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Indigenous Ecological Knowledge and Systems of Ethnic Farmers Located at Different Altitudinal Locations along Agno River, Philippines

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ABSTRACT

Ethnic farming communities located at different altitudinal locations in Agno River, Philippines face climate stressors that threaten their agricultural production. This paper determined the climate stressors experienced in the watersheds, investigated and assessed the exposures to climate stressors, and identified the ethnic affiliations of the communities, their farming practices and indigenous knowledge and systems to cope with the climate stressors. Data were gathered using pre-tested questionnaires during one-on-one interviews, focused group discussions and key informant interviews. Secondary data were likewise consulted. Majority of the communities' ethnic affiliations are Karao, Ibaloi and Kalanguya. Farming techniques practiced include crop rotation and multicropping. The percentage of farmers in Ambuklao watershed doing it is twice as high as in both San Roque and Binga watersheds. Almost all farmers in Ambuklao do crop rotation, but apparently no one practices multicropping. Most farmers in Ambuklao plant high-value vegetables. Crop rotation is also done in San Roque and Binga where multi-cropping is also practiced. The elevational differences of the three watersheds dictate the choice of farming systems. Farm areas in Ambuklao are mostly located at higher slopes and ridges where flooding as a mean of watering is not possible. The practice of indigenous knowledge systems (IKS) in farming includes uma (kaingin), burning and applying the ash as fertilizer, natural composting, use of scarecrows and aduyon. Majority of the respondents indicated using indigenous farming systems or techniques. This did not significantly differ from the 49% who said they do not do so.

INTRODUCTION

The Intergovernmental Panel for Climate Change (2014) confirms that global warming is real. Among its effects is changing climatic pattern which has become a globally-disturbing and alarming concern. The accelerated increase in the greenhouse gases (GHG) emissions and concentration buildup in the atmosphere is the major culprit for climate change.

Furthermore, scientific evidence has confirmed that climate change is a global challenge facing humans and their socio-economic activities, health, livelihood, and food security (Clarke *et al.*, 2012). Studies show that ag-ricultural yield will likely be severely affected over the next hundred years due to unprecedented rates of changes in the climate system (Thornton *et al.*, 2011). These continuing impacts remain to pose threat on food security. Agriculture, particularly crop production, de-pends on relatively consistent weather patterns from year to year. (Mase *et al.*, 2016).

These impacts of climate variability have been detrimental to agriculture and farming communities. For instance, the irregular climate variability such as prolonged droughts and floods threaten the livelihood of rural people and farming communities who are mostly dependent on agriculture (Ranganathan *et al.*, 2010).

Climate change impacts on agricultural production are often integrated with its effects on forest/crops productivity, water availability, soil fertility, and sustainability of other environmental and natural resource systems. As what Easterling *et al.* (2007) claim, an increase in the frequency of occurrence of climate extremes such as droughts and flooding may lower crop yields and live-stock productivity. Likewise, crop production is constrained to increasing climate, crop varieties and planting areas, soil degradation, and water availability during crop growth period. In addition, Ranganathan *et al.* (2010) suggests that crop losses may continue to intensify be-cause of the increased climate variability which can be one of the deciding factors that influence future food security.

Damage to agriculture has also been experienced in the Philippines because of the impacts of climate change. Cabanilla and Velasco (2006) reported that rice production losses due to typhoons are substantial. Eighty one percent, seventy eight percent and seventy one percent of the total rice losses for Central Luzon, Bicol and Visayas, respectively, were attributed to typhoons in 1994. In the same report, it was highlighted that typhoons, floods, and droughts have caused 82.4% of rice loss from 1970-1990, the highest of which was in 1971.These alarming data and experiences has become very serious which triggered for an extensive and immediate concern over the confounding influence of climate change, particularly in the upland farming communities.

The watershed ecosystems are important natural sources of food, water, shelter, bio-medicines and many

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other products for human consumption. Moreover, the ecosystem serves as place or abode for upland communities, venues for agricultural industry or operations and agro-tourism, and field laboratory for training and re-search. The ecosystem strengthens the stability and value of the forest-based ecosystem and the farming communities thereat.

Watershed ecosystem in the Philippines is one of the life-support systems that is expected to be adversely affected by climate change and extreme climatic variations. Yet, a large proportion of the past studies on watersheds had their main attention merely on the biophysical components. Few researches investigate the farming communities' farming systems located within watershed ecosystems. Pulhin *et al.* (2006) emphasized that information on the impacts of climate change on local communities inhabiting these watersheds and their coping mechanism to minimize its adverse impacts are lacking.

The watersheds within Agno River Basin hosts upland ethnic communities which are mostly dependent on slope farming as their major source of livelihood.

Statement of Problem

The watersheds which are the focused sites of this study are the Ambuklao Watershed, Binga Watershed, and San Roque Watershed. These are located in the different altitudinal locations, i.e. Ambuklao Watershed which is located in Bokod Municipality, Benguet, Cordillera Administrative Region, is higher in altitude (dam eleva-tion is 758 m.a.s.l.), followed by Binga Watershed in Ito-gon, Benguet (dam elevations is 563 m.a.s.l.), and San Roque Watershed Forest Reservation (dam elevations is 295 m.a.s.l.) which is located within the municipalities of San Manuel and San Nicolas,

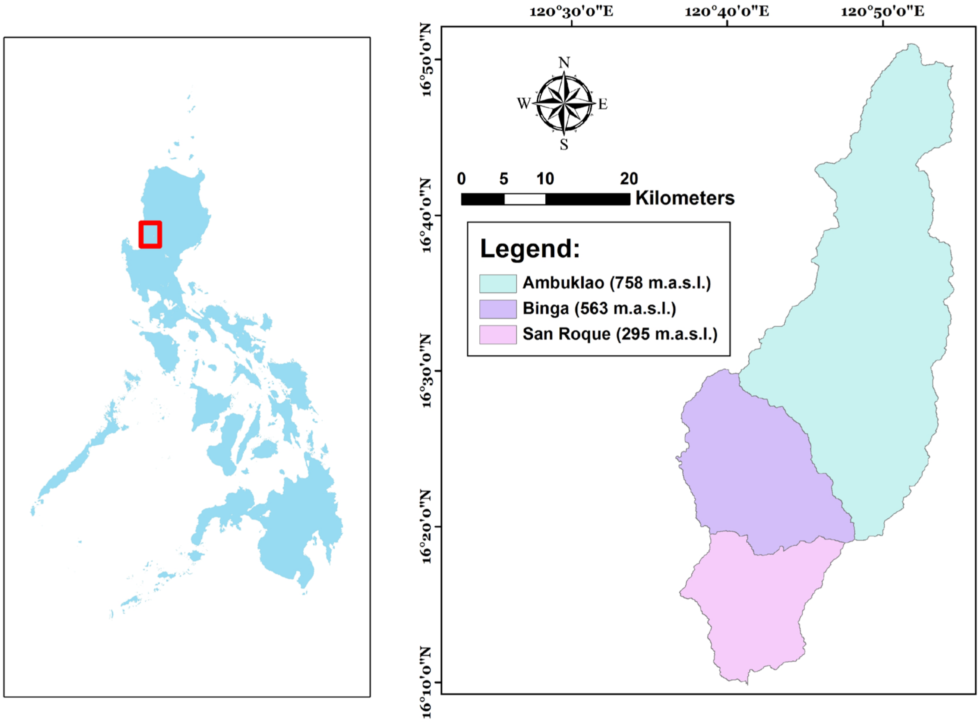

Figure 1: Map depicting the location of the three watersheds as study sites

Pangasinan, Philippines (Figure 1).

The three watersheds are noted as a high priority for management. They serve as a life-support system for local communities by providing water for domestic and agro-industrial purposes and for hydro-electric power plants. Thus, these watershed ecosystems are managed for multiple uses.

With notable reasons as stated, this study therefore aimed to address the following questions:

1. What are the ethnic affiliations and beliefs regarding farming of the communities that inhabit these watersheds?
2. Are there any climate stressors brought about by climate change and climate variabilities and extremes experienced in the study watersheds?
3. What are the indigenous knowledge and systems employed and farming practices being implemented by the communities within the Agno River Basin?
4. Do topographical differences, altitudinal locations and ethnic affiliations have influence on the farming systems and indigenous knowledge and systems risks and vulnerabilities of farming barangays/communities?

Objectives

Generally, the study determined, assessed, compared and analyzed the climate stressors and the indigenous knowledge and systems of the farming communities located at various altitudinal locations with distinct topographical characteristics in the three major watersheds (Ambuklao, Binga and San Roque Watersheds) along Agno River Basin.

Specifically, the study focused on the following concerns:

1. Determine the ethnic affiliations and beliefs of the

communities inhabiting the Agno River Basin, Philippines;

2. Identify the climate stressors and determine and compare the exposures to stressors of the ethnic communities inhabiting the Agno River Basin, Philippines;

3. Categorize the cultural farming practices and indigenous knowledge and systems implemented by the ethnic communities inhabiting the Agno River Basin, Philippines;

4. Determine if topographical differences, altitudinal locations and ethnic affiliations and cultural beliefs have influence on the farming systems and indigenous knowledge and systems of farming communities?

Scope and Limitations

This study determined if there is a significant difference in the exposures to climate change related stressors of the watersheds located at different altitudes with distinct topographical characteristics in the Ambuklao Watershed (high altitude), Binga Watershed (mid altitude) and San Roque Watershed (low altitude). Likewise, the study aimed to solicit answers from the selected farming communities as represented by selected barangays their ethnic affiliations, cultural farming systems and indigenous knowledge and practices. It is necessary to include the awareness and perception of respondents to the impact of climate change on farming practices in the study sites (Lucero *et al.*, 2016). This is because they are the ones directly involved and affected by the local climatic conditions and climate related hazards. Moreover, Bierbaum *et al.* (2013) stressed that the concerned stakeholders must be included from the outset to define the key questions to be answered and to identify feasible options for coping with climate change that address specific needs. To ensure that the information to be gathered are accurate, stakeholders should be consulted and be part of the assessment. This has been emphasized by McNeely *et al.* (2017) when he stated that stakeholder engagement, trust, and support (i.e., engaging those who are both using and managing the land and natural re-sources being assessed) are fundamental to any assess-ments if subsequent climate change adaptation plans are to be successfully adopted and implemented.

Similarly, same opinion was reminded by USAID (2016) that stakeholder's involvement throughout the assessment process is critical to capitalize on local knowledge, promote transparency, and increase legitimacy and accountability. Stakeholders should be consulted, include their questions and concerns in the assessment, and involve them in the data gathering and analysis to the greatest extent possible.

The study is, therefore, limited to the assessment of the current degree or level of exposures to climate change related stressors, the ethnic affiliations and cultural beliefs and farming practices of the selected farming communities represented by pre-selected barangays in the Ambuklao, Binga and San Roque Watersheds located at different altitudinal locations with distinct topographical characteristics in the Agno River Basin, Philippines.

MATERIALS AND METHODS

The study sites were focused on the three water sheds located along the Agno River, Philippines Representative farming barangays/communities in each of these study sites/watersheds were pre-selected and identified to represent the drainage areas of the three hydro-electric dams along Agno River, namely; the Am-buklao, Binga and San Roque Watersheds.

The number of respondents correspond with the represented area of the focus watershed. Based on the percentage of the total area, sixty (60) percent, twenty five (25) percent and fifteen (15) percent represented Ambuklao, Binga and San Roque, respectively. Totaling to 230 respondents, 138 respondents were from Ambuklao watershed, while San Roque and Binga watersheds were represented by 58 and 34 respondents, respectively.

Determination of Climate Stressors, Exposures and Eth-nic Farming Practices and Indigenous Knowledge and Systems

Population and Locale of the Study Sites

Each of the farming communities in the three study watersheds was represented by a focused community with distinct ethnic identities. These communities were identified and pre-selected based on their historical affin-ity with the watershed under study. They are known to be a closed community and as such, have preserved their cultural practices in all aspects of life.

Participants in the Key Informant Interviews (KII) and Focus Group Discussions (FGD) belonged to different groups and stakeholders who are knowledgeable of their area of expertise.

The Data Gathering Tool

The first part of the survey questionnaire gathered information on their socioeconomic profile. It was designed to determine the income and income sources, ownership, farming, and awareness of benefits derived from watersheds.

The second part of the questionnaire was divided into assessments of exposure and cultural farming practices and indigenous knowledge and systems.

The significant climate change-related stressors considered in this study are those validated and identified during the pre-testing of interview questionnaire and grouped according to the works of Oppenheimer *et al.* (2014). These are prolonged and extreme rainfall intensity typhoons with extreme winds, flood, drought, and pests and diseases.

The degree of exposures to climate stressors can best be assessed by the direct impact it has on the various dimensions of community life (LEAD Pakistan, 2017). Adhering to this premise, the climate change related exposures of farming communities along the Agno River basin were assessed using a bottom up approach and partici-patory rural appraisal. Respondents described the frequency of occurrence of the climate change related hazards as the various impacts on each of the following sectors: agricultural/ socioeconomic, water, health, environmental, and institutional.

Cultural Farming Practices and Indigenous Knowledge and Systems

Adaptations of the community in terms of farming practices and indigenous knowledge and systems refers to the ability of the community to adjust to climate stressors, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2007). Probing questions were used to discover cultural farming practices and indigenous knowledge and systems of the community as well as the extent of use.

Comparison, Interpretation and Analysis of the Results of Assessments

Data were analyzed using SAS. Descriptive statistics such as frequency, percentages and means were used to present the profile of the respondents. Inferential statistics was applied to other data. Specifically, the Chi Square Goodness of Fit test was used to determine if significant differences exist in the socio-demographic and economic profile and farm related information which were categorical in nature, in the three watershed areas. In the case of continuous data such as age in years, annual income, farm size and years in farming, analysis of variance (ANOVA) was employed.

All throughout the study, the probability values were considered significant if less than 0.05 and highly significant if less than 0.01. Results data were compared, interpreted and analyzed using qualitative and quantitative methods. Descriptive statistic was used to express the representation of scenarios.

RESULTS AND DISCUSSION

Ethnic Affiliations and Profile of the Communities

By educational status, there is an equal percentage of respondents (36%) who went through elementary and high school. A slightly more than one fourth went to college. However, the distribution significantly differed across the sites as majority of the respondents in Binga only graduated from elementary. An equal percent (55%) of those in San Roque finished college. In Ambuklao, the percent distribution did not differ so much by elementary, high school and college education although the greatest percent of respondents finished high school. This result suggests that the geographical locations which dictate the proximity of the watersheds to tertiary schools influenced the educational attainment of the respondents. San Roque, being nearest to Urban areas where tertiary schools are located, registered the highest percentage of those who finished college, while Binga which hosts the remotest communities registered the lowest percentage who finished college education. This is similar with the observation of Falch *et al.* (2013) that geographical locations constrain educational choices. Falch *et al.* (2013) further explained that individuals living close to universities or schools arguably have lower commuting, relocation, or psychological costs. Likewise, Flannery and Cullinan (2014) indicate that geographical proximity to universities and professional colleges increases the probability for school leavers to continue education.

Significant variations in ethnicity were also observed as the respondents in Ambuklao were almost all Karao (98 %) but none in Binga and San Roque. Almost all and most of those in San Roque and Binga, respectively were Ibaloi and Kalanguya tribes. Only 4 of the 230 respondents do not belong of the three major ethnic tribes present in the study watersheds.

Slightly more than one-third of the respondents had been farming for 10 years or of shorter duration and slightly less had been farming for 16 or more years. Although the bulk of the respondents in Ambuklao and Binga had been into farming for 10 years or less in contrast to San Roque where more farmers spent longer years of 16 or more, the difference did not matter ($p>0.05$).

Table 1: Ethnic affiliations of community-residents

Variables	Ambuklao		San Roque		Binga		Total	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Ethnicity								
Karao	136	98.5	0		0		136	59
Ibaloi	1	0.75	11	19	29	85	41	17
Kalanguya	1	0.75	44	76	3	8	48	20
Others	0		3	5	2	7	5	4

Moreover, there is at least one household member who is available for labor in almost all households in Ambuklao and Binga in contrast to San Roque where many households have no member who can help work for the family. This result of the study confirms the earlier result that majority of the communities in San Roque watershed are into white collar jobs, wage earners or engaged into farming. This could be justified by the proximity of the watershed to urban areas which are host to many job oppotunities.

Regardless of study site, more households tend to belong to the lower income bracket. However, the differences in the distribution were not significant. The same is true in terms of mean household income per year even if such varied by as much as P20, 000. The mean annual income of P52, 743 revealed an estimated monthly family income of less than P5, 000 per month. The lowest mean income was observed in Binga where all respondents except two, were farmers. When asked as to how they perceive the sufficiency of their income, eight in every 10 respondents in Ambuklao expressed that their income was sufficient. The situation was quite opposite in Binga where majority claimed their income was not enough. The same was noted for exactly half of the respondents in San Roque. To augment their resources, loans are resorted to by majority of those in Ambuklao, one third of those in Binga and half of those in San Roque. Loans are obtained either from private individuals or cooperatives. However, in Binga watershed, small scale mining is an-other source of income although it causes high risks and vulnerability to the miners.

Climate Hazards and Exposures

The farming communities' exposure to climate related hazards or stressors (Table 2) were variable with averages of medium for Ambuklao, and low for both Binga and San Roque, respectively. The overall average exposure to hazards of the whole Agno River Basin was however estimated as low. The differences, however, has an average P-value of 0.386 which indicates that there was no statistically significant difference at 5 percent level of confidence. However, for flood hazard, result of the same statistical test revealed that Binga and San Roque watersheds have average scores categorized as low while very low score was noted for Ambuklao watershed. This result of the study might be interpreted as confusing since Ambuklao is located at the higher altitude com-pared to Binga and San Roque watersheds. However, this might be because residents of Binga and San Roque are already used to the occurrence of flood and that they come up with adequate strategies to overcome their exposure to flood. On the contrary, for Ambuklao residents, despite their higher altitudinal location are not used to flood occurrence so they consider river-swelling as hazardous. Consistent with this result are the average scores for flood producing hazard prolonged and extreme rainfall intensity for the three watersheds. This complementing result is that despite statistically not significant scores, score for Ambuklao is higher (2.6) than Binga and San Roque with identical scores of 2.0.

Table 2 revealed that hazards typhoons and extreme winds and drought have statistically similar scores for the three watersheds which are considered having medium exposure.

Table 2: Climate hazards and average exposures scores

Hazards	Ambuklao	Binga	San Roque	P value
Prolonged and extreme rainfall intensity	2.6	2.0	2.0	0.441^{ns}
Typhoons and extreme winds	2.2	2.8	2.2	0.441^{ns}
Drought	2.2	2.2	2.2	0.543^{ns}
Flood	2.2	1.2	1.8	0.441^{ns}
Pests and Diseases	1.6	1.0	0.8	0.459^{ns}
Average	**2.16**	**1.84**	**1.80**	**0.386^{ns}**
Description	**Moderate**	**Rare**	**Rare**	

The same table yields that hazard pests and diseases posted the lowest average score among the considered hazards for all the watersheds. However, for purposes of comparison, their average scores revealed that they are categorized as low for both Ambuklao and Binga and very low for San Roque.

A closer look at Table 2, however, shows that despite the lack of significant difference in the scores of the hazards or climate stressors typhoons and extreme winds, corresponding categories of these scores differ. Similarly, scores for hazards drought and pests and diseases were not significantly different but differs with their corre-sponding categories.

Cultural Farming Practices and Indigenous Knowledge and Systems

The study revealed that communities in the study watersheds have similar farming strategies to adjust to the effect of climate related hazards or stressors. Their corresponding answers revealed that cultural farming practices and indigenous knowledge and systems are similar but the timing of implementation is not the same for the three watersheds. This is despite the differences in their ethnic affiliations, distinct topographical features and altitudinal differences.

The local residents and householders are found to show cultural farming practices and indigenous knowledge and systems (Table 3).

Table 3: Cultural farming practices in Agno River Basin, Philip-pines

Cultural Farming Practices	Watershed
Mono-cropping	Ambuklao, Binga, San Roque
Multi-cropping	Ambuklao, Binga, San Roque
Crop Rotation	Ambuklao, Binga, San Roque
Use of high value crops	Ambuklao, Binga, San Roque

Relying or using cultural farming practices and indigenous knowledge and systems (Table 4) to offset the effects of different hazards could be equated to the educational status of the residents. Noticeably, Ambuklao is the most who are adoptive of the cultural farming practices and indigenous knowledge and systems. Next are the residents of San Roque and least are those from Binga. This finding is related to the educational status of the three watersheds where Binga residents are the most educated, followed by residents in San Roque and least from Ambuklao. The same sequence is observed in comparing the relative wealth of residents in the three watersheds. This leads one to infer that increasing educational attainment and wealth diminishes implementation and dependence on cultural farming practices and indig-enous knowledge and systems. As mentioned earlier, Binga residents have higher educational and economic status than those in Ambuklao and San Roque because of its geographical location and topography.

In the three watersheds, there are other agricultural activities undertaken to ensure crops/products grown which could support food requirements. These are remnants of the animism religion of the early Filipinos. All these are supportive of adaptation strategies to moderate harm/risk and exploit beneficial opportunities (Garcia *et al.*, 2016, DENR-ERDB, DENR Climate Change Project; Mallari, 2015).

Table 4: Indigenous Knowledge and Systems (IKS) implemented by watershed

Indigenous Knowledge and Systems	Ambuklao	Binga	San Roque
Uma (kaingin)	adopters	adopters	adopters
Burning	adopters	adopters	adopters
Natural composting	adopters	adopters	adopters
Fallow	adopters	adopters	adopters
Aduyon	adopters	adopters	adopters
Scarecrow	adopters	adopters	adopters

The practice of indigenous knowledge systems (IKS) in farming and gardening is comparable among the three study sites as less than half of the respondents in Ambuklao, exactly half of those in Binga and majority of those in San Roque reported use of such system. Thirty-five farmers reported doing the uma (kaingin) which entails clearing parts of the land sometimes the forest and planting therein. Burning which has long been prohibited, was reported by a few. Natural composting is another indigenous practice among 32 farmers. As the rice fields are cleared and prepared for planting, grasses and rice hays are buried inside the soil to allow decomposition. In gardens, the grasses including sunflower are placed inside the soil as a farmer digs the land. Planting is done when the organic materials start to decompose. Some however just burn the grasses then apply the ash as fertilizer. Fallow is practiced while waiting for the rain and as some take on other jobs for a few months. Isolated use of scarecrows and bayanihan system locally known as aduyon, were reported. Aduyon was reported in San Roque and Binga. The farmers apply indigenous knowledge to improve their living conditions, enhance or rehabilitate environmental conditions, maximize and sus-tain land productivity and its sustainability as well as mit-igate negative effects of climate variability, while using the area for production purposes.

In determining the underlying reason for the overall result of implementation, it could be deduced that geographical location and topography play a major role. Binga, being geographically located near the urban center of Baguio City, gives residents easy access to education, other means of livelihood, and centers of transportation and communication. This proximity is further enhanced by the presence of paved roads which are serviceable year-round being less prone to landslides and road cuts, a property attributed to favorable slopes.

In comparison, San Roque, which is nearer to markets and other urbanized areas than Ambuklao, also has more residents adopting the farming indigenous knowledge and systems. Aside from its distance to market and urbanized areas, San Roque's geographical location also dictates a better climate condition than Ambuklao because of its lower elevation with relatively milder temperature regime. This result of this study is parallel with the statement of IPCC (2014) that different communities experience climate stressors differently and their ability to cope, respond and adapt varies depending on where they live, how they earn a living and their socioeconomic status.

While majority of the respondents indicated using cultural/spiritual techniques, this did not significantly differ from the 49% who said they do not do so (Table 5). The practice of indigenous knowledge and systems

Table 5: Farmers-Respondents implementing indigenous knowledge and systems

Variables	Ambuklao		San Roque		Binga		Total (n= 230)	
Practice of indigenous knowledge and systems	**F**	**%**	**F**	**%**	**F**	**%**		
No	76	55.07	24	41.38	17	50	117	50.93
Yes	62	44.93	34	5.86	17	50	113	49.07

$X^2c = 9.01, p=0.06^{ns}$

(IKS) together with cultural/spiritual beliefs in farming and gardening is comparable among the three study sites as less than half of the respondents in Ambuklao, exactly half of those in Binga and majority of those in San Roque reported use of such system. On top of the cultural farming systems, the farmers adopted the indigenous knowledge and practices and are also being used as farming techniques. Majority of the residents who are adopting these farming techniques indicated that these are to offset the impact of climate stressors on their farms.

CONCLUSIONS

The communities perceived the climate stressors and have developed their farming techniques/strategies to offset the impacts

The implementation of cultural farming practices and indigenous knowledge and systems is dependent on their experiences of the climate stressors. However, the practice of these farming techniques is somehow dictated by their educational attainment, proximity to urban centers and presence of paved roads for easy access.

RECOMMENDATIONS

The cultural farming systems and indigenous knowledge and practices could be integrated or complemented with science-based strategies.

To preserve and maintain their cultural identity, it is necessary to maintain these practices for the next generation, as long as the communities are still relying on them before a disaster or in times of difficulty

A similar study should be conducted to include other climate-related stressors and consider other ethnic communities. For example, frost (andap) is a new emerging climate stressors of upland farming communities. However, there were no mention and there were no recorded frost occurrences at the study sites.

There is a need to infuse and undertake an economic analysis of the cultural farming practices and indigenous knowledge and systems to determine their corresponding costs and benefits

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