Working Paper

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Regine Joy P. Evangelista, Kharmina Paola A. Evangelista,
Joan U. Ureta, and Rodel D. Lasco

World Agroforestry Centre

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## Abstract

The municipality of Lantapan, located within the Manupali watershed, has an agriculture-based economy, with almost 90% of the households relying on smallholding agriculture. This study used the capital-based approach to qualitatively assess the vulnerability of smallholder farming households in the three sub-watershed clusters in Lantapan, Bukidnon to climate-related shocks. Following the IPCC framework of vulnerability, which assesses exposure, sensitivity and adaptive capacity this study explored the different variables that contribute to vulnerability using a mix of quantitative and participatory data gathering techniques. Overall, the descriptive analysis shows that the smallholder households in the Tugasan sub-watershed are the most vulnerable to climate-related shocks among the three clusters. More than environment or social factors, poverty seems to contribute most to the Tugasan cluster's vulnerability, as the households come considerably behind other clusters in terms of financial and physical assets. The farming practices of Tugasan farmers may also contribute to their vulnerability. For example, practices such as monocropping and not planting trees on their farms make them more susceptible to climate impacts. Based on these results, interventions to help reduce smallholders' vulnerability to climate shocks should focus on livelihood activities and farming practices, such as agroforestry, that are more climate resilient and can help provide both financial and environmental benefits.

**Keywords:** climate change, vulnerability, extreme events, capital assets, smallholders

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# Introduction

Small-scale farmers or smallholders make up a significant part of the agriculture sector, especially in Asia (Thapa 2009). Aside from their substantial contribution to food production, smallholders also serve as custodians of natural resources (IFAD 2008) especially in upland and mountainous regions in developing countries, like the Philippines. Despite these, smallholder farmers remain poor and food insecure owing to the myriad of challenges they face including low productivity, poor infrastructure, and insufficient social and market-based support services (Okello 2012). These socio-economic, demographic and policy conditions, along with their location, compound to make smallholder farmers more vulnerable to another threat: climate change (Morton 2007).

In fact, the IPCC asserts that smallholder or subsistence farmers are the most at risk to climate change impacts (Easterling et al 2007), including more severe and prevalent climate hazards such as typhoons, floods, landslides and droughts. The Philippines is one of the countries that are directly exposed to multiple climate-related hazards (Crepin 2015). These extreme events have affected the agricultural sector, especially smallholders who cultivate lands using mainly family labor and are mostly dependent on farming as their principal source of income (Ojwang et al 2010).

Several studies discuss how changes in the climate pattern can affect or are already affecting the agriculture sector. With higher temperatures, projected impacts on agriculture include 10-20% declines in yields in the next 40 years (Nelson et al 2009; Thorlakson and Neufeldt 2012), enhanced proliferation of weeds and pests (Nelson et al 2009) and variation in cropping calendars. This trend of increasing surface temperatures could also impact the hydrologic cycle and various watershed processes. Specific potential impacts include changes in run-off, nutrient enrichment, sediment loading and evapo-transpiration rates in a watershed system (Band et al 1996; Chang et al 2001; Evans et al 2003; as cited in Marshall and Randhir 2008).

Aside from increases in temperature, rainfall variability and increase in the magnitude and frequency of extreme weather events are already being experienced by farmers, and have resulted in losses in crops and livestock (Thorlakson and Neufeldt 2012), and decrease in availability of fresh water and degradation of watersheds (Manuamorn 2014). Added to that is the increasing demand for food and other natural resources which has resulted in the further degradation of the watersheds. This contributes to the increased vulnerability of smallholder farmers.

While climate change impacts on agriculture affect both small- and large-scale farmers alike, smallholders are expected to be more vulnerable due to inherent factors. For instance, Rurinda and colleagues (2014) studied the vulnerability to variable and changing climate of smallholder households in Zimbabwe. Their study showed that smallholder livestock production is largely affected by drought because it causes lack of feeds, while crop production is more vulnerable to increased rainfall variability. Moreover, Manuamorn (2014) also stated that the vulnerability of the farmers in the Greater Mekong area is affected by their dependence on rainfed agriculture and non-timber forest products (NTFP), which are mostly climate-sensitive natural resources.

In another study, Saldajeno et al (2012) concluded that the vulnerability of upland communities in the Philippines was mainly attributed to low capital assets among households. Meanwhile, the study by Nkondze et al (2013) showed that vulnerability of households in Swaziland was influenced mostly by household characteristics, including numbers of sick members, employed members and dependents, and household size.

Like many parts of the Philippines, the municipality of Lantapan has an agriculture-based economy, with almost 90% of the households relying on smallholder agriculture (Municipality of Lantapan 2012). Being located in an ecologically important area such as the Manupali watershed entails that the activities of Lantapan farmers impacts on their immediate localities and on those located in the downstream areas.

Therefore, this study aimed to assess the vulnerability of smallholder farmers in Lantapan, Bukidnon province to climate-related shocks by looking at the indicators of vulnerability. It combines both qualitative and quantitative approaches to objectively compare the vulnerability of the three largest sub-watershed clusters in Lantapan. This study is part of the three-year project of the World Agroforestry Centre (ICRAF) titled '*Climate-smart, tree-based, co-investment in adaptation and mitigation in Asia* (Smart Tree-Invest)' which aims to improve the livelihoods and resilience of smallholder farmers through the promotion of climate-smart, tree-based agriculture. The results of this study will provide basis for developing a co-investment scheme, which aims to restore the Manupali Watershed while improving the lives of smallholder farmers in Lantapan, Bukidnon.

# Materials and Methods

## Study site

This study was conducted in three sub-watersheds of the Manupali Watershed located in the municipality of Lantapan, Bukidnon province in the southern Philippines. It lies at the foothills of Mt. Kitanglad, an important landscape and protected area in northern Mindanao. The fourteen *barangays* or villages of the municipality share a total land area of 35,465 hectares. Its elevation ranges from 320 to 2,938 meters above sea level (masl) with generally rugged and steep topography in the upper areas and gently sloping land in the lower portion. The soil composition of mainly Adtuyon and Kidapawan clay in Lantapan is highly suitable for agriculture. Because of its contribution to the food security of the entire region, it has been considered as the 'vegetable basket' of the south (Catacutan and Duque 2006).

Lantapan has a Type IV climate, which is characterized by more or less evenly distributed rainfall throughout the year and indistinct dry and wet seasons. It has an average monthly rainfall of 224.54mm, while its maximum annual rainfall is 2,552.4mm. The period from November to April is relatively dry, while more rain is experienced for the rest of the year. The highest amount of rain usually falls on the months of May and October.

The municipality has a population of 55,934 in 2010. The *Talaandig* is the main indigenous group in the area, accounting for almost half of the entire municipal population. Other ethnicities include *Cebuano*, *Boholano*, *Igorot* and *Ilocano*. The influx of migrants is attributed to the suitability of farming in the area. Majority of the residents rely on agricultural activities to earn a living.

## Selected clusters

The three largest sub-watersheds in Lantapan were selected as the three clusters of the project. The sub-watersheds of Tugasan, Alanib and Kulasihan drain into the Manupali River, which then ends up in the Pulangui IV Reservoir — one of the sources of irrigation and electric hydropower in Bukidnon (Rola et al 2004). Aside from watershed services, the clusters are also important in agricultural production, and farming remains as the primary livelihood of the residents. In addition, large agricultural companies operate in the municipality, particularly in the Alanib and Kulasihan clusters. Table 1 shows the biophysical and physical characteristics of the clusters.

Table 1. Characteristics of the cluster sites

| Characteristics | Tugasan | Alanib | Kulasihan |
|---|---|---|---|
| Biophysical | | | |
| Area (hectares) | 4,879.29 | 6,595.83 | 10,075.52 |
| % timberland | 84.54 | 48.00 | 27.00 |
| % A&D lands* | 15.46 | 52.00 | 73.00 |
| Elevation (masl) | 1,000- 2,700 | 500-2,900 | 300-2700 |
| Villages covered | Kibangay, Basac | Songco, Alanib, Kaatuan, Baclayon, Poblacion, Balila | Alanib, Poblacion, Bugcaon, Kaatuan, Bantuanon, Capt. Juan, Kulasihan |
| Socio-economic | | | |
| Livelihood | 80% of the households are involved in farming | 60% of the households are involved in farming | Majority are involved in farming while others work as labourers in agricultural companies |
| Dominant commodities | vegetables, maize, coffee and sugarcane | vegetables, maize, banana | maize, rice, coffee, sugarcane and root crops |

*Alienable and Disposable (A&D) lands refers to those lands of the public domain which have been the subject of the present system of classification and declared as not needed for forest purposes.

For each cluster, sampled villages were chosen to represent the upland, midland and lowland areas. The Alanib cluster was represented by Barangays Songco, Alanib and Balila, while Barangays Kaatuan, Bantuanon and Kulasihan represented the Kulasihan cluster. Meanwhile, the Tugasan cluster is composed of only one village – Barangay Kibangay. The following figure (Figure 1) shows the land cover map of the study site.

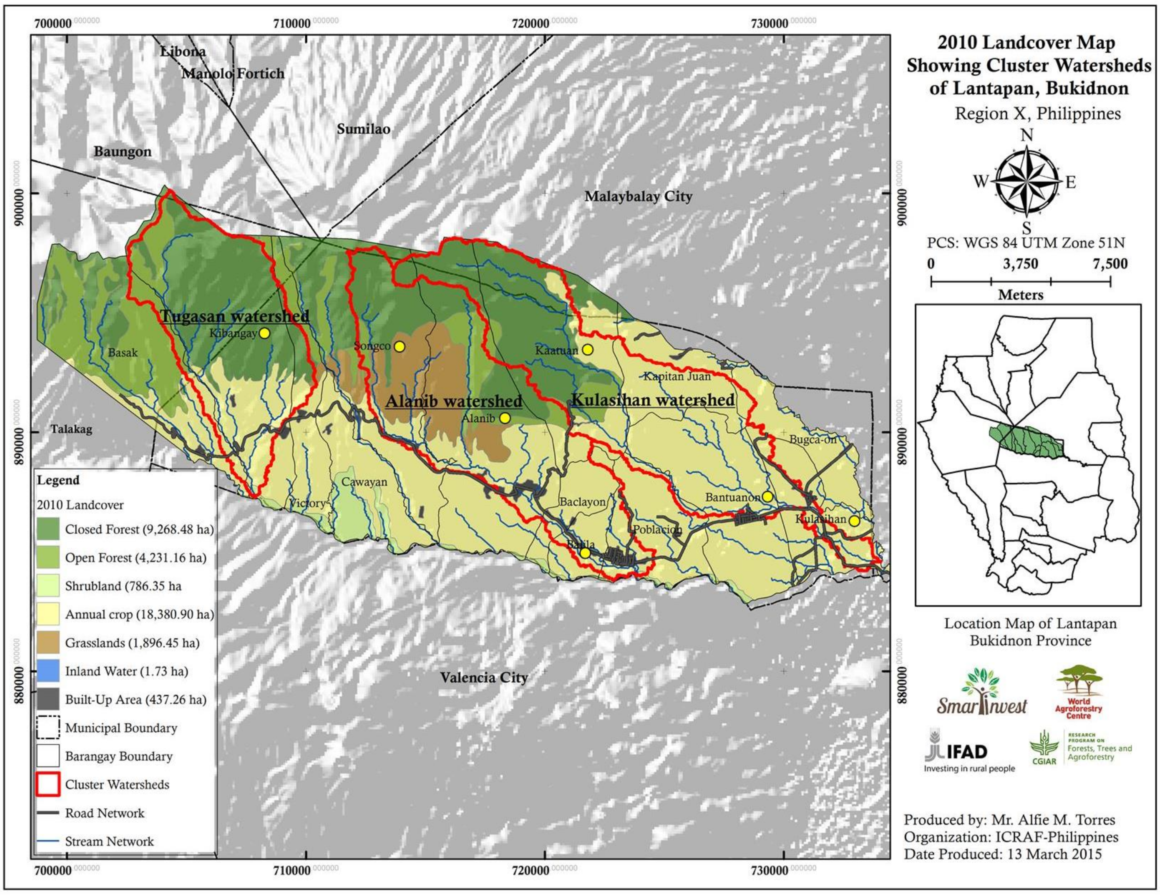


**Figure 1.** Land cover map of the three sub-watershed clusters in Lantapan, Bukidnon, Philippines

## Data collection and analysis

The Capacity Strengthening Approach to Vulnerability Assessment (CaSAVA) method was employed in the data collection. CaSAVA uses participatory approaches to collect gender-disaggregated information, while strengthening the awareness and capacity of the respondents to think and articulate latent problems in the community (Dewi et al 2013). A household survey and focus group discussions were undertaken in each cluster to solicit information on the vulnerability of smallholder farmers.

***Household survey.*** A livelihood and assets survey was undertaken to evaluate the sensitivity and adaptive capacity of smallholder farmers. A total of 165 respondents were interviewed from different households in the clusters. They represent 22.88% of the total population of smallholder farmers in the area. An equal number of male and female farmers were targeted at the start of the survey. However, more men famers were interviewed than women, because some were not available during the survey proper. The distribution of respondents across the cluster is presented in Table 2.

Table 2. Distribution of respondents across the clusters

| Cluster | Female | Male | Total |
|---|---|---|---|
| Tugasan | 20 | 25 | 45 |
| Alanib | 26 | 34 | 60 |
| Kulasihan | 32 | 28 | 60 |
| Grand total | 78 | 87 | 165 |

Stratified random sampling based on economic status (i.e. low, average, high) was employed in selecting the respondents. Prior to the sampling, a list of smallholder farmers with corresponding economic status was requested from the Department of Agriculture (DA) technicians of the municipality of Lantapan. Farmers with low economic status are those with less than 0.5 hectares of land and houses usually made of light materials. Average farmers, on the other hand, are those with 0.5-1.5 hectares of land and houses built using a combination of light and concrete materials. Lastly, those with more than 1.5 hectares of land and concrete houses are categorized as farmers with high economic status. The classification of farmers relied solely on the judgment of DA technicians assigned to the sampled barangays.

The survey instrument included questions on the five capital assets, knowledge on agroforestry and tree preferences and their perceptions of the environment and their household condition. Descriptive statistics was used to analyze the results of the household survey.

***Focus group discussions.*** Focus group discussions on the Shocks, Exposures, Responses and Impacts (SERI) were conducted in each cluster. The main purpose of this activity was to evaluate the different climate- and market-related shocks that were experienced by the smallholder farmers. Two groups of smallholder farmers participated in the FGDs in each cluster. The first one was composed of all male farmers, while the other one of female farmers. On the average, there were eight participants in each group.

The topics of the FGD included timeline analyses, participatory mapping, natural disasters and extreme events profiling, and assessment of efforts to overcome the consequences of the identified disasters and events. The results of this activity contributed to the qualitative analysis on exposure and adaptive capacity of the three clusters.

## Vulnerability assessment and variable selection

This study purports that the level of vulnerability of smallholder farmers vary depending on their inherent or internal priorities and capacities (Allen 2003), as well their external or biophysical environment. Following an extensive literature review of international and national journal articles, this study adopted the two most widely used vulnerability frameworks – the IPCC framework approach and the Sustainable Livelihoods Framework (SLF). Both frameworks are commonly used in developing an index or model for measuring climate change vulnerability. The assessment in this study, however, used these frameworks as a guide in exploring the present vulnerability of smallholder households in the three sub-watershed in Lantapan, Bukidnon to climate-related shocks.

Under the IPCC framework approach, vulnerability is described as a function of exposure, sensitivity and adaptive capacity. As illustrated in the equation below, exposure and sensitivity both contribute to vulnerability while adaptive capacity reduces it.

$$\text{Vulnerability} = f\ (\text{exposure} + \text{sensitivity} - \text{adaptive capacity})$$

The SLF, on the other hand, is a framework that seeks to improve the understanding of the factors that affect livelihoods of rural communities (IFAD 2009) and has frequently been used in vulnerability and poverty assessments of rural communities. It is most often used in composite index analyses as a framework for indicator selection since it classifies indicators into the five asset categories of human, social, natural, physical, and financial capital (DFID 1999). The SLF allows room for modifications as needed. For instance, the indicators of adaptive capacity presented in the IPCC Third Assessment Report (IPCC 2001), including economic resources, technology, infrastructure, information and skills, and institutions and equity, generally reflect assets and resources based on the SLF. The five capital assets were used in the indicator selection for adaptive capacity while a modified SLF was used as sensitivity components.

Following these frameworks, the indicator selection process also took into consideration the relationship of each indicator to vulnerability through related literature review. By combining both qualitative and quantitative analysis of the components and indicators, this study objectively compares the vulnerability of each cluster to climate-related shocks. The components and sub-components of vulnerability are presented below, as well as the selected indicators and their hypothesized relationship to vulnerability. The rationales for each indicator are further explained in the results section of this paper.

## Exposure

Exposure refers to “the degree, duration and/or extent in which the household is in contact with, or subject to, the perturbation” (Adger 2006 and Kasperson et al, in Gallopin 2006), which in this study are climate-, or weather-related shocks such as drought, flooding, heavy rainfall, landslide, pests and diseases, wildfires and typhoons. In climate change literature, exposure relates to “the nature and degree to which a system is exposed to significant climatic variations” (IPCC 2001). It is usually measured by the frequency of natural disasters that occurred within a certain period in a given place (Hahn et al 2009). Following the participatory nature of this study, the exposure of smallholders in the three clusters was therefore evaluated through the FGD results on two aspects (Table 3). First, exposure was assessed quantitatively based on the number of the most remarkable climate- or weather-related natural disasters experienced in the clusters. Second is through the qualitative discussion of its impacts. During the SERI FGD, smallholder farmers were asked to identify the climate- or weather-related natural disasters they experienced in their cluster. These points, coupled with the results on impact analysis were used in the analysis of exposure.

Table 3. Components and indicators of exposure used in this study.

| Component | Indicator | Parameters | Hypothesized relationship to exposure |
|---|---|---|---|
| Exposure | Remarkable shocks | Number of most remarkable climate-related shocks | The cluster that identified more shocks have higher exposure |
| | Impacts | Impacts of consequences of shocks | The cluster that identified more impacts have higher exposure |

## Sensitivity

On the other hand, sensitivity is defined as the degree to which a system is affected, either adversely or beneficially, to climate variability, climate change or extreme events (IPCC 2001, in IPCC WG II 2007). Measures under this category are aimed to capture the present state of the smallholders' socio-economic conditions that could increase or reduce the potential impacts of natural disasters. In adapting and modifying the sustainable livelihoods framework, this study was able to reflect the different potential sources or aspects of sensitivity including livelihood, financial, human and physical sensitivities. These aspects also served as the components of sensitivity and comprised the different indicators shown below (Table 4).

Table 4.Components and indicators of sensitivity used in this study.

| Component | Indicator | Parameters | Hypothesized relationship to sensitivity |
|---|---|---|---|
| Livelihood Sensitivity | Type of land use | Type of land use, percentage of households that practice mono-cropping | Mono-cropping is more sensitive than diversified farming (i.e. more prone to pest and diseases) |
| | Number of plots | Average number of plots cultivated per household | More plots are less sensitive than single plots |
| | Diversity of crops | Average number of crop species across all plots | Higher diversity is less sensitive |
| | Number of trees on farm | Average number of trees per household | More trees are less sensitive |
| | Number of farm animals | Average number of farm animals owned | More farm animals are less sensitive |
| | Slope | Percentage of households for each type of slope | Farms in highly sloping areas are more sensitive than in flat areas |
| Human Sensitivity | Dependency ratio | Average ratio of dependents (<15 yrs and >64 yrs old) over members between 15 - 64 yrs of age | Higher dependency ratio (more dependents) are more sensitive |
| | Health | Type of toilet facility | Households with unhygienic toilet facilities are more sensitive |

| Component | Indicator | Parameters | Hypothesized relationship to sensitivity |
|---|---|---|---|
| Financial Sensitivity | Annual income | Average annual household income | Lower income are more sensitive |
| | Income from agriculture | Average percentage of income from agriculture | Higher dependence on farm income are more sensitive |
| | Poverty threshold | Percentage of households below poverty line | Households below poverty line are more sensitive |
| Physical Sensitivity | Type of house material | Percentage of households for each type of house building material | Households with light housing materials are more sensitive than concrete or semi-concrete houses |
| | Access to electricity | Percentage of households with electricity | Households without access to electricity are more sensitive |

### Adaptive Capacity

Adaptive capacity is defined by the IPCC (2007) as the "ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences". Adaptive capacity in individuals and communities is necessary for the design and implementation of effective strategies that can reduce the likelihood and magnitude of risks from climate change impacts (Brooks and Adger 2005). The IPCC and similar definitions (Levina and Tirpak 2006; O'Brien et al 2004; Engle 2011) successfully capture the complexity of the adaptation process. Using such definitions allows decision makers to consider both reducing vulnerability and taking advantage of available resources to overcome the challenges of climate change.

This paper therefore describes the adaptive capacity of smallholder farmers in Lantapan by exploring their five capital assets and their present adaptation practices. The components and indicators are presented below (Table 5).

Table 5. Components and indicators of adapative capacity used in this study.

| Component | Indicator | Parameters | Hypothesized relationship to Adaptive Capacity |
|---|---|---|---|
| Human Capital | Household size | Number of household members | Adaptive capacity decreased with more household members |
| | Education | Educational attainment of household heads | Adaptive capacity increases with higher education levels |
| | Non-formal education | Number of climate and livelihood trainings attended | Adaptive capacity increases with more trainings attended |
| Natural Capital | Land holdings | Average size of lands | Adaptive capacity increases with larger land holding |

| Component | Indicator | Parameters | Hypothesized relationship to Adaptive Capacity |
| --- | --- | --- | --- |
| | Accessibility of farms | Distance from home to plot | Adaptive capacity increases with shorter distance from home to farm |
| | Forest utilization | Percentage of households that gather or collect forest products<br>Type of collected forest products | Adaptive capacity increases with sustainable access to forest products |
| Financial Capital | Income Sources | Percentage of households with income from non-agriculture sources | Adaptive capacity increases with more income from non-agriculture sources |
| | Financial support | Number of households which received regular financial support from the government (4Ps) | Adaptive capacity increases with regular financial support |
| | Savings | Percentage of households with savings | Adaptive capacity increases with access to savings |
| | Ownership of lands | % of households that owned agricultural lands | Adaptive capacity increases with ownership of land |
| | Access to Credit | % of households with financial loans/ credits | Adaptive capacity increases with access to credit |
| Social Capital | Membership in organizations | Number of organizations where anyone in the household is an active member | Adaptive capacity increases with more organizations |
| | Sources of information | Number of sources of climate and livelihood related information | Adaptive capacity increases with more sources of information |
| Physical Capital | House ownership | Number of houses owned per household | Adaptive capacity increases with house ownership |
| | Vehicle ownership | Number of vehicles owned per household | Adaptive capacity increases with vehicle ownership |
| | Communication devices ownership | Number of gadgets owned per household | Adaptive capacity increases with gadget ownership |
| | Ownership of agricultural equipment | Number of agricultural equipment per household | Adaptive capacity increases with ownership of agricultural equipment |
| Present Adaptation Strategies | Adaptation strategies | Number of reactive and proactive strategies per cluster | Adaptive capacity increases with more adaptation strategies |
| | Successful efforts | Number of efforts with 75% success rate and above | Adaptive capacity increases with more successful adaptation strategies |

SERI results were again summarized to assess smallholders’ present adaptation strategies. The success ratings were based on the farmers’ perceptions on how effective the strategies were in relieving the impacts of the natural disasters, ranging from 0% or not effective to 100% or very effective. Only responses collected the household level were included in this study.

## Results and discussion

### Exposure

According to the farmers in the three sub watershed cluster in Lantapan, they experienced different types of remarkable natural disasters in the last 10 years. As presented in Table 6, all the clusters were exposed to flooding, landslide, pests and diseases, while drought only affected the Tugasan and Alanib clusters. On the other hand, heavy rainfall and typhoon caused adverse impacts in Tugasan and Kulasihan clusters. Only the FGD participants in the Alanib cluster recalled the occurrence of wildfires. Table 6 further shows that the residents in the Kulasihan cluster experienced the most number of remarkable climate-related natural disasters in the last decade, with Kulasihan and Tugasan coming in closely at second and third. However, in terms of adverse impacts of all natural disasters, Tugasan identified slightly more impacts or consequences (21 impacts) than the two other clusters (20 impacts). To identify the extreme event that affected them the most, male and female FGD participants was also able to rank each extreme event based on the most severe.

Table 6. Number of most remarkable natural disasters in the clusters from 2004-2014 based on community FGDs

| | Tugasan | | Alanib | | Kulasihan | |
|---|---|---|---|---|---|---|
| Natural Disaster | No. of remarkable events | Impacts | No. of remarkable events | Impacts | No. of remarkable events | Impacts |
| Drought | 2 | Crop damage<br>Loss of livestock<br>Decline in income<br>Lack of food supply | 1 | Crop damage<br>Low production<br>Wildfire | n/a | |
| Flooding | 2 | Crop damage<br>Delay in delivery of products<br>Loss of livestock<br>Infrastructure damage | 3 | Crop damage<br>Loss of livestock<br>Low production<br>Financial loss<br>Infrastructure damage | 3 | Crop damage<br>Loss of livestock<br>No income<br>Financial loss<br>Infrastructure damage<br>More debt |
| Heavy rainfall | 1 | Crop damage<br>Decline in income<br>Infrastructure damage | n/a | | 2 | Loss of livestock<br>Financial loss |

| | | | | | | |
|---|---|---|---|---|---|---|
| Landslide | 1 | Crop damage | 1 | Infrastructure damage | 1 | Crop damage |
| | | Delay in delivery of products | | | | Tree damage |
| | | Loss of livestock | | | | Financial loss |
| | | Impassability of roads | | | | No access to farm |
| | | Infrastructure damage | | | | |
| Pests and diseases | 1 | Crop damage | 3 | Crop damage | 2 | Crop damage |
| | | Poverty | | Cutting infested trees for fuel wood | | Financial loss |
| | | | | Low production | | |
| | | | | Planted other crops | | |
| | | | | Stopped planting | | |
| | | | | Apply for other jobs (e.g. laborer) | | |
| | | | | Low income | | |
| | | | | Rent out farms | | |
| Wildfires | n/a | | 2 | Crop damage | n/a | |
| | | | | Pollution | | |
| Typhoon | 2 | Cannot apply fertilizer | n/a | | 3 | Crop damage |
| | | Crop damage | | | | Loss of livestock |
| | | Disruption in farm activities | | | | Tree damage |
| | | | | | | No income |
| | | | | | | Infrastructure damage |
| | | | | | | More debt |
| Total | 9 | 21 | 10 | 20 | 11 | 20 |

***Tugasan cluster.*** Participants of the FGDs in this cluster identified the least number of climate-related natural disasters (9). The most remarkable natural disasters, based on the number of mentions during the FGD, were drought, flooding, and typhoons. Meanwhile, the most remarkable extreme event for male farmers in the Tugasan Cluster was the occurrence of pests and diseases in 2013. Club root disease enlargeg the of roots of cabbage, broccoli and cauliflower which, ccording to the FGD participants, could be attributed to the high soil acidity. As a consequence, they experienced around 30% decline in harvest. This led to the rise of vegetable prices, loss of capital and poverty. Hence, some of the farmers decided to stop planting vegetables. Meanwhile, for the female farmers, Typhoon Pablo in 2012 was the most remarkable natural disaster. Because most of the farms are on sloping lands, water run-off damaged or washed out their crops. Farms situated near the rivers were also affected by flooding.

Crop damage was the usual consequence of the natural disasters that occurred in Tugasan. Farms were easily affected by climate-related events since most of the crops planted are vegetables. Unlike trees, they are not deep-rooted and can either be easily washed out by flood or wither during the dry season. Other impacts include disruption in farm activities, delay in the delivery of products, infrastructure damage and loss of livestock. These further led to financial losses, declines in income and food insecurity for the smallholder farmers.

***Alanib cluster.*** Flooding and pest and diseases were the most frequently mentioned extreme event for farmers in this cluster, which identified 10 climate-related shocks for the past 10 years. On the other hand, the occurrence of drought in 2004 was the most remarkable natural disaster for male farmers who recalled that there was no rain for a period of four to five months. Drought resulted in the withering of their corn and vegetables, and even led to wildfire. Female farmers, on the other hand, perceived that the flooding caused by Typhoon Pablo in 2012 was the worst disaster they experienced. Although river flooding only lasted for one night, the Alanib river overflowed by 6-10m on both sides. As a result, the water facility of the municipality was damaged and was not able to provide water to Barangays Songco and Bugcaon for three months. Moreover, some crops and livestock near the river were washed out by the flood.

All the identified natural disasters in the Alanib cluster caused crop damage. In addition, the landslide in 2012 damaged portions of their farm-to-market roads. Other direct consequences of the disasters included livestock loss, health problems and pollution. As a result, farmers suffered financial losses and declines in family income. Renting out lands and switching to off-farm or non-farm occupations were some of the indirect impacts of the disasters.

***Kulasihan cluster.*** FGD participants in this cluster were able to recall the most number of notable natural disaster (11), with typhoon and flooding being the most frequently occurring extreme events. In fact, Typhoon Pablo in 2012 was the most remarkable natural disaster for both women and men farmers in Kulasihan cluster. Typhoons and heavy rainfall lasted for two to three days and resulted in infrastructure damage, livestock loss and crop failure. Farmers suffered great financial loss and declines in income.

All the remarkable natural disasters that were experienced in Kulasihan resulted in crop damage. Other impacts of the disasters include livestock loss, inaccessibility of farms and damage to household assets. This led to financial loss, more debts and further declines in income of smallholder farmers.

## Sensitivity

*Livelihood sensitivity*. The smallholder farmers' agricultural practices affect the sensitivity of their livelihoods to climate-related shocks, as some farming systems may be more sensitive than others. This is best represented by the land use adopted by the farmers. While several typologies for farming land use have been studied and recommended worldwide, the participatory nature of this research necessitates that the typology used be simplified and easily understood by farmers.

Based on interviews, FGDs and the survey with farmers, their land use was classified based on whether cash crops or trees were solely planted or combined in each of their farm plots. The most common land use across all clusters was monocropping (Figure 2), where plantation crops like corn and banana are preferred (Ureta et al 2015). Also common was the practice of combining crops in one plot with trees, often fruit and timber, as perimeter fences. Smallholder farmers in Lantapan also practice different types of agroforestry, like rubber and cacao agroforestry. Multicropping of cash crops was also fairly common, while planting only trees was the least common practice.

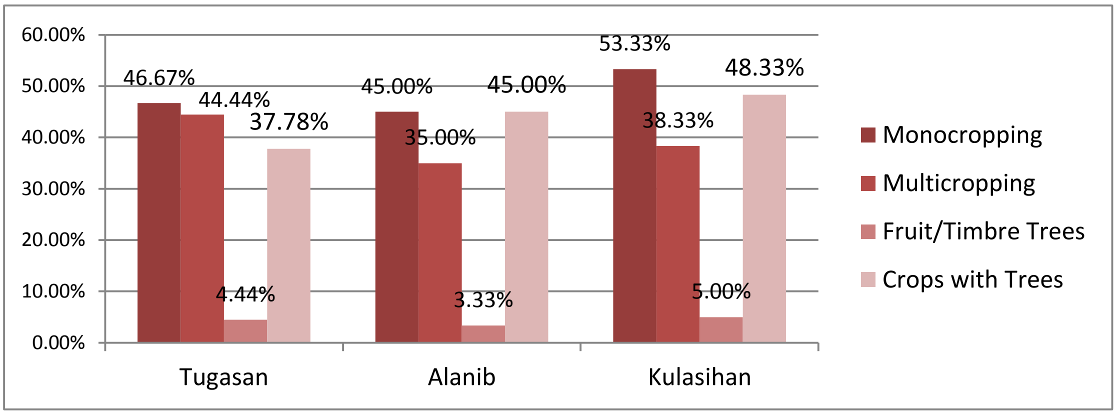


Figure 2. Smallholder farmers' landuse per plot (multiple responses, percentage out of total respondents per cluster)

These results also complement the data on the number of farm plots wherein majority of the households either own or manage only one plot. It should be noted though that, similar with land use, more farmers in the Kulasihan cluster cultivate more than one plot than the other clusters (Figure 3). Having more plots spreads the risk of potential crop failure or damage due to typhoons, heavy rains and floods.

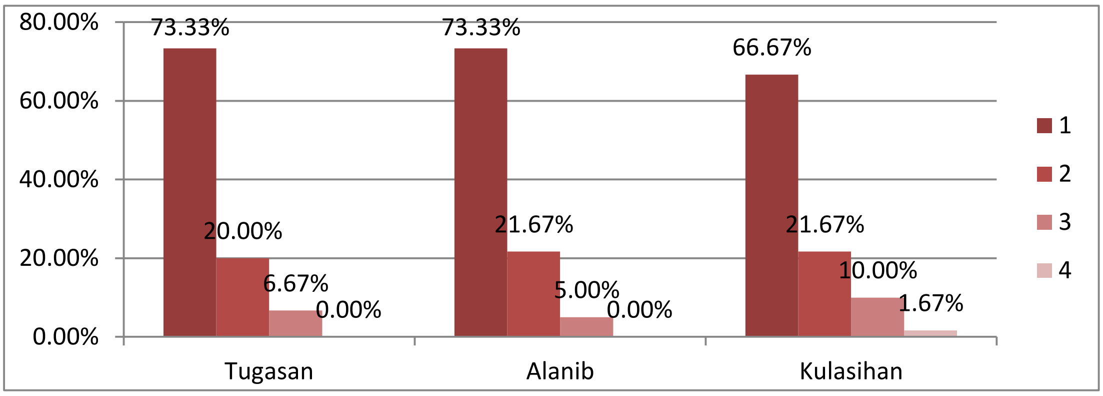


Figure 3. Number of farm plots owned or managed by smallholder farmers

Diversifying though planting two or more crops in one or several plots was also a practice adopted by almost all smallholder farmers in Lantapan, as evidenced by the results that the average number of crops species planted in all clusters is two (Table 7). Crop diversification is a rational and cost-effective way to manage risks and reduce sensitivity to climate variability and extremes (Lin 2011). For farmers in the Philippines, crop diversification has been an effective strategy that maximizes the use of land and optimizes farm productivity and income (Espino & Atienza 2001). Crop diversification is also an effective way of adapting to climate change (Lasco et al 2011), and is known to reduce the negative impacts of pests, diseases and variable climate (Lin 2011).

Table 7. Composition of farms in the three sub-watershed clusters

| Farm Composition | Tugasan Cluster | Alanib Cluster | Kulasihan Cluster |
|---|---|---|---|
| Average number of crop species across all plots | 2.2 | 1.98 | 2.33 |
| Average number of individual tree stands planted across all plots | 142.78 | 207.5 | 438.95 |
| Average number of farm animals owned | 5.07 | 7.13 | 11.13 |

On the other hand, having trees on farms is also recognized as an effective means of reducing vulnerability to climate change impacts (Lasco et al 2014). Trees help reduce sensitivity to climate shocks not just by providing subsistence and extra income from fruit and timber products, but also by providing ecosystem services, such as soil and water conservation, serving as wind breaks, and even improving the microclimate. While some farmers in Lantapan do not have trees on their farms, majority do have them. The number of tree stands, however, is very variable, ranging from a few trees around their farms to over a thousand trees for those who have timber or rubber plantations.

In terms of farm animals, majority of the smallholders in Lantapan practiced backyard animal raising, with poultry as the most common choice (54.54%). In all clusters the number of individual animals was also variable, but majority had less than 10 animals. Having farm animals adds an extra layer of protection against climate shocks by providing food or extra income when needed. However, they can also be a liability and can result in farmers incurring losses during disasters. For example, Lantapan farmers mentioned during the FGDs that one of the common impacts of flashfloods is the death of their farm animals due to drowning.

Majority of the farmers in Alanib described their farms as all sloping (Figure 4). On the other hand, farms lands in Tugasan are mostly flat. Physical farm characteristics, such as the slope of farms, also influence the ease of farming and their practices, including the crops that they choose to plant, thus contributing to how sensitive farmers' livelihoods are to climate shocks.

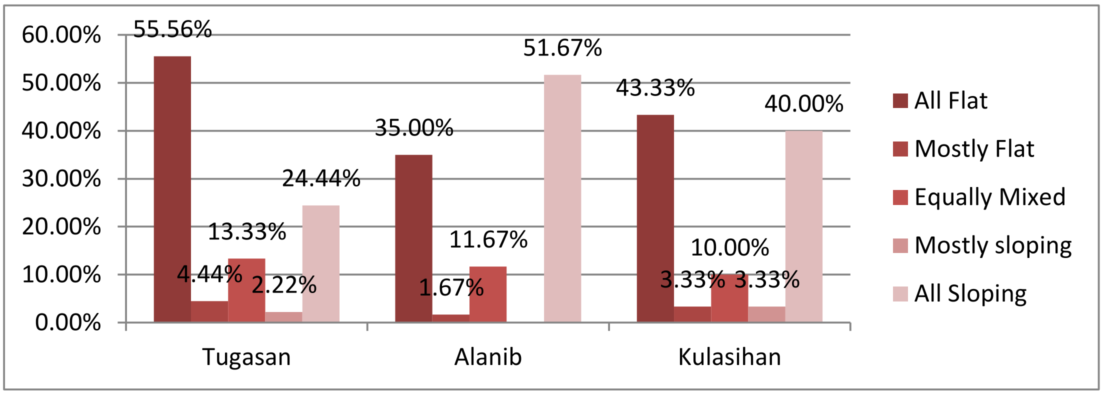


Figure 4. Slope of farms in the three sub-watersheds in Lantapan

*Human sensitivity*. Human sensitivity in this study is represented by age dependency ratio and health. The dependency ratio is the proportion of the number of individuals of dependent age (less than 15 and more than 64 years) to those of working or economically productive age (15 to 64 years) within a population (National Statistical Coordination Board 2003). This is often expressed as a percentage, or per 100 working age population. The most recent data for Bukidnon shows that the dependency ratio is 67.2 or 67.2 dependents per 100 working individuals in the population.

In this study, however, the age dependency ratio was computed per household to reflect the pressure on the working individuals to provide for all household members. A dependency ratio of one signifies that there is an equal number of dependent and working-age household members. A ratio of less than one signifies that there are more productive members in the family, while a ratio of more than one connotes that there are more household members of dependent age.

A vulnerability and adaptation assessment of smallholder cacao farmers in Nigeria revealed that a household's dependency ratio significantly affects both vulnerability and adaptive capacity, in that a higher dependency ratio increases vulnerability and even decreases their capacity to adapt (Longe and Oyekale 2013). For households with limited financial resource like smallholder farmers, a high number of dependents increases sensitivity and may limit their ability to bounce back or recover from the impacts of natural hazards, like climate extremes (Siagian et al 2014).

The results of this study show that the average dependency ratio for all clusters is less than one, implying that majority of the households have more members that are of productive than of dependent age (Figure 5). The Alanib and Kulasihan sub-watersheds also have a high number of households wherein all members are of the productive age (i.e. no dependents). On the other hand, a few households still have a high number of dependent family members, which may increase vulnerability during climate shocks.

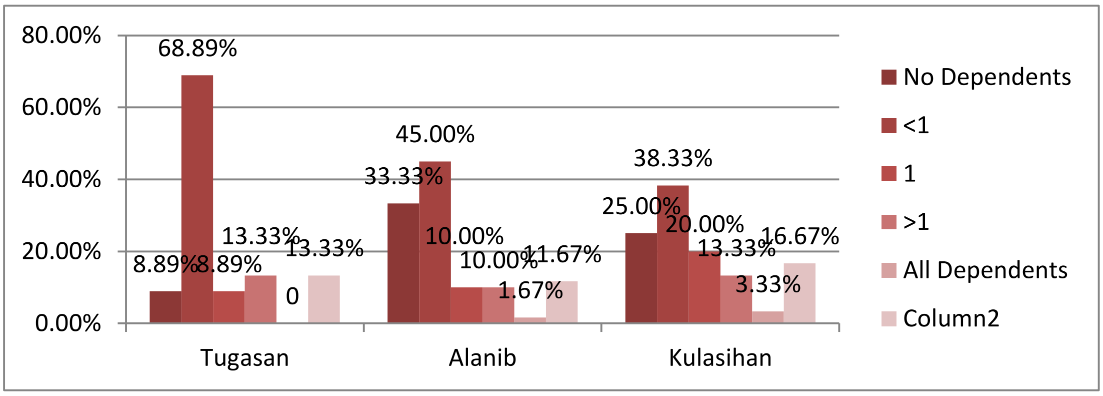


Figure 5. Households' age dependency ratio among three sub-watersheds

On the other hand, health is a key human capital, which also serves as input to other forms of human capitals, especially productivity (Bloom and Canning 2003; Bleakley 2010). It is especially important within the context of climate change, which impacts the health and well-being of communities, as well as their natural and economic environments. Climate variability and extremes can impact the health sector in many ways, including malnutrition due to the unavailability, inaccessibility and low quality of food and water; and  increase in infectious disease vectors like mosquitos. It can also directly cause health problems and even deaths, such as heatwave-related deaths (Confalonieri et al 2007).

In this study, variable health was represented by the availability and type of toilet facility used by the household (International Institute for Population Sciences (IIPS) and Macro International 2007, Madhuri, Tewari and Bhowmick 2014). The health of an individual is a complex concept attributed to several factors, one of which is poor sanitation due to lack of proper toilet facilities. Poor sanitation remains to be a crucial public health issue worldwide, and it is linked to 280,000 deaths every year due to diarrhea (World Health Organization 2015). According to the same WHO report, lack of hygienic sanitation facilities is also linked to the transmission of other diseases, such as cholera, dysentery, hepatitis A, typhoid and polio, as well as other tropical diseases.

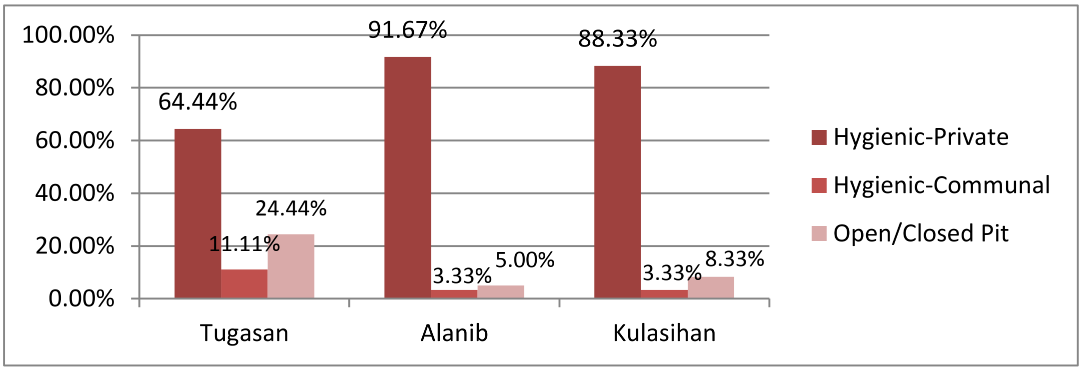


Figure 6. Type of toilet facilities used by farming households in Lantapan, Bukidnon

The results show that most of the households across all clusters use hygienic sanitation facilities, specifically private toilet facilities with water and those that drain into a sewage system or a septic tank (Figure 6). However, there are more households that use open or closed pits as toilets in the Tugasan cluster, which is in the higher elevations of the Manupali watershed, than the other clusters in lower elevations. These results could hint at the fair state of health of farming households in Lantapan, except those in Tugasan where unsanitary toilet facilities are still being used by some residents.

***Financial sensitivity.*** High income has been associated with less vulnerability to climate shocks. As argued by Wood and colleagues (2014), wealthier farmers are more likely to make farm-associated changes to lessen the impacts of climate shocks in general. On the contrary, resource poor farmers were usually risk-averse, and were hence less flexible to adopt change and innovations.

The average income of smallholder households in the three clusters in Lantapan appears to be connected with elevation, with average incomes increasing as one goes downstream in the watershed. The Tugasan cluster, which is the smallest sub-watershed and the highest elevation in the Manupali watershed, had the lowest average annual income among the three clusters, at around USD 4,915.37[*] (Table 8). On the opposite end is the Kulasihan cluster with the highest average income at over USD 7,479.91[*] and is the furthest downstream. Survey results further show that almost half of the farming households in Tugasan Cluster were living below the poverty line. This is reflective of the persistent problem of high poverty incidence in the Philippine uplands. Poverty compounds other issues and increases the sensitivity of upland communities to climate-related disasters.

[*] Official exchange rate is 1PHP= USD 46.792 as of 24 May 2016, available at http://www.bsp.gov.ph/statistics/sdds/exchrate.htm

Table 8. Average annual income and percentage of income from agriculture

| | Annual Income (USD)* | Income from Agriculture (%) | Households below poverty line (%) |
|---|---|---|---|
| **Tugasan** | 4,894.14 | 74.58 | 46.67 |
| **Alanib** | 6,481.02 | 58.48 | 38.33 |
| **Kulasihan** | 7,515.65 | 54.77 | 36.97 |

The high dependence on natural resources for income also illustrates the financial sensitivity of smallholder farmers, who often have limited financial resources other than farming. It is one of the commonly used indicators of different climate change vulnerability indices (e.g. Ahsan and Warner 2014; Pandey and Jha 2012; Hahn et al 2009). Vincent and Cull (2010) argued that households that heavily depend on activities utilizing natural resources are more likely to exhibit higher vulnerability to climate shocks. Pulhin and colleagues (2009) found that upland communities in Albay, Philippines were suffering declines in agricultural production due to occurrences of typhoons and El Niño. Hence, farmers, especially those who solely rely on on-farm income, experienced huge financial losses.

Results of this study show that a large percentage of smallholder farmers' income was derived from on-farm and off-farm income sources. As indicated in Table 8, more than half of their income, especially in the Tugasan cluster, was obtained from agriculture activities. On the average, respondents in the Kulasihan cluster recorded the lowest dependency on agriculture as a source of income.

***Physical sensitivity.*** The sensitivity of physical resources to climate- and weather-related disaster depends largely on the materials used. For example houses made of light materials, such as nipa huts, are expected to be more sensitive to typhoons than concrete houses. In the watersheds of Lantapan, majority of the farming families already live in houses made of concrete materials, which are sturdier and can withstand extreme weather more than light housing materials such as wood and nipa shingles. Figure 7 shows that this is true except in the Tugasan cluster, where more houses are built with a mix of light and heavy materials (semi-concrete).

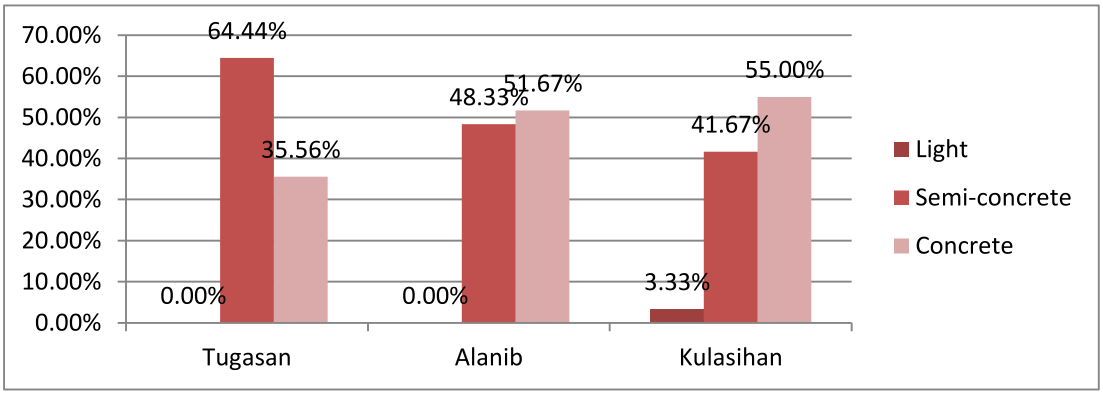


Figure 7. Type of building materials used for houses

Access to basic public utilities such as electricity, presents a wider perspective of physical sensitivity in terms of the physical presence and state of social services accessible to the households in the area. For example, access to electricity has been considered as a good indicator of wealth or development in index studies (Bryan 2013). In Lantapan, while  majority of smallholder farming households do have access to electricity (Figure 8), 20% of respondents in the Tugasan cluster still do not. As mentioned earlier, Tugasan is the furthest upstream and the most remote among the three sub-watersheds, which could explain why social services, such as the provision of electricity lines, have not reached some of the areas in the cluster.

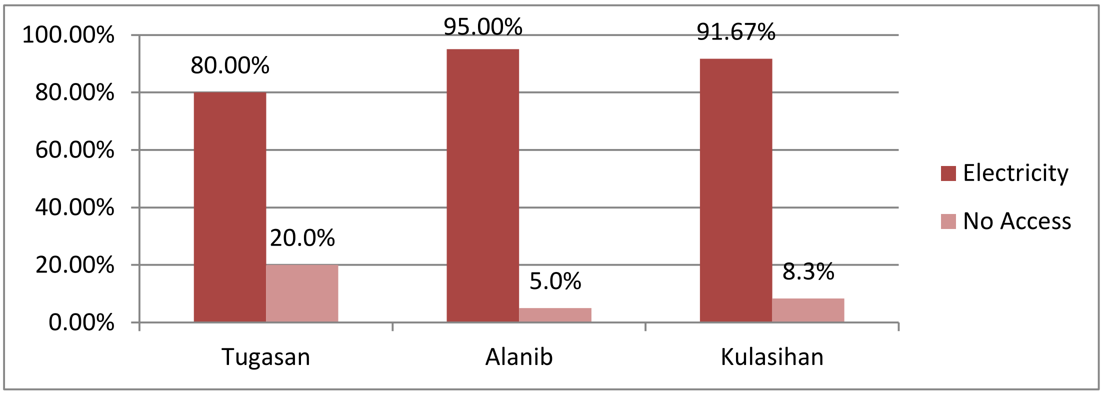


Figure 8. Access to electricity

## Adaptive Capacity

### Human Capital

**Household size.** Studies have shown that household size interconnects with poverty in the Philippines (Orbeta 2005; Virola and Martinez 2007) and consequently, with climate change vulnerability (Longe and Oyekale 2013; Siagian et al 2014; Saldajeno et al 2012). In this study, the household sizes for all sub-watersheds varied greatly from two to 13 household members, with an average of 6.44, 4.95 and 4.48 for the Tugasan, Alanib and Kulasihan clusters, respectively. It is also reflective of the census data for the municipality of Lantapan and the whole province of Bukidnon, with an average household size of 5 and 4.96, respectively. This is contrary to the commonly held belief that rural areas, especially farming households, have larger family sizes.

The figure below (Figure 9) shows the breakdown of household size classified into small (1-3 members), medium (4-6 members) and large (≥7 members). A closer observation shows that the Tugasan cluster had more households with a large family size (48.89%) than both Alanib and Kulasihan clusters, where majority of the households were of medium size (55% and 65%, respectively). The  Alanib and Kulasihan clusters had more households of small size than large households, while Tugasan had the least number of small households.

Based on household size, it could be inferred that farming households in the Tugasan Cluster may be more vulnerable to climate change impacts. A review of literature done by Cutter et al (2009) suggested that a large family size increases social vulnerability to climate hazards. Saldajeno et al (2012) further explained that larger households may have limited capacity to adapt and manage their resources. Large households are also associated with poverty (Orbeta 2005), as data from the Philippines show that poverty incidence increases as household size increases (Virola and Martinez 2007; Reyes et al 2012).

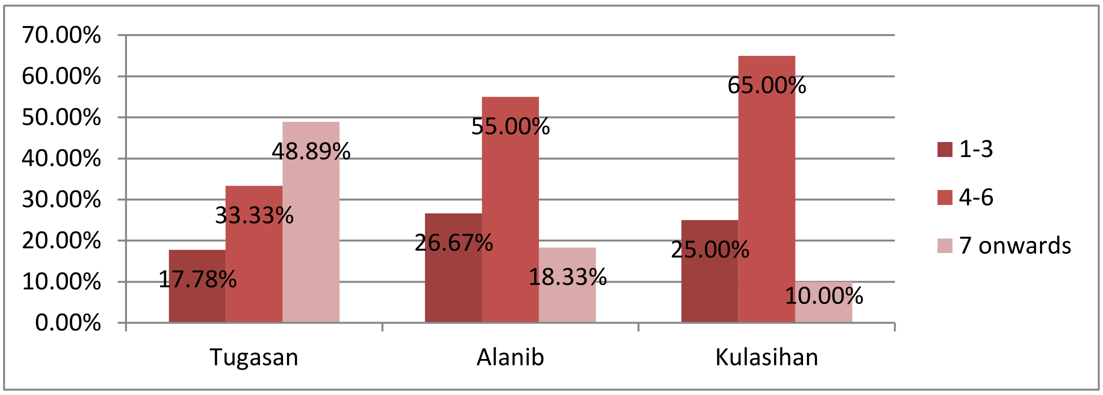


Figure 9. Household sizes of the three sub-watershed clusters in Lantapan, Bukidnon

**Education.** It has been theorized that higher education levels of household members, both formal and non-formal, results in higher capacity to adapt and lower vulnerability. Education can directly and indirectly reduce the negative impacts of extreme climate events, especially through improving risk perception, reducing poverty and promoting access to information and resources (Muttarak and Lutz 2014).

Household heads with higher levels of education may better respond to the negative effects of climate change. This is supported by a nationwide study in the Philippines which found that having household heads with higher levels of education, specifically college education, significantly reduces the number of deaths from natural disasters (Lucagbo et al 2013). The same study purports that education is an important adaptation measure because people with higher level of education may have an enhanced ability to recognize risks. They may also be more willing to change risky behaviors than those who have lower levels of formal education.

The figure below (Figure 10) shows the highest education levels attained by the household heads of smallholder farming households in the three sub-watershed clusters in Lantapan, Bukidnon. Survey results reveal that across the three clusters, majority of the respondents only reached or completed primary education, at 19% and 21% respectively.

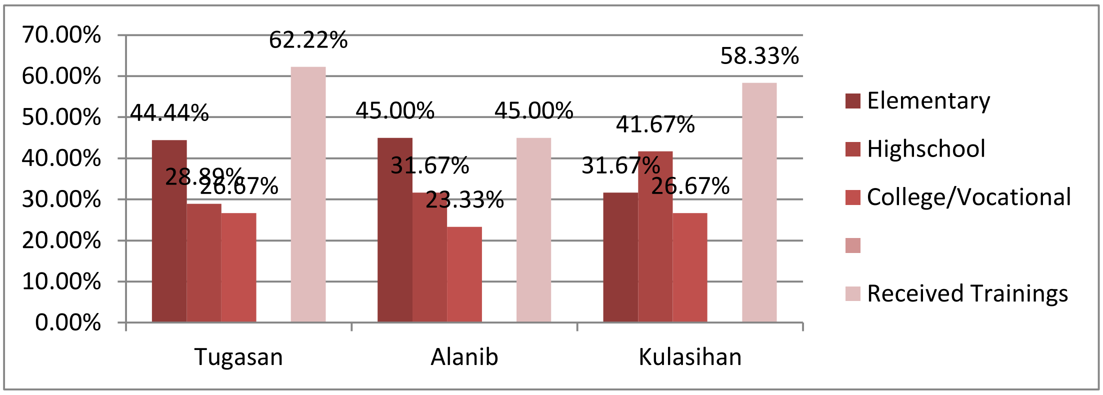


Figure 10. Formal and non-formal education received by farming household heads/households in Lantapan, Bukidnon

Similar to high levels of formal education, non-formal education, specifically trainings, can have a positive impact on households' adaptive capacity towards climate change. Farming households often rely on capacity building programs to enhance their skills and learn about new techniques and developments in farming technologies. In more recent times these programs include information campaigns on environmental issues such as climate change. These activities are often provided for free by relevant government agencies, non-government organizations and private agri-companies.

In this study, the respondents were asked if they had received from different institutions any farming-related information, such as on plant pest and diseases, land conservation, seedling and nurseries, planting and management for productivity post harvest treatment, climate change and environmental hazards. In all sub-watershed clusters, majority of the households received training from various institutions, except in Alanib, where many respondents did not receive any training.

## Natural Capital

Agricultural land holdings. The characteristics of farmers' landholdings represent the natural capital that they can utilize for their livelihoods and reduce their vulnerability to climate shocks. For this study, farm characteristics include farm size, distance of house to farm, number of farm plots and slope. Households with larger farm size and higher number of plots are likely to be less sensitive to climate shocks, while those with farther distance from house to farm and steeper slopes are more sensitive. A different study shows that a larger farm size makes farming households less vulnerable to poverty, because the availability of land for cultivation reduces risk exposure from both economic and natural shocks (Maloka 2008). This becomes even more apparent in considering climate risk from climate change.

For this study, smallholder farmers were purposively sampled with the help of the Municipal Agriculturist's Office (MAO) and based on the knowledge of the agricultural technicians on the actual farm size of each farmer. Since the information from the MAO are sometimes not updated, the actual farms size of the farmers ranged from .06 to 10 hectares. Despite this, the average farm size for each cluster was within what can be considered as smallholding farms with 2 ha of land area. The Tugasan cluster had the smallest average farm size (1.41 ha) and Kulasihan the largest (2.20 ha) (Table 9).

Table 9. Size and distance of agricultural land holdings of smallholder farmers in Lantapan, Bukidnon

| Farm Characteristics | Tugasan | Alanib | Kulasihan |
|---|---|---|---|
| Average Farm Size (in hectares) | 1.41 | 1.82 | 2.20 |
| Average Distance from House to Farm (in kilometers) | 1.32 | 2.46 | 1.85 |

The results also revealed that majority of the farmers tend to travel at least 1 km or more to get to their farms; this is in contrast to farmers who resided within or beside their farms. The survey shows that farmers in the Alanib cluster needed to travel the farthest (an average of 2.46 km) to reach their farms (Table 9).

Forest utilization. In the past, rural communities have constantly relied on ecosystem services and goods from forests in their day-to-day lives. While this reliance may have lessened due to agricultural development and oftentimes physical and policy restrictions, forest goods and services remain an important resource especially in adaptation to climate change (Pramova et al 2012).

Braatz (2012) explained that during climate-related shocks, forests serve as safety nets during emergencies, as a source of goods for consumption or income, and as a source of alternative employment when farming is no longer viable. This shows that in the short term or during the immediate impact of climate shocks, forest utilization may reduce vulnerability. However, a study of livestock farmers in West and South Africa proposes that the opposite may be true in the long term. Steeg et al (2013) contend that free access to natural resources such as forests may exacerbate vulnerability in the long run since reliance on forest resources, especially for diversifying income sources, may worsen the effect of climate change in the future.

For the rural community in Lantapan, however, fewer households collect forest products than those who do not in all sub-watershed clusters (Figure 11). This was not always the case though, as the farmers explained during the FGDs that they were able to collect more forest products before, especially game and timber products, when they were still had free access to the forest. Now that the forests within Lantapan are under strict protection by the government, they are not able to hunt wildlife for food or cut down trees for timber, although many still gather firewood for cooking, especially in Kulasihan, which is closer to the intact forest. Figure 12 shows the types of forest products collected by smallholder farming households in the study site.

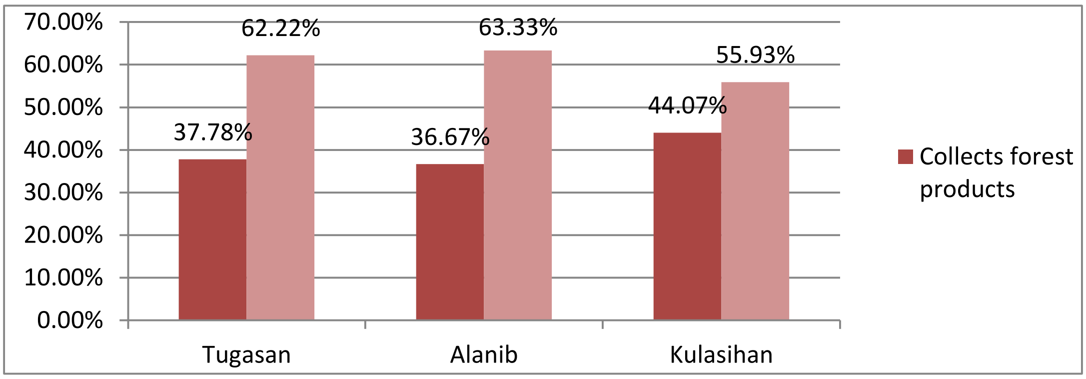


Figure 11. Percentage of households that collect forest products in Lantapan, Bukidnon

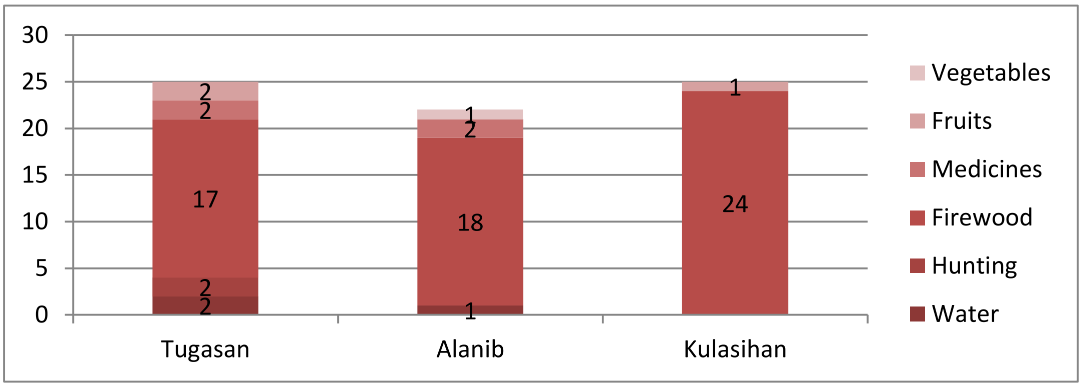


Figure 12. Types of forest products collected by smallholder farming households in Lantapan, Bukidnon (multiple answers)

## Financial Capital

**Income sources.** As discussed earlier, respondents in the Tugasan cluster recorded the lowest mean annual income, while those from Kulasihan have the highest. Dependence on agriculture as the main income source of income was also highest in Tugasan. Similarly, majority of the household heads in the Tugasan cluster had no alternative income sources other than farming, with only 28.89% saying they had a non-agriculture related livelihood (Figure 13). The most common alternative livelihood in all clusters is being an employee for both private companies and public or government agencies.

Apart from income from livelihood sources, some respondents were also receiving financial support from relatives, or were recipients of government's *Pantawid Pamilyang Pilipino* Program (4Ps). 4Ps is a human development program of the national government that provides conditional cash grants to extremely poor households for their healthcare, improved nutrition, family development and the education of children aged 0-14 (PCDSPO 2012). As reflected in Figure 13, only 13.33% of the respondents from Tugasan cluster received financial support. On the other hand, highest percentage of respondents receiving support was from Kulasihan Cluster.

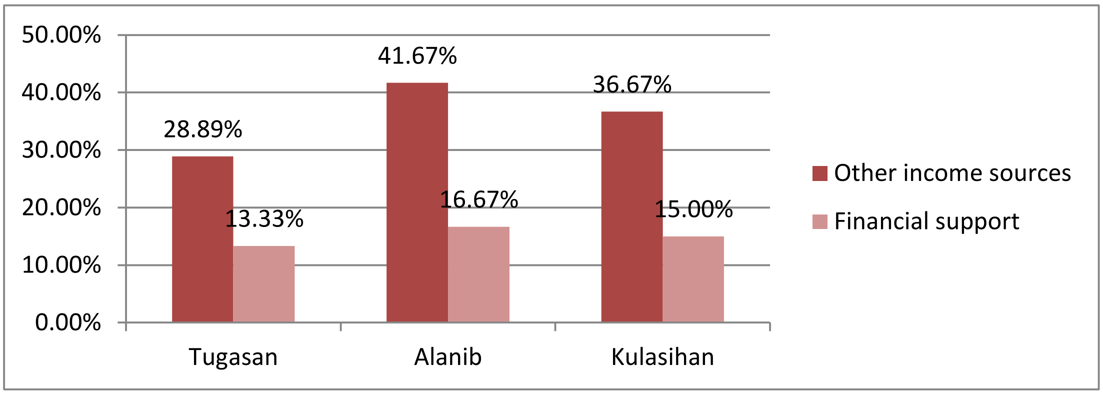


Figure 13. Percentage of household heads with non-agriculture income sources and percentage of households who receive financial support

**Savings.** Nazari and colleagues (2015) argued that lack of savings contributes to households' vulnerability to climate-related stress. In the study of Notenbaert and colleagues (2013) in Mozambique, they found that households' ability to save cash significantly lessened their vulnerability level. They explained that households could use savings to meet their needs in times of extreme events. This is also consistent with the results of the FGDs in the study site. The FGDs highlighted that farmers who have savings were able to recover easily from the impacts of shocks. For instance, farmers used their savings to buy farm inputs to replace their crops or repair the damages on their farms.

As reflected in Figure 14, majority of the farmers in the three clusters had no savings. Respondents from the Kulasihan cluster recorded the highest proportion of farmers who had savings to those without, while Alanib had the lowest. Farmers in Tugasan and Kulasihan clusters tended to save money through self-keeping while farmers from Alanib cluster usually kept savings in banks or cooperatives. Moreover, wives were usually the ones managing the household savings.

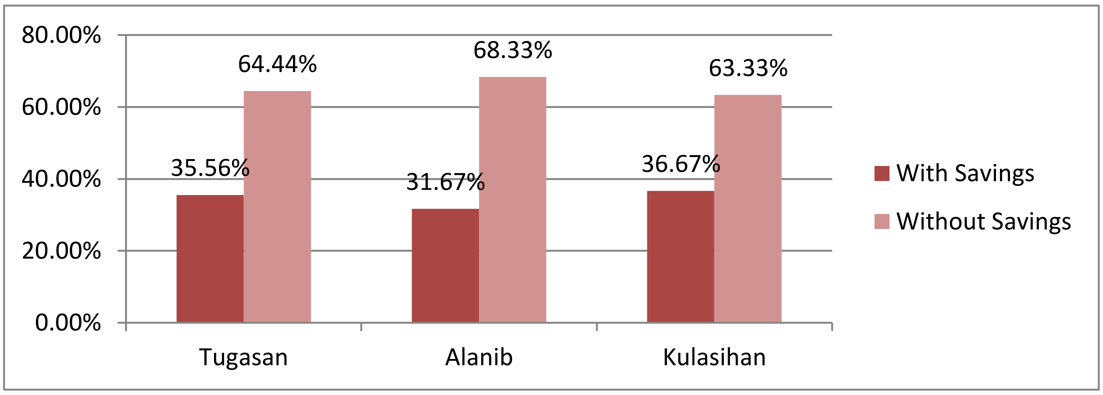


Figure 14. Percentage of households with and without savings

**Land Ownership.** This study theorized that land ownership contributes to adaptive capacity in the form of collateral and other benefits. Moreover, Fitzpatrick and Compton (2016) concluded that insecure land tenure largely contributes to poverty and disaster vulnerability in the Philippines. Some literature also suggest that farmers with secure land tenure were more likely to implement adaptation measures to climate change (e.g. Ozor et al 2010; Antwi-Agyei et al 2015), thereby reducing their vulnerability.

The FGD participants explained that farm ownership helps them recover from disasters. Despite suffering huge financial losses from crop failure, they could either sell or rent out their lands to replenish their capital. Some of them also entered into profit-sharing agreements with financers to re-establish their farms. Tenants, on the other hand, were usually left with few options to continue farming. This prompted most of them to shift to other livelihoods. As shown in Figure 15, almost all of the smallholder farmers in the clusters owned their farms. The highest proportion of farmers with tenurial instruments was recorded in Tugasan, while the least was in Kulasihan. Majority of them inherited these lands while some purchased them from other villagers.

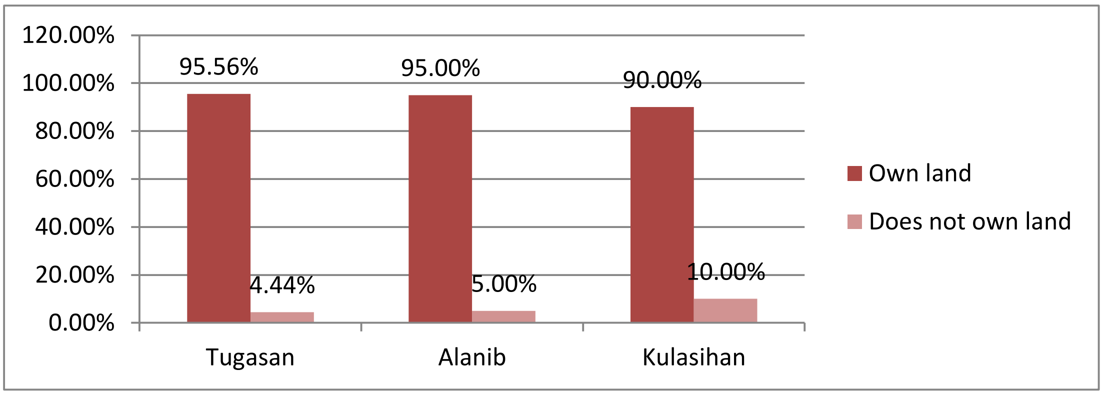


Figure 15. Percenatge of households who own land for farming

**Access to credit.** It has been hypothesized that access to credit lessens the vulnerability of farming households. As highlighted by the FGD participants, access to credit enables them to recover from disasters and extreme events. For instance, they usually availed of loans after shocks to buy farm inputs and adopt new farming strategies (e.g. contour farming, diversifying crops). This is consistent with the results of the study of Villanueva (2014), and it indicates that institutional credit has a positive and significant impact on agricultural output in the Philippines. Some studies from other countries also had similar results (e.g. Rima 2014; Ekwere and Edem 2014), while others were not able to establish a direct link between agriculture credit and output (e.g. Sriram 2007; Hussain 2012). A study by Yadav and Sharma (2015) concluded that well-functioning and efficient credit markets promote equitable distribution of resources, thereby alleviating rural households' poverty. Mbakahya and Ndiema (2015) argued that access to credit improves farmers' financial resources and ability to implement adaptation options.

Smallholder farmers in the study site had access to different sources of formal credits (i.e. government, agricultural companies, bank, micro-finance institutions). For the purpose of this study, only those with existing loans were considered to have credit access because this confirms their capacity to satisfy the requirements of credit facilities (e.g. collateral, stable source of income). As indicated in Figure 16, the highest proportion of respondents with access to credit to those without was recorded in the Tugasan cluster while the Kulasihan cluster had the smallest. Farmers in Alanib and Kulasihan usually availed of loans from cooperative intuitions while those from Tugasan tended to borrow money from the bank.

Most of the farmers from the Tugasan and Kulasihan clusters used their loans to buy farm inputs (i.e. seedlings, fertilizer, pesticide) while majority from the Alanib cluster alloted them for daily consumption. Results further show that farmers' wives were usually the ones applying for loans across the clusters. In general, they described the loan processes as easy as most did not require any collateral.

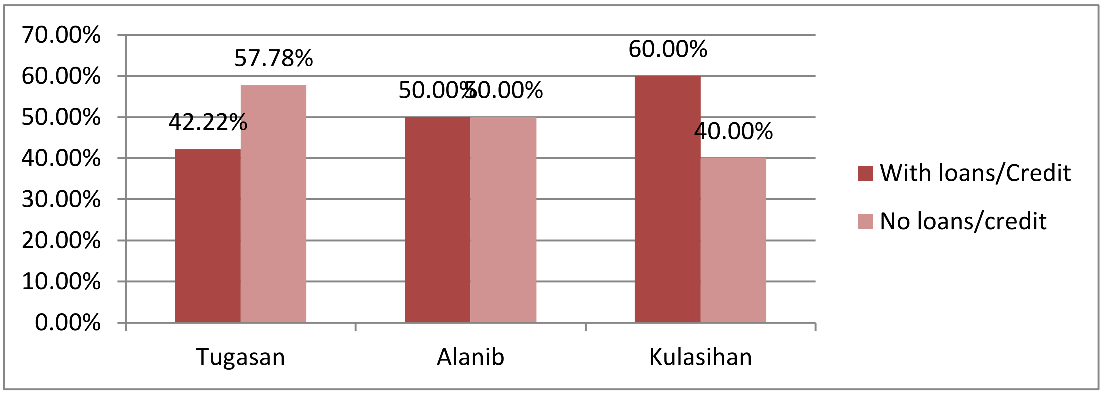


Figure 16. Percentage of households with access to credit

## Social Capital

Membership in organizations. Adger (2001, as mentioned in IPCC 2007) described social capital as the "norms and networks that enable people to act collectively". This is most accurately represented by the farmers' memberships in organizations that stand for their values and needs. In the face of climate-related disasters, these organizations can provide the needed material and emotional support. A study in West and Southern Africa found that membership in community organizations reduced vulnerability to climate change because it promoted greater access to information and opportunities (Steeg et al 2013).

Households in Lantapan have a wide array of formal groups to choose from, but the most common is membership in religious organizations, of which 54.33% of all survey respondents were members. Religion is an essential social element to the residents of Bukidnon, where 77.42% are Roman Catholics (Provincial Government of Bukidnon 2016). On the other hand, even though all respondents are involved in farming, only 29.09% were members of farmer organizations in Lantapan. According to the FDGs most of the existing farmers' groups in the municipality were already inactive.

Results also show that majority of the household members are part of at least one or more organizations, which is to be expected considering the other types of organizations in Lantapan, including women's, IPs, youth and environmental organizations (Figure 17). However in Alanib there are more households without participation in any group.

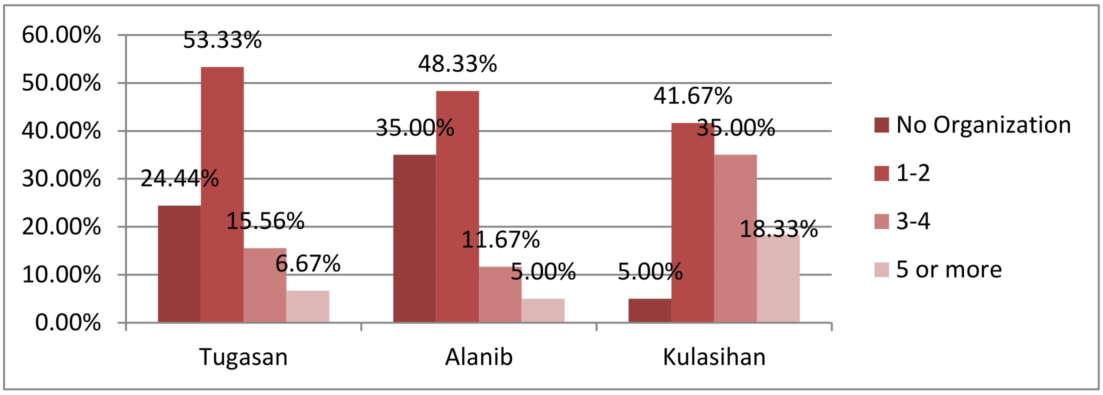


Figure 17. Number of organizations where household members are members in Lantapan, Bukidnon

Sources of information**.** As mentioned earlier, the sources of information a household has access to affects how households react or adapt to the impacts. These are the avenues through which farmers derive pertinent information that could strengthen their ability to adapt to climate change, either directly from training and sources of climate information or indirectly through interactions and knowledge-sharing with other farmers (Defiesta and Rapera 2014).

The surveyed households were asked to recount from where they received climate- or livelihood-related information. As presented in Figure 18, the most common source of information related to their livelihood and climate change was television, accessed by 80% of smallholder households in Lantapan. Second was the barangay or village local government unit (75.15%) and third most common were their neighbors (68.48%). This shows that a mix of mass media and interpersonal sources of pertinent information were available to smallholders. The survey further showed that majority of the households had access to more than one source. Often they relied on a mix of the top three information sources mentioned earlier.

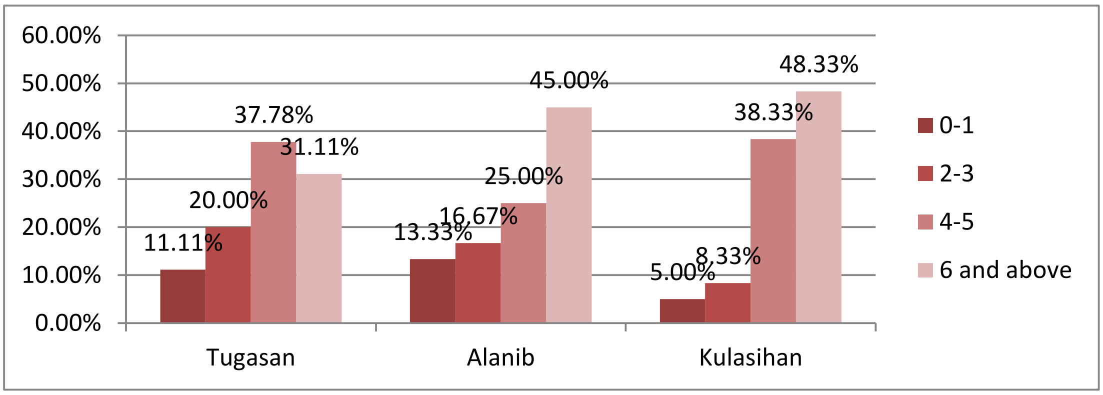


Figure 18. Number of sources of livelihood and climate-related information

**Physical capital**

Physical capital, also called manufactured capital, refers to material goods and infrastructure that contribute to production or service provision, but are not part of its output. This may include buildings, infrastructure, such as transport networks, communications, waste disposal systems and technologies (Forum for the Future *no date*.) In this study of smallholder farmers in Lantapan, physical assets such as the ownership of house, gadgets, transport and electric utilities, as well as farm equipment, were explored.

Physical assets. Assets, such as houses, vehicles or gadgets, are not only utilized for its obvious benefits but can also serve as collateral in times of need, especially during climate-related disasters. Results show that almost all of the households in the three sub-watershed clusters in Lantapan were homeowners, with only a few who were renting (Figure 19).

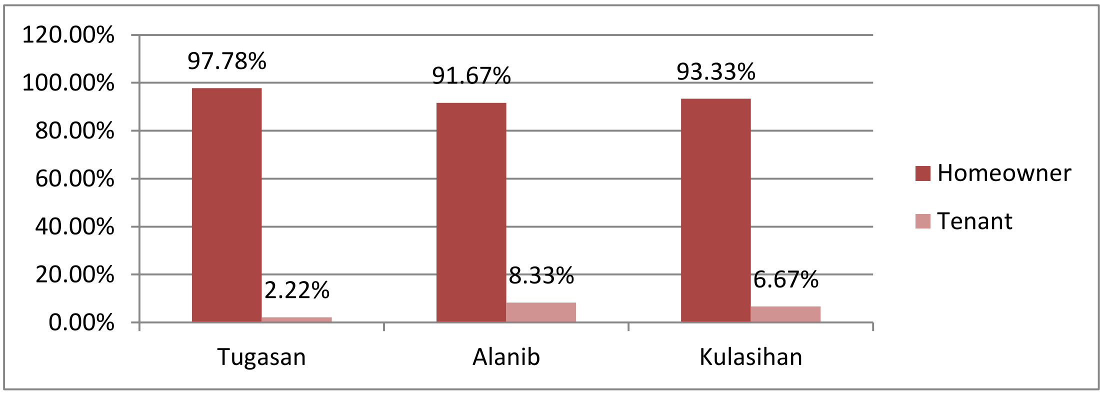


Figure 19. Percentage of farmer respondents who are homeowners or renting

Owning a means of transportation, like cars or motorcycles, may not be a luxury, but a necessity in the far-flung villages that are not easily reached by public transportation. These vehicles are also used to transport farm supplies and harvests to and from the market place. Contrary to expectations, the village clusters farther upstream away from the town center have more households that did not own vehicles (60%) (Table 10), than do the nearer villages. Of those who owned vehicles, majority own a motorcycle which is cheaper to purchase and maintain. Motorcycles for rent are also a means of livelihood for many households in Lantapan because some unpaved roads are not passable to common four-wheeled vehicles.

Table 10. Vehicle ownership of smallholder farmers

| Cluster | None | Motorcycle | Car | Average number of vehicles |
|---|---|---|---|---|
| **Tugasan** | 60.00% | 82.22% | 6.67% | 2.20 |
| **Alanib** | 43.33% | 88.33% | 23.33% | 2.33 |
| **Kulasihan** | 21.67% | 86.67% | 18.33% | 2.17 |

Similar with many areas in the Philippines, ownership of communication devices, such as mobile phones, have become a necessity for almost all the households in Lantapan, regardless of their economic state. Mobile phones are not just used for personal communication but for transacting business as well. Majority of households had at least one mobile phone, and in some cases almost all family members had their own (Table 11). During the FGDs, farmers in Lantapan signified that a strong mobile network signal is a strength in their villages, compared to other areas in Mindanao without cellphone signal. On the other hand, internet access is limited in Lantapan, as well as the ownership of computers or laptops.

Table 11. Ownership communication devices

| Cluster | None | Mobile Phone | Personal Computer/Laptop | Average number of Gadgets |
|---|---|---|---|---|
| **Tugasan** | 17.78% | 82.22% | 6.67% | 2.20 |
| **Alanib** | 10.00% | 88.33% | 23.33% | 2.33 |
| **Kulasihan** | 13.33% | 86.67% | 18.33% | 2.17 |

**Ownership of agricultural equipment.** Ownership of farm equipment, such as tractors, threshers or sprayers, enables farmers to use better farming technology, hence enhancing their adaptive capacity (Defiesta and Rapera, 2014). However, many smallholder farming households in Lantapan did not own any farm equipment and relied only on manual labor or equipment borrowed from neighbors. Alanib cluster had the most number of households without any farming equipment (53.33%), while Tugasan had 42.22% and Kulasihan the least at 41.67%. While majority mentioned they had farm equipment, except in Alanib, almost all of these were sprayers which are quite common and easy to purchase (Figure 20). Only nine out of the 165 respondents owned a tractor, and only two have threshers.

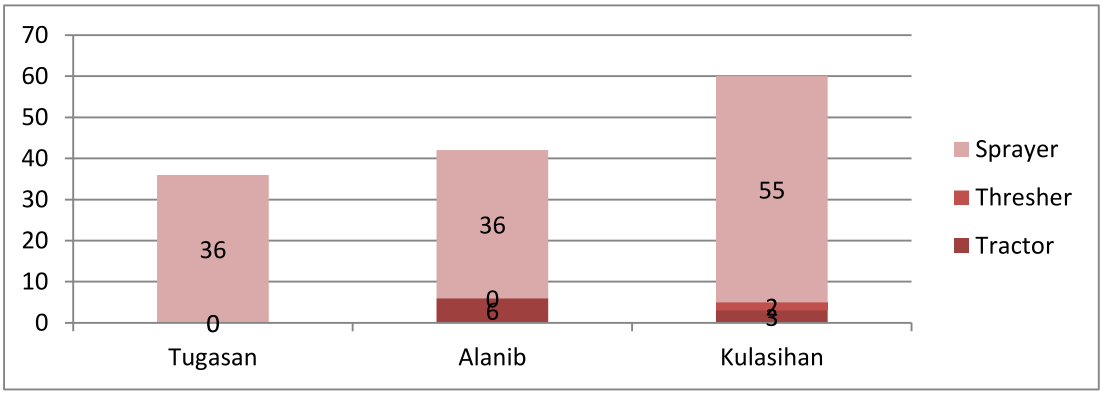


Figure 20. Number and type of agricultural equipment owned by smallholder farmers in Lantapan

***Present adaptation strategies.*** The local knowledge derived through the CaSAVA framework provided inputs as to how the smallholder farmers of Lantapan cope with the impacts of climate-related shocks and hazards. Through FGDs, residents from Lantapan identified their adaptation strategies practiced at the household and community levels and rated them according to their perceived level of success of each strategy. This study makes a distinction between the responses to the hazards themselves, as mentioned in the exposure sections, and the responses to the consequences of these hazards, including crop failure, damage to farm and properties, financial loss and food insecurity, among others. Table 12 lists the responses to climate-related hazards and its consequences, as well as the corresponding average success level from 100 to zero. It should be noted that none of the responses to hazards received a success rating lower than 50%, meaning the FGD participants considered their adaptation strategies to be effective.

Table 12. Responses to hazards and its corresponding success rating at the household level

| Response | Tugasan | | Alanib | | Kulasihan | |
|---|---|---|---|---|---|---|
| | Hazard | Success rate (%) | Hazard | Success rate (%) | Hazard | Success rate (%) |
| Alternative source of water | Drought | 100 | | | Typhoons | 50 |
| Planting sunflower | Typhoonss | 100 | | | | |
| Planting trees | Heavy rainfall | 100 | | | | |
| Using wooden stakes and twine as windbreak | Typhoonss | 100 | | | | |
| Canal/drainage construction | Heavy rainfall | 100 | | | | |
| Frequent watering of plants | Drought | 75 | | | | |
| Change the type of crop | Pests and diseases | 50 | | | | |
| Replanting of crops | Flooding, Typhoons | 50 | | | | |
| Water pump installation | | | Drought | 100 | | |
| Contour farming | | | Flooding, landslide | 50 | | |
| Longer hose to water the crops | | | Drought | 50 | | |
| Multiple cropping | | | Pests and diseases | 50 | | |
| Using pesticides | | | Pests and diseases | 50 | | |
| Smoking | | | Pests and diseases | 50 | | |

| | | | | |
|---|---|---|---|---|
| Using pesticides | | | Pests and diseases | 100 |
| Avail loans | | | Typhoons | 50 |
| Alternative livelihood | | | Typhoons | 50 |
| Total number of responses: | 8 | 6 | | 3 |

***Tugasan cluster.*** The Tugasan cluster had the most number of adaptation strategies listed, which were done to cope with losses with farm impacts brought about by drought, flooding, heavy rainfall, pests and diseases, landslides and typhoons. Majority of the responses were considered highly successful with 100% rating, including searching for other sources of water during drought such as rivers, planting of sunflower plants for pest control, planting of trees to reduce flooding, using wooden stakes and twine as windbreak, and constructing canals or drainage.

***Alanib cluster.*** This cluster employed the second most number of adaptation strategies, however FGD participants rated majority of the responses as slightly effective at 50% rating. FGD participants considered installing water pumps as the most effective method for addressing drought impacts. Although less effective, farmers in Alanib cluster also did contour farming, using longer hoses to water crops and multiple cropping, using pesticides and smoking as methods of pest control.

***Kulasihan cluster.*** Farmer participants in the Kulasihan cluster identified only adaptation strategies for pest and diseases and for typhoons. Using pesticides for pest and diseases in crops was considered very effective. Since the major impact experienced in the cluster was crop damage due to typhoons, the farmers availed loans to replant. Some farmers looked for alternative sources of livelihood, such as working as farm laborers in other areas or as hired workers in the multi-national companies. These responses to typhoons, however, were considered only slightly effective in countering the negative impacts.

## Assessment of Vulnerability

To ascertain which of the three clusters was the most vulnerable to climate-related shocks, simple ranking based on the above mentioned indicators was done, with one (1) being the most vulnerable. Table 13 summarizes all the components and indicators used, along with their hypothesized relationship to vulnerability. Each indicator could either increase vulnerability (+), or decrease it (-), therefore some categorical parameters were transformed to express its relationship to vulnerability.

The results show that while Kulasihan ranked the highest in terms of number of remarkable climate-related shocks and disasters, all three clusters may be very close in terms of level of exposure, since the number of the most remarkable disasters as well as the number of impacts they recalled do not differ much. All clusters had experienced severe impacts from flooding, landslides and pest and diseases.

In terms of the sensitivity of the farmer's livelihood, which constitutes their present farming conditions and practices, results were similar between the three clusters, where monocropping is the most prevalent practice. However, the human, financial and physical sensitivities show that Tugasan may be more sensitive to climate impacts. Households in this cluster had the highest average number of dependents, lowest incomes and higher dependence on agriculture. Poverty was also prevalent in Tugasan, which had the most number of households without electricity and the most number of houses made of light materials.

While exposure and sensitivity both contribute to increased vulnerability, their adaptive capacity counters this by allowing households to anticipate, respond to and reduce negative impacts. Across the five capitals, the Kulasihan cluster ranked highest in terms of adaptive capacity, except in natural capital where all three clusters tied. All three clusters relied on their natural capital, which represents the natural resources that the households can utilize to cope with disasters. The Tugasan and Alanib clusters were tied with the lowest scores in three of the five capital assets, namely human, social and physical capital assets. However, similar with the sensitivity results, Tugasan was the lowest in terms of financial capital. This is to be noted as some adaptation strategies, especially for farm impacts, are costly. Households in the Tugasan and Alanib clusters identified more coping responses than Kulasihan, which mentioned only three adaptation strategies. Tugasan had the most number of highly successful strategies (success rating of 75% or higher) while both Alanib and Kulasihan only identified one highly successful strategy.

Table 13. Ranking of vulnerability indicators among the three subwatersheds in Lantapan, Bukidnon.

| Component/Indicators (+/- relationship to vulnerability) | Tugasan | | Alanib | | Kulasihan | |
|---|---|---|---|---|---|---|
| | Value | Rank | Value | Rank | Value | Rank |
| **Exposure** | | | | | | |
| Number of most remarkable climate-related shocks (+) | 9 | 3 | 10 | 2 | 11 | 1 |
| Number of identified impacts or consequences of shocks (+) | 21 | 1 | 20 | 2 | 20 | 2 |
| **Sensitivity** | | | | | | |
| Percentage of households that practice mono-cropping (+) (%) | 46.67 | 2 | 45.00 | 3 | 53.33 | 1 |
| Average number of plots cultivated (-) | 1.33 | 2 | 1.32 | 1 | 1.47 | 3 |
| Average number of crop species (-) | 2.2 | 2 | 1.98 | 1 | 2.33 | 3 |
| Average number of trees per household (-) | 142.78 | 1 | 207.5 | 2 | 438.95 | 3 |
| Average number of farm animals owned (-) | 5.07 | 1 | 7.13 | 2 | 11.13 | 3 |
| Percentage of households with sloping farms (+) (%) | 26.66 | 3 | 51.67 | 1 | 43.33 | 2 |
| Percentage of households with >1 dependency ratio (+) (%) | 13.33 | 2 | 11.67 | 3 | 16.67 | 1 |
| Percentage of household without hygienic toilet facilities (only open/closed pits) (+) (%) | 24.44 | 1 | 5 | 3 | 8.33 | 2 |
| Average annual household income (-) (PhP) | 229,006 | 1 | 303,259 | 2 | 351,672 | 3 |
| Average percentage of income from agriculture (+) (%) | 74.58 | 1 | 58.48 | 2 | 54.77 | 3 |
| Percentage of households below poverty line (+) (%) | 46.67 | 1 | 38.33 | 2 | 36.97 | 3 |
| Percentage of households that use light materials for housing (+) (%) | 0 | 2 | 0 | 2 | 3.33 | 1 |
| Percentage of households without access to electricity (+) (%) | 20.0 | 1 | 5 | 3 | 8.3 | 2 |
| **Adaptive Capacity** | | | | | | |
| Average household size(+) | 6.44 | 1 | 4.95 | 2 | 4.48 | 3 |
| Percentage of household heads with no high school education (+) (%) | 44.44 | 2 | 45.00 | 1 | 31.67 | 3 |
| Percentage of households that did not receive any training(+) | 37.78 | 3 | 55.00 | 1 | 41.67 | 2 |
| Average Farm Size (-) (Ha) | 1.41 | 1 | 1.82 | 2 | 2.2 | 3 |
| Average Distance from House to Farm (+) (km) | 1.32 | 3 | 2.46 | 1 | 1.85 | 2 |
| Percentage of households that do not collect forest products (-) (%) | 62.22 | 2 | 63.33 | 3 | 55.93 | 1 |
| Percentage of households with non-agriculture income sources (+) (%) | 28.89 | 1 | 41.67 | 3 | 36.67 | 2 |
| Percentage of households with regular financial support (+) (%) | 13.33 | 1 | 16.67 | 3 | 15.00 | 2 |
| Percentage of households without savings (-) (%) | 64.44 | 2 | 68.33 | 1 | 63.33 | 3 |
| Percentage of households that do not own land (+) (%) | 4.44 | 3 | 5 | 2 | 10.00 | 1 |
| Percentage of households without access to loans/credit (+) (%) | 57.78 | 1 | 50 | 2 | 40.00 | 3 |

| Component/Indicators (+/- relationship to vulnerability) | Tugasan | | Alanib | | Kulasihan | |
|---|---|---|---|---|---|---|
| | Value | Rank | Value | Rank | Value | Rank |
| Average number of organizations of household members (-) | 2.58 | 2 | 2.33 | 1 | 3.53 | 3 |
| Average number of relevant information sources (-) | 4.42 | 1 | 4.53 | 2 | 5.28 | 3 |
| Percentage of households that do not own their home (+) (%) | 2.22 | 3 | 8.83 | 1 | 6.67 | 2 |
| Percentage of households without communication gadgets (+) (%) | 17.78 | 1 | 10 | 3 | 13.33 | 2 |
| Percentage of households without vehicles (+) (%) | 60 | 1 | 43.33 | 2 | 21.67 | 3 |
| Average number of households without agricultural equipment (+) | 42.22 | 2 | 53.33 | 1 | 41.67 | 3 |
| Number of adaptation strategies per cluster (-) | 8 | 3 | 6 | 2 | 3 | 1 |
| Number of efforts with 75% success rate and above (-) | 6 | 2 | 1 | 1 | 1 | 1 |
| AVERAGE RANK (closer to 1 is more vulnerable) | 1.74 | | 1.91 | | 2.24 | |
| COUNT OF 1 | 16 | | 11 | | 8 | |

Taking the components and indicators at equal weights and comparing the vulnerability of smallholder farmers in the three sub-watershed clusters in Lantapan reveals that households in the Tugasan cluster are the most vulnerable with an average rank of 1.74. This is expected as it ranked first in almost half of the indicators (45.71%). On the other hand, the downstream sub-watershed Kulasihan had the lowest vulnerability among the three (2.24). The same trend is observed in the sensitivity and adaptive capacity levels, wherein higher vulnerability is observed in the upstream cluster while vulnerability decreases going down the watershed.

## Summary and Conclusions

This study explored the vulnerability of smallholder farming households in the three sub-watershed clusters in Lantapan Bukidnon to climate- and weather-related shocks. It followed the IPCC framework for vulnerability, using the five capital assets of the sustainable livelihood approach as a guide. The results combined both quantitative and qualitative data to capture the present exposure, sensitivity and adaptive capacity of the households. This study also assessed which of the three sub-watersheds was the more vulnerable, and towards which aspects support could be directed to increase their resilience to climate shocks. The results were further summarized by averaging the relevant parameters and ranking them to come up with exposure, sensitivity and adaptive capacity levels.

Exposure was assessed based on the numbers of remarkable climate-related natural disasters and impacts mentioned by the farmers in the three clusters and revealed that all three clusters had similar levels of exposure. This can be expected because the three clusters, while located in different elevations across the watershed, are geographically close to one another and have similar topography and other conditions.

Sensitivity to climate-related shocks was assessed by looking at the livelihood, financial, human and physical sensitivities of the smallholder farming households in the three sub-watersheds. Many of the variables show that sensitivity increases as one goes further in the uplands, with Tugasan cluster being the worst off among the three. As one goes downstream, the smallholder communities tend to become less sensitive to climate-related disasters. This is commonly the case in rural areas in the Philippines, where upland farming communities are poorer than their lowland counterparts, and development tends to center around easily accessible lowland areas.

Adaptive capacity in this study is measured by looking at the five capital assets of smallholders as well as their present coping strategies to climate-related shocks. While the results show that a certain level of adaptive capacity does exist in the three sub-watersheds, majority of their present responses remain reactive coping responses.

Overall, the descriptive analysis shows that among the three clusters, the smallholder households in the Tugasan sub-watershed were the most vulnerable to climate-related shocks. More than environment or social factors, poverty seems to contribute most to their vulnerability, as they came considerably behind other clusters in terms of financial and physical assets. The farming practices of Tugasan farmers may have also contributed to their vulnerability. For example, practices such as monocropping and not planting trees on their farms make them more susceptible to climate impacts.

Based on these results, interventions to help smallholders become less vulnerable to climate shocks should focus on promoting livelihood activities or farming practices, such as agroforestry, that are more climate-resilient and can provide both financial and environment benefits. It is also evident the poverty alleviation remain an integral part of efforts to decrease vulnerability for rural communities. Upland development should also remain a priority focus among development institutions as such communities remain more vulnerable to extreme events because of their location and inaccessibility.

This method of vulnerability analysis can only qualitatively compare the vulnerability of the three clusters at the time the data was gathered, thus the next step would be to compute for the actual vulnerability index using the same variables and parameters. A regression analysis to quantitatively determine the factors that affect vulnerability among farmers will also help verify the conclusions of this study.

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