



# Farmers' Adaptation of Floods, Droughts and Disaster Risk Preparedness: The Case of Angat, Bulacan, Philippines



## ABSTRACT

Variability of rainfall caused by climate change has brought great impacts in the country, especially the agriculture sector. This study aimed to assess the effects and impacts of climate change, particularly flood and drought events, in the agriculture sector of Angat, Bulacan, Philippines. A household survey was conducted with 393 farmers surveyed using multi-criteria questionnaires. Sixty-two percent of farmers has been affected by drought, and 33.84% of them had their crop production decreased for more than 50% of their usual harvest. Absence of rain has affected majority of farmers (29.50%) whose farmlands are rainfed. Lack of irrigation facilities also affected the level of crop production in the locality. Majority of the respondents (46.56%) have experienced the effects of floods, especially those who reside near Angat River where overland flow occurs. Aside from damaged infrastructures and properties, the respondents also experienced water-borne diseases like diarrhea and skin infections. Farmers were able to adapt with the effects of climate change such as creating their own wells and planting crops that are suitable for the season. This study could aid in the improvement of adaptation measures of local farmers in Angat.

**Keywords:** flood, drought, climate change, Angat, agriculture, adaptation strategies

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## INTRODUCTION

Climate change poses a major threat to critical environmental sectors like water resources, agriculture, health, biodiversity, and coastal resources (Weiskopf et al. 2020). Weather extremes and changes in rainfall patterns are likely to lead to more frequent and severe drought and or flooding events (Gautam 2016). Due to adverse impacts brought by climate change, vulnerable communities and individuals need to cope with climate-related hazards and do appropriate adjustments either through innovations, behavioral change, and risk management improvement (Demissie and Meaza 2018).

Angat is considered as one of the municipalities of Bulacan, Philippines vulnerable to climate change impacts. According to Bulacan's Provincial Development and Physical Framework Plan (PDPFP), 31.85% of the municipality is exposed to flooding. The area also has high susceptibility to rain-induced landslides. Thus, more population would be affected when heavy rains occur. Climate change is also expected to greatly affect the agricultural economy of Angat, as it is the main economic activity of the municipality. Increasing trends in maximum length of dry spell were recorded from past drought reports, and these are expected to

affect agricultural production in the area, especially the rainfed agricultural lands (Monghi et al. 2010).

Maintaining the productivity of the agricultural sector of Angat is imperative as it provides food security and is the main source of income of the majority. Climate change adaptation strategies are crucial to protect the agricultural sector of the community as well as the community members (Anik and Khan 2012). How the community perceives these environmental conditions is key to informing behavior, including the need to adapt to the changing climate (Nash et al. 2019). To have a better response to environmental risks and formulate strategies to cope with climate change, it is critical to have a better understanding of the farmers' adaptations of these disaster events and their impacts.

The main objective of the study is to assess the farmers' adaptation of droughts, floods, and the disaster risk preparedness to formulate localized strategies to cope with future disaster events. Specifically, the study aimed to assess the level of awareness of farmers on past drought and flood events and their impacts on the farmers' livelihood; determine the farmers'

perception of disaster risk preparedness to document existing local adaptation strategies; and identify new adaptation measures.

**MATERIALS AND METHODS**

**Area of Study**

The study was conducted in the municipality of Angat, located in the 3rd district of Bulacan Province, Philippines. It is considered a first class municipality with a yearly income of more than a hundred million. It is bounded by the municipalities of San Rafael and Bustos in the North; Sierra Madre Mountain Range in the East; the municipalities of Santa Maria and Norzagaray in the South; and the municipality of Pandi in the West (**Figure 1**). Angat is situated in 121°1'15.25" East and 14°56'15.00" North. It has an aggregated land area of 6,526 ha and a total population of 61,062 according to 2017 Municipal Comprehensive Land Use Plan (MCLUP) of the Angat Municipal Office. The municipality is comprised of 16 small administrative units called barangays, namely Banaban (2,220 people), Baybay (887 people), Binagbag (5,374 people), Donacion (2,700 people), Encanto (4, 837

people), Laog (1,270 people), Marungko (4,504 people), Niugan (4,606 people), Paltok (1,500 people), Pulong Yantok (5, 122 people), San Roque (5,167 people), Santa Cruz (5,849 people), Santa Lucia (2,566 people), Santo Cristo (5,183 people), Sulucan (5,935 people), and Taboc (3,342 people) (*MCLUP 2017*). Barangay Sulucan still has the highest population among the 16 barangays, while Baybay has the least population.

Agriculture is the major economic sector of the municipality with crop farming and livestock raising as the main activities. Angat has a total of 1,937 ha of agricultural lands in which 900 ha are irrigated while 1,037 ha are rainfed (*MCLUP 2017*). According to the Municipal Agriculture Office (MAO), rice is the major crop produced in the locality followed by selected vegetables like ampalaya, okra, sitaw, etc.

Angat, under the Type I climate according to the Modified Corona's Classification of Climate, has two pronounced seasons. It is dry from November to April, and wet during the rest of the year. Maximum rain is experienced in the area usually during the months of June to September.

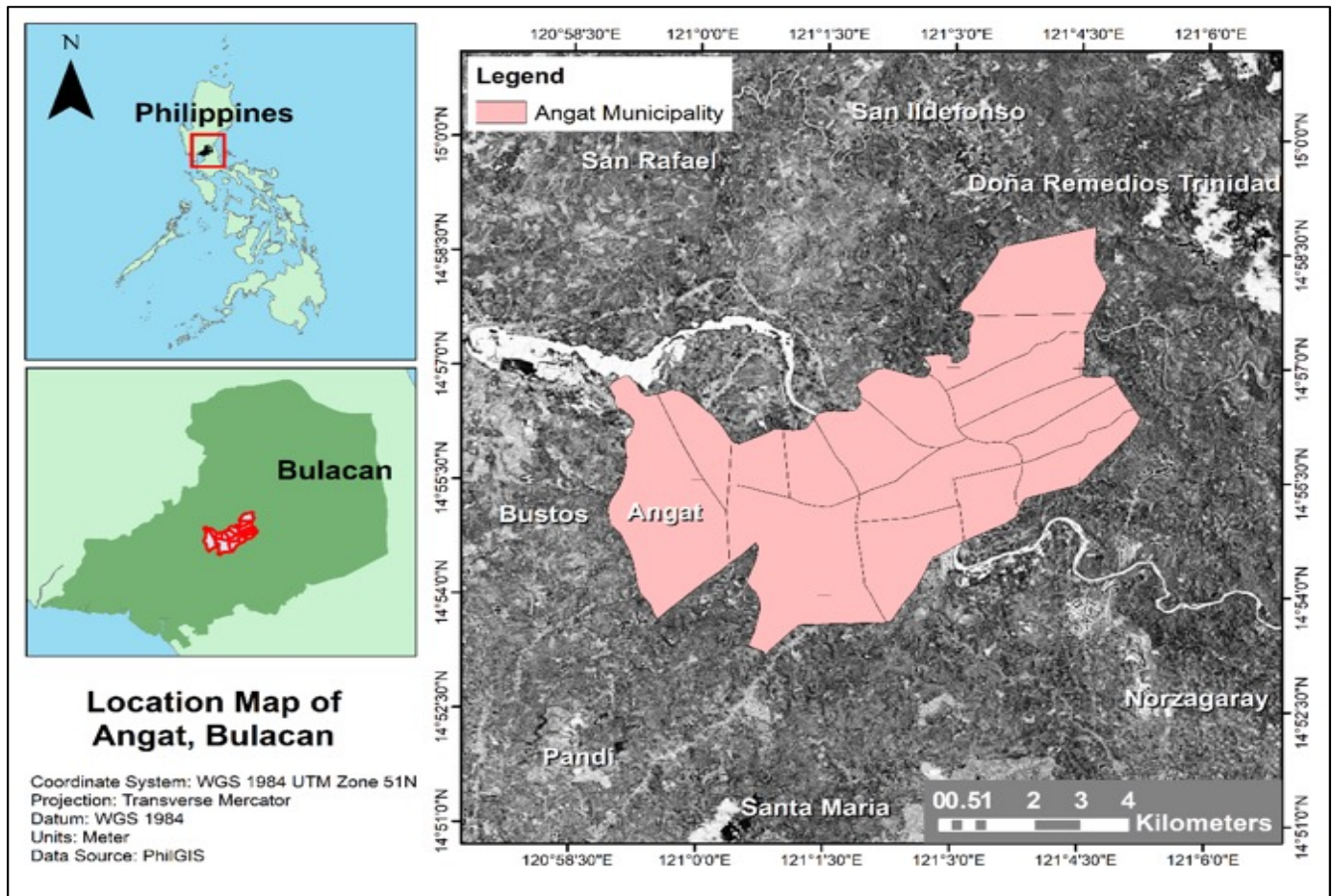


Figure 1. The study was conducted Angat, Bulacan, Philippines, as highlighted in the map.

## Data Collection

The study conducted a multi-criteria household survey to acquire and assess the following information from the farmer residents: socio-demographic and socio-economic profile, knowledge and awareness on droughts and floods, and adaptation on the farmers' disaster risk preparedness. A sample size of 300 was determined using the Cochran formula (Equation 1) (Singh and Masuku 2013).

$$n = \frac{n_0}{\left[1 + \frac{(n_0 - 1)}{N}\right]} \quad (1)$$

where: n = sample size  
N = population size  
 $n_0 = Z^2pq/e^2$

where: Z is the abscissa of the normal curve that cuts off an area  $\alpha$  at the tails;  
p is the estimated proportion of an attribute that is present in the population;  
q is 1 - p;  
e is the desired level of precision

Note: Confidence level = 95%;  
a = 0.05

Three-hundred ninety-three out of 1,367 farmers from the 16 Angat barangays were surveyed, with the help of some volunteers from Lingkod-Lingap sa Nayon (LLN) (Table 1 and Figure 1). This group is composed of Barangay Nutrition Scholars (BNS) and Mother Leaders who usually assist in carrying out health and social programs on the barangay and provincial levels.

The study opted to use the actual surveyed size to have a better representation of the farmer population in Angat, Bulacan, Philippines as this would provide more accurate results (Andrade 2020). The computed sample size is the minimum sampling size (Ahmad and Halim 2017).

## Data Analysis and Interpretation

The socio-demographic and socio-economic characteristics of the respondents were analyzed using descriptive statistics. Data encoding was done using KoBoCollect, an android-based mobile application used for collecting field data. Processing and analysis of collected data were done using KoBoToolbox, an open-source suite of tools used for collecting, analyzing, and managing field survey data (Lakshminarasimhappa 2021), and Microsoft Excel.

## RESULTS AND DISCUSSIONS

### Socio-Demographic and Socio-Economic Characteristics

The survey revealed that there were more male farmers than females. Thirty percent of the respondents belong to the 50 to 59 years old age group and classified as married (75.06%). Filipino is the primary language spoken by the community, followed by Tagalog, English, Bisaya, and Ilocano. Elementary undergraduates led the surveyed population (21%), followed by elementary graduates (20%), and high school graduates (17%). At present, the municipality has 19 pre-elementary/elementary schools, eight high schools, and one tertiary education institution, Lourdes College of Bulacan,

Table 1. Farmer population, sample size, and actual surveyed size per barangay in Angat, Bulacan, Philippines.

Barangay	Farmer Population	Percentage	Target Sample Size	Actual Surveyed Size
Banaban	76	5.56	17	17
Baybay	88	6.44	19	19
Binagbag	195	14.26	43	44
Donacion	88	6.44	19	19
Encanto	72	5.27	16	16
Laog	103	7.53	23	25
Marungko	110	8.05	24	27
Niugan	89	6.51	20	20
Paltok	92	6.73	20	20
Pulong Yantok	51	3.73	11	24
San Roque (Pob.)	39	2.85	9	33
Santa Cruz (Pob.)	27	1.98	6	19
Santa Lucia	55	4.02	12	14
Santo Cristo (Pob.)	6	0.44	1	32
Sulucan	146	10.68	32	35
Taboc	130	9.51	29	29
TOTAL	1,367	100.00	300	393

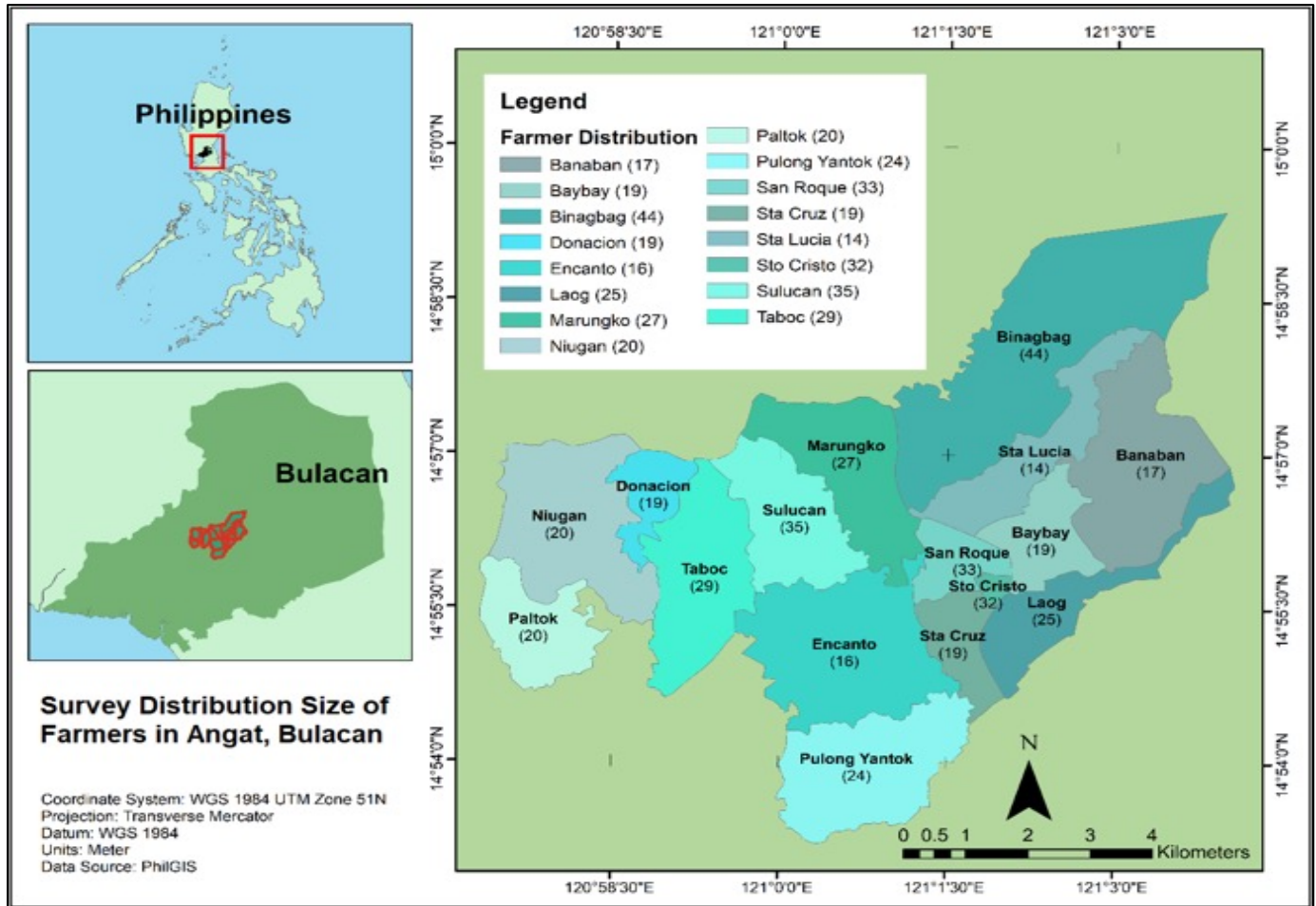


Figure 2. Farmer survey size distribution for each Barangay in Angat, Bulacan, Philippines.

located in Barangay Marungko. Majority of the survey respondents own both their house and lot (73%), while 15% of them were living at the lands provided by the government.

Most of the respondents rely on agricultural activities such as crop farming, livestock, and poultry raising as their primary sources of livelihood. Additionally, 60.81% of the respondents have an average monthly income of under PhP 11,000 (minimum wage), while 26.46% of them have an average monthly income ranging from PhP 11,000 to PhP 24,999. There were some cases where the average monthly expenses exceed the monthly average income of the respondents. Majority of the respondents' monthly expenditures are usually spent on their personal debts, food, drinking water, and hospital costs.

**Agriculture Sector**

For Agriculture, majority of the people in Angat are involved in crop farming and livestock production (MCLUP 2017). Data shows that 56.23% of the respondents are solely into crop farming, 4.58% are

into livestock production, and 29.52% of the people are engaged in both activities.

Angat is comprised of large areas of rice lands and vegetations. The survey reflected that 85.75% of the respondents are engaged in crop farming activities. Majority of these household farmers own the farmlands with 44.21% responses, while others are tenants (29.67%) who rent land properties from the landlords, and some are employed laborers (15.13%). For farmland location, 48.66% of the respondents are involved in lowland farming while 43.62% are in upland farming. The average farm size per farmer is around 1.70 ha. Majority of them do not have any plans of expanding their farmlands (64.99%) because of insufficient finances. Others (14.24%) have plans of adding more farmlands for additional harvest and profit. In terms of the farming system used by the respondents, 47.48% of them apply monocropping with rice as the most commonly planted crop. On the other hand, 43.32% of the farmers are into intercropping where they plant grains and vegetables at the same time (Table 2). On average, the respondents have been involved in farming for almost 30 years.

Table 2. Crop farming profile of surveyed farmers in Angat, Bulacan.

Crop Farming	Frequency (n=337)	Percentage (%)
Labor Status		
Owner	149	44.21
Laborer	51	15.13
Rent	100	29.67
No Answer	37	10.98
Farm Location		
Upland	147	43.62
Lowland	164	48.66
No Answer	26	7.72
Farming System		
Monocropping	160	47.48
Intercropping	146	43.32
No Answer	31	9.20
Has plan for changing farmland size		
Yes (increase land)	43	12.76
Yes (decrease land)	5	1.48
None	219	64.99
No Answer	70	20.77

Angat is a major producer of rice in the country. All 16 barangays of the municipality grow rice and selected vegetables (MCLUP 2017). This was reflected on the survey wherein 43.03% of the farmers grow grain crops, followed by mixed crops (47.48%). This can be attributed to the intercropping practices of the Angat local farmers. A number of respondents also grow vegetable crops (8.01%) and fruit crops (0.89%) (Table 3). To maintain the growth of crop production in Angat, the municipality has stated in their plan to divert any urban development away from the farmlands for preservation and expansion of their agriculture.

Majority of the agricultural lands of the respondents are rainfed (29.50%) rather than irrigated. This was also reflected on their 2017 MCLUP where rainfed area is around 1,037 ha while irrigated area is 892 ha only. Other farmers utilize the nearby stream waters (15.67%) for their croplands, as well as deep wells (10.44%), springs (9.40%), and local water utilities such as the Angat Water District (4.18%). A small percentage of the farmer respondents have land areas equipped with irrigation systems. Based on the survey, 4.18% have regular water supply from national irrigation systems, while 3.66% benefit from communal pump irrigation systems.

Water shortage is the most common issue encountered by farmers in the locality (35.09%), especially during dry season which starts around the month of March and ends in May, according to the local farmers. Since most

Table 3. Agricultural crops cultivated by surveyed farmers in Angat, Bulacan, Philippines (2017).

Crops	Frequency (n=337)	Percentage (%)
Crop Types		
Grains only	145	43.03
Fruits only	3	0.89
Vegetables only	27	8.01
Mixed	106	47.48
No Answer	2	0.59
Grains		
Rice	229	67.95
Corn	11	3.26
Mixed	57	16.91
No Answer	40	11.87
Fruits		
Banana	3	0.89
Dragon Fruit	1	0.30
Mango	6	1.78
Papaya	26	7.72
Calamansi	1	0.30
Mixed	18	5.34
No Answer	282	83.68
Vegetables		
Ampalaya	11	3.26
Kangkong	1	0.30
Okra	22	6.53
Tomato	3	0.89
String beans	10	2.97
Squash	1	0.30
Mixed	129	38.28
No Answer	160	47.48

of their farmlands are rainfed, majority of farmers find alternative sources of water supply when there is less rainfall (Table 4). Other problems encountered by the respondents, are insufficient finances (19.25%), typhoons or natural catastrophes (16.18%), farm pests (14.65%), drought (13.97%), and fire (0.85%).

The second economic activity of Angat next to crop farming is livestock and poultry raising (34.10% of the respondents). Most of the respondents own the lands they use for raising livestock and poultry (44.78%). Others are tenants (23.13%) and laborers (12.69%). Majority of the lands used for livestock and poultry raising are located in the lowlands (50.75%) and 41.04% are in the uplands. Forty-six percent of the respondents do not have plans on increasing their livestock and poultry lands because of insufficient finances. Almost twenty-four percent (23.88%) of them are willing to expand their lands for additional profit (Table 5). On average, livestock and poultry farming have been an economic activity of the municipality for around 16 years, with majority of the respondents having two years of experience.

Table 4. Summary of crop farming issues and solutions of the farmer respondents in Angat, Bulacan, Philippines.

Crop Farming Problems	Number of Farmer Respondents	Months/Year Encountered	Solution
Water Shortage	206	March-May	-- wait for the rain -- find or create their own wells as source of water supply -- borrow and use other farmers' water source or equipment -- choose crops that are suitable for dry season -- do not plant at all
Drought	82	March-May	-- plant only a part of their land -- plant drought tolerant plants
Typhoons or natural catastrophes	95	2009 (Typhoon Ondoy)	-- use suction motors to get water from streams -- get crop insurance -- wait for the typhoon to pass before they plant again -- create drainage canals by digging their farmlands -- get excess water from the flooded plain (through suction motor) and transfer them to drier plains
Lack of Finances	113	-	-- borrow/save money for farming funds -- give away free crop seeds -- plant crops that are of high value and profit for the specific month
Pests	86	All year round	-- use pesticides -- ask help from the Municipal Agriculture Office -- halt crop planting

Table 5. Livestock and poultry farming profile of surveyed farmers in Angat, Bulacan, Philippines.

Livestock and Poultry Farming	Frequency (n=134)	Percentage (%)
Labor Status		
Owner	60	44.78
Laborer	17	12.69
Rent	31	23.13
No Answer	26	19.40
Farm Location		
Upland	55	41.04
Lowland	68	50.75
No Answer	11	8.21
Has plan for changing livestock and poultry farmland size		
Yes (increase land)	32	23.88
Yes (decrease land)	4	2.99
None	62	46.27
No Answer	36	26.87

Livestock raising is the most common activity among the respondents (58.21%), while others are engaged in poultry raising (15.67%), and mixed poultry and livestock production (23.13%). Mixed livestock production is the most common practice for the livestock category (23.88%), followed by swine production (20.15%), carabao production (15.67%), cattle production (14.18%), and goat production (6.72%). Currently, there is an increasing trend of population for swine inventory compared to the past. However, the production for

carabao and cattle is declining due to farm mechanization. For poultry, majority of the respondents are into chicken raising (29.10%). Others are practicing mixed poultry production (5.97%), and duck production (2.24%), goose and quail production (1.49%). Like swine, the trend of chicken as a commodity has also been increasing.

Households who are engaged into livestock and poultry raising mainly get their water supply from local water utilities (20.90%). Other farmers source out water from deep wells (17.16%), streams (13.43%), springs (10.45%), and nearby rivers (8.96%). Major usage of these sources are as drinking water of the livestock and poultry for production.

Similar to crop farming, water shortage is the most common problem encountered by respondents for livestock and poultry raising (26.25%). This can be attributed to the lack of irrigation systems in the locality. Farmers resort to wait for rain or to source out from local water utilities to prevent the animals from dehydration, which is also a significant problem as revealed in the survey (13.75%). The second major problem as reflected in the survey is the presence of animal diseases (25.63%). Last July 2019, the Philippines had an outbreak of African Swine Fever (ASF), and Angat, Bulacan was one of the affected municipalities. Around 193 swine from Barangay Sulucan and Niugan were culled and disposed last September 2019 (*Organization for Animal Health 2020*) to prevent the spread of disease.

Other problems faced by the animal raisers are insufficient finances (21.88%), storms and natural catastrophes (6.88%), and insufficient food supply (5.63%). The respondents also presented some solutions to the problems mentioned above (Table 6).

**Knowledge and Awareness on Droughts**

Part of the study is to determine the awareness and knowledge of the local farmers on drought and how it is being managed in the municipality. From the survey, 70.48% of the farmers responded that they have experienced drought and its impact, especially in doing their farming activities. Respondents (47.33%) have experienced drought seasonality, which is commonly characterized for countries with well-defined dry and rainy seasons (Hao et al. 2018), like the Philippines (Table 7). According to farmers, March to May are the drought months in the locality where they experience zero rainfall and water shortage (Figure 3). Same month duration (March-May) is recorded as the warmest season in the Philippines as stated in the National Drought Plan (NDP) for the Philippines (2019).

According to Bulacan’s Provincial Development and Physical Framework Plan (PDPFP), the agricultural sector of Bulacan has high level of vulnerability to drought. Prolonged drought in the province has serious degrading effects on crop production. This was reflected in the survey results wherein 33.84% of the respondents experienced reduction of more than half of their crop harvest because of drought. Around 11.96% of farmers have 10-25% of production losses. Others have reduced their crop harvest by 26-50% (11.70%), by less than 10% (1.78%), and 0.51% for no crop production losses.

Among the crops being produced by the municipality, grain crops are the most affected by drought (45.40%), followed by vegetables (18.62%), and fruit crops (3.97%).

Table 7. Drought experience of the respondents.

Drought	Frequency (n=393)	Percentage (%)
Have experienced drought:		
Yes	277	70.48
No	60	15.27
No Answer	56	14.25
Type of experienced drought:		
Seasonal	186	47.33
Annual	26	6.62
No Answer	181	46.06

Due to insufficient water supply during drought season, majority of rice crop production in Angat, Bulacan is affected (46.56%), as this crop has high water requirement. Hence, some farmers resort to planting vegetables, even for a much lower profit compared to rice, since these crops do not need a large supply of water (Estrope 2019).

Livestock and poultry production are also affected by drought according to Bulacan’s PDPFP. Due to lack of water supply, farm animals suffer from dehydration and heat stress, and ] eventually die. Based on the survey, 16.28% of the respondents said that drought has affected their livestock farming, while 6.36% said otherwise. Seven percent of the respondents, whose livestock and poultry farming are affected by drought, have experienced more than 50% of livestock and poultry loss. Others have reduced their livestock production by 26-50% (2.8%), by less than 10% (2.8%), by 10-25% (1.27%), and 0.67% for no livestock and poultry production loss.

Livestock (9.16%) is more affected by drought than poultry (1.78%). Farmers who practice mixed livestock raising (4.33%) have encountered production loss because their animals are greatly affected by drought. For poultry, chicken production was greatly affected because of heat stroke brought by drought to the chickens.

Table 6. Summary of livestock and poultry issues and solutions of surveyed farmers in Angat, Bulacan, Philippines.

Crop Farming Problems	Solution
Water Shortage	-- wait for the rain -- get water from deep wells or local water utilities
Dehydration of Animals	-- bring animals to the veterinarian -- get water from deep wells or local water utilities
Presence of many Animal Diseases	-- bring animals to the veterinarian -- have the animals vaccinated -- inform the municipal authorities regarding the animals susceptible to diseases
Insufficient/ Unstable Food Supply	-- allot crop harvests for the animals
Storms and Natural Catastrophes	-- move animals to safer places
Insufficient Finances	-- get financial help from the municipal authorities -- borrow money for livestock/poultry raising

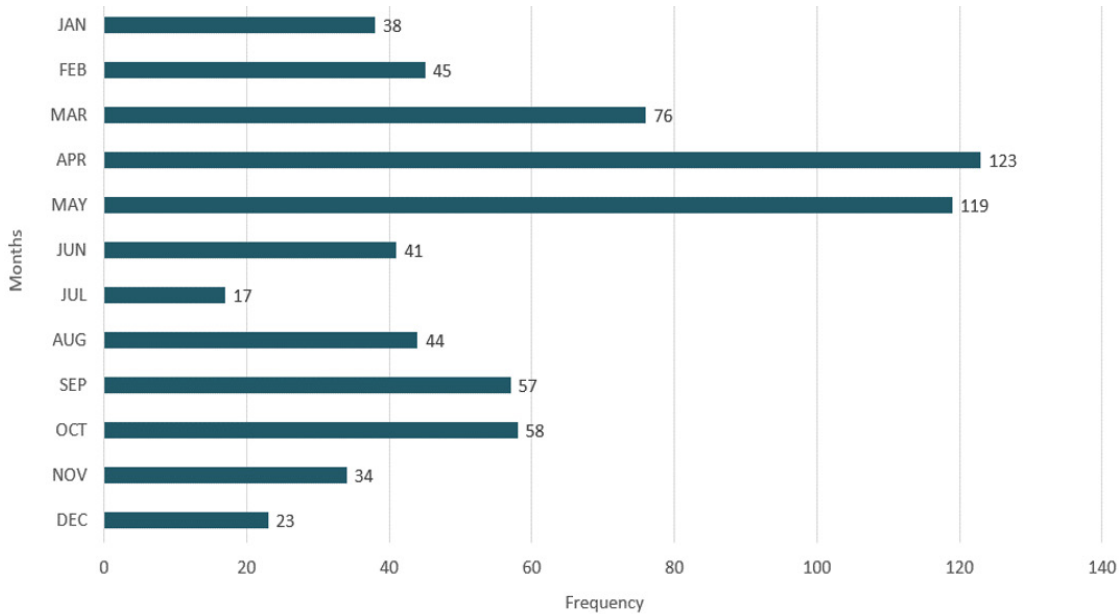


Figure 3. Usual drought months according to the surveyed farmers in Angat, Bulacan, Philippines.

Drought has significant impacts also to the health sector of a community. One of its potential impacts is water contamination due to water shortage, which may lead to increased cases of diarrhea and influenza-like-illnesses (Villarín et al. 2016). Warmer temperatures brought by drought may also increase heat stroke cases among the community, especially the elderly (PDPFP 2014). As reflected in the survey, household farmers in Angat, Bulacan have experienced the health impacts brought by drought (39.19%). Hypertension is the most common illness experienced by local farmers (12.14%). Other farmers have also experienced the following diseases: dehydration (8.44%), diarrhea (8.23%), skin infections (8.23%), heat stroke (6.17%), and other mild illnesses like headache and dizziness (5.56%) (Figure 4). Affected farmers were able to get health assistance, as majority of help came from their own family members (26.87%). Some respondents were able to get help also from the local government unit (2.99%) and other governing units.

Extreme drought events have big impacts on the major water resource of the community, which is Angat dam. Reduced water inflow is one its effects which leads to domestic water shortages (NDP 2014). Drought has affected the respondents' water supply. When asked if drought has affected their water supply, 45.80% of the respondents have concurred. Around 31.81% of them said that due to water shortage, they resorted to change their water source. Respondents usually source out water from deep wells (13.49%), but they resort to getting water from refilling stations (20.10%) when drought season comes since warmer temperatures brought by drought results to groundwater depletion (Figure 5).

### Knowledge and Awareness on Floods

Aside from drought, an assessment on the awareness of the local farmers of flood and its effects in their community. Forty-six percent of the respondents have experienced the impacts of flood, majority on the months of July-August (14.50%). Habagat (Southwest Monsoon) and Tropical Storm Karding (international name: Yagi) caused extreme flooding events in August 2018. A yieldloss of 76.67% was experienced among the twelve barangays involved in agricultural farming. Ninety-two farmers were affected, and almost PHP6 M (US\$107,764) worth of production cost were damaged (Cruz 2018). Some residents have experienced flooding every occurrence of rain (9.92%), wherein most of the respondents are from barangays who are highly susceptible to flooding (i.e., Banaban, Binagbag, and Sta. Cruz). Flooding usually happens on the roads or streets, according to the 19.85% of the respondents,

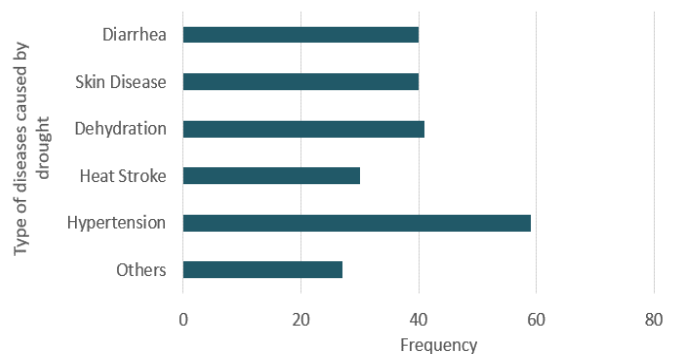


Figure 4. Common types of diseases experienced due to drought by the surveyed farmers in Angat, Bulacan, Philippines.



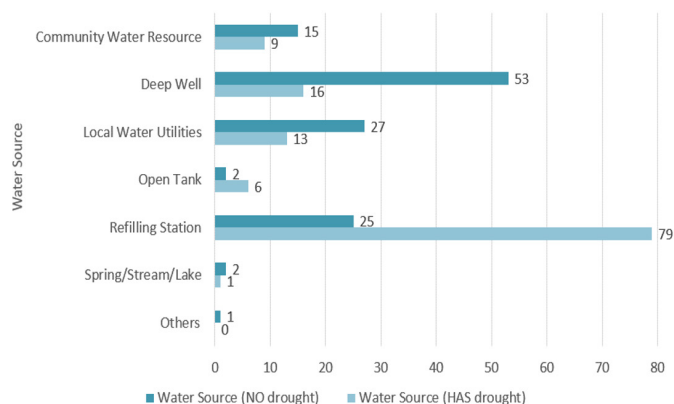


Figure 5. Water sources of surveyed farmers in Angat, Bulacan, Philippines depending on the occurrence of drought.

while 11.20% of them have experienced flooding inside their houses. The usual flood depth is between 0.6-1.5 m when heavy rains pour for almost five hours and will subside in four hours after the rain (Table 8).

Overland flow from rivers/streams is the most common cause of flooding according to the residents (20.29%). Majority of the answers were from barangay Sto. Cristo, which is located close to Angat River. According to the residents, flooding happens when water from Angat dam during continuous heavy rains. Flooding incidents in the community were mostly reported (20.10%) to the barangay or municipal officials.

The agriculture sector of Bulacan has the highest level of vulnerability to flood impacts, especially those that are located at the coastal areas. Angat municipality was ranked as one of the areas with the highest risk to population and property flooding (PDPFP 2014). Based on the survey, flood events have impacted the farming activities of the locals. Twenty-seven percent of the respondents said that flooding affects their crop production. Among the respondents who answered, 15.78% have experienced more than half of crop yield losses because of the effects of flood. Six percent of farmers have 26-50% production losses. Others have reduced their harvest by 10-25% (2.29%), and by less than 10% (0.25%). No one mentioned that their harvest did not change because of flood impacts.

In terms of crops, majority of grain crops are greatly affected by flooding. From the Damage Assessment Report of Municipal Agricultural Office, 149.50 ha dedicated for rice farming and 17 ha of farmlands for vegetable crops were damaged by Typhoon Ompong (international name: Mangkhut) last September 2018. This can be attributed to the higher number of rice crops being planted in the municipality

Table 8. Flood awareness of the surveyed farmers in Angat, Bulacan, Philippines.

Flood	Frequency (n=393)	Percentage (%)
Have experienced flooding:		
Yes	183	46.56
No	129	32.82
No Answer	81	61.32
Frequency of Flooding experience:		
Every time it rains	39	9.92
Only once a year	56	14.25
On specific months	57	14.50
No Answer	241	61.32
Types of flood encountered:		
Flood Entered your house	44	11.20
Flood happened outside your house	78	19.85
Both	11	2.80
Others (flood happened in the rice field only)	5	1.27
No Answer	255	64.89
Depth of flood encountered:		
Less than 0.07 m	19	4.83
0.07-0.30 m	42	10.69
0.60-1.52 m	45	11.45
Above 1.52 m	22	5.60
No Answer	265	67.43

compared to other crops like vegetables and fruits as reflected in the crop farming component of the survey.

Flooding also affects the livestock and poultry production of the municipality. Farm animals, especially those located near the river streams, are drowned by massive floods brought by overflowing water from the rivers. In the survey results, 8.91% of farmers engaged in livestock and poultry farming have experienced the impacts of flooding. Four percent of these farmers suffered from more than 50% of livestock and poultry damage and loss. Others have reduced their production by 26-50% (2.29%), by 10-25% (1.02%), by less than 10% (0.25%), and 0.51% for no livestock and poultry production loss.

This is similar to droughts in the area, wherein livestock animals (5.60%) are more affected than poultry (0.51%). Farmers who practice mixed livestock raising (3.31%) are more affected by floods rather than single type livestock raisers. Some mixed livestock raisers said that they had difficulties in herding many types of livestock, especially during calamities, because not all animals are in the same area. Some are being raised in the upland farms while others are situated in the lowlands. For poultry,

majority of the affected animals are chickens (3.05%).

Flooding not only causes damages to infrastructures, agriculture, and the environment. Some major risks brought by floods could also affect the health of the population. One of the major impacts is disease outbreak within the community that can lead to higher morbidity or worse, mortality within the population (*PDPFP 2014*). Drowning, injuries, and skin diseases are also some of the immediate effects of flooding (*Du 2010*). Majority of the respondents whose health were affected by floods are those who reside along the Angat river network (i.e., Sto.Cristo, Laog, Sta.Cruz, Banaban, Sta. Lucia) (**Figure 6**). Other barangays that are far from the river have the least affected respondents (i.e., Paltok, Pulong Yantok). This reveals that residents who have exposure to contaminated flood water have higher risks of getting water-related and communicable diseases.

Skin diseases and diarrhea are the most common water-borne diseases experienced by the survey respondents. Skin diseases like fungal infection are developed when the skin had direct contact with contaminated flood water and became moist (*Balato et al. 2014*). Having open wounds also has higher risks of getting infectious skin diseases. Most of the residents from barangay Sto. Cristo have experienced having skin diseases since flood water reaches the level of their houses every time there are typhoons. Diarrheal diseases, which are acquired when there is water supply contamination, are also very common among the barangays who are near the Angat river. Health assistance was provided for those who were affected, and majority of the help came from their family members as well.

According to the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), one of the impacts of floods is the contamination of water supply. The need for potable water increases as flood affects the water system of the area. The survey results revealed that majority of deep wells become unusable when flooding occurs. People from barangay Banaban, who usually source out their water from deep wells, have resorted to getting water from refilling stations as it is safer and cleaner (**Figure 7**).

**Knowledge and Awareness on Disaster Risk Preparedness**

The survey also assessed the view of the Angat people in terms of preparedness and reduction of disaster risks in the municipality. They were asked to evaluate the existing strategies and measures of

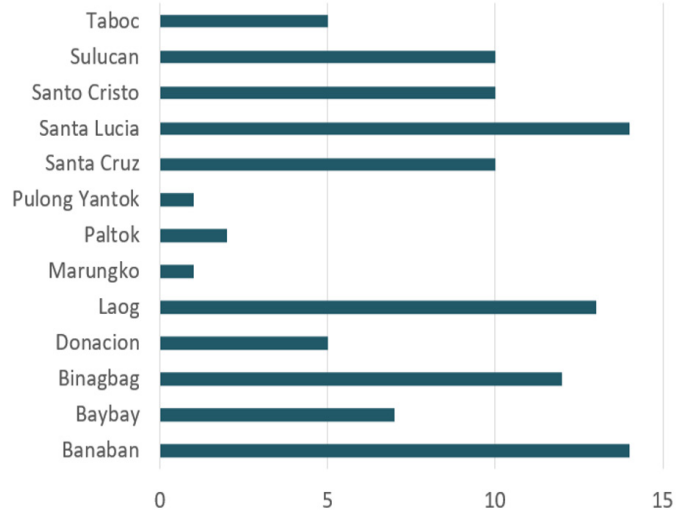


Figure 6. Barangays in Angat, Bulacan, Philippines whose health are affected by flooding.

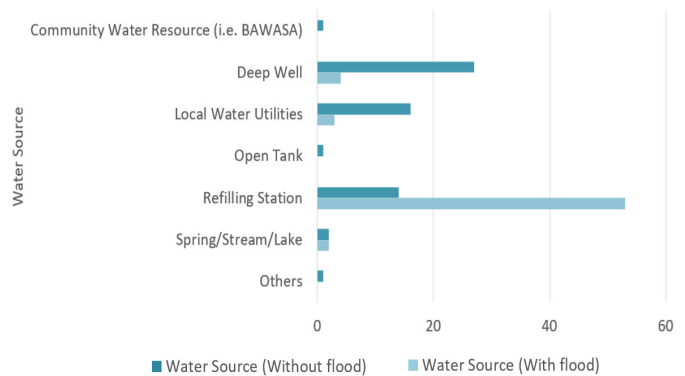


Figure 7. Water sources of surveyed farmers in Angat, Bulacan, Philippines depending on the occurrence of floods.

the community on disaster preparedness. From the survey results, 80.15% of the respondents said that they have received early warnings for incoming disasters in the area (**Figure 8**). Thirty-nine percent of them have received early warnings through television news and updates. Others were informed through text/SMS (22.45%), through radio news (19.29%), via barangay patrol announcements (16.33%), house-to-house announcements (1.86%), and others (1.48%).

The Angat municipal government has appointed a unit that is dedicated to Disaster Risk Reduction and Management (DRRM) activities focusing on the four thematic areas of the national DRRM plan: prevention and mitigation, preparedness, response, and early recovery and rehabilitation (*MCLUP 2017*). The survey results have reflected that Angat is practicing disaster risk prevention measures to prepare the community for future calamities. Thirty-eight percent are stockpiling of goods and medicines. The Local Government Unit (LGU) also

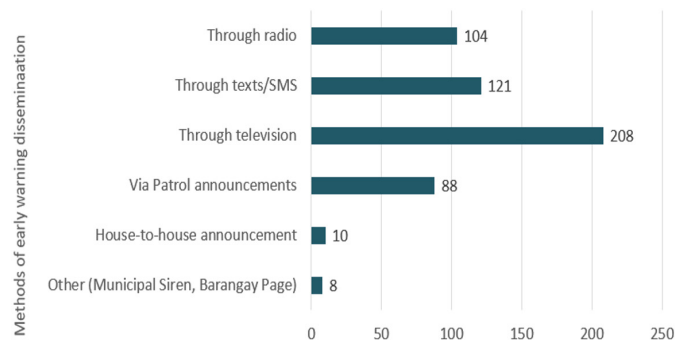


Figure 8. Methods of early warning dissemination according to Angat, Bulacan, Philippines respondents.

prepares areas for evacuation (22.61%), simulates disaster drills, and conducts training seminars related to Disaster Risk Management (DRM) (19.29%).

For the improvement of disaster preparedness in Angat, 40.35% perceived the benefits of conducting seminars and trainings related to disaster risk preparedness. Others have seen the need for improvement of the municipality's early warning system (27.49%). The locals are also willing to engage in disaster risk assessment studies to further identify the gaps of DRM in the municipality (17.74%). They have also seen the importance of allocating funds for disaster mitigation activities (13.45%) (Figure 9). Items of appointing units to take action for the improvement of DRRM in the municipality, the respondents have recognized the importance of coordination and cooperation among community members (32.03%). Also, they have identified the vital role of the LGUs in building disaster-resilient communities through proper conduct of DRRM strategies (31.05%). Other units perceived by the respondents to act for the improvement of DRRM are the: community groups (22.52%), national authorities (7.97%), and NGOs (6.43%) (Figure 10).

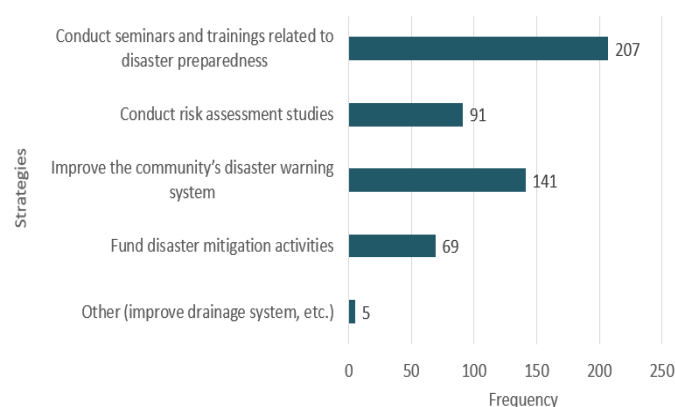


Figure 9. Strategies to improve Disaster risk preparedness in Angat, Bulacan, Philippines.

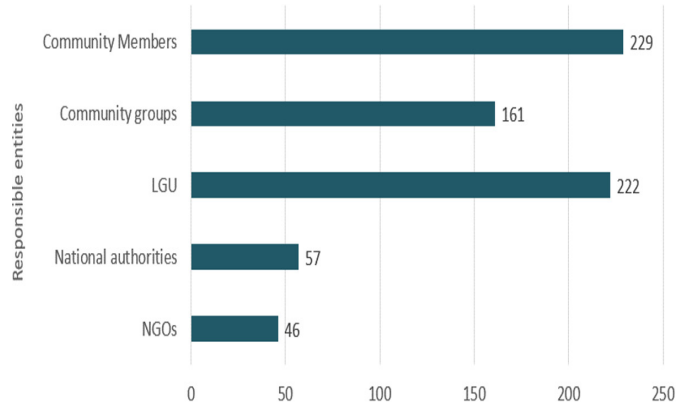


Figure 10. Entities that should be responsible for Disaster Risk and Management according to the surveyed farmers of Angat, Bulacan, Philippines.

### CONCLUSIONS AND RECOMMENDATIONS

The local farmers of Angat, Bulacan were knowledgeable and aware of the past extreme events that the municipality had encountered. Most of the respondents became conscious of these events due to the impacts and damages these disasters brought to their agricultural livelihood and to their environment. Majority of the respondents shared their personal experiences on dealing with droughts and floods, as well as the issues and their personal solutions to these problems. Through this study, some issues brought by the effects of droughts and floods were given light. One key problem of farmers during drought is the lack of water supply. Larger percentage of the respondents were only dependent on rainwater as source for their agricultural needs. This could imply that there is a need for the local government unit to rehabilitate communal irrigation networks and develop even small scale but efficient irrigation systems to sustain the needs of drier agricultural lands. Irrigation efficiency can be achieved by using water-saving technologies such as increased lining of on-farm canals (Rosegrant and Sombilla 2018), with proper allocation rules and timing of release (Shah 2015). In addition, the respondents perceived major impacts of floods on their community. Agricultural lands lack drainage canals so heavy rains result to flooding in the plains. Majority of houses of the respondents on nearby streams do not have any protection against recurring flashfloods and this results to negative impacts on their health and damages on their properties. New structural measures could be implemented to reduce or prevent the damaging effects of floods in these communities. Drainage improvement projects and physical infrastructures like riverbank stabilization structures should be given attention and funding by the local government.

Although factual survey questions on the occurrence of disaster events were easily answered by the respondents, quantification questions were hardly answered. The farmer respondents had limited knowledge on the damage values; types of crops and livestock affected by droughts and floods; detailed health and water supply impacts. This indicates that the awareness of respondents was mostly based on their personal experiences and how they see disasters holistically. This reveals the need for more transparency of disaster reports from the local disaster management offices to the community. Proper and frequent dissemination of disaster information, especially to disaster-prone communities, would help the people plan their actions and strategies for future disaster occurrences.

Existing local disaster risk preparedness measures were identified through the survey. It shows that the respondents were aware of the strategies being implemented in their community, and that they were able to apply these in their households. Opinions of the locals related to disaster risk preparedness were also documented, and these new ideas could be helpful in improving the existing programs and strategies for disaster risk preparedness of the locality.

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