Vulnerability Assessment of People's Livelihood in Quirino: It's Implication on Adaptation to Climate Change

Joel G. Carig[1] and Elizabeth T. Carig[2]

[1] Department of Forestry, Quirino State University, Diffun, Quirino, Philippines 3401; joel_carig@yahoo.com
[2] Research and Development Office, Quirino State University, Diffun, Quirino, Philippines 3401; elizabeth.carig@qsu.edu.ph

Keywords:

climate variability, livelihood, livelihood assets, vulnerability index

ABSTRACT

Quirino province's economy is largely dependent on agriculture. The extended wet and dry seasons experienced by the local community are expected to occur repeatedly in the future, which implies that local people and their livelihoods may continue to become vulnerable to the negative impact of the changing climate. This study was therefore conducted to determine the livelihood vulnerability of farming communities across the five livelihood asset using the LVI and IPCC-VI method and develop a livelihood vulnerability map for the study area. Key informants interview were also undertaken to validate data gathered from the survey. A total of 139 farmers from barangays of Liwayway in the municipality of Diffun, Villamor in Cabarroguis, Tres Reyes in Saguday, Dumabato Norte in Maddela and San Ramos in Nagtipunan, served as respondents of the study. This study employed descriptive method using survey questionnaire to gather the necessary data. The Livelihood Vulnerability Index (LVI) using multiple indicators and the Intergovernmental Panel on Climate Change – Vulnerability Index (IPCC-VI) were used in determining the livelihood vulnerability index of the respondents. The LVI and IPCC-VI results are consistent, showing the farming communities under study, are moderately vulnerable to the impact of the changing climate. Human, natural, social, physical and financial assets may be enhanced to improve the local farmers' capacity to recover from the negative impact of climate change. The development of livelihood vulnerability index map could provide helpful information on local planners and decision makers in planning appropriate projects and programs for adaptation.

INTRODUCTION

The Philippines is occasionally affected by the El Niño Southern Oscillation (ENSO) that induces extended wet and dry seasons (Lasco *et al.*, 2008). Since the country has only two seasons, the ENSO phenomenon meant more water during the rainy seasons, and drier during the dry seasons. The agriculture sector, which is highly dependent on climatic conditions, has become one of the most affected sectors (Kurukulasuriya and Rosenthal as cited by Panthi *et al.*, 2015) in in terms of climate change impacts.

Quirino Province's economy is largely dependent on agriculture, with more or less 42,000 hectares planted to various agricultural crops, like rice, corn, banana and cassava (QFMP, 2008). Like any other provinces in the country, Quirino has not been spared from extreme climate events. Some of the strongest typhoons that crossed the province include Karen (2014), Lawin (2016), Ompong (2018), Rosita (2018), and Dullana (2017). These weather disturbances have

caused flooding, landslide and soil erosion in sloping areas, and damaging millions of worth of standing crops. Aside from the occurrence of heavy and extremely heavy rainfalls, local people have also experienced prolonged dry seasons, bringing almost the same amount of damage with that of typhoon events (Dullana, 2017; ABS-CBN News).

The occurrence of these phenomena are expected to occur repeatedly in the future, which implies that local people and their livelihoods will continue to become vulnerable to climate change impacts unless mitigation and adaptation measures are developed. No matter how flexible they are, the occurrence of climate-related events will still, in general, affect their resilience and adaptive capacity. Understanding the state of livelihood is very crucial so that measures to be designed are expected not only to respond to climate change adaptation but also in poverty reduction.

To determine the vulnerability of local farmers' livelihood to the changing climate including associated events like flooding, landslide and soil erosion, the Livelihood Vulnerability Index (LVI) using multiple indicators and the Intergovernmental Panel on Climate Change – Vulnerability Index (IPCC-VI) was used (Pasakhala, 2010). The result of the study is expected to provide information on the current conditions farming communities in Quirino and give local planners and decisions makers in developing projects and programs to help local communities recover from the negative impacts of the changing climate.

The overall objective of this study is a) to determine the livelihood vulnerability of farming communities across the five livelihood assets using the LVI and IPCC-VI method; and b) to develop a livelihood vulnerability map using the LVI results which could be used as basis in planning for climate change adaptation strategies.

MATERIALS AND METHODS

The survey was carried out in late 2014 to early 2015. Drought and rainfall were analyzed using available meteorological data obtained from the Isabela State University – AgroMet Station.

The Sustainable Livelihood Assessment Framework (SLAF) (DFID, 1999) was used in the assessment of livelihood vulnerability. The SLAF classifies five major livelihood assets into physical, human, financial, social and natural capital (Balgis *et al.*, 2010), to which vulnerability assessment also adds consideration of exposure to climate hazards. The increase in entitlement of livelihood assets increases the capacity of local people to adapt and reduces their vulnerability to climate change (Pasakhala, 2010). On the other hand, the reduction in entitlement of livelihood assets increases their exposure and vulnerability to climatic change. Therefore, the vulnerability of local people to climate change impacts depends on their livelihood assets.

Construction of the LVI. The indicators used in calculating the LVI were lifted from various studies on livelihood vulnerability to climate variabilities, including that of Hahn (2009), Pasakhala (2010) and Panthi *et al.* (2015). However, some of the indicators were substituted to fit with the local context. Primary data from household survey were combined with secondary meteorological data obtained from the Isabela State University – AgroMet Station to complete the livelihood vulnerability indicators.

The indicators were categorized into five major assets: human, natural, social, physical and financial. Under the human asset, five major components and 12 sub-components were used, natural asset has three major components and ten sub-components, social asset has two components and six sub-components, physical and financial assets have one component each with four and five sub-components, respectively. Summary of vulnerability indicators is shown in Table 1.

Table 1. Asset, major components and sub-components comprising the livelihood vulnerability index

Asset	Major Component	Sub-component
Human	Health	Average time to nearest hospital
		Percent of HH who have experience climate-related sickness
	Knowledge and skills	Percent of HH who having less than 50% educated members
		Percent of HH without communication facility
	Livelihood strategies	Percent of HH who have not diversified their crops
		Percent of HH whose major source of income is agriculture
		Percent of HH who have not adopted stress-resistant crop varieties
		Percent of HH without any livestock possession
		Percent of HH who have experienced pests/diseases in their farms
		Percent of HH who have not attended any seminar or training
	Food	Months of food insecurity
	Labor force	Percent of HH where at least 50% its members are not within the productive age
Natural	Land	Average size of land
		Percent of HH who do not own any land for production
	Natural resources	Percent of HH who do not have access to water source for irrigation
		Percent of HH who are dependent on forest resources
	Natural disasters and Climate Variability	Average number of heavy and extremely heavy rainfall for the last 30 years
		Number of drought occurrences over the last 30 years
		Percent of HH who have experienced losses from climate-related events
		Percent of HH who have experienced drought
		Percent of HH who have experienced flooding
		Percent of HH who have experienced strong typhoons
Social	Demographic conditions	Average number of HH members
		Percentage of female-headed households
	Social networks	Percent of HH who have not received government/non-government organizations (GO/NGO) support
		Percent of HH who do not participate in organizational activities
		Percent of HH who have not provided support to neighbors during calamity
		Percent of HH who are inactive members of organization
Physical	Housing and production means	Percent of HH whose type of house is temporary/semi-temporary
		Percent of HH without vehicle
		Percent of HH without irrigation facility
		Percent of HH without facility for mechanize farming
Financial	Finance and incomes	Percent of HH whose properties are not insured
		Percent of HH who do not have savings
		Percent of HH with existing loans
		Percent of HH who do not have access to financial organizations
		Percent of HH whose income is below the food threshold

Another method used in determining vulnerability follows the definition of IPCC, where vulnerability is a function of exposure, sensitivity and adaptive capacity (Pasakhala, 2010). Exposure is the magnitude to which a system is exposed to climate variabilities (Hanh et al, 2009) or considered the "external stressors" (Acosta-Michlik as cited by Pasakhala, 2010). Sensitivity is "being affected by exposure" while adaptive capacity is the ability to recover from the impact of exposure (Smith & Wandel, 2006).

The major sub-components used in the first method were regrouped under exposure, adaptive capacity and sensitivity. Natural disasters and climate variability were categorized under exposure, while water, food and health sub-components were classified under sensitivity. All the remaining variables not classified under the first two fell under adaptive capacity group (Panthi et al, 2015). The summary of variables after they were regrouped is shown in Table 2.

Calculation of the LVI. Both the LVI and the IPCC VI uses the Balanced Weighted Average Approach (Sullivan *et al.*, 2002; Nguyen *et al.*, 2013) to calculate vulnerability index. Under the first method, each of the sub-component was assumed to contribute equally to the overall vulnerability index. The equation was adapted from the Human Develop Index (HDI) which was used to calculate life expectancy index (UNDP, 2007) and in LVI to calculate risks. The equation is as follows:

$$\text{Index} = \frac{S_{observed} - S_{min}}{S_{max} - S_{min}} \qquad \text{Eq.1}$$

Where:
$S_{observed}$ is the actual value of the sub-component
S_{min} is the minimum values
S_{max} is the maximum values

Minimum and maximum values were set to standardize the value between 0 and 1. For example, for variables that measure frequencies, the minimum value is 0 and the maximum value is 100%, average time to nearest hospital ranged from 0-60 minutes, and months of food insufficiency was between 0-12 months. After sub-component values were normalized, the value of each major component was calculated using equation 2:

$$M_{vj} = \frac{\sum_{i=1}^{n} \text{index}_{svi}}{n} \qquad \text{Eq.2}$$

Where:
M_{vj} is the value of major component.
Index *svi* represents the sub-component values indexed by *i* of major component M_j.
n is the number of sub-components in each major component M_j.

The values of the 12 major components were used in equation 3 to get the aggregate values of the five livelihood assets.

$$LVI_v = \frac{\sum_{i=1}^{n} W_{mj} M_{vj}}{\sum_{i=1}^{12} W_{mj}} \qquad \text{Eq.3}$$

Where:
LVI_v is the Livelihood Vulnerability Index
W_{mj} is the weight value of major component

The range of LVI is between 0 to 1, where 0 denotes least vulnerability and 1 denotes high vulnerability. Low vulnerability was within the range of 0 to 0.33; moderate vulnerability is 0.34-0.66 and high vulnerability is 0.67 to 1.

The second method used in computing for VI is based on the IPCC definition of vulnerability, where exposure, adaptive capacity and sensitivity were highlighted. The formula is shown below:

Vulnerability = (Exposure – Adaptive capacity) * *sensitivity*

The IPCC-VI ranges from -1 to 1, -1 denoting least vulnerability and 1 the most vulnerable. Least vulnerability means that the adaptive capacity of a certain community is better than their exposure to a certain stressor. Moderate vulnerability means that

Table 2. Categorization of sub-components into contributing factors using IPCC's definition of vulnerability

Sub-component
Exposure
Percent of HH who have experience climate-related sickness
Percent of HH who do not have access to water sources for irrigation
Average number of heavy and extremely heavy rainfall for the last 30 years
Number of drought occurrences over the last 30 years
Number of HH who have experienced losses from climate-related events
Percent of HH wo have experienced the occurrence of pests/diseases in their farms
Percent of HH who have experienced drought
Percent of HH who have experienced strong typhoons
Percent of HH who have experienced flooding
Adaptive Capacity
Percent of HH who own land for production
Average size of land
Percent of HH with concrete type of houses
Percent of HH with irrigation facility
Percent of HH with communication facility
Percent of HH with livestock possession
Percent of HH with facility for mechanize farming
Percent of HH with vehicle
Percent of HH with at least 50% members are educated
Percent of HH with non-farm activities
Percent of HH who have attended seminar or training
Percent of HH whose members are within the productive age of 15-65 years old
Percent of HH whose income is above the food threshold
Percent of HH who have access to financial services
Percent of HH who have savings
Percent of HH without loans
Percent of HH whose properties are insured
Percent of HH who are active members of organization
Percent of HH who have received GO/NGO support
Percent of HH who participate in organizational activities
Percent of HH who have provided support to neighbors during calamity
Percent of HH who produce diverse crops
Percent of HH who have adopted stress-resistant crop varieties
Sensitivity
Percent of female-headed household
Average number of HH members
Percent of HH who are dependent on forest resources
Percent of HH with food insecurity

exposure and adaptive capacity are the same while extremely/highly vulnerable means the exposure is higher than the adaptive capacity (Ncube *et al.*, 2016).

The equivalent description for each level of vulnerability was based on Ncube *et al.* (2016), as follows:

Low Vulnerability category - means a household has the capacity to recover from impact of a negative event using their livelihood, and with insignificant adjustments to their way of life. Such household will be able to recover using their livelihood assets with little support from outside entities (LVI = 0 to 0.33; IPCC-VI = -1 to 0.33).

Moderate Vulnerability category - means households need some level of external help to recover from a given shock (LVI =0.34-0.66; IPCC-VI = -0.34 to +0.33).

High Vulnerability category – means households need to be provided with significant help in order to recover from the negative impact of a certain event. In many cases, households under this category are welfare cases, if situation get worse, eventually may not be able to exist if suitable assistance is not provided (LVI = 0.67 to 1; IPCC-VI = 0.34 to 1).

Key Informants Interview

Key informants interview were also undertaken to validate some of the findings of the study. Key informants include staff from the Municipal Agriculture Office and Technical Staff of a local non-government organization working in the study area.

Study Area and Household Surveys

The study sites included barangays of Liwayway in the municipality of Diffun, Villamor in Cabarroguis, Tres Reyes in Aglipay, Dumabato Norte in Maddela and San Ramos in Nagtipunan, all in the province of Quirino. The combined area of the study sites was 5,113.19 hectares.

This study used purposive sampling in selecting the respondents. Purposive sampling was used since it allows the researcher to have fair "judgement in selecting the units that are to be studied", for this study, the farming communities of Quirino. A total of 139 individuals served as respondents to the survey questionnaire. Respondents were selected from the list of members obtained from the five Agrarian Reform Beneficiaries Organization operating in the study area. The most number of respondents came from Dumabato Sur with 59 individuals (42.45%), followed by Villamor with 36 individuals (25.90%), and Liwayway with 19 (13.67%).

RESULTS AND DISCUSSION

Assessment of Livelihood Vulnerability.

Figure 1 and Figure 2 shows the vulnerability index of five livelihood assets and the 12 major components. The overall LVI is 0.43 which has a qualitative description of moderate vulnerability. This result shows that despite ownership of various livelihood assets, household respondents still need some level of outside help to be able to overcome a given shock (Ncube *et al.*, 2016). Households within the study sites possesses enough human and social asset as gleaned from the average LVI of 0.31 and 0.30, respectively. These index have equivalent description of low vulnerability. Natural, physical and financial assets have VI of 0.47, 0.47 and 0.62 respectively, which are all within the range of moderate vulnerability. However, the diagram shows that there are specific assets (financial) and major components (finances and income, livelihood strategies, natural disasters and climate variability) that needs to be given attention since they fall under the category of high vulnerability indices.

The succeeding sections provide a comprehensive discussion on the assessment made for the five livelihood assets: human, natural, social, physical and financial assets and their sub-components. A summary of the LVI index for the different livelihood assets as well as their sub-components is shown in Appendix Table 1.

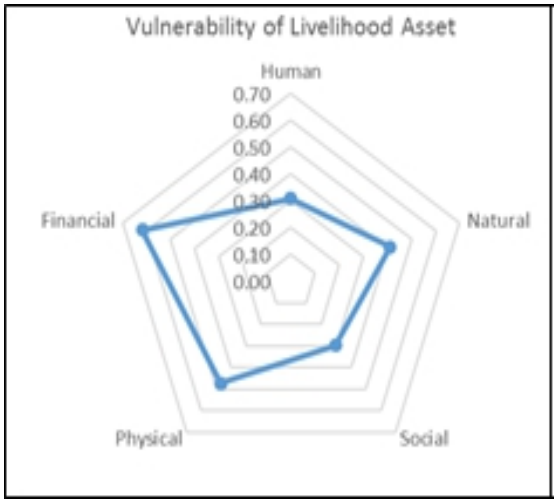


Figure 1. Vulnerability diagram of five livelihood asset

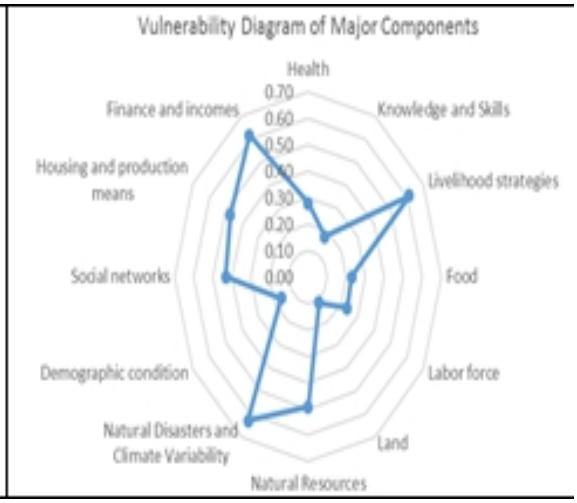


Figure 2. Vulnerability diagram of major components

Assessment of Livelihood Vulnerability of Farming Communities in Terms of Climate Variabilities Across the Five Livelihood Asset Using the LVI Method.

Human Asset Vulnerability. Five major components to include health, knowledge and skills, livelihood strategies, food, and labor force and 12 sub-components were assessed under human asset.

In general, human asset index is 0.31, which is equivalent to low vulnerability. Health, knowledge and skills, food, and labor force have LVI of 0.28, 0.18, 0.23 and 0.24 respectively., all within the category of low vulnerability. This means that households in the study site have enough human asset that may be used to recover from the negative impact of climate variabilities and associated events. However, in terms of livelihood strategies, vulnerability index is equal to 0.61 which falls within moderate vulnerability. It was also found that four of the five sub-components of livelihood strategies, to include source of income, diversity of crops, adoption of new crops and occurrence of pests and diseases, have high VI.

It was learned that 100% of the respondents do not have other source of income except agriculture and most provide labor services to neighbors in various farming activities. The major crop grown is rice, corn or combination of rice-corn for farmers who have both ricefields and cornlands. This finding is very essential because farmers need to be provided with information regarding crop diversification so that risks could be spread. It was further learned that aside from drought and typhoon induced damages and losses, pests and diseases occurrences have been a major problem in monocropping system.

This situation is further aggravated by the absence of alternative non-farm sources of income which, if present, could contribute to the adaptive capacity of local people. Related studies show that risks are better managed before and recovery is easier if there is a portfolio of livelihood with different risks attributes (Reardon & Vosti, 1995 as cited by Paavola, 2008). This means that households with diverse set of livelihood have better chances of coping with changes than those with only one type of livelihood activity (Panthi *et al.*, 2015).

According to key informants, recovery from climate-related losses usually takes several cropping seasons. The

reasons behind the difficulty in recovery is that, first, because they don't have other sources of income and second, they are into monocropping. Therefore, if they get affected by typhoon or drought, they have a hard time recovering because their livelihoods are totally affected. As a result, at least 16% of the total respondents reported to have experience food insufficiency of up to 1 and a half months in a year.

Natural asset vulnerability. Natural asset has an overall index of 0.47 equivalent to moderate vulnerability. Natural disasters and climate variability have the highest index of 0.80 equivalent to high vulnerability, followed by natural resources with 0.49 and land with 0.11 with equivalent description of moderate and low vulnerability, respectively.

Land is an important asset for farming communities and it is also an indicator of wealth (Nguyen *et al.*, 2015). Farmers who do not own lands can have higher vulnerability than farmers who own the land they till. In the study area, only a small percentage of the respondents do not own lands for agricultural production. The average area of land holding range from 0.5-1 hectare. The maximum size is 6 hectares and the minimum is ¼ hectare.

In terms of access to natural resources, a little over 90% of the respondents do not have access to water sources for irrigation. Irrigation facilities like water canals, small water impounding dams and water pumps are available for use, however, during the dry seasons these facilities could not supply irrigation water needs of the farmers. Water sources are available but farmers hardly tap because of the additional costs that may be incurred. This is so because majority of the respondents are living in lowland areas and accessing water sources for irrigation would be difficult. On the other hand, only a small percentage (7.9%) are dependent on forest resources. The stringent implementation of forest laws and policies by the Department of Environment and Natural Resources (DENR) regarding harvesting of forest products, local communities were regulated from accessing forest resources.

Natural disasters and climate variability sub-component have the highest VI from all the variables assessed. The VI is 0.80 which is equivalent to high vulnerability. Based on rainfall data obtained from Isabela State University – Agromet Station, the recorded number of heavy and extremely heavy rainfall over the period 2014-2016 days are few but the magnitude of damage on properties and infrastructures have been intense (Dullana, 2017).

Experience with flooding has VI of 0.20 and damaged/losses from climate-related events has 0.61 index. These indices have equivalent description of low and moderate vulnerability respectively. All the remaining variables, to include experience with drought, experience with typhoon, average number of heavy and extremely heavy rainfall and drought occurrences have VI of 1, which is equivalent to high vulnerability. This coincide with the disclosure of key informants who said that both typhoons and drought occurrences have negatively affected their agriculture activities, their properties and infrastructures.

Social Asset Vulnerability. Two major components and six sub-components were assessed under social asset. The overall index is 0.30 which is equivalent to low vulnerability. This means that demographic conditions and social networks of the population under study is basically satisfactory. The number of household members is 4.

The percentage of female headed families (2.2%) and inactive members of organizations (8.6%) as indicator of demographic conditions and inactive membership to organizations have very low VI.

Although organizational membership is high, a majority of the respondents have not participated in any organizational activities. Participation is very important because "energies and resources of individual

citizens are tapped, which provide a source of special insights, information, knowledge and experience, and eventually contribute to the soundness of community solutions (Cahn & Camper Cahn, 1968, as cited by Bowen, 2007). Therefore, to reduce vulnerability index, participation in various organizational activities should be encouraged so that projects and programs to be implemented comes from the local people themselves. According to key informants, organizational membership is very important since support from government and non-government organizations are basically coursed through formal organizations. Therefore, if a community resident is not a member or an inactive member of an organization, then his/her chances of getting support is also slimmer because active organization members are usually prioritized. Community organizations are therefore important because they make community networks stronger, and these networks basically contribute in reducing climate change vulnerabilities (Panthi *et al.*, 2015).

It was also observed that majority of the households have not provided support to their neighbors during or after a calamity. This is understandable since local community members would tend to recover first before they would be able to help other members in their community.

Physical Asset Vulnerability. One major component and four sub-components were tested under physical asset. The overall vulnerability index is 0.47, with an equivalent qualitative description of moderate vulnerability. Exposure to climate variabilities would definitely affect the local community since majority of the houses of the respondents are basically made up of temporary and semi/temporary materials. Majority also do not have vehicle that may be used during emergencies. During the dry seasons, almost 50% of the respondents do not have access to irrigation facilities.

From the four sub-components assessed under this category, type of house has the highest index of 0.66, which is within the high vulnerability category. It was learned that a little over 66% of the total respondents have temporary and semi-temporary types of houses. These type of houses are usually made up of wood, bamboo and thatch materials. In the event of strong typhoons and flooding, these type of houses can be easily destroyed because they are made up of light materials. This is the reason why vulnerability index of this component is high.

It was found that more than half of the respondents do not own any vehicle (VI = 0.52). Considering the distance of some of the areas to the nearest police station, rescue units or hospital, the respondents could not easily be able to request for assistance or help during or after a calamity. Therefore, the ownership of vehicle is very important because private vehicles can be used during emergency periods.

On the other hand, access to irrigation facility has an index of 0.47 which is equivalent to moderate vulnerability. Almost half of the respondents, especially those from rolling to mountainous areas do not have access to communal irrigation facilities and rely on rain for irrigation. According to key informants, if irrigation facilities could be constructed, then bigger agricultural areas may still be developed for production purposes. This in the long run, would provide additional income to the family, thereby reducing their vulnerability to the negative impacts of climate variabilities.

Interview with key informants and field visits revealed that irrigation facilities like water canals and small water impounding dams are available for use during the dry seasons, but only for some farmers whose farms are within or near NIA-irrigated areas. Large farm areas. There are farmers who could not access irrigation water from irrigation facilities due to distance and topography. Private water pumps are available for rent but

majority of the farmers do not want to avail these facilities due to the additional cost that may be incurred from their use.

Financial Asset Vulnerability. Vulnerability of financial asset was assessed using four sub-components, namely, savings, loan, access to formal credit, and income below the food threshold. Overall, the vulnerability rating is 0.62 which has a qualitative description of moderate vulnerability.

It was found that majority of the respondents do not have financial savings, they have existing loans, and do not have access to financial services. Despite the presence of multi-purpose cooperatives like Abrasa Multi-Purpose Cooperative (AMPC), Diffun Savings and Development Cooperative (DISADECO), Maddela Integrated Farmers Savings and Development Cooperative (MIFSADECO) and Tres Reyes Agricultural Credit Cooperative (TRACC) within the province, almost 45% of the respondents have not accessed these cooperatives for financial credits. Instead, most farmers rely on neighbors and loan sharks, which usually give high interest rates, for their financial needs. Access to financial institutions is very important because they can provide livelihood support and instruments for risks management (Heltberg et al, 2015 as cited by Panthi *et al.*, 2015).

A little over 37% of the respondents have income below the food threshold. Food threshold is defined as "the minimum income required to meet basic food needs and satisfy the nutritional requirements set by the Food and Nutrition Research Institute (FNRI) to ensure that one remains economically and socially productive". As of 2015, the monthly food threshold is pegged at PhP5,458.00 for a family of 4 (NSCB, 2015). This means that at least 1/3 of the respondents do not have enough money to support the food needs of their families. Income, along with livelihood diversification are important factors that should be maintained and enhanced to reduce impact of climate vulnerabilities (Ghimire *et al.*, 2015, as cited by Panthi *et al.*, 2015).

Assessment of Livelihood Vulnerability of Farming Communities in Terms of Climate Variabilities Across the Five Livelihood Asset using the IPCC-VI

Following the IPCC –VI definition of vulnerability, the different sub-components were regrouped into three major components: exposure, sensitivity and adaptive capacity. A total of nine subcomponents were classified under exposure, 23 under adaptive capacity and four for sensitivity. Refer to the attached Appendix Table 2 for the categorization of sub-components to respective contributing factor based on IPCC – VI. The overall vulnerability index is 0.032, which has an equivalent qualitative description of medium vulnerability. This means that exposure and adaptive capacity of the local people are more or less the same. However, exposure to climate variability is higher than that of the adaptive capacity and sensitivity. The result of VI obtained from this method is consistent with the computed LVI. Refer to Figure 3 for the vulnerability diagram.

From the three sub-components assessed, exposure has the highest index with 0.69, which is within the high vulnerability range, while adaptive capacity and sensitivity index are 0.43 and 0.21, respectively. This

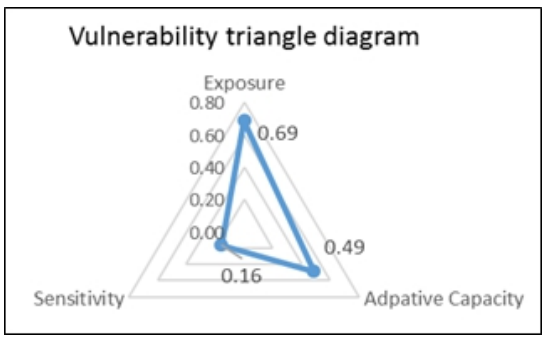


Figure 3. Vulnerability triangle diagram of the study sites

means that despite exposure to climate variabilities, local people have the capacity to adjust and recover from a given stress.

The study area and the local people are basically exposed to climate variabilities and extreme events including associated consequences. As discussed earlier, over the last 30 years, drought, numerous strong and very strong typhoons including associated consequences like flooding, landslides and soil erosion were experienced by the local people. These climate-related events have negatively affected their properties and livelihood. While the occurrence of these events are minimal in a year, the damaged and losses have been intense. For example, in 2010, typhoon Juan damaged no less than Php 1.5 billion cost of properties in the region and most of the damage was on rice with at least Php1.2 billion losses, equivalent to 84,223 metric tons of harvestable palay. The affected rice farms are at least 50% of the total land area planted to rice in the region (Lagasca, 2010).

Despite exposure to extreme climate events, key informants revealed that it usually takes the local people at least two cropping seasons before they could fully recover from their losses. Government and non-government support in the form of agricultural subsidies enabled them to overcome the negative impact of typhoons and droughts occurrences.

Livelihood Vulnerability Map

To develop the LVI map of the five barangays being studied, respondents were grouped to determine the vulnerability index per barangay. From the result obtained from the LVI method, the livelihood vulnerability map for the study area was generated. Liwayway and Villamor are highly vulnerable, while San Ramos, Dumabato Norte and Tres Reyes are moderately vulnerable. The summary of LVI generated per barangay is reflected in Table 3. Refer to Annex A for the LVI map.

Table 3. LVI per barangay

Barangay	LVI	Description
Liwayway	0.72	High vulnerability
Villamor	0.76	High vulnerability
San Ramos	0.66	Moderate vulnerability
Dumabato Norte	0.66	Moderate vulnerability
Tres Reyes	0.65	Moderate vulnerability

CONCLUSION AND RECOMMENDATION

Numerous dependent and interrelated variables based on the current situation of the study area were used in determining LVI and IPCC-VI. Human assets have low VI but livelihood strategies should be given special attention by concerned agencies. In terms of natural assets, local communities remained exposed to natural disasters particularly with drought and strong typhoons. In terms of social assets, local communities need to intensify their participation in different organizational activities and the need to develop the spirit of giving during calamities. For physical assets, type of housing needs to be improved and irrigation facility remained inadequate. Finally, for financial asset, all the five sub-components are within the moderate to high vulnerability. Both the LVI and IPCC-VI results showed that the livelihood of the local communities are moderately vulnerable to the negative impact of the changing climate.

While the local people have the capacity to recover from a given shock, they need some level of external help to fully recover from damage or losses caused by the negative impact of climate change.

In order to assist farming communities, shift from moderate to low vulnerability category, the following may be included in the projects and programs to be designed for their adaptation:

1. To further improve human assets, livelihood strategies available for local farmers may be enhanced. Knowledge and skills on livestock production, crop diversification, adoption of resistant crop varieties and pests/diseases management may be provided through trainings. Agencies such as the Department of Labor and Employment, Department of Trade and Industry, the Quirino State University through its Extension and Services Unit, may be tapped to assist in identifying and developing non-farm-based livelihoods as alternative sources of income for the local farmers. If non-farm-based livelihoods are available, risks are generally spread, and therefore, will eventually reduce their livelihoods' vulnerability to the impact of climate change.
2. On natural asset management, the construction of water irrigation facilities that can be directly accessed by local farmers may be a priority project of the local government units or the National Irrigation Administration. Small-water impounding projects, irrigation canals, windmills and other structures that can improve and increase supply of irrigation water should be constructed to benefit the local farmers. The National Irrigation Administration may be tapped to assist in improving irrigation structures while Irrigators Association can be tapped to access funds from funding agencies for maintenance of irrigation facilities. The Department of Environment and Natural Resources and the respective Municipal Environment and Natural Resources Office may re-introduce the concept of agroforestry (including the introduction of flood and drought-resistant species), with the ultimate goal of improving yield and productivity.
3. Improving social assets is also equally important. The Municipal Agriculture Office and other concerned agencies may be tapped to assist the local farmers in organizing themselves into farmers' organization/associations. Their organization into active organizations/ associations will improve their linkage and collaboration with agencies who could help them in times of calamities.
4. Local government units may also focus on providing appropriate information on improving physical assets. Appropriate areas for settlement to regulate exposure to flooding as well as strong typhoons may be identified. Appropriate housing materials may also be disseminated for use.
5. If the four earlier-mentioned assets are improved, local farmers may be taught on how to manage their financial assets through savings and application of crop insurance. Saving money that may be used during calamities is important. Farmers may also be encouraged to regularly apply for crop insurance from the Philippine Crop Insurance to protect their crops from typhoons, droughts, long duration rainfall and other disasters.
6. Lastly, a province-wide LVI assessment may be undertaken to develop the LVI map. The development of the LVI map will greatly help decision-makers and local planners in formulating projects and programs that are responsive in managing the negative impacts of climate change.

LITERATURE CITED

ABS-CBN News (2016, Oct 15). Typhoon 'Karen' makes landfall over Aurora. news.abs-cbn.com/news/10/15/16/typhoon-karen-makes-landfall-over-aurora.

Balgis, O. E., Nagmeldin, G. E., Hanafi, A. & Sumaya, Z. (2005). Sustainable livelihood approach for assessing community resilience to climate change: Case studies from Sudan. AIACC Working Paper No.17.

DFID (1999). Sustainable Livelihood Guidance Sheets. Retreieved June 5, 2016, from http://www.eldis.org/go/livelihoods/.

Dullana, R. (2017, Oct 21). In numbers: Cagayan Valley a year after super typhoon Lawin. Rappler. www.rappler.com/newsbreak/iq/185949-numbers-cagayan-valley-one-year-super-typhoon-lawin.

Hahn, M. B., Riederer, A. M. & Foster, S. O. (2009). The Livelihood vulnerability index: A pragmatic approach to assessing risks from climate variability and change — A case study in Mozambique. *Global Environmental Management*, *19*(1), 74-88.

Lagasca, C. (2008, Oct 28). Typhoon crop losses in Cagayan Valley reach P1.5 billion. Philippine Star. Retrieved June 18, 2014, from http://www.philstar.com/nation/624450/typhoon-crop-losses-cagayan-valley-reach-p15-billion.

Lasco, R. D., Pulhin, F. P., Jaranilla-Sanchez, P. A., Garcia, K. B., & Gerpacio, R. V. (2008). Mainstreaming climate change in the Philippines. Working Paper nr 62. Los Banos, Philippines. World Agroforestry Centre. 23p.

Ncube, M., Madubula, N., Ngwenya, H., Zinyengere, N., Zhou, L., & Francis, J. (2016). Climate change, household vulnerability and smart agriculture: The case of two South African provinces. *Jàmbá: Journal of Disaster Risk Studies, 8*(2), Art. #182, 14 pages. http://dx.doi.org/10.4102/jamba.v8i2.182.

NSCB (2015). Poverty incidence among Filipinos registered at 21.6% in 2015 – PSA. Retrieved June 25, 2017, from https://psa.gov.ph/content/poverty-incidence-among-filipinos-registered-216-2015-psa.

Paavola, J. (2008). Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. Environmental Science Policy II, 642-654.

Panthi, J., Aryal, S., Dahal, P., Bhandari, P., Krakauer N., & Pandey, V. P. (2015). Livelihood vulnerability approach to assessing climate change impacts on mixed agro-livestock smallholder around the Gandaki river Basin in Nepal. *Regional Environmental Change.* https:/doi.org/10.1007/s10113-015-0833-y.

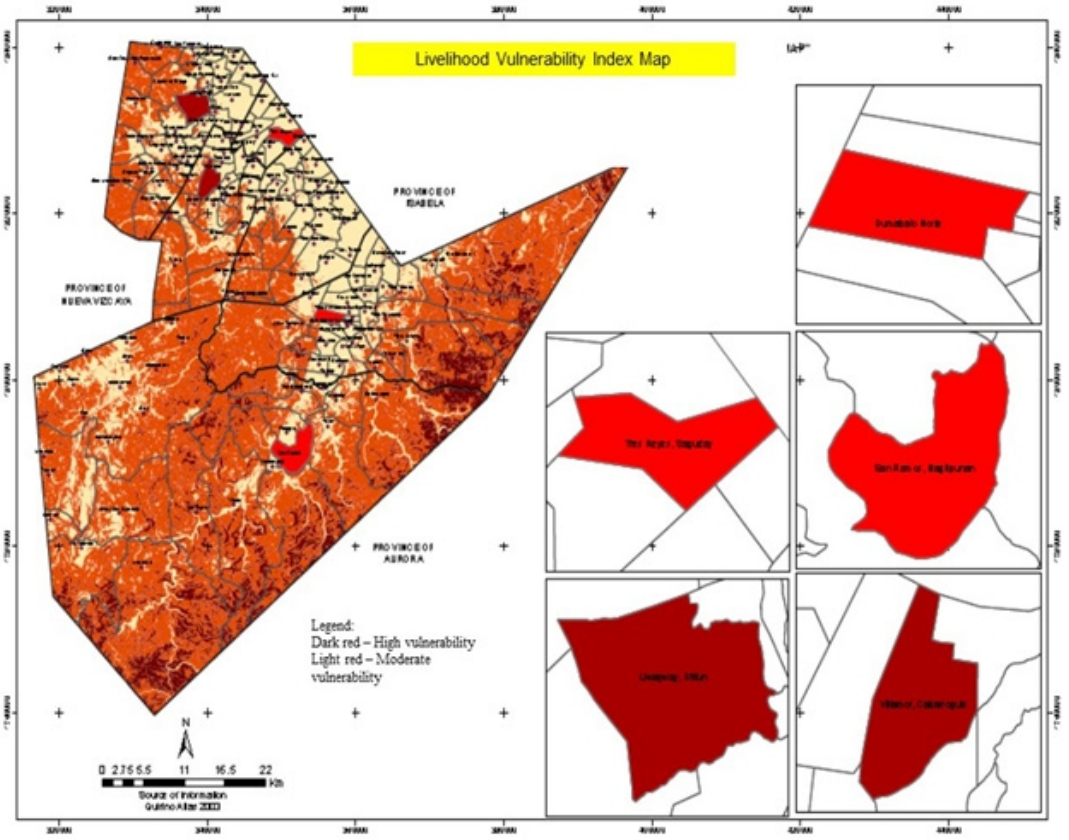
Pasakhala, B. (2010). Assessing the vulnerability of peoples' livelihood in Far Western Nepal [Unpublished thesis]. Asian Institute of Technology. Thailand.

Quirino Forestry Master Plan (2008). Province of Quirino.

Smith, B. & Wandel J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, *16*(3), 282-292.

UNDP (2007). Life expectancy at birth (Years). Retrieved June 15, 2017, from http://hdr.undp.org/en/69206.

Annex A. LVI Map of the five barangays being studied



Appendix Table 1. Result of assessment for the livelihood asset

Asset	Major Component	Sub-component	Unit	Observed Value	Maximum Value	Minimum Value	VI
Human	Health	Average time to nearest hospital	Minutes	30	60	15	0.33
		Percent of HH who have experience climate-related sickness	Percent	22.3	100	0	0.22
		Health average					0.28
	Knowledge and skills	Percent of HH who having less than 50% educated members	Percent	31.7	100	0	0.32
		Percent of HH without communication facility	Percent	3.6	100	0	0.04
		Knowledge and skills average					0.18
	Livelihood strategies	Percent of HH who have not diversified their crops	Percent	100	100	0	1.00
		Percent of HH whose major source of income is agriculture	Percent	94.2	100	0	0.94
		Percent of HH who have not adopted stress-resistant crop varieties	Percent	90.6	100	0	0.91
		Percent of HH without any livestock possession	Percent	74.8	100	0	0.75
		Percent of HH who have experienced pests/diseases in their farms	Percent	58.3	100	0	0.58
		Percent of HH who have not attended any seminar or training	Percent	10.8	100	0	0.11
		Livelihood strategies average					0.61
	Food	Months of food insecurity	Percent	23	100	0	0.23
		Food average					0.23
	Labor force	Percent of HH where at least 50% its members are not within the productive age	Percent	23.7	100	0	0.24
		Labor force average					0.24
		HUMAN ASSET AVERAGE					0.31
Natural	Land	Average size of land	Hectare	1	4	0.5	0.14
		Percent of HH who do not own any land for production	Percent	8.6	100	0	0.09
		Land average					0.11
	Natural resources	Percent of HH who do not have access to water source for irrigation	Percent	90.6	100	0	0.91
		Percent of HH who are dependent on forest resources	Percent	7.9	100	0	0.08
		Natural resources					0.49
	Natural disasters and climate variability	Average number of heavy and extremely heavy rainfall for the last 30 years	Count	33	33	0	1.00
		Number of drought occurrences over the last 30 years	Count	2	2	0	1.00
		Percent of HH who have experienced losses from climate-related events	Percent	84.9	139	0	0.61
		Percent of HH who have experienced drought	Percent	100	100	0	1.00
		Percent of HH who have experienced flooding	Percent	20.1	100	0	0.20
		Percent of HH who have experienced strong typhoons	Percent	100	100	0	1.00
		Natural disasters and climate variability					0.80
		NATURAL ASSET AVERAGE					0.47
Social	Demographic conditions	Average number of HH members	Count	4.44	10	2	0.31
		Percentage of female-headed households	Percent	2.2	100	0	0.02
		Demographic conditions					0.16
	Social networks	Percent of HH who have not received government/non-government organizations (GO/NGO) support	Percent	38.1	100	0	0.38
		Percent of HH who do not participate in organizational activities	Percent	49.6	100	0	0.50
		Percent of HH who have not provided support to neighbors during calamity	Percent	77	100	0	0.77
		Percent of HH who are inactive members of organization	Percent	8.6	100	0	0.09
		Social networks					0.43
		SOCIAL ASSET AVERAGE					0.30
Physical	Housing and production means	Percent of HH whose type of house is temporary/semi-temporary	Percent	66.2	100	0	0.66
		Percent of HH without vehicle	Percent	51.8	100	0	0.52
		Percent of HH without irrigation facility	Percent	47.5	100	0	0.48
		Percent of HH without facility for mechanize farming	Percent	23	100	0	0.23
		PHYSICAL ASSET AVERAGE					0.47
Financial	Finance and incomes	Percent of HH whose properties are not insured	Percent	92.1	100	0	0.92
		Percent of HH who do not have savings	Percent	62.6	100	0	0.63
		Percent of HH with existing loans	Percent	71.9	100	0	0.72
		Percent of HH who do not have access to financial organizations	Percent	44.6	100	0	0.45
		Percent of HH whose income is below the food threshold	Percent	37.4	100	0	0.37
		Finance and incomes					0.62
		FINANCIAL ASSET AVERAGE					
		LVI				Total	0.43