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Vulnerability of Banana-Based Farming Communities of Apayao to Climate Change Hazards

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Abstract: **The study was conducted to assess the vulnerability of banana-based farming communities of Apayao to climate change hazards. The results of the study showed that typhoon, torrential rainfall, drought, increased incidence of pest and diseases, and soil erosion were the main climate change hazards affecting banana-based farming communities in the areas covered by the study.**

In Buluan, Conner, the community is vulnerable to typhoon, torrential rainfall and increased incidence of pests and diseases. Exposures to these climate hazards are medium to high; but adaptive capacities of the community are moderate. The potential impact outweighs the adaptive capacities of the community. On the other hand, the community is moderately resilient to drought and erosion.

The overall vulnerability index showed that the banana-based farming communities of Buluan, Conner and Atok, Flora are vulnerable to climate change hazards. Comparison of vulnerability indices of communities with similar crop commodities located in upper and lower elevations did not differ significantly.

In conclusion, typhoon, torrential rainfall, drought, increased incidence of pest and diseases, and soil erosion were the main climate-related hazards affecting banana-based productions in the areas covered by the study. With high exposures and sensitivities to climate change hazards, high dependency of farmers to climate sensitive sources of income and moderate to low adaptive capacities, generally, the banana-based production communities were rated vulnerable.

Keywords: **Vulnerability indices, Climate Hazards, Resiliency, banana-Based farming communities, Apayao.**

1. INTRODUCTION

Climate is defined as long-term weather patterns that describe a specific region or place [1]. Elements of the weather patterns include temperature, cloudiness, humidity, precipitation, and winds [2]. Global climate change indicates a change in either the mean state of the climate or in its variability, persisting for several decades.

Climate change threatens agriculture production's stability and productivity [3]. In many areas of the world where agricultural productivity is already low and the means of coping with adverse events are limited, climate change is expected to reduce productivity to even lower levels and make production more erratic [4,5]. Long term changes in the patterns of temperature and precipitation that are part of climate change, are expected to shift production seasons, pest and disease patterns, and modify the set of feasible crops affecting production, livelihoods and lives.

The Philippines being an archipelagic country is one among the most vulnerable to the adversities of climate change due to its location and natural attributes, is prone to natural hazards. It is located along the typhoon belt on the Western North Pacific Basin where 66% of tropical cyclones enter or originate. Typhoons average 20 events per year; five to seven of which can be very destructive. Flooding has become the most prevalent disaster since 2000. Areas along the over 17,000 km coastline are vulnerable to tidal surges due to high population density. According to the United Nations International Strategy for Disaster Reduction (UNISDR) reports that "the Philippines topped the disaster league of 2011 with 33 major reported events, affecting 12.5% of the population.

The Cordillera Administrative Region (CAR) ranked 27th in a Climate Change Vulnerability Mapping conducted among 500 regions and provinces in Southeast Asia in terms of vulnerability to extreme weather related events [6,7,8].

The Apayao and Kalinga provinces ranked 25th among the seventy four (74) provinces identified as vulnerable to climate change related hazards. In Apayao alone, the dominant economic activity and opportunity is farming where majority of the crops is weather dependent. Climate change hazards can aggravate this, making the livelihood become vulnerable. According to Aman, Ocampo, Domingo and Agpuldo [9], heavy rains, typhoon and the occurrence of pest are the most prevalence climate change hazard in cassava based farming communities in Apayao. Their income sources from agriculture such as farming, backyard gardening and orchard are seen to be sensitive to the climate hazards.

In response to this, there is a need to reduce the vulnerability of communities in the hazard areas [10]. Reducing the vulnerability of communities requires increasing their adaptive capacities. Moreover, the information of this phenomenon be understood by the rural communities who are themselves affected by this problem.

2. CONCEPTUAL FRAMEWORK

Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed; its sensitivity, and its adaptive capacity".

There are three components of the vulnerability in the climate change context, these are: exposure, sensitivity and adaptive capacity. It implies that a system is vulnerable if it is exposed and sensitive to the effects of climate change and at the same time has only limited capacity to adapt. On the contrary, a system is less vulnerable if it is less exposed, less sensitive or has a strong adaptive capacity.

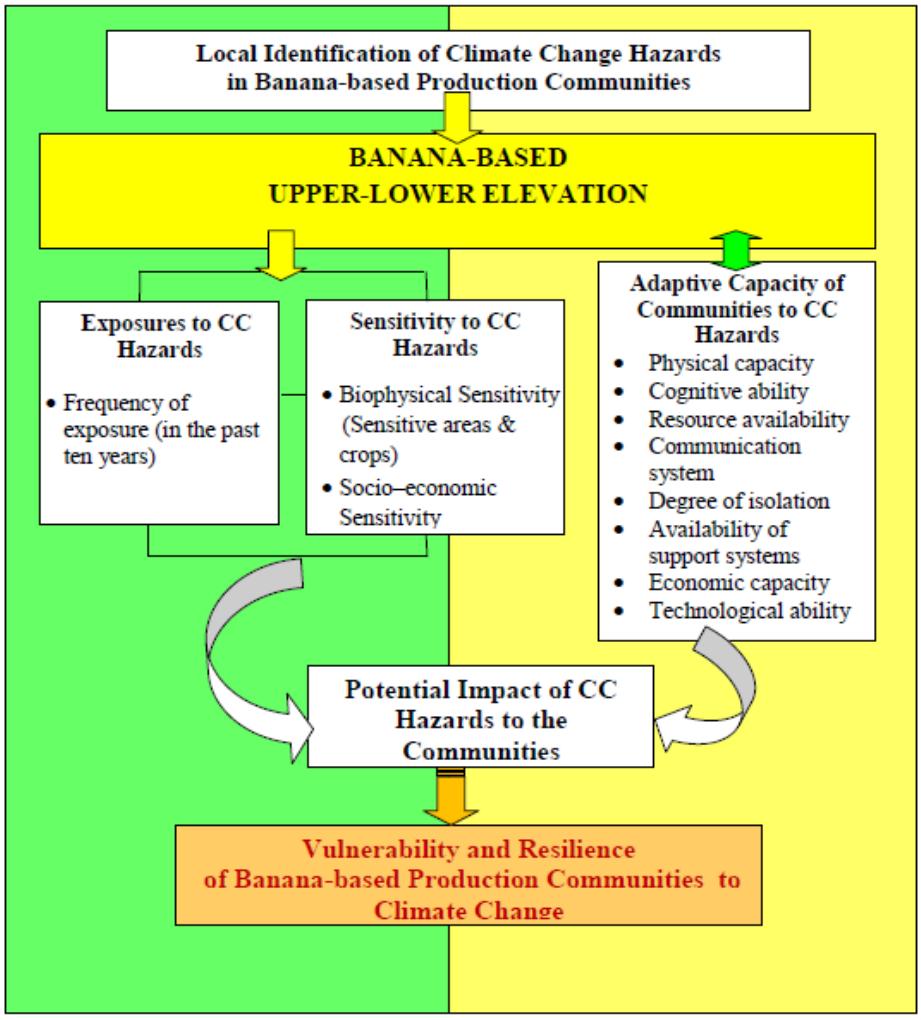


Figure 1. Conceptual Framework for Assessing Vulnerability to Climate Change ***(Modified from Allen Consulting, 2005)***

In this study, the vulnerability and resilience of the based and banana-based farming communities to climate change is determined by the nature of the climate change hazards in the communities, the frequency of exposure of the communities to climate change hazards and their biophysical and socio-economic sensitivity potentials. Exposures and sensitivities of these crop-based communities together describe their potential impacts that climate changes have on communities; however, the abilities of the communities to adapt to climate change modulate the effects of their exposures and sensitivities to climate change hazards. As such, in assessing vulnerability of a community, it is important to first identify the type of climate abnormalities that climate change could bring (Figure 1).

Objectives:

Generally, the study aimed to assess the vulnerability of the banana-based farming communities in Apayao to climate change hazards.

Specifically, the study aimed to:

1. describe the nature of natural hazards experienced by the communities for the last ten years;

2. determine the vulnerability and resiliency of the communities by assessing the:

a. exposure level of the communities to climate change hazards

b. sensitivity of the communities to climate change hazards

c. adaptive capacities of the communities to climate change hazards;

3. estimate the vulnerability index of the banana-based farming communities to climate change hazards; and

4. determine the significant difference of the vulnerability indices of banana-based farming communities in lower and upper elevations.

3. MATERIALS AND METHODS

Location of the Study Sites:

This study was conducted in the Province of Apayao particularly in the selected barangays of the Municipalities of Conner and Flora, Apayao. These municipalities are known for growing banana. In Conner, the barangay where the study was conducted is Barangay Buluan and Barangay Atok in Flora.

The selection of study site selection was based on production scale and trade volumes of crop produced, number of farmers affected, and its likely vulnerability to weather extremes and changing weather patterns. Moreover, the crop production is the major farming activity of the households in the selected barangays. In addition, topographical conditions and geographical differences of the selected sites vary considerably.

Respondents of Surveys and Focused Group Discussions:

The respondents for the surveys were the households of banana-based growing communities in Buluan, Conner and Atok, Flora, Apayao. In the focus group discussions (FGD), the participants were the barangay leaders and farmers in the selected sites (Table 1).

Table 1. Distribution of household respondents per study site

STUDY SITE	HOUSEHOLD RESPONDENTS
Buluan, Conner	30
Atok, Folra	26

The number of participants from the banana-based farming communities to the focused group discussions is presented in Table 2. A survey instrument was designed as guide in collecting data from the farmer participants and barangay leaders (Appendix C).

Table 2. Number of participants to the focused group discussion per study site

STUDY SITE	HOUSEHOLD RESPONDENTS
Buluan, Conner	7
Atok, Folra	11

Primary and Secondary Data Collection of the Study:

Primary data were collected at the community and household level applying different research methods and tools including focus group discussions (FGDs), household interviews, and key informants interviews (KIs).

Available secondary information on the biophysical and socio-economic characteristics of the farming communities were gathered from the Municipal Agriculture Office (MAO), Municipal Planning and Development Office (MPDO), Municipal's Comprehensive Land-use Plans (MCLUPs), and Socio-economic Profiles (SEP) of the Barangays covered by the study.

Prior to secondary data gathering, site reconnaissance was conducted to observe the biophysical and socio-economic characteristics of the areas covered by the study. A transect walk and photo documentation was done to closely observe the various components of the area.

4. DATA PROCESSING AND ANALYSIS

In assessing the vulnerabilities of banana-based farming communities, the study followed the procedure of "Vulnerability and Adaptive Capacity Assessment for Different Agro ecosystems [11, 12, 13] (VAST-Agro) developed by ASC-CA, UPLB.

Exposure to Climate-related Hazards Assessment:

Exposures of the crop-based farming communities to climate-related hazards were assessed by identifying the climate hazards experienced in these communities in the past ten years and frequency of exposures in the past ten years. Impacts of the climate events and their influence to agriculture and development were also determined.

The data gathered from the respondents about the frequency of occurrences of identified climate change hazards in the last ten years (typhoons, rainfall and temperature patterns) were compared with information obtained from the literature review. In particular, perceptions and observations of respondents on typhoon occurrences were triangulated with existing data sourced out from PAG-ASA online. Data triangulation served to validate collected data. The following scoring were used:

Frequency/10years	Description	Score
0	None	0
1-2x	Very rare	1
3-4x	Rare	2
5-6x	Moderate	3
7-8x	Frequent	4
9-10x	Very frequent	5

Sensitivity to Climate-related Hazards Assessment:

Sensitivities of the farming communities to climate- related hazards were assessed based on biophysical characteristics and socio-economic characteristics.

In assessing the community's sensitivity to climate-related hazards, the following steps were:

a) For each of the hazard identified, the farmer-respondents of both surveys and focused group discussions were asked what area or crops are prone to damage because of the hazard. If the area is given, the crops that were planted in the sensitive area were asked.

b) The percentage of each of the affected area/crop from the total agricultural area of the barangay was also determined.

c) The community also listed the sources of income and proportion of the households engaging in each source of income.

d) The proportion of households engaging in agriculture and sources sensitive to climate change was also determined.

e) The percentage of income coming from climate-sensitive sources was also determined.

The following scoring in assessing the community's sensitivity to climate-related hazards were used:

Biophysical and Economic Sensitivity Potential	Description	Score
0	None	0
1-20%	Very low	1
21-40%	Low	2
41-60%	Moderate	3
61-80%	High	4
81-100	Very high	5

Adaptive Capacity Assessment:

Capacities of the farming community were assessed based on the eight capacities of a community that enable the people to adjust to climate change, moderate potential damages, take advantage of opportunities, or cope with the consequences. These were the following variables used for each capacity:

1. *Physical capacity* – family labor
2. *Cognitive ability and linguistic capacity* – literacy rate
3. *Resource availability* – access to transportation and communication system
4. *Communication system* – presence of communication system.
5. *Degree of isolation*- location and access
6. *Availability of support systems*- presence of support systems
7. *Economic Capacity* –income level and diversity of income sources
8. *Technological ability* – knowledge of technological adaptation

The following scoring for adaptive capacity assessment were used:

Score	Description
0	None
1	Very Low
2	Low
3	Moderate
4	High
5	Very High

Technological Adaptation:

Technological adaptation differed for different climate. The adaptations the communities have employed for each of the hazards identified to lessen the impact of the hazards were determined. The following scoring for technological adaptation were used:

Technological Adaptation	Description	Score
0	None	0
1-20%	Very low	1
21-40%	Low	2
41-60%	Moderate	3
61-80%	High	4
81-100	Very high	5

Computation of Vulnerability Index:

Vulnerability index (VI) suggests the vulnerability of the community to the potential damage that climate-related hazards may bring. It is the difference between the adaptive capacity index and the potential impact index. It may not show the absolute value of vulnerability but it is useful in comparing vulnerabilities of different communities. Vulnerability index was computed for each of the climate hazards as follows:

Vulnerability Index (VI) = Adaptive Capacity Index (ACI) – Potential Impact Index (PII)

Where: $ACI = \frac{\text{Total Adaptive Capacity Score (ACS)}}{\text{Maximum Adaptive Capacity Score (MACS)}}$

$PII = \frac{\text{Exposure Score (ES)} + \text{Sensitivity Score}}{\text{Maximum Exposure Score (MES)} + \text{Maximum Sensitivity Score (MSS)}}$

In computing for the VI, the data were summarized first using the form below before the VI for each climate hazard is computed. The over-all vulnerability index for the community is computed by getting the average of all vulnerability indices of the different climate hazards.

Table for Summary Score

Variables	Typhoon	Drought	Heavy Rain	Pest
Scores				
Exposure (ES)				
Sensitivity (SS)				
Adaptive Capacity (ACS)				
Maximum Scores				
Exposure (MES)	5	5	5	5
Sensitivity (MSS)	5	5	5	5
Adaptive Capacity (MACS)	45	45	45	45
Indices				
Exposure (IE)				
Sensitivity (IS)				
Potential Impact (PII)				
Adaptive Capacity (ACI)				
Vulnerability Index (VI)				
Over all Vulnerability Index				

The qualitative interpretation of the vulnerability index is shown below:

Index Value	Qualitative Interpretation
0.80 – 1.00	Extremely resilient
0.50 – 0.79	Highly resilient
0.20 – 0.49	Moderately resilient
-0.19 – 0.19	Vulnerable
-0.49 - -0.20	Moderately vulnerable
- 0.79 - -0.50	Highly vulnerable
- 1.00 - -0.80	Extremely vulnerable

Comparison of Vulnerability Indices:

The t-test for independent variables was estimated to compare the vulnerability indices of banana-based farming communitied through the Microsoft Excel Format Software Program.

5. RESULTS AND DISCUSSION

Description of Study Sites:

The province of Apayao is located in Northern Luzon and forms the head of Cordillera Administrative Region (CAR). It is bounded by the provinces of Ilocos Norte and Abra on the west, Cagayan on the north and east, and Kalinga on the south.

The province has a total land area of 397,700 hectares (3,927.70 sq. km.), comprising 21.47 percent of CAR's total land area. It is classified into Upper and Lower Apayao. The upper portion occupying 67.2 percent of the total land area is predominantly mountainous topography characterized by the towering peaks, plateaus and intermittent patches of valleys, a characteristic common to the province and in the Cordillera Region as a whole. Upper Apayao is composed of the Municipalities of Calanasan, Kabugao, and Conner. Lower Apayao, on the other hand, occupies 32.8 percent of the total land area, is generally flat land with rolling mountains, and plateaus. It is composed of the Municipalities of Flora, Luna, Pudtol, and Sta. Marcela [14]. Apayao climate falls under Corona Type III, characterized by no pronounced season, relatively wet from June to December and dry for the rest of the year. Heaviest rains occur during the months of August to October. Typhoons frequently occur during the months of July to October.

Municipality of Flora, Apayao:

Biophysical Characteristics:

The municipality of Flora lies in the northeastern part of thee Apayao Province between Latitude 121° 15'and 121° 30' north, and between Longitude 18° 14' and 17° 45'. It is bounded on the north by the Municipality of Sta. Marcela, Apayao; on the south by the municipality of Kabugao, Apayao; on the east by the municipality of Allacapan, Cagayan; and on the west by the municipalities of Luna and Pudtol, Apayao. The municipality has a total land area of 42,334.93 hectares accounting for only 10 percent of the total area of Apayao.

Based on the slope map, the topographic features of the municipality located in the northern portion, is characterized as a mixture of areas with flat to nearly flat, undulating to rolling as well as strongly rolling relief. About 33% of the municipality belongs to this slope category. The biggest portion however about 43% of the total land areas located in the middle portion and extending towards the southern end, has been described to having a rolling to moderately steep to steep land features. This covers mostly all barangays except Poblacion East, Poblacion West and Bagutong. Very steep slope is confined at barangays Malayugan and Upper Atok.

The Municipality of Flora falls under Climate Type III having no pronounced season. Meanwhile, Flora has been observed to be relatively dry from March up to May and wet for the rest of the year. Heaviest amount of precipitation occurs from the early part of November to the later part of February with moderate rain showers from May to October [15].

Socio-economic characteristics:

Flora is basically agricultural devoting 72% of the municipality's land area to lowland and sloping agriculture. The topography of the land is ideal for farming. More than quarter of the municipality sitting on lowland plains and rolling/undulating areas of 0-3% and 3-18% slopes respectively, are suitable to intensive agriculture.

Rice is the municipality's principal agricultural crop grown reflected in large track of agricultural land (about 43%) devoted to both paddy irrigated and rain fed rice lands. Some rice lands are irrigated through either a communal irrigation system or through the Apayao-Abulog Irrigation System. Average rice production is 70 cavans/hectare.; an acceptable recovery rate of 60% [16].

Other significant crops planted are corn, bananas, pineapple, and coconut. Bamboo and orchids are also grown although their commercial value is not fully explored. An estimated 1,000 hectares are identified suited to agricultural production

but are idle and not fully utilized. Land use and vegetation studies can indicate exactly what crops are suitable to grow in these lands. Also, as agriculture development is one of the major thrusts of the present government, technology transfer and adequate provision of agricultural support facilities may further improve present yield and sustain production. It is however, essential to address the flooding problem resulting to decreases yield of the land [17].

Atok is one of the 16 barangays of Flora. It has an area of 1556 hectares with a population of 1,007 that composed of 110 households. The barangay was surrounded by bodies of water like the creeks and the Apayao River. The topography of the land is ideal for farming which is suitable to intensive agriculture. Rice is the common agricultural crop in Atok grown in both paddies irrigated and rainfed. Other crops planted are corn, bananas, coconut and some vegetables [18].

Most commercial activities are agriculture-related, such as rice and banana wholesaling and retailing. Flora's public market, although considered the center of commercial activities, provides limited trades and residents aiming for large-scale commercial and trade activities go to the other more urbanized municipalities of Cagayan province such as Abulug, Ballesteros, Aparri and even as far as Tuguegarao City.

Municipality of Conner, Apayao:

The municipality of Conner is geographically a landlocked area located in the lower most portion of the province coordinates 17'45' latitude and 121'20' longitude. It is 94 kilometers from the City of Tuguegarao, Cagayan 560 kilometers away from Manila. It is bounded on the east by the Province of Cagayan; on the west by the Province of Abra, on the north by the municipality of Kabugao, with Balbalan and Pinukpuk, Kalinga sharing its southern boundary.

Conner has a land area of 69,430 hectares, located at the "Neck and Lower Jaw" of the bust like map of Apayao or at the foothills of the Cordillera range traversing the borders of Cagayan, Kalinga, and other municipalities of Apayao. It is composed of twenty one (21) barangays.

Conner is also characterized by rolling hills interspersed with pocket valleys traversed by two major rivers, the Nabuangan and Baren Rivers.

Socio-economic Characteristics:

Agriculture remains to be the primary occupation of the municipality. Rice, corn and banana are the main products of the people supplemented by seasonal production of coffee, tropical fruit and vegetables. Banana is being supplied to various parts of Luzon making the municipality one of the largest producer of banana in the country. Food processing of banana products has been established by a cooperative in the municipality and has been observed to be in demand in the local market [19].

Nature of Climate-Related Hazards in Banana-based Farming Communities:

All the respondents of both surveys and focus group discussions identified five climate change hazards affecting the banana-based farming communities of in Conner, Apayao. These hazards include typhoon, torrential rainfall, drought, increased incidence of pest and diseases and erosion. In Flora, the respondents identified four hazards namely: typhoon, torrential rainfall, drought and increased incidence of pests.

Vulnerability of Banana-Based Farming Communities in Apayao:

Farming is a unique industry for it combines home life and business. The house of the farmer is the office where he manages his farm enterprise. The wife, children and other relatives are integral parts of the farm. They help the farmer in the operation of his farm.

On the other hand, farming is subjected to great risks. Farming is always exposed to many possible destruction such as typhoon, flood, heavy rainfall, drought, erosion, and pest and diseases. Financing farming is also a difficult task because of the various risks involved.

Banana production in Apayao has been experiencing a declining trend during the recent years and many factors have been implicated. One of these factors is the effect of the uncontrolled bunchy top virus (BTV) disease and aggravated by the effects of other climate related hazards.

Despite the production problems faced by the banana growers, majority of the farmers in both selected Barangays are still engaged in this livelihood because of its demand and promising market. Based on field observations and interviews from the farmers, banana is planted in combination of upland rice and corn. Rice is produced as staple food for family consumption, while corn and banana are produced as cash crops for sources of income

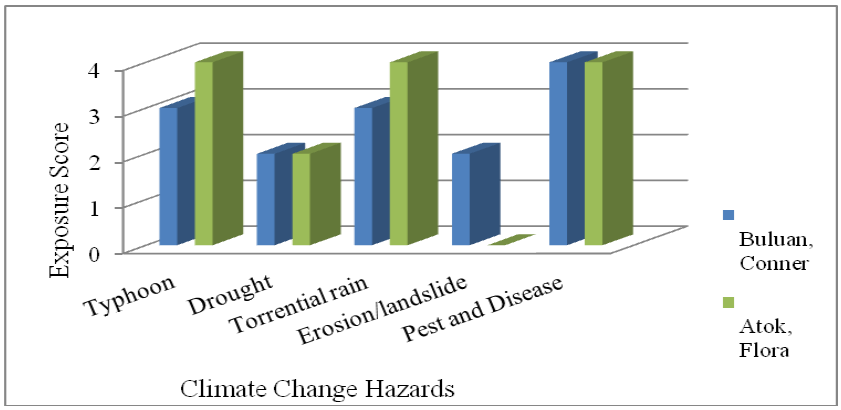
The vulnerability of the banana-based production areas were assessed based on exposure level to identified climate change hazards, sensitivity, and adaptive capacities.

Exposure to climate change hazards:

Figure 2 presents the exposure of the communities to climate change hazards. All farmers in the surveys and focus group discussions were requested to identify their experiences and describe the impacts associated with weather patterns in the past 10 years. According to the result of FGD and household surveys, most of the respondents in Buluan, Conner identified that typhoons, long & torrential rain, drought, erosion, and occurrence of diseases particularly on banana were the hazards experienced. Torrential rain and high incidence of diseases were the climate change hazards that frequently occurred in both study sites in the past 10 years. Typhoon on the other hand, frequently occurred in Atok, Flora but moderately occurred in Buluan, Conner in the last ten years.

According to the farmers, banana production is at its lowest during extreme weather conditions such as continues rains and after strong typhoons. However, an increased in production is attributed under normal and favorable rainfall conditions.

The farmer-respondents also claimed increased incidence of disease particularly *Fusarium* wilts during heavier rains attributed to crop production losses.



Legend: 4– Frequent 3– Moderate 2 – Rare 1- Very rare

Figure 2. Exposure of the Banana-based Communities to Climate Change Hazards

Sensitivity of the Banana-based Farming Communities to Climate Change Hazards:

Sensitivity of the banana-based farming communities to climate related hazards were assessed based on their biophysical and socio-economic characteristics.

Biophysical Sensitivity of the Banana-based Farming Community in Buluan, Conner to Climate Change Hazards:

The biophysical sensitivity of banana-based farming community in Buluan, Conner was assessed by the percent of agricultural area devoted for the crop and other agricultural crops and the percent magnitude of damage of climate change hazards for each crop. Thus, the areas or crops that were prone to damages of climate change hazards were assessed by looking into their biophysical sensitivity potential.

Table 3 presents the biophysical sensitivity of the crop to climate-related hazards. Data on biophysical sensitivity potential of banana and other agricultural crops in Buluan, Conner and their corresponding scores show that the hazards brought about by typhoon and pest and diseases had the higher score of 3 which is moderate and low to very low on the effects of torrential rain, erosion and drought.

During the field visit to the site, the farmers and the researcher observed that bananas were affected with the dew or very low temperature in the area causing chilling injury on leaves. Other crops in the area like rice and corn are known to be sensitive and vulnerable to climate change. Considerable households also engaged in fruit based farming in the sites. Fruit bearing trees are mostly affected by typhoons and prolonged rainfall inducing fruit fall.

Table 3. Biophysical sensitivity of the banana-based farming community in Buluan, Conner to climate change hazards

HAZARD	SENSITIVE AREA/ CROPS	% OF TOTAL AGRI AREA (A)	% MAGNITUDE OF DAMAGE (B)	BIOPHYSICAL SENSITIVITY POTENTIAL (AXB) 100	SCORE
Typhoon	Banana	60.00	50.00	30.00	
	Upland Rice	10.00	50.00	5.00	
	Corn	15.00	40.00	6.00	
	Lowland Rice	5.00	30.00	1.50	
	Fruit trees	5.00	50.00	2.5	
Total				**45.00**	**3**
Drought	Banana	60.00	10.00	6.00	
	Upland Rice	10.00	40.00	4.00	
	Corn	15.00	40.00	6.00	
	Lowland rice	5.00	10.00	0.50	
	Fruit Trees	5.00	30.00	1.5	
Total				**18.00**	**1**
Torrential rain	Banana	60.00	30.00	18.00	
	Upland Rice	10.00	40.00	4.00	
	Corn	15.00	20.00	3.00	
	Lowland rice	5.00	10.00	0.50	
	Fruit trees	5.00	30.00	1.50	
Total				**27.00**	**2**
Erosion	Banana	60.00	20.00	12.00	
	Upland Rice	10.00	50.00	5.00	
	Corn	15.00	40.00	6.00	
	Lowland rice	5.00	10.00	0.50	
	Fruit trees	5.00	10.00	0.50	
Total				**24.00**	**1**
Pest and Disease	Banana	60.00	60.00	36.00	
	Upland rice	10.00	30.00	3.00	
	Corn	15.00	40.00	6.00	
	Lowland rice	5.00	30.00	1.50	
	Fruit trees	5.00	40.00	2.00	
Total				**48.50**	**3**

Legend: 5 – Very high 4 – High 3 – Moderate 2 – Low 1 – Very low

Biophysical Sensitivity of Banana-based Farming Communities in Atok, Flora to Climate Change Hazards:

The biophysical sensitivity of banana-based farming community in Atok, Flora was assessed by the percent of total agricultural area devoted for the crop and other agricultural crops and the percent magnitude of damage of climate change hazards for each crop. Thus, the areas or crops that were prone to damages of climate change hazards were assessed by looking into their biophysical sensitivity potential.

Result shows that the agricultural crop productions in Atok, Flora is highly sensitive to typhoons giving a biophysical sensitivity score of 4 or "highly sensitive" description. Among the crops listed in Table 4, banana had the highest percent of sensitivity potential to typhoon and pest and diseases. A similar finding was observed in Buluan, Conner that among the listed agricultural crops, banana had the highest percent of sensitivity potential. The result is attributed to the higher percentage of households engaging in banana production and the high magnitude of damage caused by the typhoons and pest and diseases to the crop.

The other crops like rice, corn, coconut and vegetable had lower percentages of sensitivity potential as shown in Table 16. The results could be explained by the lower percentage of households engaging in the production of these crops and the lower percentages of magnitude of damages by the identified climate change hazards.

Table 4. Biophysical sensitivity of the banana-based farming community in Atok, Flora to climate change hazards

HAZARDS	SENSITIVE AREA OF CROPS	%OF TOTAL AGRI AREA (A)	% MAGNITUDE OF DAMAGE (B)	BIOPHYSICAL SENSITIVITY POTENTIAL (A+B)/ 100	SCORE
Typhoon	Banana	54.00	75.00	40.5	
	Rice	41.00	50.00	20.5	
	Corn	3.00	50.00	1.5	
	Vegetable	2.00	50.00	1.0	
	Coconut	2.00	20.00	.4	
Total				**63.90**	**4**
Drought	Banana	54.00	10.00	5.4	
	Rice	41.00	30.00	12.30	
	Corn	3.00	30.00	0.9	
	Coconut	2.00	10.00	0.20	
	Vegetable	2.00	40.00	0.8	
Total				**19.6**	**1**
Torrential rain	Banana	54.00	40.00	21.60	
	Rice	41.00	40.00	16.4	
	Corn	3.00	30.00	0.9	
	Coconut	2.00	10.00	0.20	
	Vegetable	2.00	20.00	0.80	
Total				**39.9**	**2**
Pest and Disease	Banana	54.00	60.00	32.4	
	Rice	41.00	40.00	16.4	
	Corn	3.00	10.00	0.3	
	Coconut	2.00	10.00	0.20	
	Vegetable	2.00	30.00	0.60	
Total				**49.9**	**3**

Legend: 5 – Very high 4 – High 3 – Moderate 2 – Low 1 – Very low

Socio-economic Sensitivity of Banana-based Farming Communities to Climate Change Hazards:

Sensitivity of a community to climate-related hazards can be assessed based on its socio-economic characteristics. Generally, income sources from agricultural crops were seen to be sensitive to the climate hazards due to dependency to weather inputs.

Several sources of incomes were declared by the households of the study sites. Table 5 shows that agricultural crops such as banana, orchard fruit production, including poultry and hog raising are the livelihoods that are sensitive to typhoons while the other sources of income like salaries and income from sari-sari stores are not sensitive to the climate change hazards.

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Table 5. Sensitivity of income sources to climate hazards and percent of households engaging in climate sensitive sources of income

SOURCE OF INCOME/FOOD	PERCENT OF HOUSEHOLD ENGAGING IN EACH SOURCE*
BULUAN, CONNER	
Agricultural crops and banana	88.00
Orchard fruit	40.00
Buy and sell	5.00
Sari-sari store	20.00
Hog raising	10.00
Salary or honorarium	18.00
Others	10.00
ATOK, FLORA	
Agriculture	92.00
Sari-Sari store	15.00
Hog raising	20.00
Salary/Honorarium	12.00
Others	20.00

**Multiple responses*

Percentage of income from climate-sensitive sources:

Figure 3 presents the percentage of income from climate sensitive sources. Most of the households from Buluan, Conner and Atok, Flora are mainly engaged in agriculture production which comprises an area ranging from of 60 percent to 70 percent of the total agricultural area. In Buluan, Conner 85 percent of the community income is solely from climate sensitive sources while in Atok, Flora 90 percent of the income comes from climate sensitive sources. Only 10 percent to 15 percent is from non-climate sensitive sources. The high percentage of income coming from climate-sensitive sources would result to high socio-economic sensitivity potential to climate change related hazards.

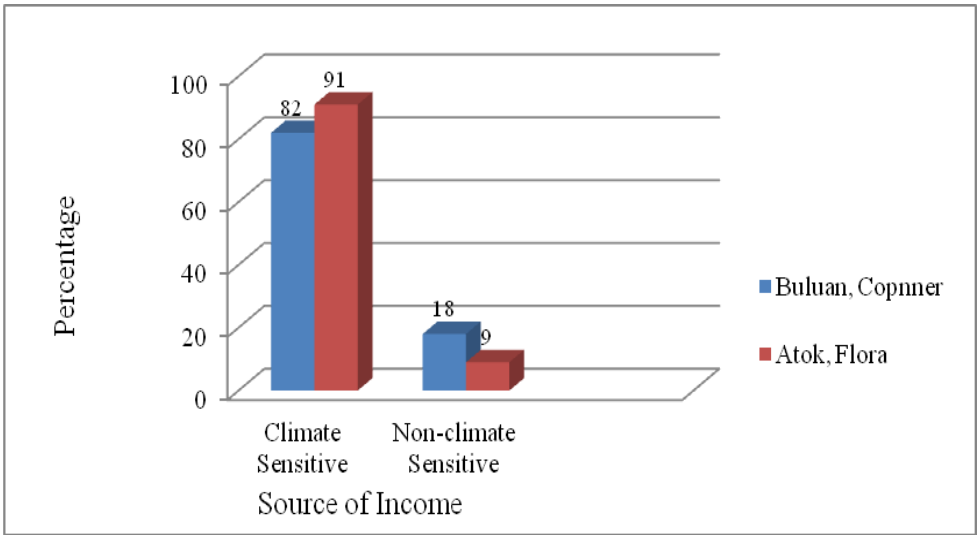

Figure 3. Percentage of Income of Banana-based Farming Communities from Climate- Sensitive Sources

Socio-economic Sensitivity Potential of Banana-based Farming Communities in Apayao:

The socio-economic sensitivity potential of the banana-based farming communities were assessed based on the percent of households engaging in agriculture and offer climate sensitive income sources and their corresponding percent of income from sensitive sources.

In terms of socio-economic sensitivity potential, Buluan, Conner has high sensitivity potential (82 percent) because almost all of the respondents are engaged in livelihood that are sensitive to climate change e.i. agriculture. In Atok, Flora, their sensitivity potential is 91 percent (Table 18). The results can be explained by the higher percentage of households engaging in agriculture. In addition, the higher the income obtained from socio-economic sensitive sources, the higher their socio-economic sensitivity potentials. This means that if a farming family has high income from sensitive sources, the higher is their socio-economic sensitivity potentials.

Both barangays have high socio-economic sensitivity potential because they have larger production areas for banana. At the same time, this is also the main source of income for most farming households in these barangays. Data in Table 6 is further deduced that the degree of sensitivity to the hazards can be due to on the proportion of the sensitive area relative to the total agricultural area of the community. Over all, prevalence and magnitude of hazards-typhoon, drought, torrential rainfall and incidence of pest and diseases have similar effects on socio-economic activity in the communities with an equal scores of 4.

Table 6. Socio-economic sensitivity potential banana-based farming communities

HAZARD	PREVALENCE (P)	MAGNITUDE (M)	SOCIO-ECONOMIC SENSITIVITY POTENTIAL(P X M)/100	SCORE
BULUAN, CONNER				
Typhoon	88.00	82.00	72.16	4
Drought	88.00	82.00	72.16	4
Torrential rain	88.00	82.00	72.16	4
Erosion	88.00	82.00	72.16	4
Pest & Disease	88.00	82.00	72.16	4
ATOK, FLORA				
Typhoon	92.00	91.00	83.72	4
Drought	92.00	91.00	83.72	4
Torrential rain	92.00	91.00	83.72	4
Pest & Disease	92.00	91.00	83.72	4

Average Sensitivity Scores of Banana-based farming Communities:

The average sensitivity scores were obtained by getting the average scores of both the biophysical and socio-economic sensitivity potential scores of the cassava-farming communities.

Table 7 shows that the banana-based farming community in Atok, Flora had an average sensitivity score of 4.0 to typhoon which means with high sensitivity, moderately sensitive incidence of pest and torrential rain with average score of 3.5 and 3.0, respectively while low average (2.5) to drought. In Buluan, Conner, the community has similar average sensitivity scores (3.5) to typhoon and incidence of pest. An average of 3.0 was also obtained on torrential rain which is moderately sensitive and a low average scores were obtained for drought and erosion (2.5).

Table 7. Average sensitivity scores of banana-based farming communities

HAZARD	BIOPHYSICAL SENSITIVITY POTENTIAL SCORE (A)	SOCIO-ECONOMIC SENSITIVITY POTENTIAL SCORE (B)	SENSITIVITY SCORE (A+B)/2
BULUAN, CONNER			
Typhoon	3	4	3.5
Drought	1	4	2.5
Torrential rain	2	4	3.0
Erosion	1	4	2.5
Pest & Disease	3	4	3.5
ATOK, FLORA			
Typhoon	4	4	4.0
Drought	1	4	2.5
Torrential rain	2	4	3.0
Pest & Disease	3	4	3.5

Assessment of Adaptive Capacity of Banana-based Farming Communities to CC Hazards:

The adaptive capacities of the banana growers were assessed based on the eight variables presented in Table 8. It shows that the adaptation capacities of banana growers in the study sites were moderately low with total scores ranging from 23-24.

Table 8. Adaptive capacity of banana-based farming communities in Apayao

VARIABLE	BULUAN, CONNER	DESCRIPTION	ATOK, FLORA	DESCRIPTION
Number of available family labor in households	3	Moderate	4	High
Literacy rate (percent of literates of the population)	4	High	4	High
General knowledge of the hazards (percent of the population who are knowledgeable)	4	High	4	High
Availability of resources (e.g. transportation, communication facilities) (percent of population with available	4	High	3	Moderate
Presence, effectiveness and efficiency of a community early warning system.	1	Very Low	1	Very Low
System of disseminating information within the community about the hazards.	2	Low	2	Low
Presence and accessibility of support system	4	High	3	Moderate
Wealth level (percent o population who can afford to spend for adaptation cost)	2	Low	2	Low
Total	24		23	

In terms of availability of family labor, it is moderate to high available with 3-4 labor forces per family. Banana is a semi-permanent crop, and maintenance requires limited labor. Literacy rate on the other hand, is high which is also reflected with the high general knowledge of the climate - related hazards. This may have an influence on adaptive capacities.

Most of the resources such as transportation, communication facilities and support systems exist in both communities giving a moderate to high to availability (3-4 scores). The presence of these resources increases adaptive capacity.

Presence of effective and efficient early warning systems is very low with a score or 1 indicating that no warning systems were present in the communities. The system of disseminating information within the community about the hazards is through cell phones, word of mouth or informed by the news from televisions and radios.

In terms of accessibility and support services, farmers in Buluan, Conner are extended with services both technically and technologically by the Department of Agriculture giving a high availability rating. Training on agroforestry and organic farming and banana fruit processing were conducted in the barangay. Thus, the availability of support services increases adaptive capacity.

In Atok, Flora, the availability of support services is moderately available. Farmers exclaimed good irrigation system for their irrigated rice fields and the improved farm to market road.

In terms of wealth level, it is relatively low with a score of 2.0 for both communities indicating that majority of the farmers cannot afford to spend for adaptation cost brought about by certain climate hazards. In addition, households of both Barangays are dependent on on-farm sources of income as reflected in Table 5. Consequently, dependency on on-farm source of income decreases adaptive capacity.

Technological Adaptations of Banana-based Farming Communities to CC Hazards:

Technological adaptations to typhoon include windbreaks, pruning of leaves, early harvesting whenever feasible, and pruning of leaves of accessible banana plants. On drought, though most of the farmers claimed that drought is not felt as a problem on banana production, some claimed mulching the harvested plants around the clumps. On diseased banana plants, spraying of chemicals and cutting them down are the practices applied by some farmers to control the diseases but these are not so effective as they claimed.

The total adaptive capacities of both communities were obtained by adding the total adaptive capacity scores and the technological adaptation score for each hazard.

As shown in Table 9, the total adaptive capacities of both communities are moderate. This means that farmers in both communities have moderate capacities to adjust to climate change, moderate potential damages, take advantage of opportunities, or cope with the consequences.

Table 9. Technological adaptations of banana-based farming communities in Apayao

HAZARD	KNOWN ADAPTATION	SCORE	DESCRIPTION
Buluan, Conner			
Typhoon	Windbreaks, pruning of leaves, early harvesting whenever feasible, pruning of leaves of accessible banana plants	4	High
Drought	Mulching	4	High
Torrential rain	None	0	None
Erosion	Intercropping	4	High
Pest & Disease	Cutting of affected plants. chemical spray	3	Moderate
Atok, Flora			
Typhoon	Windbreaks, pruning of leaves, early harvesting whenever feasible, pruning of leaves of accessible banana plants	4	High
Drought	Mulching	4	High
Torrential rain	None	0	None
Pest & Disease	Cutting of affected plants	4	High
0-none to 5-very high			

Table 10. Total adaptive capacity (AC+TA) score

HAZARD	BULUAN, CONNER	ATOK, FLORA
Typhoon	28	27
Drought	28	27
Torrential rain	24	24
Erosion	28	-
Pest & Disease	27	27
Maximum adaptive capacity=45		

Vulnerability Indices of the Banana-based Farming Communities to CC Hazards:

The level of vulnerability of each community depends in the difference between the adaptive capacity index for each hazard and the potential impact index for each hazard and is represented by a vulnerability index for each hazard (VI). The over-all vulnerability index for the community is computed by getting the average of all vulnerability indices of the different climate hazards.

Table 11a shows the vulnerability index of banana growing community in Buluan, Conner. The community is vulnerable to typhoon, heavy rainfall and pests and diseases. Exposure of the community to these climate change hazards is medium to high but low to drought and soil erosion. In terms of sensitivity, the community is moderately sensitive to the effects of identified climate-related hazards.

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Table 11a. Vulnerability index of banana-based farming community in Buluan, Conner

VARIABLES	TYPHOON	DROUGHT	TORRENTIAL RAIN	EROSION	PEST & DISEASE
Scores					
Exposure (ES)	3	2	3	2	4
Sensitivity (SS)	3.5	2.5	3	2.5	3.5
Adaptive Capacity (ACS)	28	28	24	28	27
Maximum Scores					
Exposure (MES)	5	5	5	5	5
Sensitivity (MSS)	5	5	5	5	5
Adaptive Capacity (MACS)	45	45	45	45	45
Indices					
Exposure (IE)	0.60	0.4	0.6	0.4	0.80
Sensitivity (IS)	0.70	0.5	0.6	0.5	0.70
Potential Impact (PII)	0.65	0.45	0.6	0.45	0.75
Adaptive Capacity (ACI)	0.62	0.62	0.53	0.62	0.60
Vulnerability Index (VI)	**-0.03**	**0.17**	**-0.07**	**0.17**	**-0.15**
Qualitative Interpretation	**Vulnerable**	**Moderately Resilient**	**Vulnerable**	**Moderately Resilient**	**Vulnerable**
Over-all Vulnerability Index (VI)		**0.09**	**Vulnerable**		

For the specific vulnerability indices, the community is vulnerable to typhoon, torrential rain and incidence of pest and diseases. Exposure and sensitivity of the community to these climate change hazards is moderate to high but adaptive capacity is moderate. For drought and erosion, the community is moderately resilient. However, if the period of drought is prolonged, it will pose constraints to banana growth.

Overall, the community is vulnerable having a vulnerability index of 0.09. Hence, their vulnerability would rather depend on the type of hazard the community is facing and their adaptive capacity.

Table 11b presents the vulnerability index of Atok, Flora, Apayao, to climate change hazards. The community is moderately vulnerable to typhoons (-0.20). The area is highly exposed to typhoon, intense or heavy rainfall and its major crops like banana, rice and corn are also sensitive to these hazards.

The adaptive capacity is moderate because there is a low economic capacity to spend for cost of adaptation. The income sources is climate sensitive, it was claimed to be just enough for the basic and daily needs of the family. Further, only few technological interventions were adapted by the farmers.

In totality, the community is moderately vulnerable with a vulnerability index of -0.37. Hence, their vulnerability would rather depend on the type of hazard the community is facing and the frequency of exposure to the hazard.

Table 11. Vulnerability index of banana-based farming community in Atok, Flora

VARIABLES	TYPHOON	DROUGHT	TORRENTIAL RAIN	PEST & DISEASE
Scores				
Exposure (ES)	4	2	4	4
Sensitivity (SS)	4	2.5	3	3.5
Adaptive Capacity (ACS)	26	26	24	26
Maximum Scores				
Exposure (MES)	5	5	5	5
Sensitivity (MSS)	5	5	5	5
Adaptive Capacity (MACS)	45	45	45	45
Indices				
Exposure (IE)	0.8	0.4	0.8	0.8
Sensitivity (IS)	0.8	0.5	0.6	0.7
Potential Impact (PII)	0.8	0.45	0.7	0.75
Adaptive Capacity (ACI)	0.60	0.60	0.53	0.60
Vulnerability Index (VI)	**-0.20**	**0.15**	**-0.17**	**-0.15**
Qualitative Interpretation	**Moderately Vulnerable**	**Moderately Resilient**	**Vulnerable**	**Vulnerable**
Overall Vulnerability Index	**-0.37 Moderately Vulnerable**			

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Comparison of Vulnerability Indices of Crop-base Farming Communities in Apayao:

The t-test for independent variables was used to compare the vulnerability indices of banana-based farming in different elevations and determine if there is a significant difference between their indices.

Results of the comparison of vulnerability indices of communities with similar crop-based productions (i.e.banana in lower elevation and banana in upper elevation) are presented in Table 12a. Result showed that along all the hazards, their vulnerability did not differ significantly even if some hazards differed in vulnerability indices like in the case of torrential rain in which Atok is vulnerable with and Buluan is moderately resilient. This is revealed in the computed t-value of -1.41 which is less than the critical value of t (2.36) at 5% level of significance.

In general, the result showed that farming communities in Apayao with similar crop-based in different elevations have the same level of vulnerabilities. The finding further implies a generalization that other agriculture-based communities with crops sensitive to exposure of climate change hazards would have similar vulnerabilities like the studied banana-based farming communities. Thus, it is assumed that Bulaun, Conner and Atok, Flora, Apayao have the same level of vulnerabilities because they have similar climatic condition.

Table 12a. Comparison of vulnerability indices of communities with similar crop-based and different elevation

VULNERABILITY INDICATOR	VULNERABILITY INDEX		df	t-comp	t-critical @ 5%	I
	Lower Elevation (Nueva)	Upper Elevation (Swan)				
	Lower Elevation (Atok)	**Upper Elevation (Buluan)**				
Banana(Overall Index)	-0.37	0.09	7	-1.14	2.36	ns
a. Typhoon	-0.20	-0.03				
b. Drought	0.15	0.17				
c. Torrential Rain	-0.17	-0.07				
d. Pest & disease	-0.15	-0.13				
e. Erosion		0.17				

Legend: df – degrees of freedom I – Interpretation ns – not significant

6. SUMMARY AND CONCLUSION

The study was conducted to assess the climate change vulnerability of selected banana-based farming communities of Apayao Province.

Typhoon, torrential rain, drought, incidence of pest and diseases, and soil erosion were the main climate-related hazards affecting banana-based productions in the studied areas. An average of 3-5 typhoons a year visits the province

The farmers of both study sites are faced with multiple, reoccurring climate change hazards to their agricultural production and livelihood. The study sites are most exposed to typhoon and torrential rain both with exposure score of 4 or "frequent" description. Only in the banana-based community in Buluan identified soil erosion as another climate-related hazard but it rarely observed in the community.

Sensitivities of banana-based production communities are low to very low on drought with a score of 2 and 1, respectively but moderate to high sensitive on typhoon, heavy rain and incidence of pest. Income sources from agriculture such as farming, orchard farming, backyard gardening are seen to be sensitive to the climate-related hazards. A greater percentage of incomes of household of both production areas come from sensitive sources while a considerable percentage is coming from non-sensitive sources. Adaptation capacities of banana-based production communities are moderate.

The adaptation capacities of banana-based farming communities are moderately low with total scores ranging from 23-24.

In Buluan, Conner, the community is vulnerable to typhoon, heavy rainfall and pests and diseases. Exposures to these climate hazards are medium to high; but adaptive capacities of the community are moderate. The potential impact therefore outweighs the adaptive capacities of the community. On the other hand, the community is moderately resilient to drought and erosion. In overall, the community is vulnerable with a vulnerability index being 0.09.

In Atok, Flora, the community is vulnerable to typhoon. This area is highly exposed to typhoon and torrential rain and its major crop like banana, rice and corn are also sensitive to these hazards. Overall, the community is moderately vulnerable with a vulnerability index of -0.37.

Comparison of vulnerability indices of these communities located in upper and lower elevations did not differ significantly as reflected in the computed t value of -1.14.

CONCLUSIONS:

Typhoon, torrential rain, drought, incidence of pest and diseases, and soil erosion were the main climate change hazards affecting cassava-based and banana—based productions in Apayao.

Based on the exposure, sensitivity, and adaptive capacity assessment, the banana-based communities of Buluan and Atok are vulnerable to climate change hazards. The vulnerabilities of these communities are attributed to their high to moderately high exposures and sensitivities to pest and disease, typhoon and torrential and their moderately low adaptive capacities.

The vulnerability conditions of the farming communities is perpetuated because of the farmers' limited technical knowledge and skills in dealing with climate related hazards that they have encountered. Current practices are based on habit or practices that they have learned from other farmers within the community.

7. IMPLICATIONS AND RECOMMENDATIONS

In the light of the findings and conclusion, the following are forwarded as recommendations.

1. Enhance the adaptive capacity of farmers to climate change through science and technology (S & T)-based farming system model such as multi-cropping, alley cropping and crop diversification;

2. Conduct researches on optimum crop diversification in banana-based farming communities;

3. Verify effectiveness of the technology adaptation used by farmers through experimentation; and

4. The result of this study is to be shared to the provincial government and R & D Planners as an input to the data base of the province and as a reference for planning and decision- making related to the concerns on climate change.

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