Climate change, rural household food consumption and vulnerability: The case of Ben Tre province in Vietnam

***Kim Anh Thi Nguyen*[1], *Curtis M. Jolly*[2]*, *Chuong T. P. N. Bui*[1] and *Trang H. T. Le*[1]**

1 Faculty of Economics, Nha Trang University, Vietnam,
2 Department of Agricultural Economics and Rural Sociology, Auburn University, Alabama Agricultural Experiment Station, Auburn, Alabama, USA.
* Corresponding author, Curtis M. Jolly, Jollycm@auburn.edu

Abstract

Climate change is associated to sea level rise, increases in temperature and inland salt water intrusion in Vietnam. Ben Tre Province in the Mekong Delta has suffered immensely from recent climate change triggered weather events. Along with salt water intrusion, unusual typhoons also inflicted serious damages to the economy of the province. In this study, we attempt to measure the effects of climate change on household consumption and levels of vulnerability. Three hundred households were surveyed. The distribution of vulnerability index showed that on average there is a 43 percent probability that a coastal household will fall below the minimum consumption threshold level of US $1.25 per capita per day. Forty-six percent of households are vulnerable to climatic risk, while 54 percent of households are considered not vulnerable. The factors affecting food consumption in rural households in Ben Tre Province are the households other sources of income, education level of head of households, livelihood diversity index, the number of contacts the household made to access credit, gender of the head of the household and the number of young people working outside the household. Level of education of the head of household marginally increases consumption risks. The average number of floods that affect the household in the past 10 years reduces consumption vulnerability while the average number of the floods that inundated the community in the past ten years increases consumption vulnerability.

***Keywords**: Climate, Change, Consumption, Vulnerability, Ben Tre, Province*

1. Introduction

Climate change effects will alter biodiversity, food production and finally rural households' vulnerability in the next decades (Tol, 2002; Velarde et al., 2005 and IPCC, 2007). In Vietnam, climate change has been observed to foster temperature increases and sea level rise, which have caused permanent inundation, increased flooding, as well as salt water intrusion (Dasgupta et al., 2007; Wassmann et el., 2004). Scientific information and climatic mapping show that 10 of Vietnam's susceptible provinces to climate change are among the top 25 percent most vulnerable areas in Southeast Asia, and that Ben Tre is one of these (Yusuf and Francisco, 2010).

The Ben Tre region has suffered immensely from climatic change as evidenced by recent salt water intrusion and increased frequency of typhoon activities. Economic damages caused by salt water intrusion from 1995 to 2008 amounted to US $32,423,080,632 including 15,782 ha of dead or less productive paddy, 13,700 ha of shed unripe coconuts, 360 ha of less productive aquaculture, and 5,289 tons of dead shrimp. The intrusion also placed 132,823 households into a situation of continued lack of fresh water (Ben Tre DPI, 2010). Nine years later, the typhoon named Durian, with wind velocity of over 133 km per hour, had severely devastated the province, which resulted in 17 deaths, 162 injured people, and 71,340 collapsed or unroofed houses (Ben Tre CEHMF, 2010).

A number of studies have examined the effects of climate change on Vietnam's economy and found varying results (Adger, 1999; Dinh, 2012), but have attributed many of the climatic occurrences to climate change events. The variation in results occurs because of spatial fluctuations of climate change effects. To observe specific effects of climate change on community food consumption vulnerability, we examine a particular case in Vietnam, Mekong Delta, Ben Tre Province, which has been seriously impacted by recent climatic change events. For these reasons, the study focuses on food consumption vulnerability assessment and poverty in the Ben Tre Province.

2. Objectives of the Study

In this paper, we assess the impacts of climate change on households' livelihoods in Ben Tre Province to determine how these changes affect the consumption vulnerability of inhabitants in these areas. Specifically we: (1) determine the extent of vulnerability of households in the selected coastal communities; (2) determine the factors that affect food consumption per capita in the coastal communities in Ben Tre Province; and (3) evaluate the effects of coastal climatic events on the consumption vulnerability and poverty in the area.

We proceed by defining the term "vulnerability"; then we examine the relationship between climate change and vulnerability; we evaluate the approaches in representing vulnerability; and propose a conceptual framework for evaluation of vulnerability. We then proceed with a methodical approach; discuss the model development; present the results and finally the discussion and conclusion.

3. Vulnerability

3.1 Definitions of Vulnerability

The term "vulnerability" has no universally accepted definition (Fussel, 2007). Studies on natural threats define vulnerability as the degree to which an unprotected unit is prone to being harmed by exposure to a perturbation or stress, in conjunction with its ability (or lack thereof) to cope, recover or fundamentally adapt (become a new system or go extinct) (Kasperson et al., 2001; Fussel, 2007). In contrast, the poverty and development literature, which focuses on social, economic and political conditions, defines vulnerability as a cumulative measure of human welfare that integrates environmental, social, economic, and political exposure to a range of harmful distresses (Bohle et al., 1994). According to Yamin et al. (2005), the communities affected by disasters define vulnerability as conditions that are determined by physical, social, economic, and environmental factors or processes, and that increase the susceptibility of a community to the impact of a hazard. In the resilience community, vulnerability is defined as a loss of pliability (Franklin and Downing, 2004).

Adger (1999) defines social vulnerability as the exposure of groups or individuals to stress as a result of social and environmental change, where “stress” refers to unexpected changes and disruptions to livelihoods. Reilly and Schimmelpfennig (1999) define vulnerability as a probability-weighted mean of damages and benefits, and give examples of crop yield vulnerability, farmer or farm sector vulnerability, regional sector vulnerability, regional economic vulnerability, and vulnerability to Commission on Food Security and Hunger. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability to climate change as: “The degree to which a system is susceptible, or unable to cope with adverse effects of climate change, including climate variability and extremes, and vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity” (IPCC, 2001).

The term economic vulnerability is mostly defined at the macroeconomic level and is well documented in the literature (Briguglio, 1995 and 2003; Atkins, et al., 2000; Briguglio et al. 2008). Johnson (2006) concurs with the definition of vulnerability as a risk of being negatively affected by economic shocks. At the microeconomic level climate change may affect livelihoods as household production systems, business entities and activities which may trigger food shortages, market failures, food insecurity and poverty (Karfakis et al., 2012).

In a model proposed in Capaldo et al. (2010) vulnerability is defined as a household’s probability to fall below a food security threshold, measured in food consumption or monetary terms, in the near future. The indicator approaches are based on developing a wide range of metrics and selecting some of them through expert judgment (Kaly and Pratt, 2000; Kaly et al., 1999), principal component analysis (Easter, 1999; Cutter et al., 2003), or correlation with past disaster events (Brooks et al., 2005). Each of these selection procedures is used to choose the indicators that account for the largest proportion of vulnerability. The selected indicators may be used at the local (Adger, 1999; Leon-Vasquez et al., 2003; Morrow, 1999), national (O’Brien et al., 2004), regional (Leichenko and O’Brien, 2001; Vincent, 2004) or global (Brooks et al., 2005; Moss et al., 2001) scales. According to Luers et al. (2003), the indicator approaches are valuable for monitoring trends and exploring conceptual frameworks.

Climate change influences food production, availability and vulnerability. The severity is caused by the dangers to the factors of production. Inputs become less accessible through physical and market damages and distortions. Prices increase and producers are no longer able to purchase them (CSACC, 2011). Climate change activities will lower cereal, grain, fish and meat production, and hence will affect what people consume. Climate change may, therefore, signify net welfare loss to household consumption and food security risks. Ligon and Schechter (2003) define a measure of vulnerability that quantifies the welfare loss associated with poverty as well as the loss from different sources of uncertainty.

3.2 Economic Conceptual Framework

Our approach is based on the expected utility theory described by Kurosaki (2003) based on Morgensten utility function. Ligon and Schechter (2002, 2003) defined vulnerability as the difference between the utility derived from some level of certainty-equivalent consumption at and above which a household would not be considered vulnerable and the expected utility of consumption. We try to develop a model that shows the effect of climate change on consumption vulnerability and make the model operational by assuming that the welfare level of an individual from a household i in period t is determined by the level of per-capita real consumption, y_{it}. Household consumption is based on household income which include all foods produced, funds converted to food use and any other sources of funds received by the individual belonging to the household. Then x_{it} is expected to fluctuate based on endogenous, exogenous and idiosyncratic shocks. It is expected that the household can smooth consumption over time, and across states of nature using various assets and financial instruments available to its members (Kurosaki and Fafchamps, 2002).

The econometric methods, which use household-level socio-economic survey data to analyze the vulnerability levels of different social groups, include three assessments: vulnerability as expected poverty (VEP), vulnerability as low expected utility (VEU) and vulnerability as uninsured exposure to risk (VER) (Hoddinott and Quisumbing, 2003). All of these methods construct measures of welfare loss attributed to shocks, but differ in that VEP and VEU measure the ex-ante probability of a household's consumption or utility falling below a given minimum level in the future due to current or past shocks, while VER measures ex-post welfare loss due to shocks (Deressa et al., 2009). In the vulnerability expected poverty (VEP) framework, vulnerability of a person is conceived as the prospect of a person becoming poor in the future if currently not poor or prospect of that person continuing to be poor if currently poor (Christisnsen and Subbarao, 2004). Thus vulnerability is seen as expected poverty, and consumption (income) is used as a proxy for well-being (Deressa et.al. 2009). We use an econometric procedure that captures observed variability in income and consumption in the past and expected poverty based on variability in consumption levels. The most commonly cited shocks resulting in welfare loss include climatic, economic, political, social, legal, crime and health shocks (Hoddinott and Quisumbing, 2003). In our study, we treat vulnerability as transient stochastic poverty and examine the probability of a household falling below a certain consumption level. We use household cross sectional data which include information on income, consumption, food and fish produced, fish caught and gleaned, demographic and socio-economic information, household assets and access to credit.

4. Methodology

4.1 Household Vulnerability Model Development

We employ the VEP method to estimate the vulnerability of coastal households to climate change. Here vulnerability is seen as expected poverty, while consumption (income) is used as a proxy for well-being (Deressa et al., 2009). This method is based on estimating the probability that a given shock or set of shocks will move household consumption below a given minimum level (such as a consumption poverty line) or force the consumption level to stay below the minimum if it is already below this level (Chaudhuri et al., 2002). The analysis hinges on the assumption that climate extremes, climatic shocks or hazards, will affect the probability that households' consumption will fall below a given minimum vulnerability level (Deressa et al., 2009). The climatic triggered events are the shocks received from typhoons, floods, salt water intrusion, coastal erosion and frequency and flood height during a given period of time.

Following Chaudhuri et al. (2002), household consumption function is defined as:

$$lnC_h = X_h\beta + e_h \quad (1)$$

where C_h is per capita consumption expenditure of household, X_h represents a bundle of observable household, and climatic shocks, β is a vector of parameters, and e_h is mean-zero disturbance term.

The equation can then be explicitly written as:

$$lnC_h = ln\Omega + \sum \beta_j lnSOC_j + \sum \alpha_i lnEV_i + \sum \gamma_k lnPh_k + e_h \quad (2)$$

where lnC_h represents the natural log of a household's per capita consumption; *lnSOC* represents the natural log of the socioeconomic household factors; *lnEV* represents that natural log of environmental factors; and *lnPh* represents the natural log of the physical and climatic factors; and e_h is the error term.

The dependent and independent variables are described in table 1

Table 1. The Dependent and Independent Variables

Variables		Abrev.	Exp. sign	Descriptions
De-pendent variable	Household consumption income	Inc		Continuous random variable
Inde-pendent variable	Age of head of household	Age	+	Discrete random variable
	Years of schooling of head of house-hold	Educ	+	Discrete random variable
	Credit access (number of contacts)	Numcre dit	+	Discrete random variable
	Dependence ratio (number of members below 15 and above 64 years old per household)	Depratio	-	Discrete random variable
	Gender of head of household	Gender	+ -	Dummy variable take value of 1 if male and 2 if female.
	House ownership	Housete n	+	Dummy variable take value of 1 if house is owned and 2 otherwise.
	Number of typhoons that affected the community (over the last 10 years)	numfloo dC	-	Discrete random variable
	Number of typhoons that affected the household (over the last 10 years)	numfloo dh	-	Discrete random variable
	Erosion	Dce	-	Dummy variable take value of 1 if affected and 2 if not.
	Salt water intrusion	Dswi	-	Dummy variable take value of 1 if affected and 2 if not.
	Farming involvment/mariculture	Dfarm	+	Dummy variable take value of 1 if involved and 2 if not.
	Fishing involvement	Dfish	+	Dummy variable take value of 1 if involved and 2 if not.
	Aquaculture involvement	Daqm	+	Dummy variable take value of 1 if involved and 2 if not.
	Livestock ownership	Withlive	+	Dummy variable take value of 1 if owned and 2 if not.
	Livelihood diversification index	Ldi	-	Index between 0 and 1.
	Receipt of remittances	Dremit	+	Dummy=1 if HH receives remittances
	Thua Duc commune			Dummy variable take value of 1 if Thua Duc and 2 if not.
	An Thuy commune			Dummy variable take value of 1 if An Thuy and 2 if not.
	Giao Thanh commune			Dummy variable take value of 1 if Giao Thanh and 2 if not.

We assume that the variance of e_h from equation 1is:

$$\sigma^2_{e,h} = X_h \tag{3}$$

where θ is a parameter estimate obtained from the three-step feasible generalized least squares (FGLS) procedure suggested by Amemiya (1977). Using the estimates β and θ, the expected log of consumption and the variance of log consumption for each household h is estimated as:

$$\hat{E}\left[lnC_h \mid X_h\right] = X_h\hat{\beta} \tag{4}$$

$$\hat{V}\left[lnC_h \mid X_h = \hat{\sigma}^2_{e,h} = X_h\hat{\theta}\right] \tag{5}$$

By assuming that consumption is log-normally distributed (i.e. that lnC_h is normally distributed), the above equations allow us to estimate the probability that a household with characteristics X_h will be poor (i.e., the household's vulnerability level will be below a given norm).

If $\Phi(.)$ denotes the cumulative density of the standard normal, the estimated probability will be given by:

$$\hat{V}_h = Pr\left(lnC_h < lnz|X_h\right) = \Phi\left(\frac{lnz - X_h\hat{\beta}}{\sqrt{X_h\hat{\theta}}}\right) \tag{6}$$

where lnz is the log of the minimum consumption/income level beyond which a household is considered vulnerable. In this model households are defined as vulnerable if they are sensitive to certain socio-economic, environmental or physical shocks.

The vulnerability index can be explicitly evaluated as:

$$lne_h^2 = ln\Omega + \sum\beta_j lnSOC_j + \sum\alpha_i lnEV_i + \sum\gamma_k lnPh_k \tag{7}$$

We use a logistic model to determine the probability of an individual from a household consuming less than US $1.25 and being considered vulnerable or consuming above $1.25 and considered not vulnerable. If there are j categories in the sample of households, the probability that a consumer is in a particular category, P_j consuming above or below US $1.25 per day is given by:

$$P_j = \frac{exp\left(\beta'_j X\right)}{\sum_{j=1}^{n} exp\left(\beta'_j X\right)}, \quad j = 1..n \tag{8}$$

One of the vectors of the coefficients β is set to zero for normalization (Wynn *et al.*, 2001). If it is β_1, that is set to zero then:

$$ln\left(\frac{P_j}{P_i}\right) = \beta'_j X_j \quad \text{i, j = 2..n and } i \neq j \tag{9}$$

4.2 Site Selection

The area of research is in the Ben Tre Province in Vietnam. This is an area with substantial numbers of vulnerable households living in low coastal zones, the majority of which are dependent on coastal resources for their livelihoods. Three coastal communes, namely Thua Duc of Binh Dai District, An Thuy of Ba Tri District, and Giao Thanh of Thanh Phu District that have been affected by recent climatic events were chosen as studied sites.

4.3 Data Collection

Both secondary and primary data were collected to facilitate the analysis needed for this study. Secondary data were provided by the Provincial People Committee and the Department of Agriculture and Rural Development. Primary data were obtained through the household survey of 300 samples within the studied sites. Three hundred samples were equally divided among three coastal communes. In each commune, the survey covered all villages with the hope that the samples represented the population. All respondent households associated with farming or gleaning activities and who indicated a willingness to participate in the survey during three months period were interviewed. The head of household or his or her designate answered the list of questions. Respondents were recruited with the help of government officials working at the commune level. We use recall data from surveys for the analyses. Therefore, climate change indicators, such as salt water intrusion; erosion along river or sea banks, the occurrence and frequency of typhoons reported; household inundation over the last 10 years and floods affecting the community in the past ten years were noted.

5. Results

Of the 300 surveys, 286 were considered adequately completed for analyses. Of the 286 heads of households completing the survey, 51 were females and 235 were males. A total of 203 of the households indicated that their primary occupation was farming, and of these 144 were involved in fishing or aquaculture (table 2).

Table 2. Socio-demographic variables

Variables	N	Mean	Median	Std Dev	Minimum	Maximum
Age	286	49.220	49.000	11.933	26.000	86.000
Ownedland	286	7,341.260	4,000.000	9,376.250	-	43,000.000
Distht	286	3,146.300	1,800.000	4,941.810	(9.000)	25,000.000
Disth20	286	285.549	100.000	472.159	(9.000)	4,000.000
Educ	286	5.395	5.000	3.174	-	13.000
Floodht	286	0.021	-	0.166	-	2.000
Depratio	286	23.398	25.000	20.360	-	75.000
Hhsize	286	4.318	4.000	1.424	1.000	10.000
Idi	286	0.491	0.500	0.238	0.250	1.000
InC	285	13.858	13.845	0.449	12.296	16.155
Numcredit	286	3.636	3.000	2.729	-	15.000
Hh1564	286	3.283	3.000	1.404	1.000	8.000
Numwithjob	286	2.510	2.000	1.324	-	8.000
Numfemale	286	2.129	2.000	1.109	-	7.000
NumfloodC	286	0.745	1.000	0.490	-	3.000
Numfloodh	286	0.668	1.000	0.479	-	2.000
Nummale	286	2.189	2.000	0.991	-	5.000

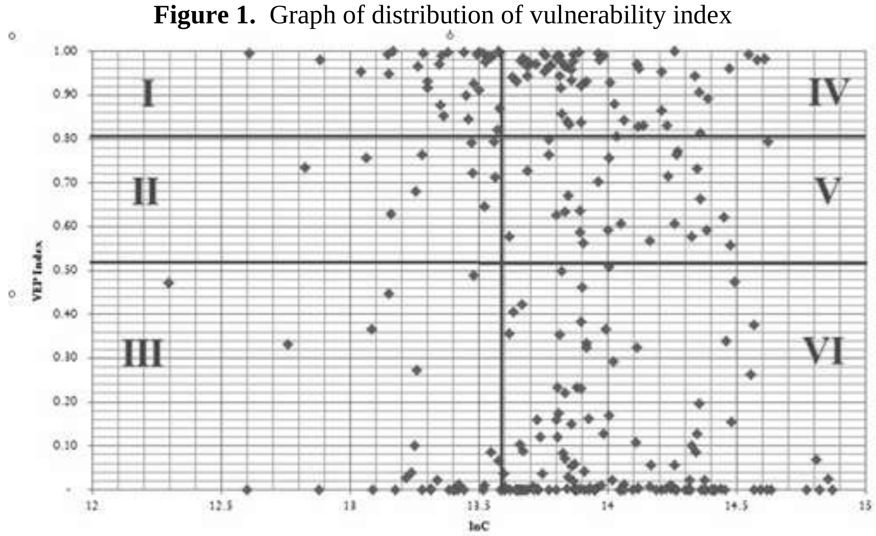
The average age of farmer was 49 years; the youngest was 26 and the oldest 86. Heads of households had an average of 5.39 years of schooling. About 7.0 percent of the sample reported having no schooling, 51.7 had only received primary education, 29.7 had received some secondary education, 11.3 had high school education but only 0.3 percent had attended college. Most farm households owned their homes and land.

5.1 Household Vulnerability Index

The mean vulnerability index is 0.43, which means on average there is a 43 percent probability that a household will fall below the minimum consumption threshold level of US $1.25 per capita per day. It is worth noting that the vulnerability index ranges from zero to one and the standard deviation is 0.41 which generates a C.V. of 95 percent which represents a large dispersion. The distribution of vulnerability index shows that 31 percent of households are highly vulnerable to climatic risk, while 54 percent of households are not vulnerable and 15 percent are moderately vulnerable.

In figure 1, we plot the x-axis to indicate the imputed values for the natural log of income while the y-axis shows the imputed values of vulnerability based on equation (5). The graph is divided into two parts on the horizontal axis, with those on the left indicating ‘poor households’ and those on the right the ‘not-poor households’. The vertical axis is divided into three sections on either side. Those on the left hand side (I, II, III) belong to the ‘poor’ households and those on the right side (IV, V, VI) the ‘not-poor’ households. Those in the upper left segment are poor today and likely to be not-poor tomorrow, and those in the middle and left are on average poor today and have a more than average chance of escaping poverty, but those on the lower left are poor today, but have the characteristics suggesting they have a more than 50 (0.5 probability level is taken as a cutoff point) percent chance of being poor in the future. Those in the upper right corner are not below the income threshold at present, but are likely to become so with any major future shock to the system, while those not-poor but experiencing a 50 to 80 percent vulnerability are less likely to be poor than the not poor individuals experiencing an 80 to a 100 percent vulnerability. There are three points very obvious from figure 1. First, “not poor households” (IV, V, VI) outnumber “poor households” (I, II, III). Secondly, the vulnerability index tends to distribute at both ends. Thirdly, it is interesting to note from the figure that not poor households are more highly vulnerable to climatic risks than poor households.

Figure 1. Graph of distribution of vulnerability index



Results from the logistic regression model are seen in table 3. The R^2 statistic ranges from 0.1733-0.2725. The odds ratios show that individuals that survive below the poverty line, that is those who live on less than $1.25 per day, are 1.75 more likely to have in the household family members who work outside the home, 3.04 times more likely to be involved in farming, 2.33 times more likely to have head of households who own livestock, and 37.78 times more likely to have a high diversification index. Members of households that consume less than $1.25 per day are 0.87 times less likely to have a head of household who is educated, 0.09 times less likely to have household members aged below 15 and above 64, and 0.75 times less likely to have household heads who have made attempts to acquire credit.

Table 3. Factors affecting standard of living as it relates to income

Effect	Estimate	Standard Error	Wald Chi-square	Pr > Chi-square	Odds Ratio Estimate	Lower 95% Confidence Limit for Odds Ratio	Upper 95% Confidence Limit for Odds Ratio
Dummy = 1 if HH is involved in farming 1 vs 2	0.5559	0.2440	5.1921	0.0227	3.0400	1.1682	7.9107
Household members below 15 and above 64/household size *100	(2.3746)	0.8827	7.2373	0.0071	0.0930	0.0165	0.5249
Education of HH head	(0.1393)	0.0571	5.9525	0.0147	0.8699	0.7778	0.9730
Livelihood diversification index (higher value lower diversity, lower value higher diversity)	3.6319	1.0118	12.8851	0.0003	37.7843	5.2009	274.5022
Number of contacts HH can access credit	(0.2854)	0.0829	11.8489	0.0006	0.7517	0.6390	0.8844
Number of family members with jobs	0.5596	0.1300	18.5407	0.0000	1.7500	1.3565	2.2577
Dummy = 1 if HH owns livestock 1 vs 2	(0.4234)	0.2165	3.8230	0.0506	2.3322	0.9980	5.4503
Rsquare-homerlemeshow	(0.1733-0.2725)						

5.2 Consumption Risks and Climate Change

An examination of the regression equation in table 4 shows that the probability of the F-statistics indicates that the model is a good fit, and the R^2 indicates that 22 percent of the variation in the dependent variable is explained by the variation in the independent variable. The model result also shows other sources of income, education, income diversity, access to credit, the number of females heading up the household and the number of household members that are working outside influence per capita consumption. Livelihood diversity index negatively influences households' per capita consumption. That means there is a risk premium associated to livelihood diversity. When the female assumes the leader of the household, income is lower. However, the per capita income of households is reduced with more individuals working outside the household.

Table 4. Regression analysis of factors influencing consumption in Ben Tre Province

Variable	*DF*	*Estimate*	*tValue*	*Probt*	*ProbF*	*Rsquare*
Intercept	1	2.1951	3.2586	**0.0013**	0.0000000012	0.2153
Other Source	1	0.0000	4.0215	**0.0001**		
Age	1	0.0021	0.4901	0.6245		
Depratio	1	(0.0746)	(0.0931)	0.9259		
Educ	1	0.0576	3.8452	**0.0002**		
Hh1564	1	0.1495	0.8146	0.4160		
Hhsize	1	(0.1114)	(0.7167)	0.4742		
Idi	1	(0.6315)	(3.2026)	**0.0015**		
Nnumcredit	1	0.0360	2.1650	**0.0313**		
Numfemale	1	(0.1188)	(2.0198)	**0.0444**		
HumfloodC	1	0.2116	1.2358	0.2176		
Numfloodh	1	(0.2839)	(1.6279)	0.1047		
Numwithjob	1	(0.1315)	(2.5410)	**0.0116**		

The results of the stochastic model in table 5 indicate that the climatic variables show that the average number of floods that affect the community in the last 10 years increased consumption risks; however, the average number of floods that affect the household lowered consumption risk. When the female is head of the household consumption risk is lower. Surprisingly education level of the head of households marginally increased the risks of consumption (α=0.07).

Table 5. Consumption risk model of climate change

Variable	*DF*	*Estimate*	*tValue*	*Probt*	*ProbF*	*Rqsuare*
Intercept	1	1.54753	1.47466	0.14146	0.003485171	0.1009
OTHSURCE	1	0.00000	0.70983	0.47842		
age	1	(0.00272)	(0.40693)	0.68438		
depratio	1	(1.32631)	(1.06359)	0.28846		
educ	1	0.04199	1.79899	0.07313		
hh1564	1	0.36188	1.26534	0.20684		
hhsize	1	(0.17477)	(0.72155)	0.47119		
Idi	1	(0.29878)	(0.97272)	0.33156		
numcredit	1	(0.03939)	(1.52056)	0.12954		
numfemale	1	(0.22624)	(2.46848)	**0.01419**		
numfloodC	1	0.77890	2.92001	**0.00379**		
numfloodh	1	(0.70580)	(2.59823)	**0.00988**		
numwithjob	1	0.04334	0.53778	0.59117		

6. Discussion and Conclusions

The study exposes some striking points about consumption vulnerability of households in Ben Tre Province that are worthwhile to policy decisions. Not-poor households outnumber poor households in terms of consumption vulnerability. Income is a proxy for consumption levels; hence the higher the income the greater the consumption risks. Since in this study consumption is measured in monetary terms it is expected that risks of consumption increase with consumption levels. That means as individuals attempt to increase their consumption the less conservative they become, there is the risk of falling below the poverty line.

In terms of consumption risk, the level of education of the household marginally increased the consumption risk of the household. This is not as anticipated since income is related to education and income increased the level of consumption. According to Haughton and Loan (2005) the effect of education on household consumption is moderated by the number of kids in the household. That means as the households income increased the household size may increase with non-contributors to the household budget.

It seems contradictory that other sources of income have a positive effect on consumption while the number of young people working outside the household negatively influenced consumption. Hung et al. (2007) stated that recent literature tends to suggest a mixed effect of nonfarm diversification on household welfare. Lanjouw and Lanjouw (1995) indicated that the effectiveness of nonfarm sector diversification depends on whether activities performed are productive or non-productive and the economic environment under which these activities are conducted. Though remittances may ensure food security, reduce poverty, provide for children's education, ease credit constraints and pay for inputs (Paris et al., 2009), in Vietnam, the young people who work outside the household must be supported for a long while before they earn sufficient funds to be completely independent.

The results show women head of households had a negative effect on consumption. Klasen et al. (2011) found that households headed by a single female are consumption poorer in Vietnam. They also stated that female headed households are not more likely to be hit by adverse events than male headed households, and female single head of households were less severely affected by shocks in Vietnam. Hence, their production and consumption levels are lower than men. Female head of households earn less income than men and their contribution to the household budget is less (Levin et al., 1999). While men, however, may have higher income levels than female, there may be vulnerable households within this group whose income is insufficient to assure household food security. Female-head of households often use resources from petty trade, remittances and other sources to ensure that the household is food secure (FAO).

The average number of floods that affect the household in the past 10 years negatively impacted consumption risk. This may be so if a household is inundated and has adaption strategies which may be helpful since yields vary with adaptation across ecological zones. Floods do have positive impacts, such as natural fishing and soil fertility on the social economy. The MRCS (2009) results from focus group discussions held in Vietnam showed that for people living in severely flooded areas, flood benefits from natural fishing vary from US $100 to $300 per household in normal flood years to US $120 to $750 per household in big flood years. However, inundation of whole communities may be disastrous causing losses of life, property, agriculture, infrastructure, social and economic activities (Dinh et. al, 2012). It is estimated that 12 percent of the rice in the Mekong River Delta crops may be loss through floods (World Bank, 2010).

The study shows that a little less than half of the people in Ben Tre Province face consumption vulnerability, but those who live above the poverty line were more vulnerable than those below the poverty line. The results indicate that as individuals and households in rural Vietnam try to improve their consumption levels there is a possibility that they may also fall below the poverty line. Hence government must consider the establishment of a safety net for those individuals and rural households who push to adopt new technologies in the light of climate change because of the possibility of sliding below the poverty line. The average number of floods that affect the household in the past ten years reduces consumption vulnerability while the average number of floods that affect the community in the past ten years increased consumption vulnerability. Climatic events such as flooding do affect in various ways community and household consumption vulnerability.

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Appendix Table 1. Variable definition

Rcode	Respondent code
C	Monthly household consumption
Inc	In (monthly per capita consumption)
numfloodC	Number of floods that affected the community (last 10 years)
numfloodh	Number of floods that inundated house (last 10 years)
Floodht	Highest flood lever that inundated house (last 10 years)
Distht	Distance of house to the coastline during high tide
Disth20	Distance of house to the nearest body of water
Gender	Gender of HH head
Age	Age of HH head
Educ	Education of HH head
Hhsize	Household size
Numfemale	Number of female family members
Nummale	Number of male family members
Numwithjob	Number of family members with jobs
Hh1564	Number of family members between 15 to 64 years old
Occaff	Dummy = 1 if primary occupation of household head is in agri, fishery
Depratio	Household members below 15 and above 64/household size *100
Dfarm	Dummy = 1 if HH is involved in farming
Dfish	Dummy = 1 if HH is involved in fishing
Daqm	Dummy = 1 if HH involved in aquaculture/mariculture
Dglean	Dummy = 1 if HH is involved in gleaning activities
Withlive	Dummy = 1 if HH owns livestock
Houseten	Dummy = 1 if HH owns their house
Numcredit	Number of contacts HH can access credit
Ownedland	Area of owned farm or fishery land
Dremit	Dummy = 1 if HH receives remittances
Dce	Dummy = 1 if property is affected by coastal erosion
Dswi	Dummy = 1 if affected by saltwater intrusion
Ldi	Livelihood diversification index (higher value lower diversity, lower value higher higher diversity)