (X6), the odds in favor of availability of food at household (Y1) increases by 1.412 or about 41.2%

Holding other things constant, for a unit increase in climatic issues affecting kitchen environment (X58) where the odds in favor of unavailability of food in the household (Y1) increases by (1-0.329) or about 67.1%. Similarly, there is a 33.8% increase of odds of unavailability of food at household (Y1) for a one-unit increase in competition for common resources (X31). For a unit increase in poverty level or decrease of household poverty/economic status (X3), the odds in favor of unavailability of food at household (Y1) increases by (1-0.59) or about 41%. Similarly, there is a 47.2% increase of odds of unavailability of food at household (Y1) for a one-unit increase in number of school going children (X2).

Results for household status of food accessibility (Y2) models show that among the climatic factors, natural disasters at local level (X45), and climatic impact on income (X46), climatic impact on household food storage system (X48), climatic impact on household sanitation system (X60), and climatic impact on increases of short term food prices (X62) are statistically significant. Among the non-climatic/general factors, prices of general food items (X22), difference between rural and city food prices (X23), low level of income (X26), incidences of mosquitoes, insects, pest (X43), incidences of disease (X44), household transportation (X11), household poverty/economic status (X3), earning ratio (X6), spouse doing job (X4), and number of school going children (X2) are statistically significant. According to the probit model, households having savings (X7) also show a statistically significant relationship with household status of food accessibility.

With reference to the food accessibility at household (Y2) logit model, the odds ratio indicate that holding other things constant, for a unit increase in climatic impact on household food storage system (X48), the odds in favor of food security at household (Y2) increases by 2.269 or about 126.9%. Similarly, there is a 80% increase of odds of food accessibility at household (Y2) for a one-unit increase earning ratio (X6). The odds of household food accessibility (Y2) for household having transportation (X11) is 176.9% higher than the odds of household without having transportation. The odds of household accessibility (Y2) for spouse doing job (X4) is 319.1% higher than the odds of household without spouse doing job. The odds of household food accessibility (Y2) for household have savings (X7) is 48.9% higher than the odds of household without having savings.

For this model, the odds on climatic factors indicate that holding other things constant, for a unit increase in natural disasters at local level (X45), the odds in favor of food accessibility at household (Y2) decreases by (1-0.747) or about 25.3%. Similarly, there is a 69.7% decrease of odds of food accessibility at household (Y2) for a one-unit increase in climatic impact on income (X46). For a unit increase in climatic impact on increases of short time food prices (X62), the odds in favor of food accessibility at household (Y2) decreases by (1-0.731) or about 26.9%. Similarly, there is a 33.7% decrease of odds of food accessibility at household (Y2) for a one-unit increase in prices of general food items (X22). For a unit increase in difference between rural and city food prices (X23), the odds in favor of food

accessibility at household (Y2) decreases by (1-0.63) or about 37%. Similarly, there is a 31.8% decrease of odds of food accessibility at household (Y2) for a one-unit increase in low level of income (X26). For a unit increase in incidences of disease (X44), the odds in favor of food accessibility at household (Y2) decreases by (1-0.741) or about 25.9%. Similarly, there is a 28.1% decrease of odds of food accessibility at household (Y2) for a one-unit increase in household poverty/economic status (X3). For a unit increase in number of school going children (X2), the odds in favor of food accessibility at household (Y2) decreases by (1-0.486) or about 51.4%.

However, in the model, some of the variables show statistically significantly unexpected sign in respect to their relationship with household food security such as the climatic impacts on sanitation system (X60) and the incidences of disease (X44) show the odds in favor of availability of food at household (Y1). Similarly, climatic impact on household sanitation system (X60) and incidences of mosquitoes, insects, pest, etc. (X43) show the odds in favor of food accessibility at household (Y2). Therefore, new additional studies need to be undertaken to justify these unusual behavior of these few variables.

3.3 Model Efficiency Test

To identify if there are any multicollinearity problems present among the variables, the Pearson Correlation tests have been performed in the study. When two variables are considered highly correlated to each other in explaining the dependent variable, it may give rise to a multicollinearity problem. In case of multicollinearity, the correlation value is considered as 0.8 or above (Field, 2000: 2, 44-322). The result shows that the correlation values among the variables fall below 0.8, which indicates that multicollinearity is absent among the variables.

Moreover, logically this study is free from endogeneity (including causality) problem because in the survey questions were asked about the impact of different factors on food security not vice versa. Moreover, technically the *ordered dependent regression* or *ordinal regression* is based on the “Generalized Linear Models” (used by EViews) and “Generalized structural equation model” (used by Stata) where the software itself takes some instrumental variables to solve the endogeneity problems.

4. Conclusions and Policy Recommendations

This study finds that several resilience factors, climatic factors, and non-climatic factors are statistically significant to explain the household status of food security. These variables also differ between food secure and insecure groups.

Climate change is one of the major potential threats for household food security in Malaysia (Alam et al., 2010, 2011). Therefore, to ensure sustainable household food security in the country, design of food security programs must integrate climatic change into the picture, and food security approaches must recognize climate change as an important driver. This integration also increases household capacity to adapt to climatic change. At the same time, climate change adaptation approaches and strategies to reduce vulnerability to climate change also increases household food security.

Prioritization of needs for investment targeted at increasing food security adaptation to climate change is important. Climate change adaptations are concentrated on improving

the potential of people, especially the most vulnerable groups, toward adapting to climate changes. This involves support for livelihoods that are climate-resilient, reduction of disaster risk, advocacy, empowerment, and social mobilization to curb the underlying causes of vulnerability (Alam et al. 2012a). To adequately deal with the effects of climate change on food security, plans have to chalk out with a good analysis of the groups that are already particularly marginal at present. They are the most affected by climate change often, and they have very limited capacities to cope with.

Therefore, climate change affects groups that have always been at risk of food insecurity, and it also affects new groups who become vulnerable to regional weather changing conditions (IPCC, 2007). Most vulnerable groups already practice some form of risk management, but their capability to adapt to climatic changes is often limited due to their extremely restricted coping-up potential. Thus, the climate change adaptation techniques and food security should empower the groups that are socially excluded to lower their vulnerability and improve their resilience (Stern, 2007; Pielke et al., 2007; FAO, 1997). Work on adaptation must address food security as a main challenge faced by the populations that are vulnerable to the climate, while food security plans in most cases offer to people's capability to adapt to changes in climate, specifically when climate change is taken explicitly into consideration.

The mitigation options are important when planning for a long future. In the long run, the people who are vulnerable should be empowered and encouraged to adapt to climate change by developing resilience via investments in health, social protection, education, infrastructure, and other methods. Monitoring weather extremes and design strategies for disaster preparation are also very important. Given these effects and the resources needed to adapt them, resources that realize the Sustainable Development Goals (SDGs) might be integrated. Further, the private sector should advocate mitigation methods like energy efficiency, renewable energy, developments and infrastructure which include dams, flood-resistant storage facilities, cyclone shelters, and techniques for lowering water loss in distribution systems, etc.

Finally, local, national, and regional administrations must be provided with adequate resources to deal with challenges of climate changes. They should put emphasis for the building of capacity in communities that are particularly at risk for food insecurity as well as climatic changes. We also suggest that new additional studies be undertaken to validate or reject the overall findings of our study. The findings of the study are empirically very new. Therefore, there are huge scopes to explore this issue further. The results of this study can be investigated further and validated against other socioeconomic factors, demographic factors, different locations, different economic groups, and different measurements of level of food security.

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Appendix: List of the variables

- Y1 Household food availability in the last one month, where available enough of the kinds of food you want to eat=1,others=0.
- Y2 Household status of food accessibility, where food secure access=1,others=0
- X1 Education level, where illiterate=1,primary=2,secondary=3,certificate=4
- X2 Number of school going children, where no school going children=1,1-2 children=2,3 children=3,4-5 children=4,more than 5 children=5
- X3 Household poverty/economic status, where marginally non-poor=1,recently marginally non-poor=2,poor=3,hard core poor=4
- X4 Spouse doing job, where yes=1,no=0
- X5 Head of household having supplementary job, where yes=1,no=0
- X6 Earning Ratio (Earning Family Member / Total Family Member) is coded in 1-5 scale based on equal value for every 20% ratio value, where 0-20%,21-40%,41-60%,6-80%,and 81-100% are coded as 1,2,3,4,5 respectively.
- X7 Household having any savings, where yes=1,no=0
- X8 Locality, where urban=1,rural=0
- X9 Ownership of house, where yes=1,no=0
- X10 Type of home, where wood made=1,mixed =2,brick=3
- X11 Household having any transport for buying food, where yes=1,no=0
- X12 Household buying bulk amount of food, where yes=1,no=0
- X13 Household having neat and clean kitchen and dining place, where yes=1,no=0
- X14 Household having a hygienic sanitation facility, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X15 Household managing waste properly, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X16 Household having knowledge about maintaining nutritious and hygienic way of cooking and washing food, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X17 Household having knowledge about taking precaution against dengue, malaria, etc., where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X18 The effectiveness of current food distribution process in Malaysia, where very low=1,low=2,normal=3,high=4,very high=5
- X19 Current road and transportation facility for food distribution process in Malaysia, where very low=1,low=2,normal=3,high=4,very high=5
- X20 Availability of expected food in the local market, where very low=1,low=2,normal=3,high=4,very high=5
- X21 Sufficiency of expected food in the local market, where very low=1,low=2,normal=3,high=4,very high=5
- X22 Current prices of general food items, where very low=1,low=2,normal=3,high=4,very high=5
- X23 Current difference between rural and city food prices, where very low=1,low=2,normal=3,high=4,very high=5
- X24 High prices of food cause household food shortage, where very low=1,low=2,normal=3,high=4,very high=5
- X25 Current level of household income, where very low=1,low=2,normal=3,high=4,very high=5

- X26 Low level of income cause household food shortage, where very low=1,low=2,normal=3,high=4,very high=5
- X27 Ready budget arrangement to buy food anytime, where very low=1,low=2,normal=3,high=4,very high=5
- X28 Availability of discount or offer on food price in the local market, where very low=1,low=2,normal=3,high=4,very high=5
- X29 The effectiveness of current food distribution process in Malaysia, where very low=1,low=2,normal=3,high=4,very high=5
- X30 Dependency on common resources for cattle or livestock feeding, where very low=1,low=2,normal=3,high=4,very high=5
- X31 Current competition among people for common resources, where very low=1,low=2,normal=3,high=4,very high=5
- X32 Current expenditure for feeding and medicine of cattle and livestock, where very low=1,low=2,normal=3,high=4,very high=5
- X33 Difference between rural and city food quality, where very low=1,low=2,normal=3,high=4,very high=5
- X34 Food quality or nutrition level in local market, where very low=1,low=2,normal=3,high=4,very high=5
- X35 Food quality on food safety in local market, where very low=1,low=2,normal=3,high=4,very high=5
- X36 Quality of drinking water, where very low=1,low=2,normal=3,high=4,very high=5
- X37 Stability of food price, where very low=1,low=2,normal=3,high=4,very high=5
- X38 Price variation among shops in the local market, where very low=1,low=2,normal=3,high=4,very high=5
- X39 Access of quick credit to buy food, where very low=1,low=2,normal=3,high=4,very high=5
- X40 Stability of food supply, where very low=1,low=2,normal=3,high=4,very high=5
- X41 Unavailability of food in market leading food shortage, where very low=1,low=2,normal=3,high=4,very high=5
- X42 Agencies supports for household food security, where very low=1,low=2,normal=3,high=4,very high=5
- X43 Current level of incidences of mosquitos, insects, pest, etc., where very low=1,low=2,normal=3,high=4,very high=5
- X44 Current level of incidences of disease like dengue, malaria, heat stretch, cold, skin disease, etc., where very low=1,low=2,normal=3,high=4,very high=5
- X45 Occurrences of natural disasters such as flood, cyclone, landslides, etc. at local level, where very low=1,low=2,normal=3,high=4,very high=5
- X46 Climatic issues and related disease reduces income, where yes=1,no=0
- X47 Climatic issues affect household food collection system, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X48 Climatic issues affect household food storage system (e.g. Refrigerator, packaging, etc.), where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X49 Climatic issues affect household food storage process (e.g. Dry, salty, oily, etc.), where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X50 Climatic issues increase household food storage cost, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X51 Climatic issues affect household usage or utilization of land, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X52 Climatic issues reduce normal food test, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5

- X53 Climatic issues reduce food longevity, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X54 Climatic issues affect household food choice and habit, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X55 Climatic issues affect household cooking system (e.g. Cooking by gas or stove not by woods), where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X56 Climatic issues affect cooking time and amount (e.g. large amount of cooking together or several time cooking for hot food or several times heating for not rotating), where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X57 Climatic issues cause to eat outside or buy ready food from outside, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X58 Climatic issues affect the environment and cleanness of kitchen, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X59 Climatic issues affect household waste management, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X60 Climatic issues affect home sanitation system, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X61 Climatic issues hamper food aid services and food supports program, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X62 Climatic issues increase short term food prices, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5
- X63 Climatic issues cause to increase food price in restaurant, where strongly disagree=1,disagree=2,not sure=3,agree=4,strongly agree=5