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REGULAR RESEARCH ARTICLE

Determinants of the decision to adopt climate change adaptation strategies among smallholder upland farmers in Southeast Asia

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ABSTRACT

This article argues that local adaptive capacity of the smallholder farmers determines their decision to adopt climate change adaptation strategies in the upland farming communities in the Philippines. This argument is based on the research conducted in the selected upland farming communities in the Philippines, Vietnam and Timor-Leste in 2017-2018 using the Local Adaptive Capacity (LAC) framework as the theoretical foundation. The study involved a survey of 637 upland farmers who were selected using simple random sampling; focus group discussion; key informant interviews; and, farm visits. Results revealed that the smallholder farmers across the three countries had low level of adaptive capacity. Binary logistics regression also indicates that leadership ($p=.078$) and innovations ($p=.000$) are the factors that influence farmers to adopt climate change adaptation strategies in the Philippines, while knowledge ($p=0.000$) and community assets ($p=0.000$) as the determinants among the smallholder farmers in Vietnam. In Timor-Leste, the decision to adopt climate change adaptation strategies are community assets ($p=0.001$), knowledge ($p=0.000$), and innovations ($p=0.007$). These results suggest an urgent need of enhancing the local adaptive capacity of smallholder farmers to be able to adapt to the impacts of climate change.

KEYWORDS

Community assets; Determinants; Innovation; Knowledge; Institutions; Impacts.

1. INTRODUCTION

Climate change is a global phenomenon which is characterized by the increase in temperature because of the increasing greenhouse gas emissions brought about by anthropogenic factors, and climate variabilities as well (Lasco et at., 2004). Climate change is a real phenomenon among the rural farm households (Defiesta & Rapera, 2014; Ngilangil et al., 2013) and the upland farming communities (Tolentino & Landicho, 2013). Several literatures point out the vulnerability of the farming sector, particularly the smallholder farmers to climate change impacts in Southeast Asia (Lasco et al., 2011; Evangelista et al., 2015; Landicho et al., 2016; Morton, 2007). Among these impacts include increased use of farm inputs, decline in crop yield, decline in farm income (Landicho et al., 2015; Tolentino & Landicho, 2013), and food insecurity after extreme weather events (Harvey et al., 2018).

With the crucial role of agriculture in the economy and its vulnerability to climate change impacts and other stressors, there is a need to invest in measures that would build and enhance the adaptive capacity and resilience of rural farming communities (Silici et al., 2021; Landicho et al., 2019; Lasco et al., 2011). Akinyi et al. (2021) also highlighted that achievable innovations or combinations of strategies can help significantly reduce poverty among vulnerable groups. Furthermore, Uy et al. (2011) argue that as income and food security are threatened by climate change, households and communities require the skills, assets, and other resources to adapt to changes.

Climate change adaptation refers to the adjustments in natural or human systems in response to actual or expected climatic stimuli or effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Studies have shown varying climate change adaptation strategies employed by agriculture sector such as crop diversification (Akinnagbe & Irohibe, 2014), agroforestry (Landicho et al., 2016; Tolentino & Landicho, 2013), changing cropping calendar (Keil et al., 2007; Shrestha et al., 2018), changing crop varieties (Shrestha, et al., 2018; Landicho et al., 2016; Snidvongs et al., 2003), organic farming (Müller, 2009), and engaging in off-farm and non-farm activities (Landicho et al., 2016).

In most cases, however, smallholder farmers are constrained to adapt to climate change impacts. Morton (2007) highlighted that being located in the tropics, as well as their socioeconomic conditions (Landicho et al., 2016; Evangelista et al., 2015), and policy trends limit their capacity to adapt to climate change impacts. Furthermore, the low and uncertain benefits from climate adaptive practices and technologies (CAPTs); costs; and lack of household resources are the key constraints in the adoption and sustained adoption of CAPTs among the smallholder farmers (FAO, 2020).

These findings and reviews indicate that climate change adaptation strategies vary among farmers. These could be brought about by factors such as socioeconomics, social relationships, knowledge and awareness and institutional support systems. Antwi-Agyei et al. (2021) noted that institutional factors such as credit access and access to extension services determine the farmers' adoption of climate change adaptation strategies. Meanwhile, several authors highlighted that socioeconomic characteristics of the farmers determine the adoption of climate change adaptation strategies (Kabir et al., 2021; Solomon & Edet, 2018; Atube et al., 2021; Centino & Vista, 2018). Nor Diana et al. (2022) argued that socioeconomic characteristics such as income, household members, farm size, land, number of workers, education, and experiences, as well as institutional support such as access to information, support from agencies and social networks, influence the climate change adaptation among the farmers in Southeast Asia.

In essence, farmers adopt climate change adaptation strategies based on their adaptive capacity. Adaptive capacity is 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 cope with the consequences (IPCC, 2007). Developing and enhancing the adaptive capacity of a farmer or a group of farmers require reliable knowledge about the climate change impacts, vulnerability and adaptation strategies, as these play a key role in influencing and gaining support from the policymakers (Marie et al., 2020).

Previous researches measured the local adaptive capacity of smallholder farmers focusing on the smallholders' assets and capitals (Defiesta & Rapera, 2020; Colting-Pulumbarit et al., 2018) and socioeconomic conditions (Mulia et al., 2017), and gender analysis (Kiumbuku et al., 2020). Besides the assets and community capitals, however, there may be some factors that could influence the adoption of climate change adaptation strategies, as well as the level of adaptive capacity of smallholder farmers.

This study explored the assessment of local adaptive capacity of smallholder farmers using a set of variables that center on the internal and external environments and conditions of the smallholder farmers, following the Local Adaptive Capacity (LAC) framework, which was forwarded by Jones et al. (2010) using mixed methods. The LAC puts emphasis on five distinct interrelated characteristics that are conducive to ensuring adaptive capacity, namely: asset base (availability of a diverse range of key livelihoods assets), institutions (existence of an appropriate and evolving institutional environment that allows for access and entitlement to key assets and capitals), knowledge and information (the ability that households and communities have to generate, receive, assess and disseminate knowledge and information in support of appropriate adaptation options), innovation (presence of an enabling environment to foster innovation, experimentation and learning in order to take advantage of new opportunities) and flexible forward-looking decision-making (ability to anticipate, incorporate and respond to changes with regard to governance, structure and future planning). These parameters determine the degree to which a community is resilient and responsive to changes in the external environment.

This article highlights the local adaptive capacity of the smallholder farmers in upland farming communities in the Philippines, Vietnam and Timor Leste, and how the different parameters determine the farmers' decision to adopt climate change adaptation strategies. This paves the way for influencing policy-makers to come up with science-based decisions in building the capacity of upland farming communities.

2. METHODOLOGY

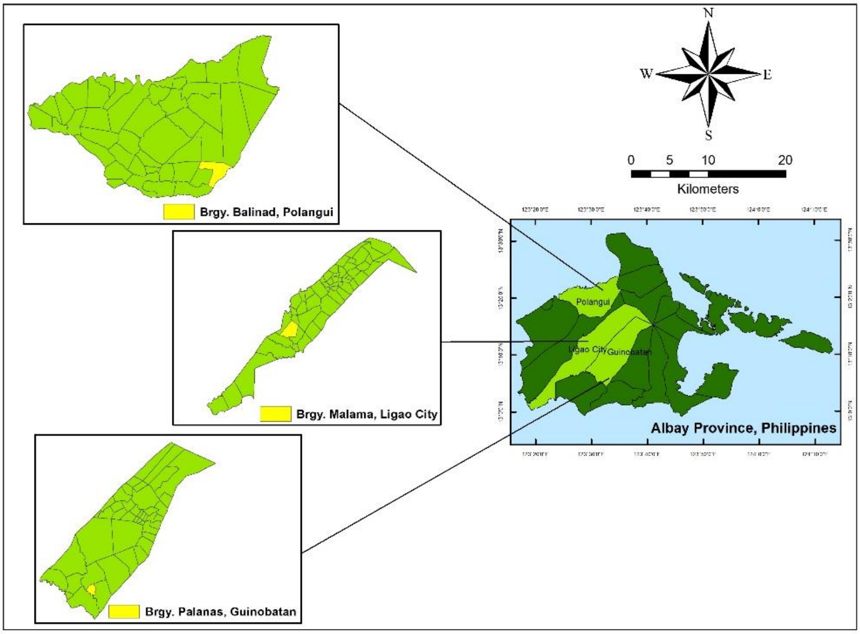

Figure 1. Location map of the study sites in Albay Province, Philippines

The study was conducted in 2017-2018. Three upland farming communities each in the Philippines, Vietnam and Timor Leste were selected as the study sites. These sites were also selected based on the following criteria: a) agriculture or farming is the major livelihood activities; b) vulnerability of the community to climate change; and c) willingness of the communities to become study sites. In some cases, for instance, in the Philippines, the peace and order situation were also considered in site selection. Figure 1 shows the three study sites in the 3rd District of Albay Province in Bicol Region, Philippines. These villages are Barangay Balinad in the municipality of Polangui; Barangay Malama in Ligao City; and Barangay Palanas in the municipality of Guinobatan. Meanwhile, Figure 2 shows that the study centered in the uplands of Quang Tri Province. Quang Tri is one of the biggest upland areas in Central Vietnam (MARD, 2014). This province belongs to Central coastal region which is the contiguous part of the South and North of Vietnam. In Timor-Leste, the municipality of Viqueque served as the study site. Viqueque is the biggest municipality with a total area of 1,873 km2 located in the eastern part of the Timor-Leste (Figure 3).

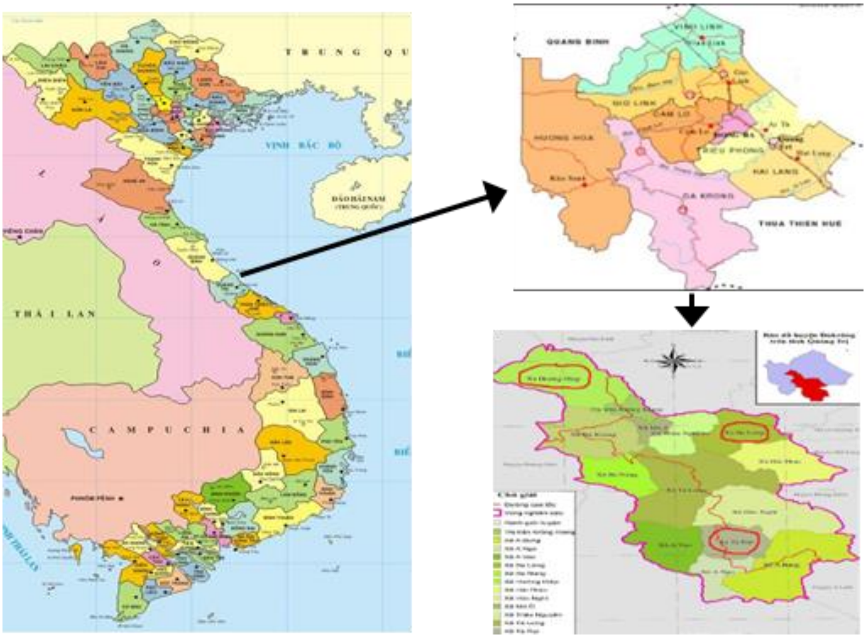

Figure 2. Location map of the study sites in Dakrong, Quang Tri Province, Vietnam

Source: Timor-Leste National Statistics Directorate 2008.

Figure 3. Location map of the study sites Viqueque municipality, Timor-Leste

2.1 Sampling of respondents

The sampling size for each of the three collaborating countries was computed using the following formula that was forwarded by Yamane (1976):

$$n = N / (1 + Ne^2) \qquad (1)$$

where: n = sampling size; N = total number of farmers; e = sampling error (5% for Philippines; 7% for Vietnam and Timor-Leste)

Table 1 shows a sampling size of 637 farmer-respondents across the three countries: 225 in the Philippines, 192 in Vietnam, and 220 in Timor-Leste. The farmer-respondents were selected using a simple random sampling.

Table 1. Number of farmer-respondents in the three collaborating countries

Study sites	Total population	Sampling size
Philippines	282	225
Vietnam	3200	192
Timor-leste	4500	220

2.2 Data gathering

Mixed method was used in data gathering. These include farm household survey, key informant interviews (KII), focus group discussion (FGD), farm visits and secondary data gathering.

- Key informant interviews (KII) were designed to gather initial information from the key persons in the community. These include the key leaders of the village and the Municipal Agriculture Officer. The initial information that was gathered from these people are the classification of the areas (whether lowland or upland areas), the types of farming system that are being practiced in the community, vulnerability of the study sites to climate change, and the types of support that are being extended by the agriculture offices for climate change adaptation.
- Farm Household Survey was administered to the 637 farmer-respondents in the three study sites. Field enumerators per study site were hired to administer the survey. The enumerators were given an orientation about the survey questionnaire before undertaking the survey.
- Focus Group Discussion (FGD) was conducted in each of the three study sites. Among the participants include the village officials, two farmer-representative per hamlet of each village, and two representatives from the local government units. The FGD participants ranged from 15-20 representatives. The FGD sessions served as a venue to present and validate the findings from the farm household survey, and further discuss key and major issues such as the dominant farming systems in the community, the observed impacts of climate change and the adaptation strategies being employed by the farmers; and other technical needs of the farmers for climate change adaptation. Selected farms were visited to validate the data gathered from the survey questionnaire, particularly on the biophysical conditions and the type of farming system being practiced.
- Feedbacking Workshop was also organized to further validate the findings of KII, FGD, household survey and farm visits. This activity was done to present the general findings of the study and validate these findings with the selected farmers of each of the upland farming community, including the Agricultural Technician from the local government units. The agricultural technicians were involved in the workshop to make them aware about the status of the upland farming communities that they assist, particularly the level of local adaptive capacities, which could serve as their basis for planning and implementing technology interventions and technical assistance.

2.3 Formulation of the local adaptive capacity index using Analytical Hierarchy Process (AHP)

This research used the Local Adaptive Capacity (LAC) framework as the theoretical foundation. The LAC framework argues that there are five elements that determine the local adaptive capacity. These include assets such as social, natural, human and financial assets; knowledge and information; institutions; innovations and leadership. The indicators and sub-indicators of each of the five assets were identified by the research team in Table 2.

Table 2. Variables and sub-indicators of the five indicators under the Local Adaptive Capacity framework

Indicators	Sub-indicators	Variables
Community Assets	Social Capital	• Active membership in existing farmers' association • Presence of immediate relatives within the community • Collaboration with external development organizations
	Human Capital	• Number of years that the respondent has been into farming • Household size • Number of family members involved in farming
	Financial Capital	• Number and type of income sources of the household • Number of employed household members • Current value of livestock being raised • Access to credit services • Status of farm ownership • Household income
	Natural Capital	• Number of crop species being cultivated • Source of water for crop irrigation • Number and type of soil and water conservation measures
Knowledge and Information	Access to agriculture and climate change-related information	• Number of time farmer-respondent attended training related to agriculture in the last fie years • Technical assistance from agricultural technicians in the last five years • Sources of information about climate change • Presence of farmer-to-farmer knowledge sharing on climate change
Innovations	Presence of climate change adaptation strategies in the respondents' farm	• Number and type of farmer-initiated climate change adaptation strategies in the last five years • Number and type of agency-initiated climate change adaptation strategies being practiced from 2010-2015 • Effectiveness of the climate change adaptation strategies
Institutions	Informal policies and agreements on upland farming	• Presence of informal policies and laws related to upland farming • Presence of social institutions in the community
Leadership and governance	Formal policies and programs related to climate change adaptation	• Presence of agricultural policies and related to upland farming • Number of programs organized by the local government units for climate change adaptation • Involvement of the farming communities in the design and implementation of climate change adaptation programs

The corresponding weights of each indicator and sub-indicator of local adaptive capacity were calculated following the Analytical Hierarchy Process (AHP). AHP was allow users to assess the relative weight of multiple criteria or multiple options against given criteria in an intuitive manner (Saaty, 1970). The weights and scores are achieved by pairwise comparisons between all options with each other (Kazpercyzyk & Knickel, 2006). The weights of each of the variables and sub-variables were computed using the pairwise comparison variables, computing the criteria weight, and checking on the consistency ratio (Figure 4).

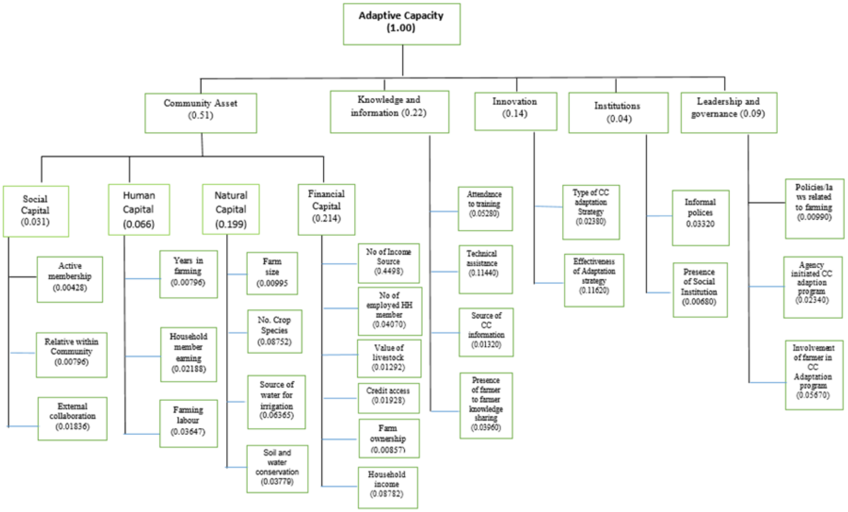

Figure 4. Distribution of points/weights of indicators and sub-of local adaptive capacity using Analytical Hierarchy Process

3. RESULTS AND DISCUSSION

3.1 Socioeconomic and biophysical characteristics of upland farming communities

Table 3 shows that more than half (56%) of the smallholder farmers were male, most (89%) of them were married, with a mean age of 45. The mean household size was five (5). Many (44%) of the smallholder farmers have reached primary education, although almost half of the farmer-respondents in Timor-Leste did not have any formal education. Farming is the major source of household income in the upland farming communities in the Philippines, Vietnam and Timor-Leste (Figure 5). However, some of these households have also engaged in off-farm and non-farm employment as additional sources of income. In farming alone, the farm households in the Philippines and Timor-Leste derived an estimated annual income of $200-399 (Figure 6). On the other hand, the upland farmers in Vietnam derived an annual farm income of $1000, which is much higher than those in the Philippines and Timor-Leste. Combined with other sources of income, however, the estimated annual household income gently increased, but overall, the same income range ($200-399) was observed in the Philippines and Timor-Leste (Figure 7). However, in Vietnam, the total estimated annual household income was recorded at $1952. These findings indicate that the upland farmers in the Philippines and Timor-Leste are small-income earners or smallholder farmers. Their annual household income is below the poverty threshold. For instance, in the Philippines, a family of five (5) should have an average monthly income of Php9064 ($181) (www.psa.gov.ph). In Vietnam, on the other hand, the upland farmers are above their poverty threshold of 700000 VND ($30 per capita/per month). The differences in the farm and overall household income could be attributed to the orientation of their agricultural production activities (whether commercial level or subsistence level), the size of their farms and the type of crops that are being cultivated (whether high value crops or not). The mean farm size across the three countries is 2.16 hectares, with Vietnam having the highest mean size of 2.88 hectares and Timor-Leste with the least size of 1.15 hectares.

Table 3. Socioeconomic characteristics of respondents in the three study sites in Southeast Asia (n= 637)

Demographic Characteristics	Frequency			Total n=637	%
	Philippines n=225	Vietnam n=192	Timor-Leste n=220		
Mean age	47	44.32	44.37	45.00	
Sex					
• Male	108	168	80	356	56
• Female	117	24	140	281	44
Civil status					
• Single	6	2	15	23	4
• Married	204	176	190	570	89
• Separated	3	1	0	4	1
• Widow/er	12	13	15	40	6
Mean household size	5	4	6	5	
Level of education					
No formal education	2	32	101	135	21
Primary education	136	78	64	278	44
Secondary	74	77	45	196	31
College	8	5	10	23	4
Vocational	5	0	0	5	1
Sources of income					
Farming	152	108	103	363	57
Off-farm	3	53	6	62	10
Non-farm employment	2	0	42	44	7
Farming+off-farm	22	9	43	74	12
Farming+non-farm	31	18	22	71	11
Farming+off-farm+non-farm	15	4	4	23	4
Estimated annual household income					
<US$200	57	18	56	131	20
$200-399	72	11	63	146	23
$400-499	45	33	33	111	17
$500-600	32	3	16	51	8
>$600	19	127	52	198	31
Mean farm size (in hectare)	2.04	3.31	1.15	2.16	

Table 4. Biophysical conditions of the farms in the upland farming communities in Southeast Asia

Biophysical Conditions	Frequency (N=637)			TOTAL	%
	Philippines* (n=225)	Vietnam (n=192)	Timor-Leste (n=220)		
Farm topography					
a) Flat	43	43	0	86	13.5
b) Rolling	36	7	82	125	19.6
c) Steep	146	142	138	426	66.9
Source of water and irrigation					
a) Spring	89	8	50	147	23.0

Biophysical Conditions	Frequency (N=637)			TOTAL	%
	Philippines* (n=225)	Vietnam (n=192)	Timor-Leste (n=220)		
b) River	21	0	28	49	7.6
c) Rainfall	225	147	131	503	78.9
d) Irrigation	4	37	11	52	8.1

*multiple response

Table 4 shows that most (66.9%) of the farms in the study sites have steep slopes. This indicates the vulnerability of the farms to soil erosion. The source of irrigation for the crops is mainly rainfall as cited by 78.9% of the respondents across the study sites. This finding also indicates the vulnerability of these farms to climate change, particularly the changing rainfall pattern. A few farmers have other sources of water such as spring (23%), river (7.6%) and irrigation (8.1%). However, the sustained availability of these other water sources also depends on the rainfall, and the management of these resources.

3.2 Agricultural production systems in the upland farming communities

In general, the upland farmers practice crop diversification. Crop diversification offers a number of advantages – ensures multiple harvests; maximizes land use; and, ensures that there is at least one crop that would compensate for the loss of the other crop brought about by natural calamities and infestation, among others. As shown in Figure 5, most (61%) of the upland farmers in the three countries are engaged in agroforestry as the main production system. Agroforestry refers to the combined production of agricultural crops and woody perennials and/or livestock in the same unit of land, for the twin purpose of ecological stability and socio-economic productivity. It is worth noting, however, that almost half (49%) of the farmers in the Philippines were also engaged in multiple cropping. Multiple cropping refers to the growing of two or more agricultural crop species, without the woody perennials, in the same unit of land. Livestock production is also integrated in the farming systems, especially in many of the farms in Timor-Leste.

Short-term to medium-term crops were mostly the agricultural components in the upland farming communities in the three countries. Majority (59%) of the farmers grow root crops across the three countries (Figure 6). Root crops require low to minimum farm inputs, and could withstand drought. Half (54%) of the farmers integrate corn (*Zea mays*) into their farming system. As shown in Figure 9, the growing of corn is prominent in Timor-Leste and the Philippines, which accounts for 60% and 54%, respectively. Corn is a cereal crop that could be the best substitute for rice. Growing of rice (Oryza sativa) may be less preferred by the upland farmers in these countries because of the climatic and capital requirements of the said crop. However, in Vietnam, about 73.4% of the farmer-respondents integrate rice in their farming system. Rice is an important cereal crop that addresses food security in the upland regions in Vietnam. Different species of vegetables are also being grown by 45% and 61% upland farmers in the Philippines and Timor-Leste, respectively, to meet their daily food needs. On the other hand, only a few farmers (7.8%) grow vegetables in Vietnam, because of the lack of irrigation. Instead, bean and soybean are integrated in the farms because of their higher market values, and their ability to improve soil conditions.

In terms of the woody perennials, Figure 6 shows that 85% of the upland farmers in the Philippines preferred fruit trees over forest trees, primarily because of the economic value of the fruit trees. In addition, harvesting and transport of forest trees even in the private farms in the Philippines are governed by certain policies. These policies constrain the farmers from growing these species in their farms. In contrast, forest tree species are more prominent in Timor-Leste and Vietnam, which account for 84% and 61%, respectively. Forest tree species, particularly Acacia (*Acacia auriculiformis*) are generally integrated as part of the reforestation and afforestation programs in Vietnam.

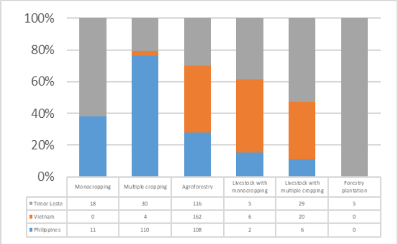

Figure 5. Agricultural production systems employed in the upland farming communities in Southeast Asia: Philippines, Vietnam and Timor-Leste

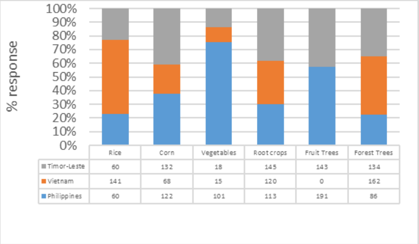

Figure 6. Crop components of the different agricultural production systems in the upland farming communities in Southeast Asia: Philippines, Vietnam and Timor-Leste

3.3 Local adaptive capacity of upland farming communities

Adaptive capacity (AC) is defined as the potential of a society to cope with perturbations and take advantage of new opportunities (McCarthy et al., 2001 in Maldonado & Sanchez, 2014). IPCC (2014) in its Fifth Assessment Report defined adaptive capacity as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, take advantage of opportunities, or to respond to consequences. An array of factors and their combinations determine the adaptive capacity of a system (McCarthy et al., 2001 in Abdul-Razak & Kruse, 2017). The LAC framework, which is the theoretical foundation of this study used five elements as measures of adaptive capacity. These are assets, knowledge and information, institutions, innovations, and leadership.

Assets refer to the social, human, natural and financial capitals of the smallholder farmers. Table 5 shows that, all (100%) smallholder farmers in the study sites had low level of assets, particularly social and human capitals/assets. Social capital refers to the social resources which people draw to carry out their livelihood activities (DFID 2000). It may be developed through network and connectedness, membership to formalized groups, and relationships of trust and exchanges. It could be built from among the community members themselves (bonding capital) or from establishing partnerships with other entities (bridging capital). The low social capital could be attributed to the absence of organized groups such as people's organizations in the study sites. As mentioned earlier, many of these farmer-respondents have reported that there are no existing people's organizations in their communities. The presence of people's organizations offers opportunities for community interaction and cooperation. As argued by Debertin & Goetz (2013), membership to civic organizations is one indicator of social capital. In the Philippines, people's organization serves as a mechanism to promote interaction, cooperation and mutual help among the community members, particularly in the establishment of agroforestry and soil and water conservation measures.

Human capital refers to the knowledge, skills and attitude of people (Coff, 2002) to enable them undertake livelihood strategies (DFID, 2000)). As discussed earlier, only few farmers in the three study sites have access to agriculture-related and climate change–related information. Only a few had attended training and seminars that revolved around agriculture and climate change. As argued by Crook et al. (2011), the quality of manpower is critical in agricultural production and farm development. Meanwhile, natural capital refers to the natural resource stocks (DFID, 2000,), where livelihoods are derived, and which provides ecological services such as nutrient cycling, soil erosion control, among others This study used farm topography, water source for crop irrigation, farm size, number of crops cultivated, and soil and water conservation measures as the indicators of natural capital. Table 5 shows that smallholder farmers in the Philippines and Timor-Leste had low levels of natural capital, while most (78%) of the farmers in Vietnam had moderate level. This could be because the landholdings of the upland farmers in Vietnam are higher than those in the Philippines and Timor-Leste. On the average, an upland farmer in Vietnam has a landholding of five (5) hectares, while those in the Philippines and Timor-Leste had only a mean farm size of 2.01 and 1.50 hectares, respectively. Farmers with bigger landholdings could optimize their crop production. Recent studies revealed that increasing agricultural productivity is influenced by the increasing farm size (Wang et al., 2015). In addition, previous discussions also indicate that farmers in Vietnam tend to plant more high value crops as compared to the two countries, and they have varied sources of water for irrigation, as compared to the upland farmers in the Philippines and Timor-Leste whose main source of water for irrigation is rainfall. In general, climate variability and extreme events have also direct effects on the natural capitals of the upland farming communities (Brown, 2018; Staudinger et al., 2012).

Table 5. Level of local adaptive capacity of farmer-respondents in the upland farming communities in Southeast Asia: Philippines, Vietnam and Timor-Leste

Indicators of local adaptive capacity	Percentage (%) of farmer-respondents								
	Philippines (n=225)			Vietnam (n=192)			Timor-leste (n=220)		
	Low	Med	High	Low	Med	High	Low	Med	High
Capitals/Assets									
Social Capital	100%	-	-	100%	-	-	100%	-	-
Human Capital	100%	-	-	100%	-	-	100%	-	-
Natural Capital	100%	-	-	25%	78%	6%	100%	-	-
Financial Capital	100%	-	-	1%	30%	69%	100%	-	-
Knowledge and Information									
Training experience	100%	-	-	100%	-	-	100%	-	-
Technical assistance	19%	81%	-	34%	66%	-	100%	-	-
Sources of information	100%	-	-	100%	-	-	100%	-	-
Knowledge sharing	100%	-	-	100%	-	-	100%	-	-
Innovations									
Farmer-initiated CC adaptation strategies	100%	-	-	100%	-	-	100%	-	-
Observed effectiveness of CC adaptation strategies	65%	35%	-	100%	-	-	100%	-	-
Institutions									
Informal policies	100%	-	-	100%	-	-	100%	-	-
Social institutions	100%	-	-	100%	-	-	100%	-	-
Leadership and governance									
Formal policies related to CC	100%	-	-	100%	-	-	100%	-	-

Indicators of local adaptive capacity	Percentage (%) of farmer-respondents								
	Philippines (n=225)			Vietnam (n=192)			Timor-leste (n=220)		
	Low	Med	High	Low	Med	High	Low	Med	High
adaptation									
CC adaptation programs of LGUs	100%	-	-	100%	-	-	100%	-	-
Consultation of LGUs with upland farmers	100%	-	-	100%	-	-	100%	-	-

Most (77%) of the smallholder farmers in the three study sites had low level of financial capital. In this study, financial capital refers to the sources of household income, estimated annual household income, savings and livestock. It may be noted that most (69%) of the smallholder farmers in Vietnam had high level of financial capital. This could be attributed to the bigger farm sizes and higher annual household income of the upland farmers (Table 3). On the other hand, smallholder farmers in the Philippines and Timor-Leste had a low level of financial capital. This suggests that these farmers had no savings or financial stock. In most cases, the income generated from farming/agriculture is invested and plowed back into the farm inputs, and basic household expenditures, including the education of their children. This view is supported by Odoemenem et al. (2013) who viewed that small-scale farmers invest their savings in agricultural activities which include the purchase of fertilizer, farm labor, and acquiring more lands; and, in non-agriculture aspects such as education, trade expansion, building houses, and purchase of durable assets.

Understanding climate change and climate variability is essential for adopting innovations and taking initiatives for coping mechanisms and climate change adaptation strategies (Dhaka et al., 2010 in Elia, 2017). Thus, farmers' knowledge on climate change issues is one of the indicators of their adaptive capacity. Knowledge and information, in this paper, refers to farmers' training related to climate change, their sources of agriculture and climate change-related information, technical assistance on agricultural production activities, and the presence of knowledge sharing among the farmers in the three upland communities. Results revealed that majority (58%) of the smallholder farmers in the three countries had low level of knowledge and information about climate change. This is corollary to the findings shown in Table 5 that the farmer-respondents in the three countries had very little training experience in agriculture- and climate change-related topics. There were no opportunities for knowledge sharing among the smallholder farmers in the three countries as shown in Table 5. This is explained by the lack of social capital and group activities that would have served as mechanisms for information and knowledge sharing.

Table 5 also shows that the smallholder farmers in the three countries had low level of innovations. Innovation is defined in this study as the initiatives undertaken by the farmers to adapt to climate change impacts, and the effectiveness of these initiatives in addressing climate change impacts on agricultural production, based on farmers' observations. The presence of informal policies and agreements among the community members, and the presence of social institutions within the community (i.e., church, barangay offices, school, etc) are the sub-indicators of institutions. Institutions are important components in climate change adaptation, such that in the absence of any formal policy or regulation from the local authorities, the community members (local communities) could implement initiatives on their own. Table 5 shows that the farmer-respondents across the three countries have low level of institutions. While there are social institutions present in the community (i.e., church, barangay office, primary schools, health centers), these institutions do not have proactive programs that are related to enhancing the farmers' capacity to improve their agricultural production and even address climate change impacts, in particular. The communities do not have verbal or informal policies and agreements that are related to agriculture and natural resources management. Jones et al. (2010) defined leadership as the ability to anticipate, incorporate and respond to changes with regard to governance, structure and future planning. In this study, leadership and forward-looking governance was measured in terms of the presence of formal policies at the local government level, which pertains to agriculture, conservation and climate change. It also includes the climate change adaptation programs that are being initiated at the local governments, and how the farming communities are being involved in the planning and implementation of these programs. Table 5 shows that there is a low level of leadership in the three upland farming communities as reported by almost all (99%) of the farmer-respondents. This is evidenced by the absence or weak formal policies and climate change adaptation policies and programs in these communities.

Given the results of the five indicators of local adaptive capacity, Figure 7 shows that 83.8% of the upland farming communities in the Philippines, Vietnam and Timor-Leste have low levels of adaptive capacity, while 16.2% have moderate levels. From the five indicators of local adaptive capacity, knowledge obtained the highest mean score of 0.318, while institutions had the lowest mean score of 0.056 as also highlighted in Figure 7.

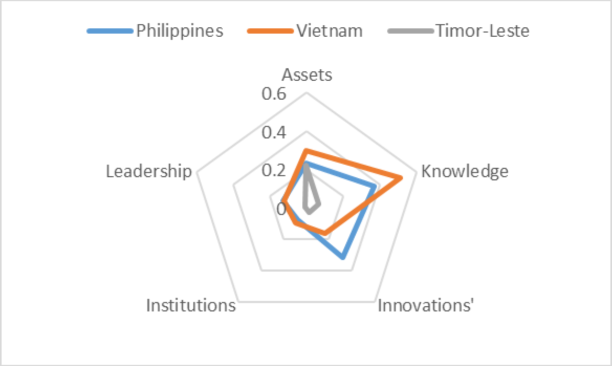

Figure 7. Local adaptive capacity of the smallholder farmers in upland farming communities in Southeast Asia: Philippines, Vietnam and Timor-Leste

3.4 Impacts of climate change on agricultural production activities of upland farmers

The severity of the effects of climate change is manifested in their impacts on the agricultural production activities of the farmer-respondents across the three countries. Figure 8 shows that the farmers in the upland farming communities in the Philippines and Vietnam are aware of the impacts of climate change as cited by 69% and 91% of respondents, respectively. Most of them have likewise observed and experienced climate change impacts on their own agricultural production activities, as noted by 84% of farmer-respondents in the Philippines, and 89% of respondents in Vietnam (Figure 9). In Timor-Leste, on the other hand, most (69%) of the farmer-respondents were not aware of climate change impacts, and neither they have observed nor experienced impacts on their agricultural production activities. Climate change has considerable impacts on the different farm components of the agricultural production systems of upland farmers in the three countries. Specifically, the farmers have noted that the change in the rainfall pattern has also caused change in their cropping season. Primarily because planting of various crops depends on water availability, considering that their agricultural areas are rainfall-dependent. Decline in the water availability was also considered as one of the impacts of climate change, particularly in areas that are experiencing long dry spells, or in areas where the onset of rainy season is delayed. The change in the rainfall and temperature patterns also influence the spread and incidence of crop pests and diseases. These impacts result in a decline in crop growth and ultimately crop yield. As a result, the farmers tend to increase the use of farm inputs to be able to improve crop growth and yield.

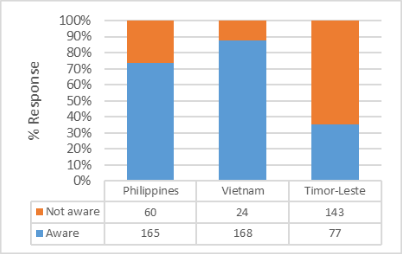

Figure 8. Farmers' awareness about climate change impacts

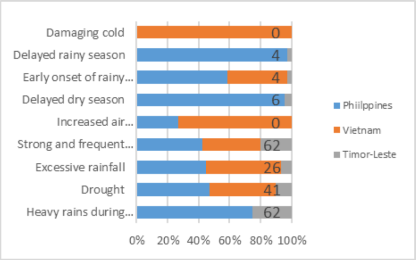

Figure 9. Farmers' observations and experiences of climate change impacts on their agricultural production

3.5 Climate change adaptation strategies employed by the upland farming communities

Figure 10 shows that overall, almost half (49%) of the farmer-respondents in the three countries employ climate change adaptation strategies. More than half (53%) of which represent the Philippines. It may be noted that 51% of the farmer respondents did not employ climate change adaptation strategies, of which 71% is comprised of farmers in Timor-Leste. The low adaptive capacity of the smallholder farmers in the three countries could explain this finding. For instance, the lack of knowledge on climate change and its impacts on agricultural production could be the reasons why most farmers in Timor-Leste were not employing climate change adaptation strategies. As argued by Shahid & Piracha (2016), the lack of awareness is a significant barrier to climate change adaptation in developing countries. In Vietnam, the lack of farmers' initiative and innovations to implement climate change adaptation strategies could explain why roughly 60% smallholder farmers did not adopt climate change adaptations strategies.

Among the climate change adaptation strategies that are being practiced by 49% of the farmer-respondents are: increase in farm inputs (25%); change in cropping pattern (22%); change in cropping combination (11%); crop diversification (11%); use of organic fertilizers (10%); increase the number of manpower (8%); engage in non-farm activities (8%); and use of soil and water conservation measures (5%) as shown in Figure 11. The results suggest that the farmers tend to adopt adaptation strategies that could easily and conveniently be done such as increasing farm inputs. On the other hand, the practice of soil and water conservation measures may be the least preferred because of the labor requirement. Some farmers combined these adaptation strategies. The number of options for climate change adaptation strategies could be a reflection of the level of awareness and information of the farmer-respondents on climate change adaptation. In terms of the observed effectiveness of the climate change adaptation strategies that they employ, 48% of the farmer-respondents across the study sites reported that these were not effective (Figure 12). The basis of assessing the effectiveness is the observed change in the crop yield. Meanwhile, 38% of the farmer-respondents have observed <10% increase in yield of the crops that they produced, while 12% observed a 10-20% increase in crop yield; and about 3% have noticed a 21-40% increase in crop yield.

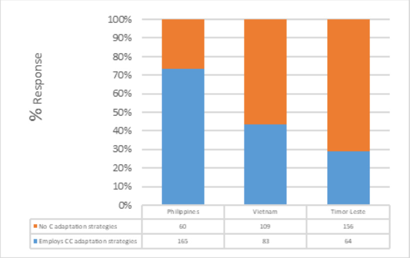

Figure 10. Practice of climate change adaptation strategies in the upland farming communities

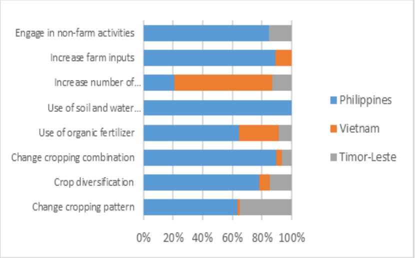

Figure 11. Climate change adaptation strategies employed by the upland farming communities

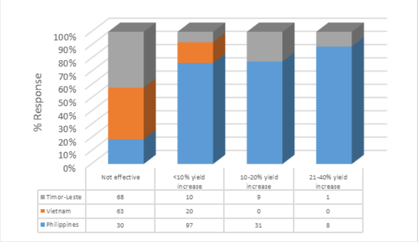

Figure 12. Effectiveness of the climate change adaptation strategies as observed by the farmer-respondents

3.6 Factors that influence farmers' decision to adopt climate change adaptation strategies

As noted in Figure 12, almost half of the farmer-respondents in the three study sites adopt climate change adaptation strategies, while the other half did not adopt or employ climate change adaptation strategies. Results of the binary logistics regression indicate that leadership (.078) and innovations (.000) are the factors that influence the farmers to adopt climate change adaptation strategies in the Philippines at .10 and .05 level of significance, respectively (Table 6). Leadership refers to the climate change adaptation policies and programs being implemented by the local government units. The leadership coefficient indicates that the likelihood of farmers' adoption over non-adoption of climate change adaptation strategies increases as the leadership score increases. This suggests, therefore, that as the local government units implement climate change adaptation policies and programs, then the farmers would have 3.1 times more likely to adopt and employ climate change adaptation strategies. The government and policymakers play an important role in enhancing the climate change adaptation of smallholder farmers (Sani & Chalchisa, 2016; Komba & Muchapondwa, 2012; Lasco et al., 2008) considering that they have the technical expertise, physical resources and financial resources that could be tapped or availed by the smallholder farmers. Innovation refers to the initiative of the farmers to employ and adopt climate change adaptation strategies, and the effectiveness of the particular adaptation strategy. The odds ratio indicates that there are 35.51 times that farmers would adopt climate change adaptation strategies for every unit increase in the innovation score. This suggests that as the practices and technologies become more effective, then the farmers would certainly adopt these to address the impacts of climate change on their agricultural production.

Table 6. Results of binary logistic regression on the factors that influence the farmers' decision to adopt climate change adaptation strategies in the Philippines.

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Leadership	4.989	2.828	3.113	1	.078*	146.786	0.575	37474.443
Institutions	-23.743	16.192	2.150	1	.143	.000	.000	2959.400
Innovations	13.083	2.195	35.518	1	.000**	480591.192	6504.583	35508486.710
Knowledge	-2.011	1.991	1.020	1	.312	.134	.003	6.628
Assets	1.058	4.736	.050	1	.823	2.881	.000	30952.865
Constant	-.795	1.375	.334	1	.563	.452		

Note: Number of observations: 225; Log-likelihood: 186.403; Prob > chi2 = 0.0000 ; Nagelkerke R2 = .395, Cox & Snell R2 .269; prediction percentage correct = 88.4%; sensitivity test = .95; specificity test = 0.68; multicollinearity test

In Vietnam, majority (56.8%) of the farmer-respondents did not employ adaptation strategies to address the impacts of climate change as discussed in Figure 11. Using binary logistics regression, results indicate that knowledge (0.000) and community assets (0.000) are factors that significantly influence farmers' decision to adopt climate change adaptation strategies, at .05 level of significance (Table 7). Specifically, for every unit increase in the farmers' knowledge and information on climate change, there is a 39.68 times chance that they would adopt climate change adaptation strategies. This implies that the higher the level of knowledge and information attained through diverse source of information on agriculture and climate change, as well as the number of contacts with extension services, the higher would be the adoption of climate change adaptation strategies. Similarly, for every unit increase in the community assets of the farmer-respondents, there is 25.35 times chance of adopting climate change adaptation strategies. The farmers with higher financial, human and social capital influence farmers' decision to adopt or not to adopt climate change adaptation. The logistic regression model was statistically significant ($p<0.05$). The model explained 81% of the variance in the farmers' decisions to adopt climate change adaptation strategies, and correctly classified 92% of the decisions.

Table 7. Results of binary logistics regression on the factors that influence the farmers' decision to adopt climate change adaptation strategies in Vietnam.

Explanatory variables	B (coef)	S.E.	Wald	Sig (p-value)
Community asset	51.530	10.234	25.351	0.000*
Knowledge and information	18.173	2.885	39.681	0.000*
Innovations	18.893	11.870	2.534	0.111
Institutions	-17.186	19.978	.740	0.390
Leadership and governance	15.065	60.827	.061	0.804
Constant	-25.406	8.503	8.927	0.003

*-2log likelihood: 84.478; Cox and Snell 2 R:0.605; Nagelkerke R2:0.811; Hosmer and Lemeshow:5.928; % of correct prediction = 92.2%. Note: * represent statistical significant level at p≤0.05*

In Timor-Leste, results indicate that community assets ($p=0.001$), knowledge (0.000) and innovation (0.007) are the factors that determine the farmers' choice of employing climate change adaptation strategies at a 0.05 level of significance (Table 8). Results suggest that for every unit increase in the community assets of the upland farmers, there are 10.49 times that farmers would adopt climate change adaptation strategies. Similarly, as their knowledge and awareness about climate change increases, there are 37.18 times that the farmers would employ climate change adaptation strategies also increases. In addition, for every increase in innovation, there is a likelihood that the upland farmers would decide to adopt climate change adaptation strategies.

Table 8. Results of binary logistic regression on the factors that influence the farmers' decision to adopt climate change adaptation strategies in the Timor-Leste

Explanatory variables	B (coef)	S.E.	Wald	Sig (p-value)
Community Asset	15.519	4.791	10.492	0.001*
Knowledge	58.742	9.633	37.185	0.000*
Innovation	65.356	24.109	7.349	0.007*
Institution	185.259	299.318	.383	0.536
Leadership	-7305.205	5971.528	1.497	0.221
Constant	48.756	47.996	1.032	0.001

-2log likelihood: **179.877**; *Cox and Snell 2 R: 0.***327**; *Nagelkerke R2:* **0.465**; *Hosmer and Lemeshow:* **5.513**; *% of correct prediction = 70.5%. Note: * represent statistical significant level at p≤0.05;*

4. CONCLUSION AND RECOMMENDATIONS

Research findings suggest that the upland farming communities in the Philippines, Vietnam, and Timor-Leste had been experiencing the impacts of climate change on their agricultural production. These include the decline in water availability for crop irrigation, spread and incidence of pests and diseases, decline in crop growth and crop yield, and increased use of farm inputs. Among the climate change adaptation strategies that were employed include: change in cropping pattern, change in cropping combination, crop diversification, use of organic fertilizers, increased number of manpower, engagement in non-farm activities, and use of soil and water conservation measures. Results further revealed that majority of the farmer-respondents had low levels of local adaptive capacity. This article also concludes that local adaptive capacity specifically assets (natural, social, human, and physical capitals), knowledge and information, innovations, and leadership are significant factors that determine the decision of the smallholder farmers in upland farming communities in employing climate change adaptation strategies.

Research results suggest that climate change is real and its impacts are being experienced by the upland farming communities in Southeast Asia. Therefore, there is an urgent need of enhancing the local adaptive capacity of these upland farming communities, particularly in the Philippines, Vietnam, and Timor-Leste to be able to adapt to the impacts of climate change.

The adoption of climate change adaptation strategies is influenced by the local adaptive capacity of the farmers, particularly their assets, knowledge, institutions, innovations and leadership. Research results suggest a weak level of assets, institutions, innovations, and leadership in the three countries. Therefore, these elements should be enhanced. The assets or capitals of the upland farming communities should be strengthened as these are the basic foundation for building their resiliency. For instance, human capital can be enhanced by training the younger generation about agriculture and conservation farming. Social capital can be strengthened by organizing community activities that would harness the active participation and involvement of the community members. The formation of people's organizations is also one way of building social capital. In addition, most of the development efforts now are coursed through the associations, and therefore, this offers opportunities for the upland farming communities to tap financial and technical support from these development organizations. Similarly, the local communities should also invest in their bridging capital by strengthening their linkages with external organizations. Again, this could be initiated by the farmers' associations or people's organizations within the communities. Financial capital can be enhanced, particularly in the Philippines and Timor-Leste, by gradually re-orienting the smallholder farmers to a market-oriented agricultural production, capitalizing on the farmers' associations as the conduit of products from the communities to the market. In addition, non-farm-based livelihood activities could also be explored by the local communities to expand household income sources. Non-farm-based livelihood activities are options when agricultural production is highly affected by natural calamities such as climate change. Natural capital can be enhanced by sustaining crop diversification and the use of soil and water conservation measures. Organic farming could also be explored to help restore soil fertility while getting away with the costly chemical-based farm inputs.

The farmers' ability and initiative to employ climate change adaptation strategies should also be coupled with technical assistance and advice from the technical experts from the local development organizations. Hence, periodic monitoring of the upland farmers could be done by assisting local development organizations to ensure that the climate change adaptation strategies are appropriate to the existing biophysical and socioeconomic conditions of the upland farming communities. The farmers' knowledge and experts' advice, when combined, could produce more effective and appropriate climate change adaptation options.

Lastly, local governments and development organizations should institutionalize local policies and programs aimed at enhancing the adaptive capacity of smallholder upland farmers. These climate change adaptation programs should be appropriate to the existing socioeconomic and biophysical conditions of the upland farming communities, and should be implemented in a holistic manner and systems approach to ensure sustainability.

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