Climate Change Vulnerability Assessment in Selected Highland Areas of Benguet: An Application of VAST- Agro Tool

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ABSTRACT

Benguet, a uniquely temperate vegetable growing province is saddled with many climate hazards owing to its high altitude. Vulnerability to climate change of highland vegetables and strawberry-based agro-ecosystem was assessed in selected barangays of Poblacion, Tuba, Benguet and Puguis, La Trinidad, Benguet using the VAST-Agro tool. The VAST Agro-tool is a rapid participatory community-based climate change assessment instrument that uses a scoring method in evaluating exposure, sensitivity and adaptive capacity to climate change to determine vulnerability index. Vulnerability is the degree to which a system is susceptible to or unable to cope with adverse effects of climate change including variability and extremes. Findings showed that both communities were vulnerable to the effects of climate change. Barangay Poblacion, Tuba had high exposure and sensitivity to the effects of landslides, frost, strong winds and hail storms. Livelihood sources like farming, vegetable trading, food processing and selling in markets were also more sensitive to these hazards despite the higher adaptive capacities of the residents. On the other hand, Barangay Puguis had higher exposure to typhoons and La Niña. More frequent and longer rain periods and typhoons caused greater damage to vegetables and strawberry crops. Residents from Puguis are relatively more resilient owing to other income sources that are less climate-sensitive like store keeping and employment in government and non-government entities.

Keywords: *climate change, vulnerability assessment, climate hazards, community resilience, temperate vegetables, VAST-Agro tool*

INTRODUCTION

Benguet province is located at the southern tip of the Cordillera Mountain Range in the northern part of the Luzon Island. It is located about 1500m above sea level and is characterized by rugged sloping terrains and deep valleys. Benguet has wet and dry seasons of equal duration and experiences heavy rainfall due to its elevation. The province has 13 municipalities which includes the selected sites for the assessments (Figure 1).

Agriculture has been the traditional source of employment of the people of Benguet largely due to the low temperature requirement of semi-temperate crops like strawberry (e.g. ~5°C temperature to produce quality fruit) and its uniquely cool weather. The primary agricultural activity is vegetable production with white potatoes, beans, peas, strawberries, cabbage, lettuce and carrots as the major crops. Further, Benguet is widely known as the "Salad Bowl" of the Philippines and later dubbed as the "Strawberry Country" being the leading producer of various species of strawberries like *Tsuga* and *Sweet Charlie*.

Current changes in prices of inputs due to

consistent heavy rains have drastically influenced the market prices of some semi-temperate vegetables and crops being supplied by Benguet. This has influenced not only the quality of living but food security as well. Decrease in crop yield and/or crop loss due to higher temperature, rainfall, and frost and increase in pests and diseases are but some of the commonly observed impacts (Calora *et al*., 2012).

Highland vegetables and strawberries are among the most vulnerable crops to climate hazards like too much rain, drought and typhoons and must be assessed to help farmers cope with such changes. The sites for growing strawberries and vegetable crops were the primary considerations in the selection of Barangays Poblacion of Tuba and Puguis of La Trinidad, Benguet for the study.

Vulnerability to climate change of the strawberry-based agro-ecosystem was assessed using the Vulnerability and Adaptive Capacity Assessment for different Agro ecosystems (VAST-Agro) tool, developed by the Agriculture System Cluster of the College of Agriculture at University of the Philippines - Los Baños. The main objective of the research was to determine the vulnerability and resilience of the communities by assessing their exposure level, sensitivity and adaptive capacity to climate change hazards.

VAST-Agro is a quick participatory method of assessing the vulnerability of a community's agricultural sector or particular crops in a community to the hazards of climate change based on their exposure to climate hazards, sensitivity to damages that the hazard may bring, and the community's capacity to cope with adversities. It is a holistic approach that uses community

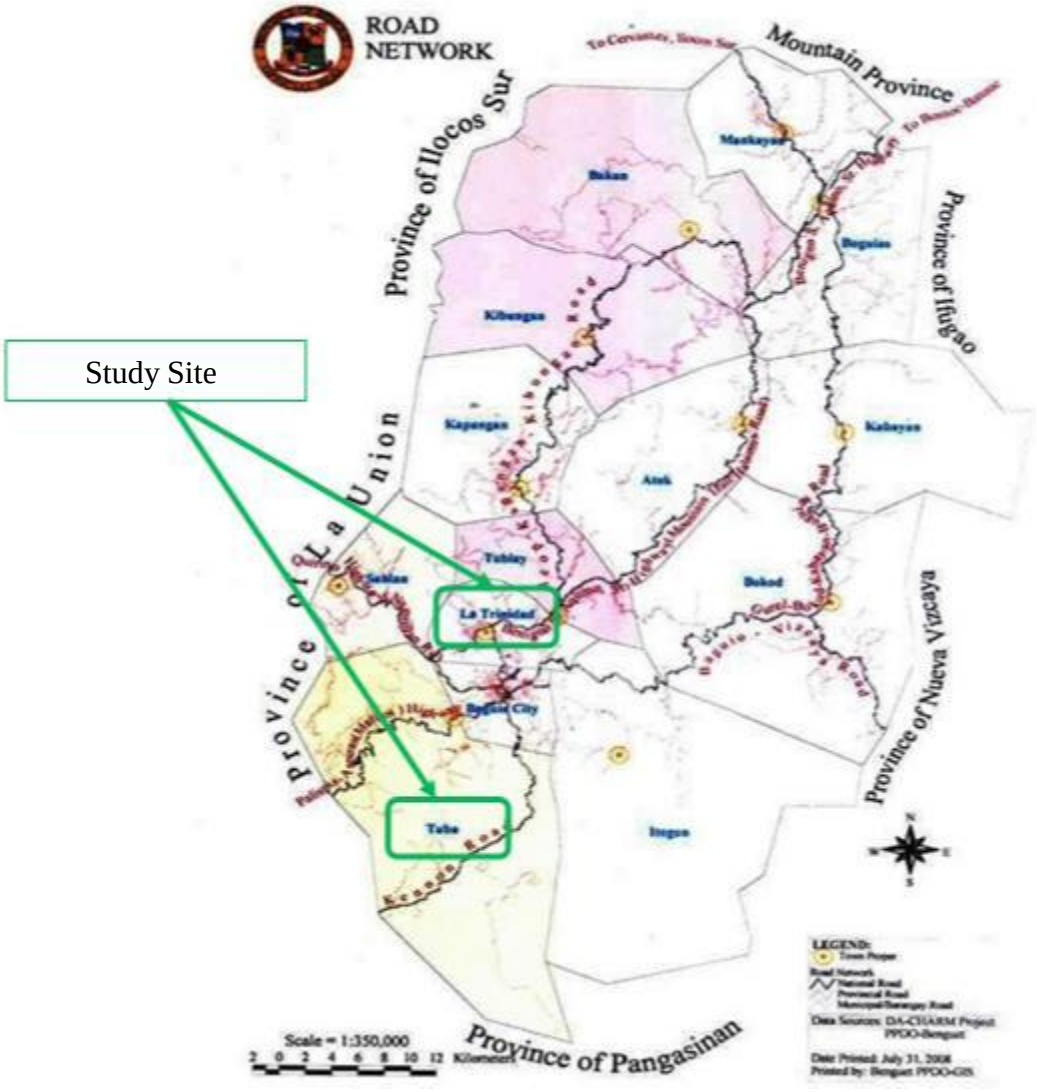

Figure 1. Locations of the study

participation to assess both bio-physical and socio-economic sensitivity. It uses a scoring method that measures variables and comes up with a vulnerability index using Microsoft Excel program (Garcia *et al.*, 2011).

Vulnerability assessment facilitates decision-making and planning especially among Local Government Units (LGUs), peoples' organizations and other stakeholders. Assessment results can be used as baseline information for community planning in the reduction of vulnerability to climate change. This is through improving adaptive capacity and by identifying proven technological adaptations used by other farmers in the area. Furthermore, this may help LGUs prioritize what hazards need to be addressed first. Communities with higher vulnerability indices for particular hazards need more assistance and intervention from LGU's.

METHODOLOGY

A. Geographic Profile of Study Sites

The study was conducted in Benguet Province, particularly in Barangays Puguis of La Trinidad, and Poblacion of Tuba from March to August 2012 (Fig. 1).

The municipality of Tuba is the 3rd largest municipality of Benguet in terms of land area occupying about 83.85 sq.km. (19.31% of the total land area). It is hemmed in the municipalities of La Trinidad, Sablan and Itogon. The topography is characterized by irregular rugged terrain and steep slopes. It is one of the municipalities in Benguet with geographic variations. It has the lowest elevation of 200m asl and up to approximately 2200m asl with several mountain peaks (CHARM-DA-CAR, April, 2010).

The municipality is politically subdivided into 13 barangays. Barangay Poblacion is one of the major agricultural areas, where strawberry and various vegetable crops are grown. It is characterized by a rolling terrain steeply rising toward sitios like Cabuyao, Pula, Saddle and Digdigwayan.

The barangay lies between elevations from 900m asl (Lower Poblacion) to about 2000m asl (Upper Poblacion including Mount Cabuyao). Sitio Cabuyao is about 2000m asl to 2,200m asl and is known as "Little Buguias" due to its parallel practice of expansive farming along the hilltop just like in Buguias, Benguet. It is where the famous twin radars of Mt. Cabuyao are located. The soil is 75% loam or Matador clay and 25% mixed type of mud and sand soil (Barangay Annual Report 2006 and Tuba MPDO Census, 2007).

Barangay Poblacion is about 3,094 hectares, of which about 45% of the land is agricultural, 49.4% is commercial forest, 0.6% is communal forest and the rest (5%) is residential. In previous years, there were grazing areas, but these were converted to agricultural lands and residential areas. Ninety-eight percent of the total land area is classified as agricultural but some of these areas are covered by forests and are privately owned or claimed.

La Trinidad is a first class municipality and is the capital town of Benguet Province. It is situated at geographical coordinates of 16°21' north latitude, 120°25' east longitude occupying a land area of 8,079.51ha with a mountainous topography. The municipality is known as the "Strawberry Capital of the Philippines". Strawberry has been identified as the town's "One Town, One Product" (OTOP) since strawberries are primarily grown in the municipality. The town has also been dubbed as the "Salad Bowl of the Philippines" because of the many highland vegetables grown in the valley. The municipality is composed of 16 barangays.

Barangay Puguis is the 3rd largest barangay of La Trinidad of about 1,021.82ha. 8% or 78ha of this is communal forest. The remaining area consists of 62% agricultural and agroforest lands while about 30% is residential. Being the largest barangay, it is one of the major areas for growing strawberry and other high value crops including chayote. The elevation of Barangay Puguis ranges from 1080 to 1720m asl. The upper portions are generally mountainous and vulnerable to landslides while the lower area is affected by

floods during the wet season due to inadequate inland drainage systems.

B. Description of the Climatic Conditions of the Study Sites

The Province of Benguet falls under the Type I climate, characterized by two distinct seasons – wet, from May to October and dry, during the rest of the year based on the Coronas classification. Based on data from PAG-ASA stations in La Trinidad and Baguio City, Tuba and La Trinidad are dry during the cool months of November to February and the summer months from March to May, while the rainy season is from June to October. Average temperature ranges from 17.3°C to 20.7°C with the coldest month in January and warmest in June. Total precipitation from June to October is about 96%.

C. Site Selection

Prior to the conduct of the study, the potential sites for implementation of the study were evaluated. Among the criteria used for selection were: (1) presence of strawberry production areas; (2) accessibility; (3) willingness of the community members to participate in this activity and (4) existence of climate hazards.

The municipalities of Tuba and La Trinidad were selected for the study since farmers in these areas grow strawberries. From each of these two municipalities, two barangays were selected: Brgy. Poblacion of Tuba and Brgy. Puguis of La Trinidad, Benguet.

D. Methodology

Site reconnaissance activities like transect walks were undertaken to gather primary data. Maps from Google Earth were overlaid with community boundaries to serve as reference maps in identifying areas damaged by hazards. Data from PAG-ASA served as references for verification. All these served as sources of baseline information for the workshop activity and gathered information was validated during the workshops conducted.

Farmers, peoples' organizations, the Municipal Agriculture Office and local government unit representatives joined separate community workshops. Assessment was done through Focus Group Discussion (FGD) and workshop using the VAST-Agro tool.

The VAST-Agro tool uses several tools to assess vulnerability: (1) hazard identification and cropping calendar mapping, (2) rate/frequency of occurrence of identified hazard, (3) hazard-sensitive areas and crops, damage incurred and magnitude of damage, (4) income source, their sensitivity and contribution to household income, (5) adaptive capacity assessment tool and (6) technological adaptation tool. Except for tool 1, each tool has a basis for scoring and is directly inputted in an Excel Program that computes the vulnerability or resiliency index. An example using a score sheet for frequency of typhoons is shown in Table 1.

All secondary data and results of the workshop were inputted in these tools. After the workshops and evaluation of vulnerability and resilience scores, results of assessment were presented for validation and some recommendations were given by participants and facilitators.

Table 1. Tool 2. Rate/ frequency of occurrence of identified hazard

Score	Frequency of typhoons that directly hit the farm areas in the past 10 years	Description
0	0	None
1	1-2x	Very rare
2	3-4x	Rare
3	5-6x	Moderate
4	7-8x	Frequent
5	9-10x or more	Very Frequent

RESULTS AND DISCUSSIONS

A. Climate Change and Variability Conditions

The average total rainfall from year 1952 to 2002 was 3878mm with an average monthly rainfall of 323.17mm. This is relatively high as compared to other areas of the country. PAGASA, Baguio City recorded the highest 24-hr amount of rainfall at 1085.8 mm (PAGASA, Baguio City).

Figure 2 presents the average monthly rainfall distribution in Baguio City from 1952-2006. The onset of the rainy season is from April to May while the heaviest rainfall was recorded in July. Table 2 shows average climatic data on temperature, relative humidity, sunshine duration and windspeed observed at the Benguet State University Agro-meteorological station in La Trinidad, Benguet covering the year 1960 to 2010.

Owing to its nearness to the eastern part that faces the Pacific Ocean and to its high altitude, Baguio City is exposed to more frequent rains and heavy typhoons. As per record, some of the most damaging typhoons have passed this area. Five of the most destructive typhoons that visited the country passed through Benguet (Calora *et al.*, 2012).

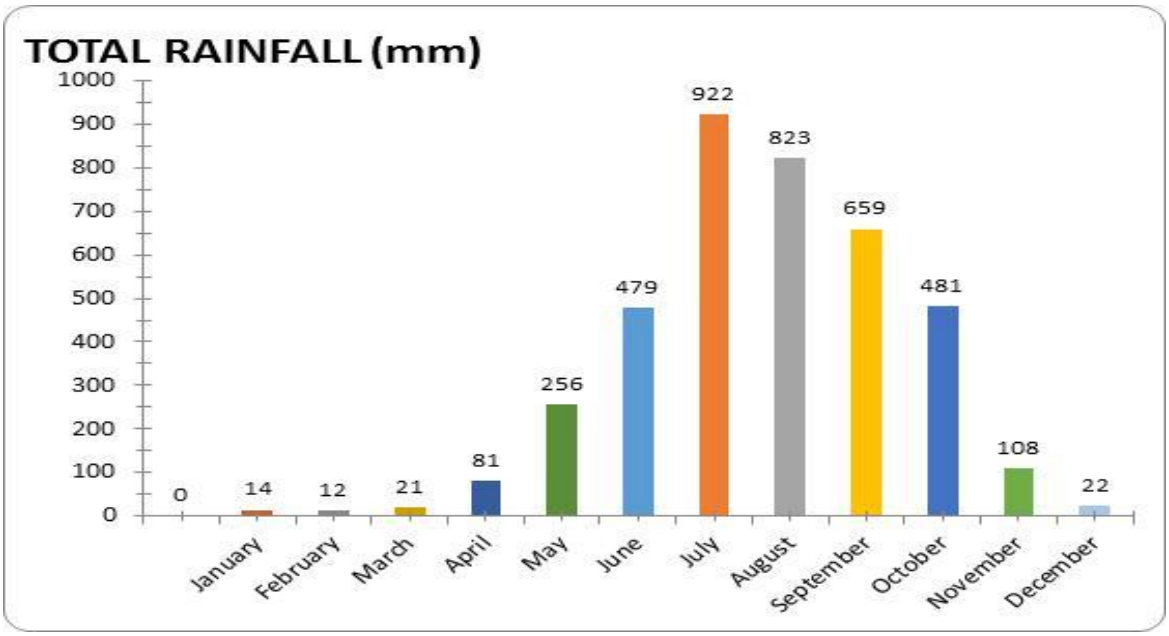

Figure 2. Average monthly rainfall in Baguio City from 1952 to 2002 (Source: PAG-ASA, Baguio City)

Table 2. Average climatic data observed at the BSU Agro-meteorological station (1960-2010)

Month	Mean temp (ºC)	RH (%)	Wind Speed (km/day)	Sunshine Duration (hrs)	ETo (mm/day)
Jan	17.3	79.6	43.7	6.7	2.73
Feb	17.7	78.8	38.2	7.1	3.21
Mar	19.0	76.2	44.6	7.1	3.76
Apr	20.2	74.4	45.5	6.8	4.04
May	20.4	78.8	50.2	5.0	3.65
Jun	20.7	82.6	68.8	4.9	3.61
Jul	20.1	84.8	75.0	3.9	3.29
Aug	20.0	86.7	67.2	3.1	3.02
Sep	19.9	84.7	54.6	3.7	3.03
Oct	19.8	83.8	55.1	4.9	3.06
Nov	19.0	80.3	42.8	5.5	2.82
Dec	18.1	78.5	45.5	6.1	2.69
Ave	19.4	80.8	52.6	5.4	3.24

B. Exposure to Climate Hazards

Taking into consideration the geography and elevation range of Poblacion, Tuba, the weather condition is rather variable between the upper portion of Poblacion and the low-lying areas. The area has a rugged topography and is also prone to erosion especially along ridges and roads during typhoon months. Most of the barangays are exposed to climate hazards such as typhoons and heavy rains usually occurring during the wet season (Table 3). Among the typhoons remembered by respondents as most damaging were typhoons *Frank, Milenyo, Ondoy, Peping, Reming, Rosing, Trining, Feria, Cosme, Pedring* and *Igme.*

Table 3. Frequency of occurrence of identified hazards in Poblacion, Tuba and Puguis, La Trinidad.

Hazard	Poblacion	Puguis
Typhoon	4 times/year	16 times in 10 years
Landslide	once a year	once a year
Frost	once a year	-
Strong wind	once a year	-
Hail storm	once a year	-
Flooding	-	16 times in 10 years
La Niña	-	twice a year
El Niño	once in 10 years	once in 10 years
Intense Rainfall	-	once a year
Pest (leaf miner)	once in 10 years	-

Sitio Cabuyao, being situated at about 2000m asl, has a colder weather and higher exposure to strong rains, winds, and typhoons. Strong winds are experienced from September to November. The temperature in this area is usually 3°C lower than that of Baguio City proper. Temperature could be as low as 3°C to 5°C. Hailstones (from May to June) and frost (from January to February) occur yearly, although the frost in this area is not as damaging as compared to that in Atok, Benguet. Thin ice sheets are sometimes found in the area during the cold season.

According to residents of this area, there was a high incidence of leaf miner infestation in 2003 which affected production of potato, legumes and celery. On the other hand, very dry condition in Poblacion, Tuba has been experienced from January to April, drying up most springs and creeks. In recent years, unpredictability of occurrence of prolonged dry months and the declining number of monsoon rains were noted, affecting planting activities in the area.

In Puguis, the climatic hazards identified by the respondents were typhoon, landslide, intense rainfall, flooding, La Niña and El Niño. The very frequent hazards experienced were typhoon and flooding. The area is usually visited by at least four strong typhoons every year. Among those that had been most damaging were typhoons *Peping, Frank, Ondoy, Trining* and *Feria*.

There is not much problem during times of prolonged dry months in lower
Puguis even during El Niño since most of the area has good irrigation facilities. The lack of appropriate drainage canals, however, has often resulted to flooding in the low-lying areas of the barangay during La Niña.

C. Seasonal calendar and cropping pattern

Strawberries grown in Poblacion, Tuba are rainfed and most farmers only utilize the first cropping since there is limited irrigation facility in the area. Strawberry is planted earlier (July or August) due to the longer flush growth period it requires. In Sitio Cabuyao of Poblacion, when strawberries are planted as early as July, they flower around September and fruits set in from November to April of the next year. The second cropping starts in March, but is devoted mostly to vegetable crops, while preparation and mass production of planting materials are being done for strawberry during this season.

In lower Puguis, strawberry is planted from July to October and harvested in November until April as long as heavy rains are not prevalent. Heavy rains result to flooding of the area causing rotting of the berries. In Longlong (Upper Puguis), however, strawberries are planted as early as May and are harvested by August since flooding is not much of a problem in the area.

Economic reasons and loss of very good varieties have made strawberry a minor crop in Poblacion. Thus, areas devoted to strawberry planting are few compared to those allotted for potatoes and broccoli. These vegetable crops are planted during September and harvested 3 or 4 months after planting. Diverse cropping by spatially dividing the area is also a common cropping system practiced in both Puguis and Poblacion, leaving planting areas for vegetables even while growing strawberries.

Highland vegetables planted in Cabuyao are carrots, potatoes, broccoli, cauliflower, chayote and leafy vegetables. These are continuously planted either simultaneously with other crops or through rotation as long as there is enough water. Water availability is thus one of the primary considerations in their farming activities.

Broccoli and lettuce are also continually planted in Upper Puguis. Leeks and lettuce are some of the highland crops planted either as alternate or intercropped vegetables. Because of the terrain, chayote is the main crop in Upper Puguis. Production of potted ornamental plants is another major venture.

D. Sensitivity to Climate-Related Hazards

Based on the results of the workshop, it was observed that the climate-sensitive crops, strawberries and some highland vegetables were among the crops most vulnerable to climate hazard (Table 4). There were higher risks in production, especially for strawberry, as experienced by farmers.

Table 4. Economic sensitivity to climate hazards of cropping areas in Poblacion and Puguis

Hazard	Sensitive crop	Poblacion, Tuba		Puguis, La Trinidad	
		Percent of total agricultural area	Magnitude of damage (%)	Percent of total agricultural area	Magnitude of damage (%)
Typhoon	strawberry	0.4	75	31	85
	highland vegetables	99.6	90	21	100
	chayote	-	-	10	75
Landslide	strawberry	0.4	20		
	highland vegetables	99.6	20		
	cutflower	-	-	21	70
	chayote	-	-	10	50
Frost	strawberry	0.4	60	-	-
	highland vegetables	99.6	100	-	-
Strong wind	strawberry	0.4	7.5	-	-
	highland vegetables	99.6	50	-	-
Hail storm	strawberry	0.4	95	-	-
	highland vegetables	99.6	95	-	-
Flooding	strawberry	31	100		
	lettuce/ broccoli	21	100		
	cutflower	21	100		
	chayote	10	50		
La Niña	strawberry	-	-	31	100
	lettuce/ broccoli	-	-	21	100
	chayote	-	-	10	75
	cutflower	-	-	21	100
El Niño	strawberry	0.4	25	31	50
	highland vegetables	99.6	25	21	20
	chayote	-	-	10	75
Intense rainfall	strawberry	-	-	31	85
	highland vegetables	-	-	21	30
	chayote	-	-	10	75
Pest (leaf miner)	potatoes/beans/ green peas/ celery	20	60	-	-

During typhoons and La Niña, strawberry farmers in Poblacion, Tuba and Puguis, La Trinidad experience 50% to 100% damage or loss. Rotting of the fruits and roots occur. Slow recovery and destruction of flowers (as high as 100%) are also problems after typhoons.

Other crops including chayote also showed root rots resulting from excessive water especially during continuous rains. Since agricultural areas planted to highland vegetables such as potatoes, carrots, broccoli and lettuce are usually wider, the potential damage from these crops is also higher as compared to strawberries which consist of only 0.4% of the agricultural area in Poblacion.

Damage to vegetable crops ranges from 80% to 100% and most of the plants need to be replaced. For broccoli, delayed flowering was also observed as the result of constant rain. Stem rotting and yellowing or a "burning effect" on flowers and curds have been observed and thus greatly reduced their quality, whereas, in chayote, flower or fruit abscission and the "agparya" effect on leaves that leads to fruit deformation have also been observed.

Since Puguis is prone to flooding, rotting of the plant parts is the common problem due to prolonged soaking. A hundred percent loss or damage occurs if the event is followed by long, hot periods causing the soaked plants to wilt. Flooding usually affects wider areas since most of the cropping area of Puguis is located in the low plains, whereas, in the mountainous areas of sitio Longlong, damaged trellises of chayote and some crops being buried were common observations only during typhoons.

Mechanical and physical damages including stunted growth and damage to the crops are the major effects of the strong winds in Sitio Cabuyao, Poblacion, Tuba for both strawberry and highland vegetable plants. In chayote-covered land, trellises are often damaged although the plants usually recover. The damage of strong winds to vegetable crops could be as high as 50%. Fruit abortion is specifically observed in strawberry, causing a 5-10% yield loss.

Hail storms and frost usually occur every January and February and are as damaging as the typhoons (60 – 100% damage) at Cabuyao. Among the effects of these to crops are occurrence of molds, death at the vegetative stage and browning of broccoli curds.

In terms of landslides, the sensitive areas in both barangays are located along the roads and the steep areas towards Sto. Tomas and Upper Puguis. Some portions towards Cabuyao have rugged terrain and are hardly planted while the rest of the area is usually hilly. Rarely do farmers plant along slopes, except in those areas devoted to chayote and coffee. Most farms had been leveled off or terraced for vegetable crop production.

The major impact of landslides in the area is the closure of the farm-to-market roads, delaying delivery of harvest. The crops become either covered with soil or are washed out. Delay in transport reduces the quality of the products. Although there is a current system for transferring commodities from one vehicle to another, this can still reduce their income by as much as 20%. Furthermore, the cost of transporting products usually increases when landslides occur along access routes.

Prolonged dry season is one of the greatest hazards in Poblacion and Upper Puguis. At its early onset, farmers no longer plant crops. In case the critical seedling stage had been surpassed, at least 25% of their crop investment can be recovered, otherwise, there is crop failure.

Highland vegetables cannot be grown in non-irrigated areas of barangay Upper Puguis since these oftentimes do not survive under El Niño conditions. Fallowing is practiced when irrigation water is really a constraint. Even chayote hardly bears fruits during El Niño and produces smaller leaves and fruits.

In Poblacion, leaf miner infestation has been associated by farmers to climate change. With the occurrence of leaf miners, 60% of yield loss was estimated due to insect infestation particularly during the vegetative stage of the crops.

Sensitivity of Income Sources to Climate Hazards

Based on the 2008 Barangay Poblacion Profile, income sources from pure farming sectors were shown to be about 22% (359 households); non-farming sectors at 28% (437 households), government and non-government enterprises 20% (322 households) and the remaining 30%, from the unemployed. Retailing of vegetable crops, selling in satellite markets and food processing are some of the agriculture-related income sources of Poblacion residents. Most of them, however, depend on farming.

Unlike in the past, there has been a reduction in dependence on pure farming as some farmers also engage in non-farm based income source to augment their incomes. Owing to the area's nearness to Baguio City, there are other income-generating opportunities. When the farmers were asked about the sensitivity of their other income sources, most believed that their livelihood sources were climate sensitive (Table 5). In Poblacion, of the 85% households which source their livelihood from agriculture and other sources, only 5% were from non-sensitive sources. Most (80%) were climate-sensitive in nature.

During the workshop in Poblacion, the computed socio-economic sensitivity potential showed that residents of Poblacion, Tuba are highly sensitive to climate hazards. Highest sensitivity score was derived for typhoons, strong winds and hail storms, followed by frost and El Niño and least for land slides and pests.

Barangay Puguis, on the other hand, is one of the commercial areas of La Trinidad. Based from the Barangay Puguis Development Plan, about 48% of the population depends on agriculture specifically vegetable, strawberry and cut flower production.

Results of the workshop showed that 10% of the households are engaged in pure agriculture; 70% in agriculture plus other livelihood while 20% are either locally or foreign-employed. Furthermore, based on the data gathered, only 40% of the households have income sources sensitive to climate hazards while 60% of the population are engaged in non-sensitive sources of income. Thus, computed socio-economic sensitivity showed that the residents of Puguis are only slightly sensitive to these climatic hazards as compared to those assessed in Poblacion, Tuba.

E. Adaptive Capacity of the Community

Most of the families had about four household members capable of supplying farm labor. As of the 2007 census, there were 1028 households in Poblacion and 1075 households in Puguis having an average household size of 4 to 5 members. Although the ratio of dependence is about 38% in Poblacion and 45% in Puguis which includes children below 15 years old and those with disabilities, farmers claim that their children help in the farms. Generally, the adaptive capacity for both areas is high (Table 6).

Table 5. Sensitivity of income sources to climate hazards in Poblacion and Puguis

Source of Income/Food	% of Households	
	Poblacion	Puguis
Pure agriculture	10.0	10.0
Agriculture + Climate sensitive income sources	80.0	10.0
Agriculture + Non-climate sensitive income sources	5.0	60.0
% of income from climate sensitive sources	65.0	20.0
% of income from non-climate sensitive sources	35.0	80.0
Employee	2.5	14.0
OFW	2.5	6.0

Table 6. Adaptive capacity of respondents from Poblacion and Puguis

Variable	Poblacion	Puguis
Availability of family labor in the household	Very high availability (≥4)	Very high availability (≥4)
Literacy rate (percent of literates in the households)	Very high (at least 90%)	82%
General knowledge of the hazards (percent of the population who are knowledgeable)	Very high (85%)	Moderate
Availability of resources (e.g. transportation, communication, facilities)	Very high availability	Very high availability
Presence, effectiveness and efficiency of a community early warning system	Very good	Good
System of disseminating information within the community about the hazards	Good	Good
Presence and accessibility of support systems	Very good	Very good
Wealth level (% of population who can afford to spend for adaptation costs)	Very low	Low

In both barangays, literacy rate is relatively high at about 82-90%. The surveys conducted by the barangays in 2007 and 2008 showed that most residents were able to go to school. They can read and write and are able to understand information about climate change hazards from different sources of information (Community Profile, 2007). The high literacy rate is attributed to the presence and accessibility of academic institutions and of public schools. In Puguis, it was observed that respondents have a moderate knowledge of the hazards and desire a more comprehensive campaign on climate change and adaptive measures. In Poblacion, most farmers are familiar with the identified hazards either because of direct exposure to the hazards or through orientation and information they receive from various sources like newspapers, radio and TV, cable stations and the PAG-ASA station.

There is accessibility, communication and the presence of early warning systems and support institutions. Both sites are accessible even if there are road cuts in Poblacion. There are other means of transferring to a next vehicle. Warning system through the use of cellphones in Poblacion is also done and is relatively effective except when electricity is down and financial resources limit the purchase of communication devices. In Puguis, the system of informing the community about calamities or hazards is through radio, SMS, and the "Batangtang" system (bell). Added to this is the personal visitation and warning done by the local officials to the community.

The presence of the Department of Agriculture (DA), Municipal Planning and Development Offices (MPDOs), National Irrigation Administration (NIA), cooperatives and LGUs working in these areas strengthen the support system in the community. Barangay Puguis, for instance, has two irrigation systems for farm and domestic uses. However, due to increasing demand for water, this is still insufficient during summer so that many farmers opt to establish their own water impounding system especially in Upper Puguis and Sitio Cabuyao.

Both areas also have good access to health services, education facilities, fire station, electricity and communication with many social welfare and civic groups and cooperatives helping in the community.

In Poblacion, out of the 1038 farmers recorded in 2006, 89% own the land they till while only 4% rent and 7% share the land with other farmers (Workshop Interview). Only 5% of the farmers though can readily replace their crop after the onslaught of typhoons in the area. A credit facility is being provided by the municipal office of Tuba but most farmers cannot readily repay their loans after the occurrence of hazards. In Poblacion, wealth level rating is rather low. The community claimed that with the presence of credit or lending agencies, they can afford to spend for adaptation costs.

F. Technological Adaptations

Technological adaptations due to the effect of typhoons in Poblacion and Puguis (Table 7) include tunneling prior to the wet season, hilling up and spraying fungicides on crops after typhoons. Tunneling is the use of a low-cost greenhouse, usually a low roof that protects the crops against continuous heavy rains, insects and frost. Hilling up, on the other hand, is earthing up or ridging. It is the practice of piling soil around the base of the plant, serving as a means of support for the stem especially in potatoes where this can even increase the number of tubers. Mulching is done in order to protect the soil and strawberries during rains. Drainage canals are constructed to lessen the impact of flooding.

Many strawberry farms have been converted to highland vegetable farms since these are more resilient to climate hazards such as heavy rains and typhoons. Most of those still planted with strawberries are located in Cabuyao but this only consists of about 0.4% of the total land area of the barangay. Only five farmers who can afford tunneling technology grow strawberries in the low-lying areas of Poblacion.

Ripraps, bench terracing and tree planting are landslide preventive measures being adopted. Cleaning of debris in landslide areas and transferring when landslides hit access roads are

Table 7. Technological adaptations practiced in Poblacion and Puguis

Hazard	Adaptation Strategy
Typhoons	tunneling, hilling up, spraying of fungicides, mulching
Landslides	tree planting, transfer, clearing of debris, riprapping/stonewall, fixing of trellis for crops
Frost	'kuwelo' (water harvesting), irrigation
Strong winds	hilling up
El Niño	irrigation; mulching
La Niña	tree planting, mulching
Hail storms	watering within the day
Intense Rainfall	tunneling, diversion canal, mulching
Flooding	no adaptation measures
Pests (leaf miner)	yellow trap and spraying of fungicides, use of *Mokusaku* technology

some of the adaptive measures which can be employed. Stone walling or riprapping is done in eroded or landslide-prone areas and damaged trellises are repaired. Crop rotation, organic farming and change of crop variety are also considered as means of adapting poor soil condition resulting from soil erosion.

Frost is also a hazard in the area. Most respondents are aware that watering could reduce the impact of frost to plants, unfortunately, only around 5% apply this technique. This is because of the inavailability of water in the area. Although the water reservoir of Baguio City is located in Cabuyao, the community is not allowed to access this. This also explains why no practical technological adaptation is applied in case of El Niño. Only few farmers adopt the water harvesting technology locally called "kuwelo" or small water impounding system due to limited funds.

In the case of pest incidence such as the presence of leaf miners, hilling up, tunneling, use of yellow trap and spraying of pesticides have also been done to minimize the effects of these pests on crops. This, however, has low effectivity thus, only about 50% of production is recovered. Other technological adaptation strategies in the community are mostly farmer-initiated like the application of Integrated Pest Management (IPM), the use of "Mukosaku" a Japanese technology where composting waste by-products are used as pesticide. Only few adopt the technology due to its high labor requirement. Some of the technological adaptations which require greater amounts of labor and cost may need intervention from farmer groups and other institutions.

G. Resilience and Vulnerabilities of Barangays Poblacion, Tuba and Puguis, La Trinidad to Climate Hazards

Based on the result of analysis after the use of the VAST-Agro tool (Tables 8 and 9) in the two communities, the following results were obtained:

1. Barangay Poblacion, Tuba had high exposure to landslides, frost, strong winds and hail storms. The area is more sensitive to the effects of typhoons, strong winds and hail storms as livelihood sources are more sensitive to these hazards. For Puguis, the area is highly exposed to typhoons, heavy rainfall and flooding while it is very rarely exposed to landslides, La Niña and El Niño.

2. Moderate biophysical sensitivity of crops was observed in both areas with 48% in Tuba and 43% in Puguis. Highland vegetables had more extensive damage of 50% to 100%.

Table 8. Summary scores of vulnerability of Poblacion, Tuba to climate and related hazards

Variables	Typhoon	Landslide	Frost	Strong wind	El Niño	Hail storm	Pest (leaf miner)
Scores							
Exposure (ES)	5	5	5	5	1	5	1
Sensitivity (SS)	5	3	4	5	4	5	3
Adaptive Capacity (ACS)	40	40	36	35	35	35	35
Maximum Scores							
Exposure (MES)	5	5	5	5	5	5	5
Sensitivity (MSS)	5	5	5	5	5	5	5
Adaptive Capacity (MACS)	45	45	45	45	45	45	45
Indices							
Exposure (EI)	1.000	1.000	1.000	1.000	0.200	1.000	0.200
Sensitivity (SI)	1.000	0.600	0.800	1.000	0.700	1.000	0.500
Adaptive Capacity (ACI)	0.889	0.889	0.800	0.778	0.778	0.778	0.778
Potential Impact Index (PII)	1.000	0.800	0.900	1.000	0.450	1.000	0.428
Vulnerability Index	-0.111	0.089	-0.100	-0.222	0.328	-0.222	0.428
Qualitative Description	Moderately Vulnerable	Moderately Adaptive	Moderately Vulnerable	Moderately Vulnerable	Moderately Adaptive	Moderately Vulnerable	Highly Adaptive
Over all Vulnerability Index				**0.027**			
Over-all Qualitative Description				**Moderately Adaptive**			

Table 9. Summary scores on vulnerability of Puguis, La Trinidad to climate and related hazards

Variables	Typhoon	Landslide	Flooding	La Niña	El Niño	Intense rainfall
Scores						
Exposure (ES)	5	1	5	1	1	5
Sensitivity (SS)	3	2	3	3	2	2
Adaptive Capacity (ACS)	37	33	33	37	36	36
Maximum Scores						
Exposure (MES)	5	5	5	5	5	5
Sensitivity (MSS)	5	5	5	5	5	5
Adaptive Capacity (MACS)	45	45	45	45	45	45
Indices						
Exposure (EI)	1.000	0.200	1.000	0.200	0.200	1.000
Sensitivity (SI)	0.500	0.300	0.600	0.600	0.400	0.400
Adaptive Capacity (ACI)	0.822	0.733	0.733	0.000	0.800	0.800
Potential Impact Index (PII)	0.750	0.250	0.800	0.400	0.300	0.700
Vulnerability Index	0.072	0.483	-0.067	-0.400	0.500	0.100
Qualitative Description	Moderately Adaptive	Highly Adaptive	Moderately Vulnerable	Moderately Vulnerable	Highly Adaptive	Moderately Adaptive
Over all Vulnerability Index		0.115				
Over-all Qualitative Description		Moderately Adaptive				

The occurrence of typhoons has caused rotting of strawberry fruits and roots while for broccoli, delayed flowering damages can be as high as 80%-100%. The "burning effect" after typhoons can reduce the quality of the products such as fruit abortion in strawberry (5%-10%) and stunted growth in chayote and beans. Damage to trellises can also occur with typhoons and landslides. Different crops have different sensitivities to hazards. Crops such as strawberries, leafy vegetables and root crops are easily damaged by typhoons but other crops such as chayote and beans incurred less damage.

3. Very high socio-economic sensitivity was evident in Poblacion but observed to be low in Puguis. In terms of economic sensitivity, the effects of the identified hazards on income sources in Puguis was minimal since most of the income sources were not purely climate-sensitive as opposed to those observed in Poblacion where most of the income sources besides farming are still climate-sensitive. In Poblacion, most of the livelihood sources are climate-sensitive. Only 5% of other income sources were from non-sensitive sources. Puguis is a highly commercialized barangay; about 48% of the population depend on agriculture specifically vegetables, strawberry and cut flower production. Further, only 40% of the households have income sources sensitive to climate change while 60% of the population are engaged in non-sensitive sources of income. Thus, the computed socio-economic sensitivity showed that the residents of Puguis are not sensitive to most of the climate hazards.

4. Generally, both areas have high adaptive capacities. Adaptive score for Poblacion is 35 (Table 8) and 33 for Puguis (Table 9). This is due to high literacy, knowledge of the hazard, availability of resources, presence of support institutions, labor availability, good communication and accessibility. Although few technological adaptations are available, there are still opportunities for improving them. Low economic capacity was claimed by both communities, where income is just enough for the basic daily needs of the families.

5. The potential impact of typhoons to Poblacion, and the strong winds and hail storms in Cabuyao can be higher due to the absence of low adaptation and low effectivity of technologies adopted.

6. Poblacion was found to be moderately vulnerable to typhoons, strong winds, frost and hail storms. It is moderately adaptive to El Niño, landslides and highly adaptive to pests (leaf miner).

7. Overall, Poblacion, Tuba is also moderately adaptive to climate hazards having a Vulnerability

Index of 0.027. Their vulnerability depends on the type of hazard the community faces. On the other hand, Barangay Puguis had an overall Vulnerability Index of 0.115. This means that the community is moderately adaptive to climate hazards identified but has greater resilience as compared to Poblacion.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the results of the study, it can be concluded that the VAST Agro-tool can be used to assess vulnerability and/or resilience of a particular community or crops to climate hazards. Although the figures came mostly from focus group discussions made with representative stakeholders, it can be validated by other secondary data thus, it can serve as basis for planning at the community level. It can also serve as basis for prioritization of projects within a municipality if applied among barangays. As the tool was used in the evaluation of Barangays Puguis, La Trinidad and Poblacion, Tuba, it was found that the two differ in terms of vulnerability to climate hazard. Both Puguis, La Trinidad and Poblacion, Tuba can be considered moderately adaptive to climate hazards.

Highland vegetables and strawberries are among the most vulnerable crops to climate hazards. Nevertheless, the competitive prices of highland vegetables and strawberries pose greater advantage to Benguet farmers notwithstanding the risks these climate hazards pose. Technological adaptations are continually being adopted to suit their needs. The total adaptive score for Barangay Poblacion and Puguis are both high, due to high adaptive score received and not due to technological adaption.

Recommendations

Although the VAST-Agro tool can be used as a rapid participatory tool that can be helpful in prioritizing climate hazards and helping communities make plans and programs to address climate hazard, results must always be validated and augmented by climate data, actual maps and records. Site validation is also necessary.

For Barangay Poblacion, Tuba, one of the recommendation is the use of an agricultural pump by residents in the area. Most prone to dryness are the more highly elevated areas of Poblacion like Cabuyao although even lower Poblacion also suffers from water shortage but to a lesser extent. Massive tree planting and/or construction of wind break for Cabuyao using bamboos, Alnus and Eucalyptus trees along slopes are likewise needed. The creation of bigger "kuwelo" which should be lined with plastic or cement material to avoid seepage and further loss of water is likewise recommended. Covering this "kuwelo" may further improve water retention. There is a need to popularize the use of "*Mukosaku* " technology in the community as applied by Kagawad Felix Siplat in coming up with practical organic farming technology for strawberry and other highland vegetables. Using yellow colored traps and other IPM technology to reduce damage brought by leaf miners would likewise be advantageous.

For Barangay Puguis, the conduct of education campaigns on climate change awareness and the use of technological adaptation strategies specifically for the climate hazards identified are recommended. There is a need for improvement of the drainage system and sewage canal in the lower elevations of the barangay and the development of an on-farm irrigation system in preparation for El Niño, or development of water harvesting technologies.

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Plate 1. Brocolli planting area and production in Cabuyao, Poblacion, Tuba

Plate 2. Tunneling used in parsley production and countoured potato farms in Poblacion, Tuba