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Vulnerability, adaptation and resilience to climate change of upland farming communities in Davao Oriental, Philippines

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ABSTRACT

The impacts of climate change are inevitable. Farming communities will be vulnerable to these climate impacts, but the proper assessment of site-specific community resilience is the key to improving and strengthening necessary resilience indicators needed to address the ever-increasing effects of climate change, such as drought and flood/landslide, based on the findings of this study. Assessing the right resilience indicators is also crucial in attaining long-lasting sustainability among upland farming communities to validate and address the impacts of climate change in the agriculture and fisheries sector. Hence, this paper aims to assess the effects of climate change, determine site-specific indicators of agro ecosystem resilience to address climate impacts and provide a framework tool for upland farmers in increasing their community resilience to climate change among upland farming communities in Davao Oriental, Philippines. This was conducted in six upland farming communities in Mati City. The paper was based on qualitative interviews using focus groups and participatory approaches to understand and identify climate resilience among participants from various rural communities. Seventy-three farmers (33 male/40 female) participated in the half-day FGD workshops. Results of the workshop showed that each upland community was able to experience two to three climate-related hazards (i.e., floods, drought, and rain-induced landslide). Moreover, communities with more diverse sources of crops, livestock, and income showed higher resilience to climate change impacts than upland farming communities with lesser crop and livestock diversity. The results of this paper could be used as baseline data in drafting site-specific policies to address and mitigate the adverse effects of climate change at the local and national levels.

Keywords: Climate change, resilience, vulnerability, upland farming

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INTRODUCTION

Climate change is one of the significant threats that humans will have to face daily. Changing rainfall intensity and occurrence, rising temperature, change in sea elevation, and its impact on plant and animal biodiversity are just some of the immediate consequences of climate change (Cinco et al., 2016; Katikiro and Macusi, 2012; Marshall, 2010). This global phenomenon has increased the severity of flooing and drought in developed and developing nations. While developed countries can with stand, cope, and mitigate the effects of solid hurricanes, typhoons, thunderstorms, flooding, and drought, many underdeveloped and developing nations are vulnerable to the impacts of climate change (Cinner et al., 2013; Lasco, Pulhin, Sanchez, Villamor, Villegas, 2008 and Macusi, Macusi, Jimenez, Catam-isan, 2020). Specifically, the Philippines is one of the developing countries in Southeast Asia that has experienced firsthand the impact of stronger typhoons, landslides, mudslides, flooding, and drought (Faustino-Eslava, Dimalanta, Yumul, Servando, and Cruz, 2013; Pati and Cruz, 2017 and Yumul, Cruz, Servando, Dimalanta, 2011). It is considered one of the most vulnerable countries to climate change impacts in Southeast Asia about climate change vulnerabilities (Ancog, Rebancos, Sumalde, 2016; Ducusin, Espaldon, Rebancos, Lucille Elna, 2019; Macusi et al., 2020 and Peras, Pulhin, Inoue, 2017). Some of the earliest vulnerability assessments of climate change in the Philippines were done by (Acosta-Michlik and Espaldon, 2008) using agent-based modelling in three specific villages in Tanauan, Batangas, Combalicer, et al., (2010) who used a lumped hydrologic BROOK90 model of Mount Makiling. The more recent climate change vulnerability studies in upland farming communities in the Philippines were focused on the vulnerabilities of Alangan Mangyan indigenous communities in Mindoro (Ancog et al., 2016), two community-based forest management (CBFM) organizations in Southern Leyte (Peras et al., 2017) and vulnerability assessment of agricultural heritage system of the BatadRice Terraces in Ifugao (Ducusin et al., 2019).

Papers on climate change adaptation focused on early warning systems in the municipalities of Infanta and General Nakar in Quezon (Cuevas, 2012), the enhanced local adaptive capacity of various local government units (LGUs) in the Philippines (Peñalba et al., 2012), the role of trees in climate risk adaptation in Wahig-Inabanga watershed in Bohol (Lasco et al., 2008), local land use planning in Albay (Cuevas, 2016), use of Indigenous knowledge of the Ifugaos as climate adaptation strategies and community-based adaptation (Soriano et al., 2017).

A few climate resilience studies were collected, and they focused on enhancing coastal livelihood resilience by building human and social capital adaptive capacity (Uy et al., 2011), tri-capital community resilience in Community-based Forest Management (CBFM) communities in Pampanga and Bataan (Jarzebski et al., 2016) and comparative resilience study on lowland organic and conventional rice farming communities in Negros Occidental (Heckelman et al., 2018).

Other studies regarding resilience to climate change impacts among upland farming communities were limited (Jarzebski et al., 2016). There were reports that climate change already affected many upland farming communities in Davao, Palawan, and Mindoro with the projection of increased precipitation in various parts of the Philippines, but a study on climate resilience among vulnerable upland communities has caught less attention, making this study very timely.

Using the definition of the Food and Agriculture Organization (FAO) on resilience adopted from the IPCC 2007 assessment, this is “the ability of a given system to go back to its original state after exposure to a disturbance.” The system in this paper is the agro ecosystem composed of a social-ecological system, while the disturbance relates to different climate-related hazards such as flood, drought, and rain-induced landslide.

Further understanding of vulnerabilities and adaptation practices among upland communities across the Philippine archipelago to address climate change impacts is vital in laying baseline foundations to determine the resilience of many upland farming communities and their technological, social, and economic status. This is to create lasting resilience amid a changing climate. Resilience will be based on the context of each upland farming community, and this paper will try to understand and compare indicators of resilience to address the impact of climate change and attain long-lasting sustainability (Cabell and Oelofse, 2012). As a result, this paper aimed to assess the effects of climate change and adaptation practices in the surveyed six upland communities in Mati City, Davao Oriental, and to determine the site-specific indicators of agro ecosystem resilience in each of the upland communities to address possible climate-change impacts, and lastly, to provide a framework/tool for upland farming communities on how to increase community resilience to climate impacts.

METHODOLOGY

Description of the study area

The study was conducted in six (6) upland farming communities in Mati City, Davao Oriental. The city is located in the southeastern part of Mindanao. It has a total population of 141,000, comprised of 26 barangays based on a 2015 census. At the provincial level, Davao Oriental ranked second, with 32% poverty incidence among families in the Davao Region (PSA, 2018). Moreover, Davao Oriental was considered one of Davao Region's provinces delineated as highly susceptible to flood and rain-induced landslide (NEDA, 2017). The registered farmers from upland communities in Mati city largely comprised 13,429, or about 80% of the farmers in the area. On average, the farmers own a farmland area of two hectares, planted with coconut, banana, mango, pomelo, and other fruit trees. For vegetable production, most of the cultivated crops are squash, eggplant, string beans (batong), tomato and bitter gourd (ampalaya) as well as ladies finger (okra). Six barangays were assessed in this study because of their exposure to climate change impacts such as drought, limited water resources, and limited agricultural or market access.

Data collection

The study was done through a focus group discussion (FGD) to assess the communities' climate change vulnerability, adaptation, and resilience. Half a day FGD workshop was conducted in each of the sixbarangays of Taguibo, Buso, Don Enrique Lopez, Don Salvador Lopez, Sanghay, and Culi-an of Mati City, Davao Oriental using indicators for assessing agro ecosystem resilience developed by Cabell and Oelofse (2012) and the participatory approach employed on climate and disaster risk by (Bread for All, HEKS, and World, 2017). Six FGDs were conducted with a total number of N=73 participants for the communities. All the participants were prior informed for one week by the agriculture coordinat or of the Mati city agriculture office before the workshop gathering. Most of the participants were men and women farmers from their villages aged 51 and up (based on unpublished prior surveys of the village areas). The barangay profile was collected from each upland farming community through the barangay governance performance management system in 2018 (see Table 1). Upon arrival, the researchers introduced the participants to the project/study. Then, they introduced them to climate change and its impacts by providing milestone examples of disasters that elicit clear pictures of climate change impacts and disasters in the Philippines. Then, climate change participatory assessment was introduced to upland farmers, who comprised five different components: hazard/community asset mapping, seasonal calendar, vulnerability matrix, hazard-impact-coping strategy, and resilience assessment and community action plan. All study participants' attendance sheets were collected after the workshop.

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Table 1. Barangay profile of six (6) upland farming communities in Mati City, Davao Oriental.

Upland Farming Barangay Profile							
Name of Barangay	Total Number of Participants**	Total Male Participants**	Total Female Participants**	Total Number of Household*	Total Population*	Land Classification *	Major Economic Source*
Taguibo	14	8	6	745	2959	Upland	Agricultural
Buso	10	2	8	522	2563	Upland	Agricultural
Don Enrique Lopez	12	5	7	897	4199	Upland Coastal Landlock	Agricultural Fishing
Don Salvador Lopez	10	6	4	1223	5401	Upland Lowland Coastal	Agricultural Fishing Commercial
Sanghay	19	8	11	400	1710	Upland Lowland	Agricultural
Culi-an	8	4	4	486	1962	Upland	Agricultural
Total	73	33	40	4273	18794		
*Barangay Governance Performance Management System (BGPMS-2018) **Research Attendance Sheet							

Vulnerability Matrix. After the hazard/community asset mapping and listing events in the community's seasonal calendar, participants were also regrouped to assess and determine the main hazards that most impacted their livelihood resources and which livelihood resources were ranked most vulnerable.

Hazard/Community Asset Mapping & Seasonal Calendar. Participant farmers in each barangay were divided into two groups. The first group, mainly men, drew a hazard/community asset map, while thesecond group, mostly women, listed on-farm and off-farm events/activities in their community for the seasonal calendar. (Mainly because the men volunteered to draw during the tasking of activities, and the women volunteered to do the seasonal calendar). Participants could identify past and present climate changes and different climate-related hazards affecting their livelihood, assets, and yearly community activities and events. Recalling of the events was related to milestones in their communities, such as the impacts of typhoon Pablo in the province, to facilitate recall of events. This technique is commonly applied during interviews to help respondents recall earlier events (Lavides et al., 2016; Lavides et al., 2010; O'Donnell, Pajaro, and Vincent, 2010).

Hazard-Impact-Coping Strategy. In this activity, the participants were allowed to identify the impact of hazards on the community's livelihood and identify coping strategies to address dangers and implications from the vulnerability matrix. The flip chart listed all the effects of the identified hazard on the different livelihoods. The respondents identified existing coping strategies and then ranked (with 10 as the highest score) according to their effectiveness and sustainability for each identified coping strategy.

Resilience Assessment and Community Action Plan. During this activity, the concept of bamboo being able to withstand and address the impact of a typhoon was used to illustrate resilience. Participant farmers were presented with the 13 indicators of agro ecosystem resilience. Each of the 13 indicators of resilience was slowly discussed with corresponding sub-indicators. These 13 indicators of resilience were the following: appropriately connected, optimally redundant, socially self-organized, functional response diversity, honors legacy, globally autonomous and locally interdependent, ecologically self-regulated, reasonably profitable, builds human capital, spatial/temporal heterogeneity, exposed to disturbance, coupled with local natural capital, reflective and shared learning. These were based on the pre-identified resilience indicators in an agro ecosystem by Cabell and Oelofse (2012). Based on the presentation, participants were given an informed decision and were asked to rank each of the 13 indicators

from one to ten, ten being the highest. High- and low-ranking indicators were further discussed to develop a community action plan. After the assessment and ranking, future community action plans were presented among the participant farmers.

RESULTS AND DISCUSSION

Vulnerability Matrix. The different vulnerable resources and livelihoods of the six (6) participant upland farming communities to climate-related hazards in Mati City, Davao Oriental, are shown in Table 2. Barangay Buso, Don Enrique Lopez, and Don Salvador Lopez experienced three (3) hazards: drought, change in rainfall patterns (short-term drought/floods), and human diseases. Sanghay and Culi-an were only affected by two (2) hazards: drought and a change in rainfall pattern, while Taguibo experienced only one (1) hazard, a shift in rainfall pattern. Farming communities that experienced more climate-related hazards showed more vulnerable livelihood resources (Buso, Don Don Enrique Lopez, and Don Salvador Lopez), while communities with lesser climate-related hazards showed lower vulnerabilityto climate change (Taguibo). Natural resources such as crops, livestock, and water were the main livelihoods being affected by drought, changes in rainfall patterns, and human diseases, while financial resources such as market price and loans were being affected mainly by drought and changes in rainfall patterns.

Table 2. Vulnerability matrix of six (6) upland farming communities in Mati City, Davao Oriental (note: letters in the sum column signify rank e.g. a=highest, b=second highest).

Barangay	Resources	Livelihoods	Drought	Changed Rainfall Pattern (Short Term Drought/ Floods)	Human Diseases	Sum
Taguibo*	Natural	Vegetables	/	2	/	2
		Corn	/	2	/	2
	Financial	Market Price	/	3	/	3
Buso***	Natural	Farming	2	2	0	4
		Livestock Raising	3	2	0	5d
		Free Range Chicken	3	3	0	6c
	Financial	Farm gate/market price	2	2	0	4
		Jobs/Employment	1	2	1	4
		Loans	3	2	1	6c
		High farm input price	2	2	0	4
Don Enrique Lopez***	Natural	Livestock (cow, chicken, swine, goat, horse, carabao)	3	2	1	6c
	Financial	Market Price	3	3	1	7b
Don Salvador Lopez***	Natural	Farming	3	3	3	9a
		Livestock (chicken, goat, cow, swine)	2	2	2	6c
	Financial	Reduce Production	3	2	2	7b
		Marketing Price	2	2	2	6c
Sanghay**	Natural	Livestock (Swine, chicken, cow, goat, carabao, duck)	3	3	/	5d
		Water source	3	3	/	6c
	Financial	Market Price	3	3	/	6c
Culi-an**	Natural	Livestock (swine, chicken, cow, goat)	2	2	/	4
		Water source (spring)	2	2	/	4
	Financial	Market Price	3	2	/	5d

* Community with one hazard
** Community with two hazards
*** Community with three hazards

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Hazard-Impact-Coping-Strategy. Table 3 shows the identified climate-related hazards in each participant community and coping strategies and adaptation used to address the impacts of short-term drought, floods, or landslides. The impact of drought in four (4) upland farming communities of Buso, Don Don Enrique Lopez, Don Salvador Lopez, and Culi-an includes lack of water for agricultural use (5), death of plants and animals (4), less productivity (3) and decrease of income (3). On the other hand, the impact of flood or landslide in Taguibo, Don Enrique Lopez, Sanghay, and Culi-an includes the death of plants and animals (3), a decrease in income (2), over flow of drainage (1), and soil erosion (1). Due to these climate impacts, many farmers were able to form their coping strategies and adaptation activities. Farmers from Buso, Don Don Enrique Lopez, Don Salvador Lopez, and Culi-an cope with the effects of short-term drought by waiting for the rain, then planting (3), working as a farm laborer (3), finding alternative sources of water (3) and working as a driver of a pedicab or motorcycle (2) while farmers from Taguibo, Don Enrique Lopez, Sanghay and Culi-an cope and adapt flood/landslides through *Bayanihan System*(2), replanting damage crops (2), money lending (1) and *negosyo* (1). In terms of effectiveness and sustainability, participant farmers were able to identify money lending (3,3), buying water for domestic use (3,3), manually fetching water (2,3), and reducing food consumption (2,3) as the most effective and sustainable ways of addressing the impact of short-term drought. Moreover, money lending (3,3), *Bayanihan System* (3,2.5), and replanting damaged crops (2.5,2.5) were seen as effective and sustainable during the occurrence of floods or landslides. Some social dynamics were negatively and positively reinforced during different climate-related hazards in the area. Based on the FGD workshop, one (1) community was able to identify the negative impact of climate change in their community, where water problems during short-term drought caused quarrels among farmers. However, positive social cohesion was reinforced during flooding or landslides, where two (2) communities identified the *Bayanihan System* as one of the practical and sustainable coping strategies.

Table 3. Impact of climate-related hazards and coping strategies/adaptation of six (6) upland farming communities in Mati City, Davao Oriental.

Barangay	Hazard	Impacts	Frequency	Coping Strategies/Adaptation	Frequency	Effectiveness	Sustainability
Buso	Short Term Drought	Lack of water source for agricultural use	5	Wait for the rain then plant	3	1.83	2
Don Enrique Lopez		Death to plants and animals	4	Farm laborer	3	1.33	1.33
Don Salvador Lopez		Less productive	3	Find alternative source of water	3	1	1.33
Culi-an		Decrease of income	3	Work extra as driver	2	1	1
		Lack of food/starvation	1	Money lending	1	3	3
		Inability to send children to school	1	Buying water (domestic use)	1	3	3
		Prone to wild fire	1	Manually fetch water from deep well	1	2	3
		Water problem cause quarrel among farmers	1	Reduce food consumption	1	2	3
		Sickness/Illnesses (sometimes lead to death)	1	Induce fogging and fruit bagging	1	3	2
		Increase crop pest and diseases	1	Look for alterntive source of food	1	2	2
				Sell livestock	1	2	2
Taguibo	Flood/ Landslide	Death of plants and animals	3	Bayanihan System (people helping each other)	2	3	2.5
Don Enrique		Decrease of income	2	Replant damage crops	2	2.5	2.5
Sanghay		Overflow of drainage system caused low mobility of residents	1	Money lending	1	3	3
Culi-an		Soil Erosion	1	Negosyo	1	1	1
				Farm labor (side line)	1	1	1
				Contour Farming	1	2	1

Resilience Indicators. The 13 indicators of agro ecosystem resilience from the six (6) upland farming communities in Mati City, Davao Oriental, were listed in Table 4. The ranking of the 13 indicators of agro ecosystem resilience was listed from lowest to highest; Appropriately Connected (1), Optimally Redundant (2), Socially Self-Organized (3) Functional/Response Diversity (3), Honors Legacy (4), and Globally autonomous & locally interdependent (5) while the highest indicators were Ecologically Self-Regulated (6), Reasonably Profitable (7), Builds Human Capital (8),

Spatial/Temporal Heterogeneity (9), Exposed to disturbance (9), Coupled with natural capital (9) and Reflective & shared learning (10).

The four communities with the highest resilience were Buso (7.9), Don Salvador Lopez (7.4), Culi-an (7.2), and Taguibo (7.1), while the communities with the lowest resilience were Sanghay (6.9) and Don Enrique Lopez (5.9). Both Sanghay and Don Enrique Lopez showed low ranking in resilience idicators of 'appropriately connected' and 'socially self-organized' due to weak collaboration among farmers and farmers organizations, inactive/non-functional farmers organizations, only a few community people were involved in farmers' organizations and absence of farmers co-op. In contrast, Don Enrique Lopez showed the lowest ranking in the 'optimally redundant resilience' indicator due to water shortage in both domestic and agricultural use as well as low access to organic nutrient sources for crop production.

Table 4. Site-specific and overall ranking of resilience indicators among six (6) upland farming communities in Mati City, Davao Oriental.

Indicators of Resilience	Taguibo	Buso	Don Enrique Lopez	Women /Men (DEL)	Don Salvador Lopez	Women /Men (DSL)	Sanghay	Culi-an	Total	Average	Rank
Appropriately Connected	6	8	3		6		5	7	35	5.83	1
Optimally Redundant	7	8	1		6		7	8	37	6.17	2
Socially Self-Organized	8	5	5		7		5	8	38	6.33	3
Functional/response diversity	6	8	6		8		6	4	38	6.33	3
Honors Legacy	5	8	5		6		6	9	39	6.50	4
Globally Autonomous and Locally Interdependent	6	5	9		7		6	7	40	6.67	5
Ecologically Self-Regulated	8	8	5		7	6W&7M	8	7	43	7.17	6
Reasonably Profitable	6	9	8		9		7	6	45	7.50	7
Builds Human Capital	6	8	9		8		7	8	46	7.67	8
Spatial/Temporal Heterogeneity	8	9	7		8	9W&7M	8	7	47	7.83	9
Exposed to Disturbance	8	8	6	7W&5M	8		8	9	47	7.83	9
Coupled with Local Natural Capital	9	9	6	6W&5M	8		9	6	47	7.83	9
Reflective and Shared Learning	9	10	7		8		8	7	49	8.17	10
Total	92	103	77		96		90	93			
	7.1	7.9	5.9		7.4		6.9	7.2			

Upland farming communities such as Buso, Don Enrique Lopez (DEL), and Don Salvador Lopez (DSL) were able to experience three (3) climate-related hazards. They were considered vulnerable, i.e., vulnerable to short-term droughts and floods (Table 2). Only Don Enrique Lopez showed the lowest resilience compared to Buso and Don Salvador Lopez due to the community's low ranking of resilience indicators such as 'optimally redundant' (1), 'appropriately connected' (3), 'socially self-organized' (5) and 'honors legacy' (5). With a higher probability of being exposed to disturbance, Buso and Don Salvador Lopez still showed the highest overall resilience to climate-related hazards, with 7.9 and 7.4 rankings, respectively. Buso and Don Salvador Lopez participants identified that their resilience was associated with indicators such as 'reasonably profitable' and 'reflective and shared learning'. Participants from both communities validate that their upland farming activities were profitable as they owned their farms with diverse crop production that did not affect their income source even if the price of coconut dropped in the past 3-5 consecutive years and were able to purchase motorbikes/vehicles. Moreover, Buso and Don Salvador Lo-

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pez participants mentioned high rank in shared learning since most farmers have access to Farmers Field School and barangay agriculture technicians with nineteen (19) active farmers and community organizations.

Four (4) resilience indicators showed differences in perspective among women and men participants from Don Enrique Lopez and Don Salvador Lopez. In Don Enrique Lopez, women ranked 'exposed to disturbance' as higher than men (7 vs. 5) because they have different experiences during drought and flood/landslide. Men mentioned that they already did their part until their shoes were used up and torn off, while women noted that they have higher determination to survive even amid disturbance. Moreover, women ranked 'coupled with local natural capital' higher when compared to men (6 vs. 5) because women managed water resources during a drought, and with this scenario, men thought that women were using excessive amounts of water even at the onset of drought in the community. In Don Salvador Lopez, on the other hand, women ranked 'ecologically-self regulated' lower than men (6 vs. 7) because women were concerned with increasing crop diversity by planting more vegetables.

In contrast, men were involved in planting falcata (timber). It was also interesting to note that women rank 'spatial & temporal heterogeneity' higher than men (9 vs 7) because women were involved in vegetable production and crop rotation was possible. In contrast, men focused on fruit trees and stated that there was difficulty doing crop rotation with coconut and cacao.

Community Action Plan. Each of the participant upland farming communities was able to assess and identify their respective community action plan, as shown in Table 5. Both communities of Buso (7.9), who had the highest level of resilience, and Don Enrique Lopez (5.9), who had the lowest level of resilience, formed seven (7) and six (6) community action plans, respectively. Participants from Taguibo also formed five (5) community action plans, followed by Sanghay with four (4) community action plans, then Don Salvador Lopez (3) and Culi-an (2).

Table 5. Community action plan of the six (6) upland farming communities in Mati City.

Barangay	Resilience Indicator	Community Action Plan
Taguibo	Honors legacy (5)	Need to have training on traditional methods combine to modern agricultural techniques
	Appropriately Connected (6)	They are proposing higher amount of calamity funds/Government Assistance (Php 2 Million per year)
	Builds Human Capital (6)	Lack of Health and Day Care Center
		Need of Birthing Place (Bahay Paanakan)
		Need of all purpose meeting hall, activity center for young people.
Buso	Globally autonomous & locally interdependent (5)	Farmers in the area were willing to re-initiate farmers co-op and motivated to have one or two.
	Ecologically self-regulated (8)	The problem is that livelihood is still not enough.
	Appropriately connected (8)	Need to improve crop production and need high quality seeds.
	Optimally redundant (8)	There is plenty of water for agricultural production but there is no established irrigation system. There is a need to build water pump to transport water to all agricultural land in the area.
	Builds human capital (8)	The need is to build functional water facilities in the area for domestic use.
	Coupled with local natural capital (9)	There is still a need to improve waste management system and residential water system.
Don Enrique Lopez	Optimally redundant (1)	Future plan-Solution: Deep well and tank (domestic and agricultural use)
	Appropriately connected (3)	Future plans: organic fertilizer machineries and federation among farmers organization.
	Socially self-organized (5)	Need to build the capacity of farmers organization
		Need financial subsidies/assistance
	Ecologically self-regulated (5)	Farmers wanted to intercrop more crops such as banana and corn.
	Reflective & shared learning (7)	Need to have Farmer's Field School in the community.
Don Salvador Lopez	Globally autonomous & locally interdependent (7)	Hoping to have co-op to help influence price for commodity.
	Functional & Response diversity (8)	There is still a need to be independent from inorganic fertilizer= need to have organic fertilizer
	Builds human capital (8)	The right side of the road were not constructed yet
Sanghay	Builds human capital (7)	They hope to have their own hospital in the community
	Reasonably profitable (7)	The people wanted to get the result of the research so that they could get necessary funding for the community.
		Need to solve dependence on fertilizer outside
	Ecologically self-regulated (8)	They wanted to plant more banana as the price is okay
Culi-an	Functional & Response diversity (4)	Training on Pest Control
	Socially self-organized (8)	Need of additional capital in the production

Each participant's upland farming community identified different site-specific community action plans to increase their resilience to climate change. Participants from Taguibo, Buso, Don Salvador Lopez, and Sanghay planned to improve the Builds Human Capital indicator, which involves the construction of health facilities (i.e., health center, *bahay Peranakan* and hospital), schools (Day Care Center), social halls (i.e., multi-purpose hall, activity center for young people) and road widening. Moreover, participants from Taguibo, Buso, and Don Enrique Lopez form a community action plan to address the Appropriately Connected indicator by acquiring machinery to produce organic fertilizer to improve crop production, high-quality seeds, a federation among farmers, and proposing higher calamity funds. Participants from Buso, Don Enrique Lopez, and Sanghay proposed to address the ecologically Self-registered indicator by planting more crops such as bananas and corn, which was seen to increase income sources. In contrast, Don Enrique Lopez and Culi-an participants provided action plans to improve their Socially Self-regulated indicator through capacity building of different farmers' organizations, financial assistance, or additional capital for production.

The different frequency of resilience indicators that need to be strengthened and developed is shown in Table 6. Based on the overall community action plans of six (6) upland farming communities, building human capital (6) had the highest rank, followed by appropriately connected (3), socially self-regulated (3), ecologically self- (3), optimally redundant (2), functional/ response diversity (2), globally autonomous (2), and reasonably profitable (2).

Resilience indicatorssuch as Build Human Capital, Appropriately Connected, and Socially Self-Regulated showed the highest frequency as community action plan reflects the need to improve the sociological component of the Socio-Ecological System, while Ecologically-Self Regulated, Optimally Redundant, and Function/Response Diversity focuses the community in strengthening ecological component of the Socio-Ecological System.

Table 6. Ranking of community action plans based on resilience indicator frequency.

Resilience Indicator	Frequency	Community Action Plan
Builds Human Capital	6	Lack of Health and Day Care Center
		Need of Birthing Place (Bahay Paanakan)
		Need of all purpose meeting hall, activity center for young people.
		They hope to have their own hospital in the community
		The need is to build functional water facilities in the area for domestic use.
		The right side of the road were not constructed yet
Appropriately connected	3	Future plans: organic fertilizer machineries and federation among farmers organization.
		They are proposing higher amount of calamity funds/Government Assistance (Php 2 Million per year)
		Need to improve crop production and need high quality seeds.
Socially self-organized	3	Need to build the capacity of farmers organization
		Need financial subsidies/assistance
		Need of additional capital in the production
Ecologically self-regulated	3	Farmers wanted to intercrop more crops such as banana and corn.
		The problem is that livelihood is still not enough.
		They wanted to plant more banana as the price is okay
Optimally redundant	2	Future plan-Solution: Deep well and tank (domestic and agricultural use)
		There is plenty of water for agricultural production but there is no established irrigation system. There is a need to build water pump to transport water to all agricultural land in the area.
Functional & Response diversity	2	Training on Pest Control
		There is still a need to be independent from inorganic fertilizer= need to have organic fertilizer
Globally autonomous & locally interdependent	2	Farmers in the area were willing to re-initiate farmers co-op and motivated to have one or two.
		Hoping to have co-op to help influence price for commodity.
Reasonably profitable	2	The people wanted to get the result of the research so that they could get necessary funding for the community.
		Need to solve dependence on fertilizer outside
Honors legacy	1	Need to have training on traditional methods combine to modern agricultural techniques
Reflective & shared learning	1	Need to have Farmer's Field School in the community.
Coupled with local natural capital	1	There is still a need to improve waste management system and residential water system.

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CONCLUSION

There was a clear indication that climate change has been affecting the six (6) participant upland farming communities. Whether this climate change was in the form of drought, change in rainfall patterns causing floods, or short-term drought during the rainy season, many livelihood resources were affected because of climate change in the region. The vulnerability of the different livelihood resources affecting the everyday lives of many farmers among upland farming communities in Mati City, Davao Oriental, was evident in the result of this study. However, the cultivation and production of diverse crops and livestock in the area have resulted in a more varied source of income in each household as well, and the availability of an alternative off-farm income, such as driving and laboring, helps reduce the impact of production losses due to drought, floods, and short-term droughts. Moreover, the availability of access to farm-to-market roads (Rank 8), diverse intercropping practices of cacao, mango, banana, corn, and vegetables (Rank 9), as well as regular monthly collaborations between farmers and advisory networks in sharing current production practices (Rank 10) increases the resilience of the participant communities to climate impacts. At the ecological scale, almost all the participant upland farming communities had diverse crop production with distinct patches that contribute to the overall resilience of each upland farming community. At the sociological scale, there was a significant disparity regarding the number of functional farmers' organizations in each community. Communities such as Taguibo, Don Salvador Lopez, and Culi-an have active farmers' organizations with multiple suppliers and traders in their respective areas, thus showing high resilience. On the other hand, communities with lower ranking in social organization, access to reliable suppliers, and collaboration with government agencies and universities resulted in lower resilience to climate impacts reflected in Don Enrique Lopez and Sanghay.

RECOMMENDATION

There is a need to create a participatory assessment/methodology intended for women in order to understand the specific role of women in coping with/adapting to the current impacts of climate change. Additionally, there is a need to assess resilience among lowland farming communities and fishing communities to validate and address the impacts of climate change in the agriculture and fisheries sectors, respectively. The result of this paper could be used as baseline data in drafting site-specific policies to address and mitigate the adverse effects of climate change at the local and national levels.

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