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Field-Level Evidences of Climate Change and Coping Strategies of Smallholder Farmers in Molawin-Dampalit Sub-Watershed, Makiling Forest Reserve, Philippines

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ABSTRACT

This article confirms that climate change is indeed a real phenomenon as observed and experienced by smallholder farmers in the Molawin-Dampalit Sub-Watershed. Using semi-structured interviews and focus group discussions, the smallholder farmers articulated their own indications of climate change. These include increasing temperature, stronger and more frequent typhoons, excessive rainfall, drought, early rainy season, and delayed dry season. Among the effects of climate change on their agricultural production include stunted growth of crops, aborted fruiting of trees, incidence of pests and diseases, and growth of unknown weeds. These have led to increase in the use and dosage of farm inputs, particularly pesticides and fertilizers; decline in crop yield; and ultimately, decline in farm income. To cope with these impacts, the farmers employed strategies such as replanting, use of chemical pesticides and fertilizers to control pests and improve crop growth, pruning, watering and diversion of water source, changing crops, and harvesting their crops earlier to minimize crop loss. Considering the vulnerability of smallholder farmers, the results suggest the need to enhance their adaptive capacities for climate change impacts using a holistic approach via human capital development, improvement of physical capital, and building their social capital.

Keywords: adaptive capacities, smallholder farmers, climate change impacts, Molawin-Dampalit Sub-Watershed
JEL Classification: Q12, Q15, Q54

INTRODUCTION

Climate change is defined as a statistically significant variation that persists over longer time scales, typically decades or longer (Pittock 2011; IPCC 2007). It includes shifts in the frequency and magnitude of sporadic weather events as well as slow continuous rise in global mean surface temperature. Climate change has become a serious global problem as evidenced by the erratic change in temperature and rainfall patterns around the world. These changes have been causing a number of impacts on all sectors of society, particularly the stronger and frequent typhoons which cause sea-level rise, storm surges, heavy floodings and landslides, long drought, decline in agricultural production, and health risks, among others. This environmental issue has become a global concern because of the magnitude and scale of its impacts, and the fact, that most scientists say, it is anthropogenic (man-made) in nature.

According to the 2007 United Nations Framework Convention on Climate Change, the rising fossil fuel burning and land use changes have emitted, and are continuing to emit, increasing quantities of greenhouse gases into the Earth's atmosphere. These greenhouse gases include carbon dioxide (CO_2), methane (CH_4), and nitrogen dioxide (NO_2); a rise in these gases has caused a rise in the amount of heat from the sun withheld in the Earth's atmosphere, heat that would normally be radiated back into space. This increase in heat has led to the greenhouse effect, resulting in climate change.

Climate change poses two distinct sets of challenges for poor rural households: challenges related to the increasing frequency and severity of weather shocks and challenges related to long-term shifts in temperature, rainfall patterns, water availability, and other environmental factors (Baez, Kronick, and Mason 2013). The IPCC Report (2001) highlights that "yields of some crops in tropical agricultural areas decrease with even minimal increase in temperature because they are near their maximum temperature tolerance. Where there is also a large decrease in rainfall in subtropical and tropical dryland/rainfed systems, crop yields would even be more adversely affected." (p. 12)

According to Mertz et al. (2009), while greenhouse gas emissions associated with the use of fossil fuels mainly comes from rich industrialized and post-industrial countries, the impacts of climate change will be more severe in poor developing countries. This is because the physical impacts are expected to be relatively large in developing country regions, where increases in the already high temperatures are likely to lead to large evaporation losses. In many developing countries, precipitation is not likely to increase as is expected in many high-latitude regions (Christensen et al. 2007).

The high number of poor people in developing countries is generally more vulnerable and likely to feel the negative effects of climate change (Yobe and Tol 2002) since their economic and technological capacity to adapt to climatic change is also very limited. Moreover, the economy of many poor developing countries relies heavily on agriculture which is mostly a vulnerable sector because of its dependence on water and temperature conditions. Most of the climate change models predict that the small farmers particularly those engaged in rainfed agriculture would bear the negative impacts of climate change (Altieri and Koohafkan 2008). This is because rainfed agriculture is largely dependent on rainfall, and therefore, any disruption in the rainfall pattern would surely influence the agricultural production activities of the smallholder farmers. Conway (1997) asserts that about 370 million of the poorest in the world live in resource-poor, risk-prone, and highly heterogeneous areas. These rural poor mostly live in marginal areas which make them more vulnerable to the negative impacts of climate variability.

Climate change experts/scientists predict that agriculture and food security in Asia would be highly vulnerable to the impacts of climate change. Specifically, there would be crop yield decline which may put many millions of people at risk from hunger; reduction in the soil moisture, and increase in evapo-transpiration which may increase land degradation and desertification. The expansion of agricultural productivity in northern areas is also expected (UNFCC 2007).

As one of the developing countries in Southeast Asia, the Philippines is highly vulnerable to climate change impacts considering its geographical features, low level of economic development, and exposure characterized by poor access to resources. More importantly, agriculture is the livelihood of the majority of the populace in the Philippines. Generally, the agriculture or farming sector is comprised of smallholder farmers, farmers whose primary source of income is subsistence farming (AFMA 1997) and who cultivate agricultural lands that are not over five hectares (Landbank of the Philippines, n.d.).

According to Raquedan (2010), the Philippines was the "world's top climate victim" in terms of damage caused by extreme weather events, and is among the top 10 countries in the "climate risk index" for the years 1998 to 2007 on the basis of average damage from such events. El Niño tends to affect agriculture in the Philippines through drought, while La Niña tends to produce greater rainfall and increased flooding.

The two strongest El Niño events in the past century occurred in 1982–1983 and 1997–1998 and both events affected agricultural production, with substantial declines in the production of four main crops: rice, corn, coconut, and sugarcane (Amadore 2005). Most recently, the El Niño of 2009–2010 produced substantial declines in farm production in the first quarter (2.8%) and second quarter (3.5%), evidently as a result of drought (Felix 2010 as cited by Lang 2011).

Rao, Verchot, and Laarman (2007) stressed that the major processes of agriculture that are directly influenced by climate change are soil; water; carbon and nitrogen cycles; crop growth and development; and incidence of weeds, pests, and diseases. These effects are manifested in terms of increased heat stress, increased evapo-transpiration, shortened seasons, and increased photosynthesis.

There have been some macro-level projections and technical recommendations from experts to the agriculture sector about mitigation and adaptation strategies to the impacts of climate change as contained in the IPCC Report in 2007. A more important concern now is to assess whether climate change is indeed real at the field level; document evidences and indications of climate change, including the observable effects of climate change in smallholder farmers' agricultural production activities; and find out how they respond and initiate actions to cope with the impacts of climate change.

This paper highlights the study conducted in the Molawin-Dampalit Sub-Watershed, a part of the Makiling Forest Reserve in Los Baños, Laguna, Philippines, which sought to characterize the socioeconomic conditions of the smallholder farmers; determine their awareness about climate change; identify their own indications and evidences of climate change based on their observations; describe the impacts or effects of climate change in their agricultural production system; and, identify the strategies that they employ to cope with and/or adapt to these impacts.

METHODOLOGY

Six barangays within the Molawin-Dampalit Sub-Watershed were selected as the study sites. These barangays represent the watershed continuum and are engaged mainly in rainfed agriculture. These include Barangays Lalakay and Timugan, which represent the upland ecosystem; Barangays Putho-Tuntungin, Anos, and Batong Malake, representing the lowland ecosystem; and Barangay Tadlac as the coastal ecosystem, which serves as the catchment area of the whole sub-watershed (Figure 1). From the list of farmers in each of the six barangays, the farmer-respondents were sampled using Slovin's formula:

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

where n = number of samples, N = total population, and e = error tolerance.

A total of 107 farmers served as the respondents for the key informant interviews as shown in Table 1. The team developed a 26-page questionnaire which revolves around socio-demographic information, farm characterization (from production to marketing), assessment of climate change evidences and impacts, coping mechanisms of farmers to climate change impacts, and the perceived role of trees in climate change adaptation.

A focus group discussion (FGD) was also organized to further discuss the key issues on climate change evidences and impacts, and the role of trees in climate change adaptation. The FGD was participated by farmers from the six barangays and representatives from the Municipal Agriculture Office. Descriptive statistics was used to analyze the information generated from this study.

Figure 1. The study sites in the Molawin-Dampalit Sub-Watershed

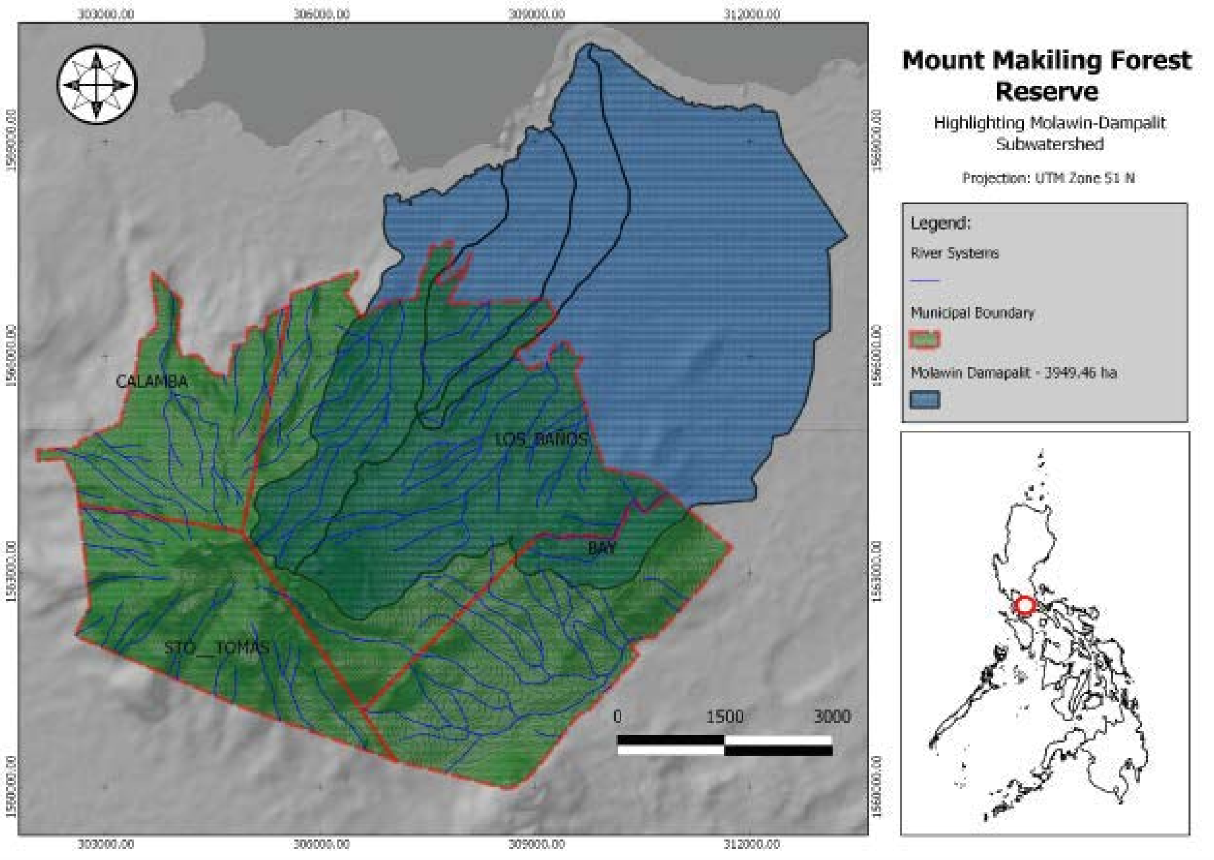


Table 1. Distribution of farmer-respondents in the study sites

Ecosystem	Barangay	Respondents
Upland	Timugan	28
	Lalakay	27
Lowland	Putho-Tuntungin	11
	Anos	13
	Tadlac	17
	Batong Malake	11
	Total	107

RESULTS AND DISCUSSION

Socioeconomic Profile of Smallholder Farmers

The smallholder farmers in this study are generally old (51–60 years old), only 6 percent belong to the 30–45 year old age range. This implies, therefore, the need to train or develop a younger generation of farmers within the farming household to ensure the sustainability of their agricultural production activities. Most (60%) of them are male, validating other related studies which indicate that farming activities are the domain of the male group. Some (40%) females are involved in farming. However, more women are involved in farm development in Barangay Timugan, maybe because the farms in this barangay are devoted to tropical plants, which can be planted even within the backyard. Thus, it is more convenient for the wife to perform both domestic and farm activities because of the farm's accessibility. Most (86%) of the farmer-respondents are married whose household size ranges from 4–6 members (45%).

Generally, the farmers within the Molawin-Dampalit Sub-Watershed are smallholder farmers. Table 2 shows that most (54%) of the farmers cultivate farms ranging from 1–3 hectares, which are mostly rainfed (74%). Their agricultural lands are classified as public lands (75%), being part of the Makiling Forest Reserve (MFR), particularly Barangays Lalakay, Timugan, and Tuntungin. As such, more than half (57%) of the farmer-respondents farm on land not covered by any tenurial instrument. They are merely considered as settlers whose ancestral families are within the MFR adopting appropriate farming activities. Meanwhile, the farmer-respondents from the lowland barangays cultivate private farms, but they are classified as tenants (22%).

Agricultural Production Systems

Most of the farmer-respondents employ multiple cropping (54%) and agroforestry (35%) as their agricultural production systems (Figure 2). Multiple cropping is basically intercropping, which involves the cultivation of two or more agricultural crops, while agroforestry is a land use system that combines two or more agricultural crops and woody perennials. Agroforestry is commonly practiced in the upland barangays, while multiple cropping is prominent in the lowland barangays. The relatively small farm sizes necessitate maximizing land use to increase crop production and farm income.

It was noted that the farmer-respondents in the lowland barangays (e.g., Tuntungin, Anos, and Tadlac) were mostly cultivating annual agricultural crops, particularly cereals (rice, corn), rootcrops, and vegetables (Figure 3). Because the flat and open areas in these barangays are very favorable to the cultivation of agricultural crops. While agricultural crops are considered as their major crops, the farmer-respondents from these barangays also plant fruit trees along their farm boundaries. It is also interesting to note that while Barangay Tadlac is a coastal community, there were also respondents who were engaged in production of rice and rootcrops. Meanwhile, the farmer-respondents in the upland barangays of Timugan and Lalakay were mostly cultivating perennial

Table 2. Socioeconomic characteristics of the smallholder farmers in Molawin-Dampalit Sub-Watershed

Socioeconomic Characteristics	Frequency (N=107)	Percentage (%)
Age		
<30	6	6
30–35	8	7
36–40	6	6
41–50	23	22
51–60	31	30
>60	30	29
Sex		
Male	60	58
Female	44	42
Civil status		
Single	4	4
Married	91	88
Separated/Widow (er)	9	9
Household size		
1–3	33	32
4–6	47	45
7–10	21	20
>10	3	3
Land area (in hectare)		
<1	38	36
1–3	56	54
4–6	7	7
No answer	3	3
Type of land		
Public	78	75
Private	23	22
Rented/Leased	1	1
No answer	2	2
Tenurial status		
Informal settler	60	57
Farm owner/cultivator	21	20
Tenant	10	10
Farm owner/non-cultivator	4	4
Leaseholder	2	2
No answer	7	7
Sources of water for irrigation		
Rainfed	77	74
River	7	7
Deep-well	6	6
Irrigation	5	5
Metered/water system	3	3
No answer	4	4

Figure 2. Agricultural production systems being employed by smallholder farmers in Molawin-Dampalit Sub-Watershed

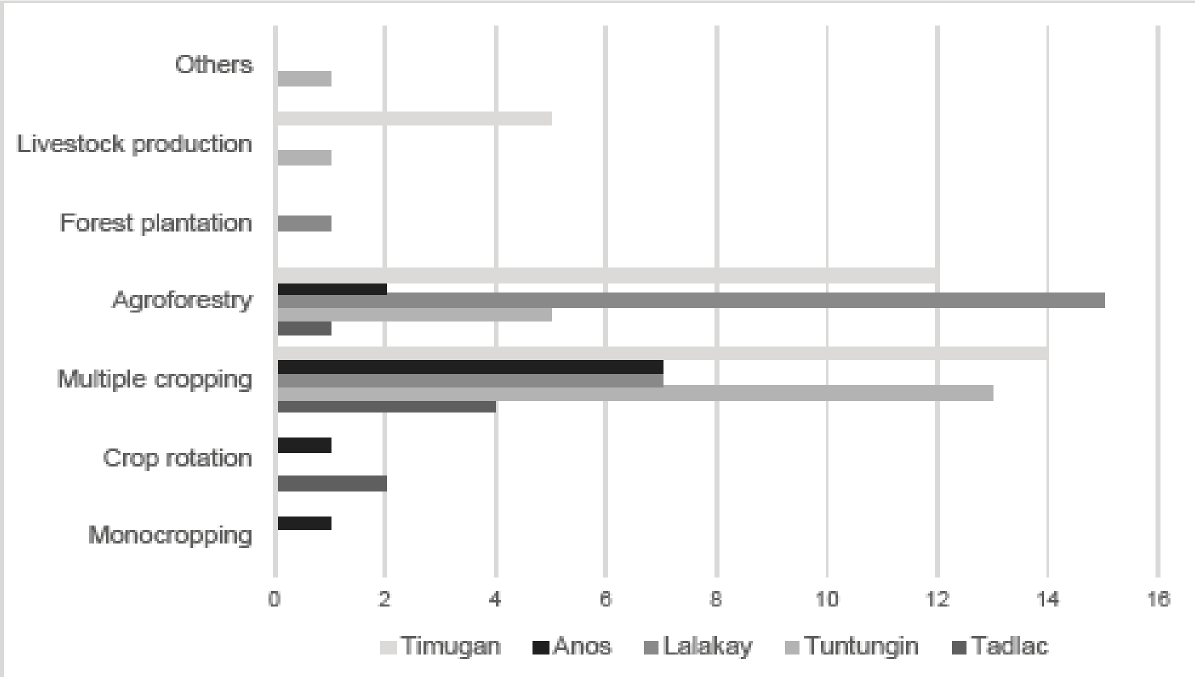
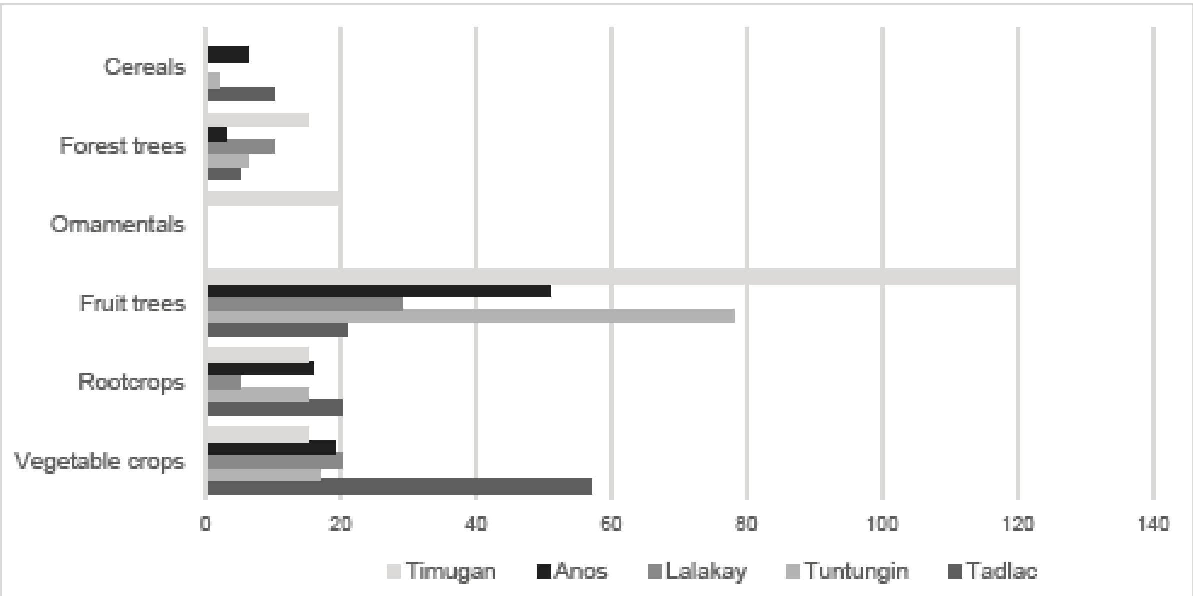


Figure 3. Crop components cultivated by smallholder farmers in Molawin-Dampalit Sub-Watershed



crops such as fruit trees and forest trees, with some rootcrops as understory. These barangays are situated within the MFR, which is mostly forested and covered, and as such, growing of purely agricultural crops would not be favorable/suitable, and is not within the policies being imposed within the MFR. Likewise, the cultivation of ornamentals, particularly tropical plants (e.g., *Heliconia* spp.) is unique in Barangay Timugan.

Evidences and Effects of Climate Change on Agricultural Production

The province of Laguna, where the Molawin-Dampalit Sub-Watershed is located, has a Type I climate. This is characterized by two pronounced seasons, which is dry from November to April, and wet during the rest of the year. The maximum rain period is from June to September. The FGD results suggest, however, that the farmer-participants from the Molawin-Dampalit Sub-watershed have observed that from 2005 to present, climatic conditions have become erratic and very variable. Strong and frequent typhoons and heavy rains have been observed as early as the 1980s continuing until the present. Long dry seasons have also been experienced in the 1990s, particularly in 1997 when El Niño hit major parts of Luzon, including Laguna. From 2005, both lowland and upland barangays have been affected by these climatic changes. Crops that were mostly affected include rice (*Oryza sativa*), corn (*Zea mays*), rambutan (*Nephelium lappaceum*), lanzones (*Lansium domesticum*), banana (*Musa sapientum*), coconut (*Cocos nucifera*), vegetables, and the cutflowers that are being grown by the farmers in Barangay Timugan (Table 3).

The FGD results are supported by key informant interviews, which also showed the awareness of the farmers about climate change based on their own observations and experiences (Figure 4). Among the indicators mentioned by the farmers are increasing temperature (58%), stronger and more frequent typhoons (50%), excessive rainfall (57%), early rainy season (31%), and long dry season or drought (43%). In essence, the farmer-respondents were already aware about the changing rainfall and temperature patterns which, according to them, have become abnormal in the recent years.

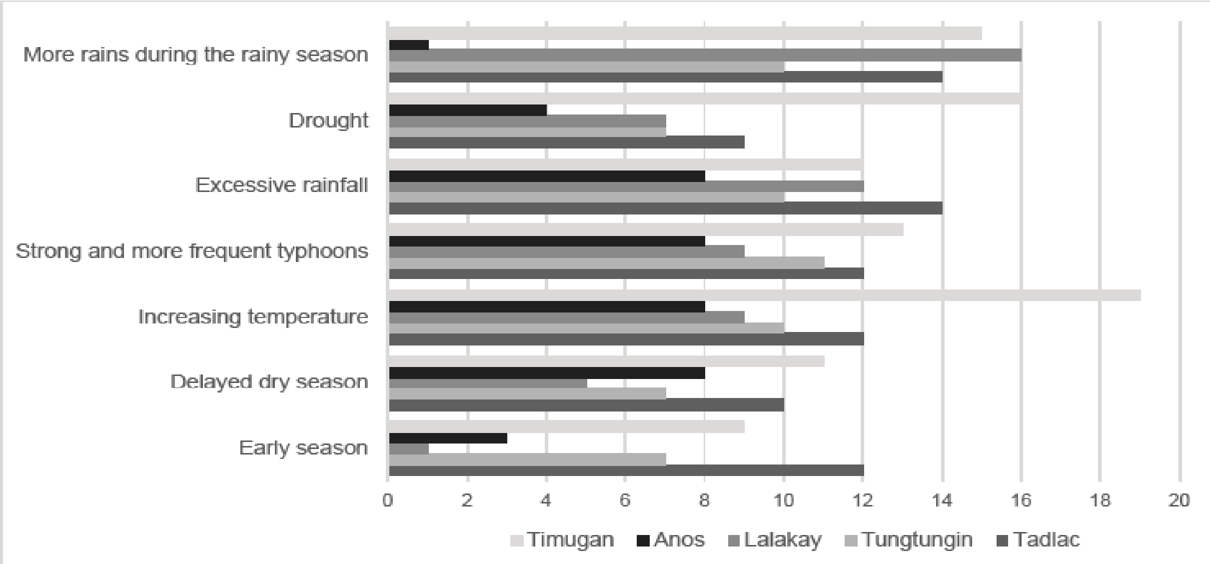
The changing climatic conditions have marked effects on the agricultural production systems of the farmer-respondents within the Molawin-Dampalit Sub-Watershed, primarily because these are rainfed areas which are heavily dependent on rainfall. One of the major impacts of erratic rainfall has been an observed delayed fruiting of rambutan, lanzones, and coconut. These fruit trees used to be the major source of income of the farmers in the upland barangays. Higher incidence of pests and diseases, including the growth of unknown weeds, has been affecting the growth of agricultural/annual crops. This finding validates earlier studies pointing out that as temperatures increase, insect pests generally become more abundant (Rao, Verchot, and Laarman 2007; Kalinda 2011; UNFCC 2007). These problems prompted farmers to increase the dosage of farm inputs such as fertilizers, pesticides, and labor. The increase in farm inputs required additional financial capital, which increased their farm expenditures.

Results of this study are validated by other similar studies that were conducted in tropical and developing countries (Mutekwa 2009; Landicho et al. 2010; Kalinda 2011). Visco et al. (2011) highlighted that the smallholder farmers in the Philippines have been experiencing climate change as evidenced by the changing rainfall and temperature patterns over the years. These climate changes have caused decline in their agricultural production, brought about by the higher incidence of pests and diseases, delayed fruiting of crops, stunted

Table 3. Indications of climate change and their effects on crops as observed by the FGD participants

Period	Climate Change Indications	Crops Affected	Effects on Crops	Coping Strategies
Timugan (Upland)				
1980-1985	Frequent typhoons	Fruit trees, string beans, corn, banana, cutflower, coconut	Damaged crops; decline in crop yield	Pruning of fruit trees
1986-1990	Heavy rains	Pechay, mustard, eggplant, rootcrops, papaya	Aborted growth	Establishment of canals to divert rainwater
1991-1995	Fluctuating and erratic climatic conditions	String beans, eggplant, cutflower, corn	Pest infestation	Replaced stakes with straw as trellis
1996-2000	Long dry season	Coconut, banana, papaya	Decline in corn yield; smaller coconuts; falling cutflower leaves and petals	Changed crops; planted rootcrops
2001-2005	Stronger and frequent typhoons and rains	Fruit trees	Pruning; trees are uprooted	Early or advanced harvesting of fruits
2006-2011	Fluctuating/Erratic climatic conditions	Vegetables (eggplant), fruit trees	Pest infestation; drying up of crops	Frequent watering; application of organic fertilizers
Lalakay (Upland)				
1980s	Strong typhoons	Coconut, corn, banana, rambutan	Decline in fruit yield; smaller fruits	Replanting
1990s	Intense ash fall	Corn	Stunted growth; pest infestation	Applied fertilizer
2005-present	Strong typhoons, landslide	Vegetables, fruit trees	Decline in crop yield	Sought assistance in terms of planting materials; replanting
Putho-Tuntungin (Lowland)				
1980-1985	Strong typhoon (Bebeng)	Rice	Decline in crop yield	Replanting of rice
1990-1995	Strong typhoon (Rosing)	Cassava, papaya	Decline in crop yield	Replanting
1996-2000	El Niño	Palay	Stunted growth; attacked by tungro virus	Chemical spray
2001-2010	Frequent typhoons (Milenyo, Santi, Ondoy, Frank)	Rice, banana, cassava, vegetables	Decline in crop yield	Replanting
Anos (Lowland)				
1990-2000	Temperature is very hot; long dry season	Corn, string beans, cassava, okra, ampalaya, papaya	Stunted growth of vegetables; smaller pods of string beans	Adjusted cropping based on the prevailing climatic conditions; sought assistance from concerned agencies; increase in the frequency of fertilizer application
2006-2011	Heavy rains and typhoons	Rambutan, lanzones	Aborted fruiting; no harvests for rambutan and lanzones; uprooted coconuts; incidence of pests and diseases;	
	Landslide	Coconut		
		Banana		

Figure 4. Farmers' observed indications of climate change in Molawin-Dampalit Sub-Watershed



growth, higher incidence of weeds because of continuous rains, and increase in labor costs (Figure 5). Similarly, Wulandari et al. (2011) mentioned delays in the harvesting of crops, decline in crop yield, decline in the quality of farm produce, and increased incidence of pests and diseases as major impacts of climate change among the smallholder farmers in Lampung District, Indonesia.

These evidences from the ground clearly support the earlier projections and predictions of climate change scientists that agriculture and food security in Asia would be highly vulnerable to the impacts of climate change (UNFCC 2007).

Coping Strategies for Climate Change Impacts

Results of the key informant interviews show that smallholder farmers employ different strategies to cope with the impacts of climate change. These strategies are technical and non-technical in nature. As shown in Table 4, the technical coping strategies are cultural farm management practices that are employed by the farmers in their agricultural production activities. These top five technical strategies include synchronizing the planting of crops with the prevailing season/climate (74%), engaging in livestock and poultry production as additional livelihood activity (71%), planting crops that are adapted to climate change (68%) particularly rootcrops, employing silvicultural techniques for trees (62%), and crop diversification (60%). They perceived that these are the strategies that would bring about immediate results. This is understandable, considering that smallholder farmers depend largely on their crops for subsistence and income, and therefore, they would certainly employ measures that are easiest to apply, most familiar to them, and are cost effective.

Similar studies have shown that rural farmers have been employing agricultural techniques such as crop diversification and agroforestry (Wulandari 2011; Visco 2011; Ashalatha et al. 2012), planting of short-term varieties, soil and water conservation techniques, pruning and fertilization to double tree densities (Mutekwa 2009; INFCC 2007).

Figure 5. Effects of climate change on the agricultural production systems of smallholder farmers in Molawin-Dampalit Sub-Watershed

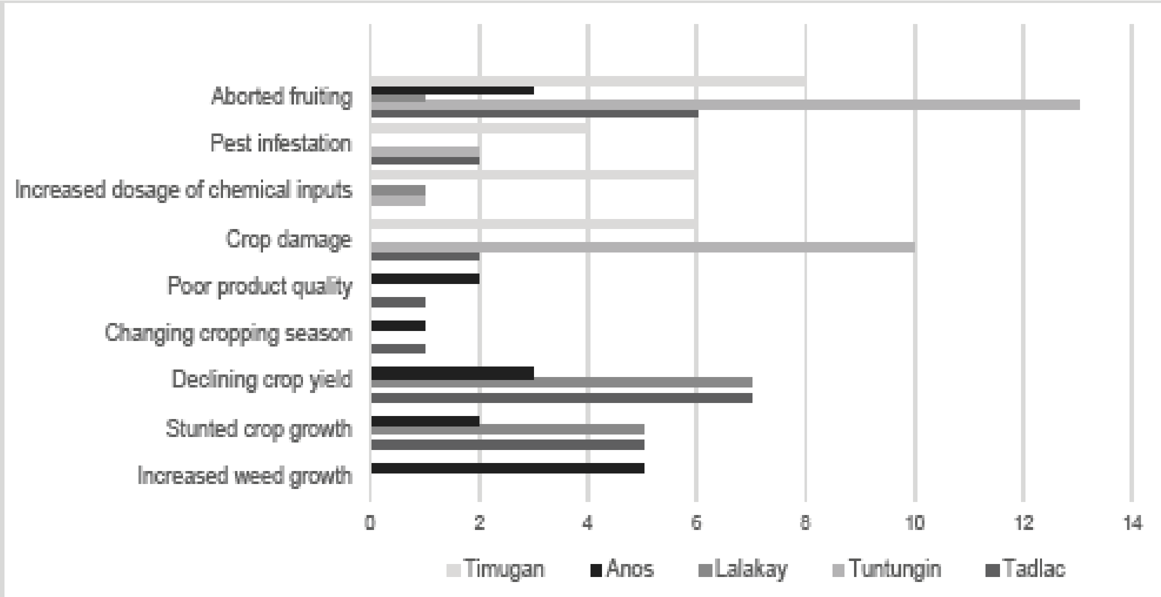


Table 4. Coping strategies for climate change impacts employed by smallholder farmers in Molawin-Dampalit Sub-Watershed

Coping Strategies	Frequency (N=104)	Percentage
Technical strategies		
Planting of crops that are adapted to climate change	71	68
Synchronizing planting with the prevailing season/climate	77	74
Chemical-based pest and diseases management	59	57
Use of traditional pest control methods (integrated pest management)	52	50
Use of fast-growing crops	63	60
Use of early-maturing crops	58	55
Use of new cropping techniques	43	41
Crop diversification	63	60
Establishment of small water impounding system for irrigation and water supply	57	54
Soil conservation measures	52	50
Engaging in livestock and poultry production	74	71
Establishment of barriers to prevent wildfires	20	19
Relay cropping	62	59
Implementation of proper silvicultural techniques	65	62
Non-technical		
Increasing financial capital for protection against climate extremes	56	54
Assistance from concerned agencies on farming systems	53	51
Capacity-building/trainings and seminars	37	35

Meanwhile, the non-technical strategies include increasing financial capital/fund allocation (54%), seeking assistance from concerned agencies (51%), and capacity building (35%).

CONCLUSION AND RECOMMENDATIONS

Results of this study show that climate change is already felt and experienced at the field level. Smallholder farmers devise their own ways of coping with the impacts of climate change on their agricultural production systems. These coping strategies are very simple and do not require any sophisticated technology and approach, but are reactive and short-term, and are only applicable to certain crops. Climate change is indeed real, and therefore, the smallholder farmers need to be enhanced with the capacities not only to cope with but to adapt to the impact of climate change. Thus, this study suggests the need to establish appropriate climate change adaptation strategies.

Enhancing the adaptive capacities of the smallholder farmers to climate change impacts should be holistic. Foremost, human capital should be developed in the form of capability building or training programs, particularly on the appropriate/site-specific climate change adaptation strategies. As discussed above, there are smallholder farmers in other tropical countries who have been employing climate change adaptation strategies such as changing their cropping patterns, establishing soil and water conservation measures, planting short-duration crop varieties, among others. The smallholder farmers in the Molawin-Dampalit Sub-Watershed should not only consider replanting as their coping strategy, but rather, should consider other crops that could withstand the changing rainfall and temperature patterns in the locality.

Secondly, physical capital, including the land and the farming system, should be enhanced. The farms of the respondents are highly dependent on rainfall (being rainfed areas), and therefore, any change in the rainfall pattern would surely affect crop performance, farm productivity, and farm income. They have small landholdings which are classified as public lands, and therefore, bound within the policies of the MFR. Specifically, for farms situated inside the MFR, farmers are not allowed to clear or open the forested/vegetated areas. In addition, they are not allowed to put up structures such as water impounding dams as source of water for their crops. These imply, therefore, the need to develop farming systems that would address the biophysical conditions of the farms within the Molawin-Dampalit Sub-Watershed. Cost-effective and environment-friendly soil and water conservation measures should be introduced in these rainfed areas, without jeopardizing the policies that govern the cultivation of upland areas/farms within the MFR. The farmers should capitalize on the presence of forest and fruit trees on their farms. The ecological services of trees, particularly their potential in climate change mitigation and adaptation, should be well recognized by the farmers via information-education campaigns and capability-building programs.

Finally, social capital enhances the capacity of an individual to address his/her problems or concerns by way of networking and establishing good relationship and solidarity between and among the members of the community (bonding capital) and their linkages with outside organizations (bridging capital). The findings indicate that only the farmer-respondents in Barangays Timugan and Lalakay have been actively involved in social organizations, particularly their farmers' association. It is through these organizations that the farmer-respondents are given the opportunity to attend trainings and seminars, avail of planting materials, and gain access to the recent developments and information about agriculture. In most cases, there has been very few support services that are being provided by local development organizations. This implies, therefore, the need to link the farmers within the Molawin-Dampalit Sub-Watershed to relevant organizations to enable them to tap the latter's assistance in any agriculture-related problems or concerns (e.g., marketing of products, climate change adaptation, etc.).

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