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# VULNERABILITY ASSESSMENT OF CASSAVA GROWING AREAS IN APAYAO, PHILIPPINES

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***Abstract:*** **The study aims to conduct assessment of the vulnerability of cassava growing areas and adaptation strategies done by the community. Specifically, the study is intended to: a. determine the degree of exposure to climate change hazards of the cassava growing communities in Apayao; determine the biophysical and socioeconomic sensitivity to climate change of the cassava growing communities; determine the adaptive capacity of the cassava growing communities to climate change; and determine the vulnerability index and resilience of the cassava growing communities to climate change.The field survey was used with questionnaire, VA tool, observation, focus group discussion and secondary data analysis as data gathering tools. Results revealed that heavy rains, typhoon and the occurrence of pest are the most prevalence climate change hazard, Income sources from agriculture such as farming, backyard gardening and orchard are seen to be sensitive to the climate hazards. Technological adaptations of the cassava growing areas differ for different climate hazards. On typhoon, windbreaks using banana, betel nut and madre cacao and maintaining the existing trees as live fence and at the same time serve as windbreaks. Some farmers claimed de-topping the cassava when there is a typhoon.Ridge planting is done at the onset or rainy season. Weed is being controlled by manual weeding , application of herbicides, off-barring and hilling up.Vulnerability indices in the three barangays where the study conducted showed that respondents are vulnerable to heavy rains, typhoon and the occurrence of pest and moderately resilient to drought. In the light of the findings and conclusion, the following are forwarded as recommendation: Verify effectiveness of the technology adaptation used by farmers through experimentation; Develop IEC materials on the technology used by farmers related to Climate change for greater diffusion; Conduct other researches in other communities other than cassava.**

***Keywords:*** **Cassava, Vulnerability Assessment, Climate Change, Technological adaptation.**

## I. INTRODUCTION

Anthropogenic activities are the major causes of climate changes[1, 2]. These activities are mainly caused by human influences such as burning of fossil fuels, agricultural practices, and land use modifications such as deforestation brought about by the spread of ever-increasing populations. These activities result in the emission of carbon dioxide ($CO_2$), a major greenhouse gas and the main gas responsible for climate change, as well as other “greenhouse” gases (i.e., gases that trap heat in the atmosphere)[3,4]. In order to bring climate change to a halt and save our planet, it is imperative to reduce greenhouse gas emissions significantly.

The Cordillera Administrative Region (CAR) is one of the highly risky region in terms of climate hazard such as typhoons, landslide and earthquake [5]. Located in a seismo-tectonically active area, and owing to its unique topography, the region is highly prone to geologic hazards such as mass movements, ground subsidence, seismic induced hazards, and flooding. The region is entirely traversed by numerous active fault lines including branches of the Digdig Fault. The July 16, 1990 earthquake caused major damages to private and public properties estimated at PhP 3.7 Billion[6].

In Apayao, the most common disasters are typhoon, landslide and flood. Severe erosion is observed in Upper Apayao particularly in the municipalities of Conner and Calanasan. Floods are common in the downstream portion particularly in areas near the Apayao River.

In response to this, there is a need to reduce the vulnerability of communities in the hazard areas. Reducing the vulnerability of communities requires increasing their capacity for disaster preparedness and response. Equally important is the capacity to develop and undertake adaptation measures as coping mechanisms for any dislocations that disasters may have on the communities' livelihood and general well-being. To date, there is no certainty as to the capacities of local communities to respond to climate change and generally weak capacities of local communities to effectively develop strategies and adaptation measures. There is also a general lack of information on alternative and innovative adaptation options in addressing the impact of climate change at the community level.

Report of the "Summary for Policymakers" of the IPCC 2007, Climate Change 2007: Impacts, Adaptation and Vulnerability, states: "Poor communities can be especially vulnerable, in particular those concentrated in high-risk areas. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies"[7].

This study builds on raising awareness on climate change and disasters including capacity building of local communities in disaster risk reduction and management with the aim of building resilient communities. This also include development of information and education materials on climate change in mediums and forms that is beneficial for the poor and the educationally disadvantage and mainstreaming the same to non-formal education and literacy programs carried out by various organizations.

While R & D is continuing, the importance of cultivating the awareness of the populace on the climate change phenomenon is inevitable. Awareness would bring about everyone's simple contribution to climate change management. Similarly, available remedial/management measures generated from R & D efforts need to be disseminated immediately for widespread application in the farms. Side by side, areas that are vulnerable to climate change need to be identified for appropriate management.

Moreover, while there are efforts among various government and non-government agencies in the local, regional, national and international levels to address concerns brought about by climate change, it is still deemed imperative that information on this phenomenon be provided to rural communities who are themselves affected by this problem. To fully understand their responsibility in climate change mitigation and adaptation, it is also important that community members recognize that they may have a role in exacerbating the problem. In this context, there is a need to design appropriate methods for disseminating information about climate change and climate protection to local areas.

**Objectives**:

Generally, the project aims to conduct assessment of the vulnerability of cassava growing areas and adaptation strategies done by the community.

**Specific Objectives:**

1. To determine the degree of exposure to climate change hazards of the cassava growing communities in Apayao;
2. To determine the biophysical and socioeconomic sensitivity to climate change of the cassava growing communities;
3. To determine the adaptive capacity of the cassava growing communities to climate change;
4. To determine the vulnerability index and resilience of the cassava growing communities to climate change;

## II. METHODOLOGY

The project employed community based approach in vulnerability assessment that work on identification of exposure level to climate hazards, sensitivity of community and their income, potential impact of the hazard, adaptive capacity and overall vulnerability to the various hazards. Coordination with the community concerns was facilitated for participatory workshops for about 50 target participants for every site. Participants were cassava growers/farmers or concerned POs, select LGU officials, MAO and MPDO officer. On the spot vulnerability assessment result was presented at the end of the workshop in order to identify recommendations in order to prioritize options where the researcher institution can help.

Further the report for the workshops was forwarded to the LGU and MPDO officer for possible mainstreaming to CLUPs and Barangay Resource Management Plan as it identifies needs and recommendations to enhance community resilience.

The study employed a combination of data collection methods: secondary data gathering, participatory rural appraisal techniques, direct field observation and community mapping. Available secondary information on the biophysical and socio-economic aspects of the cassava growing communities was gathered from relevant agencies to understand the local and regional context of the local communities. Project documents, maps, reports was sourced from the Municipal Agriculture Offices (MAOs).

Climatic data like rainfall, typhoon occurrences, temperature, El Niño, La Niña and other natural occurrences was taken from the Philippine Atmospheric, Geophysical and Astronomical Administration (PAGASA). Secondary maps or information such as land use, elevation and slope maps was secured from the DENR and LGUs. Community mapping of vulnerable areas will also be facilitated to identify other variables that are important to the farming communities.

Transect mapping was conducted to enhance the biophysical data from secondary sources and to document relevant information that may not be apparent and which could be helpful during workshop discussions.

For the assessment, the study will use the VAST-Agro tool developed by ASC-CA, UPLB. VAST-Agro stands for Climate Change Vulnerability and Adaptive Capacity Assessment for Different Agroecosystems. The tool is a rapid assessment tool that is community-based, focused on the agriculture sector and views agriculture as a holistic system with biophysical, economic, socio-cultural and political components. It has three major components: assessment of exposure to climate-related hazards; assessment of sensitivity to climate-related hazards and assessment of adaptive capability or ability to cope with adversities and further develop into resilient production systems.

Focus group discussion and cross sectoral forum consisting of various stakeholders was done to identify exposure hazards, sensitivity and adaptive mechanism; to identify the concerned agencies that can support the farmers on CC adaptation and to present secondary data for validation.

**Site Identification:**

Assessment was done in the 3 select municipalities of Apayao Province particularly in the cassava growing communities. Site selection was initially based in terms of production scale and trade volumes, crop produced, number of farmers and consumers affected, and its likely vulnerability to weather extremes and changing weather patterns.

Assessment of the exposure of the cassava growing communities to climate change hazards

Assessment of the exposure of the different zones to climate-related hazards was done through data gathering on:

*Climate statistics*: rainfall, temperature, humidity, wind, tropical cyclones, drought occurrences, trends and changes in climate and other CC-related disturbances. Impacts of the climate events and their influence to agriculture and development was determined.

*Agricultural data*: land use, production areas, soil characteristics, crops and cropping system, seasonal calendar, management practices, crop losses, support services, government programs/projects and other related data

*Community map or barangay development plans Transect mapping among field sites Community workshop* Assessment of the sensitivity of the communities to climate change hazards Sensitivity of the zones to CC-related hazards was assessed based on:

*Biophysical characteristics*: identify agricultural commodity or area prone to damage caused by CC. The degree of sensitivity was determined.

*Socio-economic characteristics*: This will include the income sources from agriculture and other climate sensitive livelihoods of the community.

Assessment of the adaptive capacity of the cassava growers to climate change hazards Capacities of the cassava growers was assessed to determine the coping mechanisms in adjusting to climate change impacts, damages and consequences. Data on the following was considered:

*Physical capacity*: family labor *Cognitive ability and linguistic capacity Resource availability*: access to transportation and communication system *Degree of isolation Availability of support systems Economic Capacity*: income level and diversity of income sources

a. Technological ability

## III. RESULTS AND DISCUSSION

### A. Exposure to Climate Change Hazards:

Climate variability and climate change pose threats and risks to agricultural sector and food security. Respondents in both the surveys and focus group discussions were requested to identify past experiences and to describe the impacts associated with weather patterns for the past 10 years. Most of them recalled the typhoons, long & heavy rainfalls, drought, and weeds. The typhoon, long rainfall, and weeds are among the most frequent hazards that occurred in the sites for the last 10 years and drought has occurred rarely (3 t0 4 times in the last ten years). The Province of Apayao particularly the Lower Apayao area is not spared from damaging typhoons bringing continuous rains. Most of the farmers were able to recall about six (6) typhoons that hit the province in the last ten years. These include: typhoon Yoyong in 2004, Super typhoon Paeng and Reming, both in 2006, Typhoons Frank and Helen in 2008, and super typhoon Pepeng in 2009.

The impact associated with the typhoons and continuous rainfalls on cassava retard growth during its vegetative growth period, affects root development, and cause rotting of enlarged roots. According to the farmer-respondents, cassava production is at its lowest during continuous rain and after strong typhoons. However, increases in production is attributed to favorable rainfall conditions.

The impact associated with the drought when prolonged is withering and reduce root sizes during its vegetative growth. The farmer-respondents claimed to have experienced a more serious impact of typhoon and continuous rain than impact associated with drought.

The cassava farmers claimed also the frequent occurrences of weeds on their farms causing crop production problems. Competition between cassava and weeds, for space, water and nutrients, reduces cassava yields.

**Table.1: Exposure level to the climate change hazards**

| Hazard | Exposure Score | | |
|---|---|---|---|
| | Nueva, Sta. Marcela | Swan, Pudtol | Sta. Lina, Luna |
| Typhoons | 3 | 3 | 3 |
| Heavy rainfall | 3 | 3 | 3 |
| Drought | 2 | 2 | 2 |
| Pest (Weeds) | 3 | 3 | 3 |

**Scoring:**

| Frequency/10 years | 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 |

### B. Sensitivity of the Communities to Climate-Related Hazards:

Different systems may differ in their sensitivity to climate change, resulting in different levels of impact. Similarly, different crops have their sensitivities, which may vary on the kind of climate related hazards.

***Biophysical Sensitivity:***

Table 2 presents the biophysical sensitivity of the crop to climate-related hazards. Result of analysis revealed that sensitivity of cassava varies on the kind of climate-related hazards. This crop has low to very low sensitivity to the effects of drought but moderately sensitive to the effects of typhoon, heavy rains and occurrences of weeds.

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**Table.2: Biophysical Sensitivity (Areas and/or Crops)**

| Hazard | Score | | |
|---|---|---|---|
| | Nueva, Sta. Marcela | Swan, Pudtol | Sta. Lina, Luna |
| Typhoon | 3 | 3 | 3 |
| Heavy rains | 3 | 3 | 3 |
| Drought | 2 | 2 | 1 |
| Pests/weeds | 3 | 2 | 3 |

| Biophysical 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 |

***Socio-economic Sensitivity Potential:***

Sensitivity of a community to climate-related hazards can be assessed based on its biophysical and socio-economic characteristics. Income sources from agriculture such as farming, backyard gardening and orchard are seen to be sensitive to the climate hazards.

**Table.3: Sensitivity of Income Sources to Climate Hazards and Percent of Household Engaging.**

| Source of Income/Food | % of Households Engaging* | Climate Change Hazards | | | |
|---|---|---|---|---|---|
| | | Typhoon | Heavy rain | Drought | Pest |
| **Nueva, Sta. Marcela** | | | | | |
| Agriculture/Farming | 85.00 | Yes | Yes | Yes | Yes |
| Backyard hog raising | 40.00 | No | No | No | No |
| Backyard poultry | 20.00 | No | No | No | No |
| Backyard Gardening | 90.00 | Yes | Yes | Yes | Yes |
| Backyard Orchard | 90.00 | Yes | Yes | Yes | Yes |
| Sari-sari store | 20.00 | No | No | No | No |
| Buy and sell | 20.00 | No | No | No | No |
| Salary | 10.00 | No | No | No | No |
| **Swan, Pudtol** | | | | | |
| Agriculture/Farming | 80.00 | Yes | Yes | Yes | Yes |
| Backyard hog raising | 20.00 | No | No | No | No |
| Backyard poultry | 15.00 | No | No | No | No |
| Backyard gardening | 20.00 | Yes | Yes | Yes | Yes |
| Salary | 5.00 | No | No | No | No |
| **Sta. Lina, Luna** | | | | | |
| Agriculture/Farming | 80.00 | Yes | Yes | Yes | Yes |
| Backyard hog raising | 10.00 | No | No | No | No |
| Backyard gardening | 10.00 | Yes | Yes | Yes | Yes |
| Buy and sell | 5.00 | No | No | No | No |
| Sari-sari store | 20.00 | No | No | No | No |
| Salary | 30.00 | No | No | No | No |

**Multiple Responses:**

Several sources of incomes were declared by the respondents of the study sites. Table 2b shows that the income sources that are coming from agriculture, backyard gardening and orchards are the livelihoods of the cassava growing communities of Apayao that are sensitive to the identified climate-related hazards while the other sources of income like hog raising, poultry, trading, salaries and income from sari-sari stores are not sensitive to the climate change hazards.

**Table.4: Percentage of Income from Climate-sensitive Sources**

| **Sources of Income/Food** | **Nueva, Sta. Marcela** | **Swan, Pudtol** | **Sta. Lina, Luna** |
|---|---|---|---|
| Agriculture only | 15.00 | 10.00 | 10.00 |
| Agriculture + climate sensitive sources | 70.00 | 80.00 | 60.00 |
| Agriculture + non-climate sensitive sources | 5.00 | 5.00 | 10.00 |
| % of income from sensitive sources | 80.00 | 85.00 | 80.00 |
| % of income from non-sensitive sources | 20.00 | 15.00 | 20.00 |
| Non-climate sensitive sources | 10.00 | 5.00 | 10.00 |
| **Total** | **100.00** | **100.00** | **100.00** |

Most of livelihood sources of the cassava growing communities in Apayao are climate sensitive. Table 3 shows the list of income and food sources and proportion of the household engaging in each source of income. It also presents the percentage of incomes coming from sensitive and non sensitive sources. Analysis revealed that greater percentage (80-85%) of incomes of cassava growing communities comes from sensitive sources. Only 15% - 20% income are from non-sensitive sources of income.

**Table.5: Socio-economic Sensitivity Potential**

| **Hazards** | **Prevalence (P)[a]** | **Magnitude (M)[b]** | **Socio-economic Sensitivity Potential (P x M)/100** |
|---|---|---|---|
| **Nueva- Marcela, Sta. Marcela** | | | |
| Typhoon | 85 | 85 | 72.25 |
| Heavy rains | 85 | 85 | 72.25 |
| Drought | 85 | 85 | 72.25 |
| Pest | 85 | 85 | 72.25 |
| **Swan, Pudtol** | | | |
| Typhoon | 90 | 85 | 76.50 |
| Heavy rains | 90 | 85 | 76.50 |
| Drought | 90 | 85 | 76.50 |
| Pest | 90 | 85 | 76.50 |
| **Sta. Lina, Luna** | | | |
| Typhoon | 10.00 | 85 | 8.5 |
| Heavy rains | 10.00 | 85 | 8.5 |
| Drought | 10.00 | 85 | 8.5 |
| Pest | 10.00 | 85 | 8.5 |

[A] % of households engaging in agriculture and offer climate sensitive income sources

[B] % of income from sensitive sources

In terms of socio-economic sensitivity potential, Barangay Nueva is 72.25 while Brgy. Swan is 76.75 (Table 5 & 6). Both barangays have greater sensitivity potential because they have larger production areas for cassava this is also the main source of income of most farming households in these barangays. In barangay Sta. Lina, only few households are engaging in cassava production. Hence, their socio-economic sensitivity potential is very low. Data on the Table deduced that the degree of sensitivity to the hazards can be reckoned on the proportion of the sensitive area relative to the total agricultural area of the community

**Table.6: Total Sensitivity Score**

| Hazards | Biophysical Sensitivity Potential (A) | Socio-economic Sensitivity Potential (B) | Sensitivity Score ( A + B)/2 |
|---|---|---|---|
| **Nueva-Marcela, Sta. Marcela** | | | |
| Typhoon | 56.25 | 72.25 | 64.25 |
| Heavy rains | 48.00 | 72.25 | 60.12 |
| Drought | 16.00 | 72.25 | 44.12 |
| Pest | 56.25 | 72.25 | 64.25 |
| **Swan, Pudtol** | | | |
| Typhoon | 42.00 | 76.75 | 59.38 |
| Heavy rains | 42.00 | 76.75 | 59.38 |
| Drought | 14.00 | 76.75 | 45.38 |
| Pest | 21.00 | 76.75 | 48.88 |
| **Sta. Lina, Luna** | | | |
| Typhoon | 15.00 | 8.5 | 15.00 |
| Heavy rains | 18.00 | 8.5 | 18.00 |
| Drought | 6.00 | 8.5 | 6.00 |
| Pest | 12.00 | 8.5 | 12.00 |

**C. Adaptive capacity of the community to climate change:**

The adaptive capacities of the cassava growers were assessed based on the eight variables presented in Table 7. It shows that the adaptation capacities of cassava growers in the three select barangays are moderately high with total scores ranging from 25-26.

**Table.7: Adaptive capacity of the community to climate change hazards**

| Variable | Nueva, Sta. Marcela | Swan, Pudtol | Sta. Lina, Luna |
|---|---|---|---|
| Number of available family labor in household | 3 | 3 | 3 |
| Literacy rate (percent of literates of the households) | 5 | 5 | 5 |
| General knowledge of the hazards (percent of population who are knowledgeable) | 3 | 3 | 4 |
| Availability of resources (e.g. transportation, communication, facilities) (percent of population with available resources). | 4 | 3 | 4 |
| Presence of effectiveness and efficiency of a community early warning system. | 1 | 1 | 2 |
| System disseminating information within the community about hazards. | 3 | 3 | 3 |
| Presence and accessibility of support systems. | 4 | 4 | 2 |
| Wealth level (percent of population who can afford to spend for adaptation) | 3 | 3 | 3 |
| **TOTAL** | **26** | **25** | **26** |

In terms of availability of family labor, it is moderately available in all select barangays with an average of 3 members per household. The table also shows a very high percent literacy rate of cassava farmers. This could serve as facilitating factors for the farmers to adopt new adaptation measures that was introduced to them. If the respondents can read, write and able to understand information about climate change hazards, this status of farmers as well could positively influence adoption of improved technologies and practices.

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

Presence of effective and efficient early warning systems in Brgy. Nueva and Brgy. Swan is very low and low in Sta. Lina, Apayao, however system of disseminating information within the community about the hazards is through cell phones, word of mouth or informed by the news at the televisions.

In terms of accessibility and support services, cassava growers of brgy. Nueva and brgy. Swan is linked to market- San Miguel Corporation, cooperatives, and DA, DAR and SUCs of Kalinga and Apayao extend support services both technically and technologicallly. In brgy. Sta. Lina, only few engaged in cassava production, they grow for subsistence only. Certainly they are not linked to market and other services as provided in the other barangays.

Based on interviews, farmers must spend for adaptation. On occurrence of weeds for instance, can be serious constraints to cassava growth and yield if not controlled and their economic control a major challenge. According to them, typically manual weed control requires about 40% of labor input. Manual weeding is often followed by off-barring which poses again another input.

**D. Technological Capacity:**

Technological adaptations of the cassava growing areas differ for different climate hazards. On typhoon, windbreaks using banana, betel nut and madre cacao and maintaining the existing trees as live fence and at the same time serve as windbreaks are some of the technological adaptations adopted by the cassava growers. Some farmers also mentioned de-topping the cassava when there is a typhoon as an adaptation strategy but it could not be effective if rains brought by typhoon is continuous or prolonged it will cause rotting of enlarged roots.

On heavy rains, ridge planting is an adaptation employed by some farmers in brgy. Nueva is planting is done at the onset or rainy season. While other farmers do not employ this adaptation strategy because it requires more labor like cutting a pointed edges of cuttings and it is more difficult to plant on ridge than furrow planting.

On drought, the usual practice of furrow planting can be considered as an adaptation to this hazard and this practice is employed by both barangays –Nueva and Swan.

On weeds, during the field visits varying weeds are observed on the farms. Because of cassava's relatively slow early growth, canopy closure can take up to three months or more, leaving the crop vulnerable to weed infestation. Weed control is often the costliest input to cassava production. While weeds can be controlled with herbicides where available, some farmers typically need to hire laborers to remove grasses by hand manually and then followed by off-barring. These methods represent a significant expenditure of money, time and energy. Manual weeding followed by off-barring is the adaptation technology claimed by the farmers.

**Table.8: Technological Capacity of the community to climate change hazards**

| Hazard | Known Adaptation | Score | Description |
|---|---|---|---|
| **Nueva, Sta. Marcela** | | | |
| Typhoon | Windbreaks using banana, betel nut and madre cacao.<br>Maintaining existing trees as live fence and windbreaks. | 2 | Low |
| Heavy rains | Ridge planting | 1 | Low |
| Drought | Furrow planting | 3 | Moderate |
| Pest (weeds) | Manual weeding supplemented with off-barring; herbicide application | 3 | Moderate |
| **Swan, Pudtol** | | | |
| Typhoon | Windbreaks; de-topping;<br>Maintaining existing trees as live fence and windbreaks | 2 | Low |
| Heavy rains | None | 0 | None |
| Drought | Furrow planting | 3 | Moderate |
| Pest (weeds) | Off-barring supplemented with herbicide application/spraying<br>Successional farming. | 3 | Moderate |
| **Luna** | | | |
| Typhoon | Windbreaks | 3 | Moderate |
| Heavy rains | None | 0 | None |
| Drought | None | 0 | None |
| Pest (weeds) | Herbicide application | 2 | None |
| **0 – none to 5- very high** | | | |

**Scoring:**

| (Percent households implementing) | 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 |

**Table.9: Total Adaptive Capacity (AC+TA) Score**

| Hazard | Nueva, Sta. Marcela | Swan, Pudtol | Sta. Lina, Luna |
|---|---|---|---|
| Typhoon | 28 | 27 | 29 |
| Heavy rains | 27 | 25 | 26 |
| Drought | 29 | 28 | 26 |
| Pest | 29 | 28 | 28 |
| **Maximum adaptive capacity = 45** | | | |

**E. Vulnerability index of the community to climate-related hazards:**

**Table.10a: Vulnerability Index ( Nueva, Sta. Marcela)**

| Variables | Typhoon | Heavy rains | Drought | Pest |
|---|---|---|---|---|
| ***Scores*** | | | | |
| Exposure (ES) | 3 | 3 | 2 | 3 |
| Sensitivity (SS) | 3 | 3 | 2 | 3 |
| Adaptive Capacity (ACS) | 28 | 27 | 29 | 29 |
| | | | | |
| ***Maximum Scores*** | | | | |
| Exposure (MES) | 5 | 5 | 5 | 5 |
| Sensitivity (MSS) | 5 | 5 | 5 | 5 |
| Adaptive Capacity (MACS) | 45 | 45 | 45 | 45 |
| | | | | |
| ***Indices*** | | | | |
| Exposure (EI) | 0.6 | 0.6 | 0.4 | 0.6 |
| Sensitivity (ES) | 0.6 | 0.6 | 0.4 | 0.6 |
| Potential Impact (PII) | 0.6 | 0.6 | 0.4 | 0.6 |
| Adaptive Capacity (ACI) | 0.64 | 0.6 | 0.64 | 0.64 |
| | | | | |
| **Vulnerability Index (VI)** | **0.04** | **0.0** | **0.24** | **0.04** |
| **Description** | **Vulnerable** | **Vulnerable** | **Moderately Resilient** | **Vulnerable** |
| **Over-all Qualitative Index** | **0.39 – Moderately Resilient** | | | |

Table 10a presents the vulnerability index of Barangay Nueva, Sta. Marcela, Apayao to climate-related hazards. The cassava is vulnerable to typhoon, heavy rainfall and to the infestation of weeds; however, it is moderately resilient to drought. The result of study corresponds with other studies and literatures saying that cassava is a drought resilient crop. But if the period of drought is prolonged it will pose constraints to its growth. In terms of over-all index, the cassava is moderately resilient obtaining a 0.39 index value and its qualitative interpretation is moderately resilient.

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**Table.10b: Vulnerability Index (Swan, Pudtol)**

| Variables | Typhoon | Heavy Rainfall | Drought | Pest |
|---|---|---|---|---|
| ***Scores*** | | | | |
| Exposure (ES) | 3 | 3 | 2 | 3 |
| Sensitivity (SS) | 3 | 3 | 3 | 2 |
| Adaptive Capacity (ACS) | 27 | 25 | 28 | 28 |
| | | | | |
| ***Maximum Scores*** | | | | |
| Exposure (MES) | 5 | 5 | 5 | 5 |
| Sensitivity (MSS) | 5 | 5 | 5 | 5 |
| Adaptive Capacity (MACS) | 45 | 45 | 45 | 45 |
| | | | | |
| ***Indices*** | | | | |
| Exposure (EI) | 0.8 | 0.8 | 0.4 | 0.6 |
| Sensitivity (ES) | 0.6 | 0.6 | 0.4 | 0.4 |
| Potential Impact (PII) | 0.7 | 0.7 | 0.4 | 0.5 |
| Adaptive Capacity (ACI) | 0.60 | 0.58 | 0.64 | 0.64 |
| | | | | |
| **Vulnerability Index (VI)** | **- 0.06** | **- 0.12** | **0.23** | **0.14** |
| **Description** | **Vulnerable** | **Vulnerable** | **Moderately Resilient** | **Vulnerable** |
| **Over-all Qualitative Index** | **0.19 – Vulnerable** | | | |

Table 10b presents the vulnerability index of Barangay Swan, Pudtol, Apayao to climate-related hazards. The cassava is vulnerable to typhoon, heavy rainfall and to the infestation of weeds; however, it is moderately resilient to drought. The result of study corresponds with other studies and literatures saying that cassava is a drought resilient crop. But if the period of drought is prolonged it will pose constraints to its growth. In terms of over-all index, the cassava is moderately resilient obtaining a 0.19 index value and its qualitative interpretation is moderately resilient.

**Table.10c: Vulnerability Index ( Sta. Lina, Luna, Apayao)**

| Variables | Typhoon | Heavy rains | Drought | Pest |
|---|---|---|---|---|
| ***Scores*** | | | | |
| Exposure (ES) | 3 | 3 | 2 | 3 |
| Sensitivity (SS) | 3 | 3 | 1 | 2 |
| Adaptive Capacity (ACS) | 29 | 26 | 26 | 26 |
| | | | | |
| ***Maximum Scores*** | | | | |
| Exposure (MES) | 5 | 5 | 5 | 5 |
| Sensitivity (MSS) | 5 | 5 | 5 | 5 |
| Adaptive Capacity (MACS) | 45 | 45 | 45 | 45 |
| | | | | |
| ***Indices*** | | | | |
| Exposure (EI) | 0.60 | 0.60 | 0.40 | 0.60 |
| Sensitivity (ES) | 0.60 | 0.60 | 0.20 | 0.40 |
| Potential Impact (PII) | 0.60 | 0.60 | 0.30 | 0.50 |
| Adaptive Capacity (ACI) | 0.64 | 0.58 | 0.58 | 0.58 |
| | | | | |
| **Vulnerability Index (VI)** | **0.02** | **-0.04** | **0.28** | **0.08** |
| **Description** | **Vulnerable** | **Vulnerable** | **Moderately Resilient** | **Vulnerable** |
| **Over-all Qualitative Index** | **0.34 - Moderately Resilient** | | | |

Table 10c presents the vulnerability index of Barangay Sta. Lina, Luna, Apayao to climate-related hazards. The cassava is vulnerable to typhoon, heavy rainfall and to the infestation of weeds; however, it is moderately resilient to drought. The result of study corresponds with other studies and literatures saying that cassava is a drought resilient crop. But if the period of drought is prolonged it will pose constraints to its growth. In terms of over-all index, the cassava is moderately resilient obtaining a 0.34 index value and its qualitative interpretation is moderately resilient.

## IV. SUMMARY, CONCLUSION AND RECOMMENDATION

The Cordillera Administrative Region (CAR) ranked 27th in a Climate Change Vulnerability Mapping conducted among 500 regions and provinces in South East Asia in terms of vulnerability to extreme weather related events.

The study aims to conduct assessment of the vulnerability of cassava growing areas and adaptation strategies done by the community. Specifically, the study is intended to: a. determine the degree of exposure to climate change hazards of the cassava growing communities in Apayao; determine the biophysical and socioeconomic sensitivity to climate change of the cassava growing communities; determine the adaptive capacity of the cassava growing communities to climate change; and determine the vulnerability index and resilience of the cassava growing communities to climate change.

The field survey was used with questionnaire, VA tool, observation, focus group discussion and secondary data analysis as data gathering tools.

Results revealed that heavy rains, typhoon and the occurrence of pest are the most prevalence climate change hazard, sensitivity of cassava is low to very low sensitivity to drought but moderately sensitive to typhoon, heavy rains and occurrences of weeds. Income sources from agriculture such as farming, backyard gardening and orchard are seen to be sensitive to the climate hazards. Analysis revealed that greater percentage (80-85%) of incomes of cassava growing communities comes from sensitive sources. Only 15% - 20% income are from non-sensitive sources of income. Adaptation capacities of cassava growers in the three select barangays are moderately high.

Technological adaptations of the cassava growing areas differ for different climate hazards. On typhoon, windbreaks using banana, betel nut and madre cacao and maintaining the existing trees as live fence and at the same time serve as windbreaks. Some farmers claimed de-topping the cassava when there is a typhoon.

Ridge planting is done at the onset or rainy season. Weed is being controlled by manual weeding , application of herbicides, off-barring and hilling up.

Vulnerability indices in the three barangays where the study conducted showed that respondents are vulnerable to heavy rains, typhoon and the occurrence of pest and moderately resilient to drought.

In conclusion, heavy rains, typhoon and the occurrence of pest are the most prevalent climate hazards in cassava growing areas. Among the technological adaptation used by cassava farmers include live fence which serves as wind breaks during typhoons, ridge planting, and successive planting . Weeds are being controlled manually, application of herbicides, off-barring and hilling up.

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

1. Verify effectiveness of the technology adaptation used by farmers through experimentation;
2. Develop IEC materials on the technology used by farmers related to Climate change for greater diffusion;
3. Conduct other researches in other communities other than cassava.

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