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ASSESSMENT OF THE IMPACTS OF FLASHFLOODS AND LANDSLIDES IN BRGY. ANDAP, NEW BATAAN, COMPOSTELA VALLEY, PHILIPPINES: A LOCAL COMMUNITY PERSPECTIVE

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ABSTRACT – In December 2012, Brgy. Andap, New Bataan in Compostela Valley suffered catastrophic damages due to Typhoon Bopha. Participatory Rural Appraisal (PRA) activities were conducted in Brgy Andap six months after the calamity to elicit the community's local ecological knowledge on the land use and livelihood changes; their impacts on environmental degradation; causal factors of the 2012 flash flood and landslide; solutions for livelihood recovery; and recommendations to mitigate flashfloods and landslides The various PRA activities include timeline, community-based resource maps, causal mapping, and focus group discussion. New Bataan used to have lush primary forest, fertile soils and abundant minerals. For decades, the livelihood in the community was mainly agricultural planting vegetables, annual crops and perennial trees. Logging and mining activities since the 1950's resulted to deforestation. These decade-long activities have increased the area's vulnerability to natural disasters. Locals perceive logging and mining activities as the major causes of landslides and floods in the locality. Community recommendations to aid in the community's livelihood recovery include support for the restoration of farming activities in the form of subsidies for agricultural inputs, provision of trainings and seminars on modern agricultural practices and establishment of micro-credit financing institutions. To mitigate flashfloods and landslides, the community recommends logging ban and planting of trees in the denuded forests, moratorium on mining and introdution of livelihood opportunities. Protection of the environment will lead to sustainable livelihoods. Climate change adaptation and mitigation strategies as well as careful consideration of the local geological and geographical characteristics of the

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locality, should be integrated in the revision of the New Bataan Comprehensive Land Use Plan (CLUP) and the Barangay Andap Development and Security Plans to make the local communities climate change-sensitive and resilient. This study has shown that participatory rural approaches provide an in-depth understanding of the local community's perception on the causes and impacts of natural hazards, and how to mitigate these impacts.

Keywords: bioremediation, heavy metal contamination, mined-out community, social attitude and acceptability

INTRODUCTION

The geographical location of the Philippines has made the country highly susceptible to natural hazards (Acosta et al. 2013). Over the past decade, the country has been one of the top 5 countries that are highly vulnerable and susceptible to natural disasters. The other four countries on the list include China, the United States, India and Indonesia (Guha-Sapir et al. 2013). In 2012, a total of 471 natural and human-induced disasters were recorded in the Philippines. These disasters affected more than 12 million people and cost more than Php 39.9 billion in economic losses. In that year, the country ranked highest in the world with the most number of fatalities caused by natural disasters. According to the Office of the U.S. Foreign Disaster Assistance (OFDA) and the Center for Epidemiology of Disasters (CRED) International Disaster Database, casualties due to natural disasters reached a total of 2,360 individuals. Majority of the deaths (1,901 people) was attributed to the devastation caused by Typhoon Bopha (Bopha). As such, the country ranked second in the world in the number of people affected by natural disasters (CDRC 2013).

Furthermore, flooding was the most frequent natural disaster in 2012. A total of 143 flooding incidences were recorded. This accounts for 30% of the total number of disasters that occurred in that year. Having occurred 115 times, fire was identified as the second most frequent disaster of 2012. The three other top disasters of 2012, in terms of frequency, were landslide (106 times), storm surge (29 times) and armed conflict (24 times). The frequency of flood and landslide events is expected to increase in the future because of the impacts of climate change and extremes. Not only climate variability but also the continuing environmental degradation have resulted to frequent occurrences of disaster events varying in magnitude from one geographic location to another (Abucay et al. 2014; Eugenio et al. 2014, 2016). Using both historical and recent (2000-2013) tropical cyclone tracks, Salvacion et al. (2014) noted that spatio-temporal risks to tropical depression and typhoon in the country have changed over the past decades. The results of this study estimated that Visayas and Mindanao islands has recorded an increase in areas and risk level to tropical storm and typhoon during the last two months of the year. This estimation is substantiated by the most recent devastating typhoons in Eastern Davao in Mindanao in 2012 (Pablo) and Eastern Samar in Visayas in 2013 (Haiyan).

Typhoon Bopha, locally known as Typhoon Pablo, caused the most destruction among the typhoons that made a landfall in the Philippines until 2012 (CDRC 2013). It was the worst typhoon in the world in that year and, after Haiyan, the second deadliest ever recorded in the Philippines. The disaster mortality (1,901 deaths) of Typhoon Bopha in Compostela Valley in the Davao region of the country on December 4, 2012 accounted for 19.7% of the global disaster mortality in 2012. The damages caused by Typhoon Bopha amounted to US$ 1.7 billion, making the Philippines one of the top countries in the world that have accumulated the highest economic losses (Guha-Sapir et al. 2013).

A landslide is the downward movement of earth, rock, or debris through a sloping terrain of land. Geology, morphology, heavy rains, earthquakes, volcanic eruption, human activities or other factors that render the slope unstable are the various factors that may cause landslides. Geology factor refers to the rock or earth material itself that may be naturally weak or fractured (https://www.nationalgeographic.org/encyclopedia/landslide/).

Flashfloods are fast-moving waters on land within a catchment where the response time of the drainage basin is short. The occurrence of a flashflood is affected by terrain gradients, soil type, vegetative cover, human habitation, and antecedent rainfall (Doswell, 2015). It occurs when the heavy rainfall exceeds the absorptive capacity of the ground or when the creeks and streams are over-filled with water that overtops their banks (NSSL).

Debris flows are fast-moving slurries of water and rock fragments, soil, and mud with the consistency of freshly mixed concrete (Rodolfo et al., 2016, Takahashi, 1981; Hutter et al. 1994; Iverson 1997; Iverson et al., 1997)). Heavy rainfall that exceeds the critical threshold of intensity, duration and accumulation may dislodge soil, sediment and rock masses into landslides that may merge to form debris flow (Lagmay et al., 2007, Pierson and Scott, 1985; Smith and Lowe, 1991).

Participatory Rural Appraisal (PRA) is an approach that encourages local community members to share, express and analyse their personal knowledge of the environmental, social and economic conditions of their community (Chambers, 1994) and it empowers communities to decide, plan, and implement their programs (Townsley 1996). PRA is used to understand the process of development in the community, and the social, economic, and environmental variables that may have affected this process (Binns et al., 1997). PRA methods are also used to elicit open participation from an intended group to explore community perception (Maalim, 2006) and to build indigenous knowledge (Mukherjee 1993). PRA acknowledges indigenous knowledge systems and its critical role in addressing concerns of a community, and has a holistic approach that focuses on the people-environment relationship (Binns et al. 1997). The visual methods in PRA, such as mapping and creating diagrams, promote interaction among the participants and bridge the gap between literacy and possible illiteracy, and build relationships with elders (Doyle and Krasny, 1994). PRA is a response to the needs of the communities and target groups Chandra (2010).

In the Philippines, PRA has been adopted to understand the dynamic interactions and environmental problems in muyong-payoh system of Banaue, Ifugao (Magcale-Macandog 2018), integrating climate change adaptation and mitigation into comprehensive land use planning (Endo et al. 2017), eliciting ecological knowledge and community perception on fish kill in Taal lake (Magcale-Macandog et al. 2014), and assessment of environmental degradation and proposed solutions in the Sta. Rosa (Magcale-Macandog et al. 2011a) and Los Banos sub-watershed (Magcale-Macandog et al. 2011b).

PRA was applied by Magcale-Macandog et al. (2011a) to understand the patterns, drivers and impacts of land-use change in Sta. Rosa subwatershed. Drivers of these land use changes were population immigration, food security, income generation, industrialization and urbanization. Impacts of these developments include air, water and land pollution; flash floods and environmental degradation. The PRA enabled the local communities to express their concerns and perceptions about the environmental problems that they face and to formulate doable solutions to address these problems. The findings of this study were helpful to the LGU officials in creating local ordinances and programs to address these environmental problems in the watershed.

Magcale-Macandog et al. (2011b) conducted an initial rapid assessment of patterns and drivers of land-use changes within the Los Baños subwatershed to understand the interactions between land cover, economic intensification and river-catchment functioning through the conduct of Participatory Rural Appraisal (PRA). Increasing population and migration to upland areas, demand for food and income, and policies were the major driving factors of land use change in the watershed. The communities proposed various solutions to their problems including alternative livelihood sources, tree planting in landslide prone areas, creation of early warning system for flash floods, strict implementation of policies on waste management, regulation on the introduction of fish species in the lake and regulation of fish cage operations in the lake.

In another study, Macandog et al. (2014) applied PRA methodologies to elicit local ecological knowledge and community perception on the driving forces and possible solutions to address fish kill in Taal lake. Fishkill in the lake were attributed to various factors that include oxygen depletion, volcanic activity, lake overturn, sudden changes in water color, seasonal temperature changes, wind velocity and direction, hydrothermal vents, poor water quality, and agricultural pollution from swine and poultry farms. The response of the community to reduce the impacts of fishkill is anchored on their local ecological knowledge, experience, technology, and vigilance.

This study was conducted to elicit community perception on the drivers and impacts of the 2012 Typhoon Pablo flash flood and landslide in New Bataan, Compostela Valley through the conduct of various Participatory Rural Appraisal (PRA) activities. Specifically, the study sought to document community perceptions and local knowledge on the influence of different livelihood activities to environmental degradation and to relate various factors that contributed to the landslide and flashflood of 2012. The study also aimed to involve the local community in identifying feasible solutions for the recovery of their livelihood and to craft adaptation and mitigation strategies to landslides and flashfloods.

MATERIALS AND METHODS

Case Study Area

Compostela Valley was the most damaged province in Davao region during the wrath of Typhoon Bopha. Heavy and continuous rainfall triggered the devastating flashfloods and landslides that ravaged the municipality of New Bataan in Compostela Valley affecting more than a thousand families and terribly ruined large scale of local livelihoods (Acosta et al. 2016). The United States meteorological experts classified the typhoon as Category 5 where winds have an average speed of 185km/hr and gusts reaching 210 km/hr. The province of Compostela Valley was the region with the most number of recorded deaths. Despite advanced warnings and preparations by communities against the tropical cyclone, Typhoon Bopha caused heavy damage with 1,067 deaths, 800 missing and Php 7 billion worth of damage to infrastructure and agriculture (Manuta 2013). Majority of the casualties and destruction occurred in Barangay Andap, New Bataan. Thus, the village of Andap was selected as the case study site.

Field Site Visit

Prior to field site visit, published literature on Typhoon Bopha and the disaster it has caused in Compostela valley were reviewed. Research team meetings were conducted to plan for the activities during the field visit. During the initial visit to New Bataan on June 5, 2013, courtesy call was made at the Mayor's office to present the study and its objectives and to seek for the Mayor's approval, support and cooperation in the conduct of the study. With the approval and support of the Mayor, the research team requested for

secondary data and photos from the LGU regarding Typhoon Bopha, including CLUP. Reconnaisance survey of the areas affected by the debris flow was done by driving around New Bataan and in Barangay Andap. Local data were collected from Barangay Andap including socio-economic information, land use and damages due to Typhoon Bopha and a copy of the Andap Barangay Development and Security Plan 2011-2015. Arrangements were made with the Barangay Andap officials regarding the conduct of the PRA the following day.

Participatory Rural Appraisal (PRA)

PRA activities were conducted in the village of Andap, New Bataan on 6 June 2013, about six months after the Typhoon Bopha calamity. In coordination with the Local Government Unit officials of New Bataan and barangay officials of Brgy. Andap, about 30 local community members were selected and invited to participate in the PRA activities. Participants include elderlies, farmers, housewives, local government officers, youth, indigenous peoples, and other community leaders who are knowledgeable on livelihood changes and environmental degradation in the village over the decades. Such composition of the participants was designed to gather perspectives of the various sectors of the community. The number of participants was limited by the size of the barangay hall where the event was held.

Various PRA activities conducted include Key Informant Interviews, Focus Group Discussion, Timeline, Community Land Use Mapping, Causal Mapping, and Strengths, Weaknesses, Opportunities and Threats (SWOT). Timeline and community-based mapping were done to capture a chronological and visual description of community developments, livelihood, deforestation and mining activities, and environmental degradation in Brgy. Andap through time. For the time line, metacards and pens were handed to the participants and they were asked to write down the significant developments (materials for housing, school, road, piped water, bridge, transportation), natural hazards (flood, El Niño), environmental degradation (deforestation, mining), and livelihood (agricultural crops and trees planted, fishing, small scale mining) for each time period (i.e., 1960-1980, 1980-2000, 2000- 2012). They were given ample time (10-15 minutes) to discuss with their group mates and write down their answers. Then, they posted their meta cards in Manila papers mounted on the wall. After all the metacards were posted for each time period, the answers were read out aloud by the facilitator and lead a focus group discussion to elaborate on the answers. The process was repeated for the next time period. The community land use mapping activity allowed participants to illustrate where major land use and livelihood changes occurred over the decades using community-based knowledge. This was executed for each time period by asking the participants to sketch a visual representation of their barangay and locate the mountains, forests, houses, roads, and areas used for planting agricultural crops and trees for each time period. The process was repeated for 3 time periods and they captured visually the changes in the land use, increase in number of houses, changes in house types, decrease in density of trees in the forest, evolution of building materials for their houses and infrastructure developments like roads, bridges, school and electricity.

Focus group discussion with the PRA participants and key informant interviews with the LGU officials including the Mayor, agriculture, environment and disaster risk reduction and management officers gathered information on the disaster brought about by Typhoon Pablo, significant factors that have influenced environmental degradation such as land use change, crops and trees planted and mining activities in the community. These activities also focus on the drivers of land use change and livelihood change and their impacts on environmental, social, and economic aspects of the community.

Causal maps showed the relations and interrelatedness of identified drivers and factors that

contributed to existing problems in the community. The participants were asked to write in metacards the various factors and drivers that contributed to the occurrence of landslide and flashflood in their locality. One factor was written per metacard and these metacards were pasted on the Manila paper posted on the wall. The participants were asked to draw lines to connect the causes and effects. Then, a focus group discussion was conducted for each connection. The process was repeated until all factors and drivers were connected to landslide and flashflood, and the group has an understanding of their causal map.

The SWOT analysis investigated the internal strengths and weaknesses of the community in addressing and solving pressing environmental and economic issues in the community. It also assessed available external opportunities and possible threats to the implementation of community-identified solutions to the problems. For this activity, the focus of SWOT analysis was their livelihood rehabilitation which was important for their recovery from the disaster brought about by Typhoon Pablo.

RESULTS AND DISCUSSION

Description of the Study Site

The municipality of New Bataan with 16 barangays was formally established by an act of Congress on 18 June 1948 in honor of Luz Banzon-Magsaysay, the widow of President Ramon Magsaysay who hailed from Bataan province in Luzon (Rodolfo et al. 2016). New Bataan is located in the province of Compostela Valley in the Davao region (Figure 1). It has a total land area of 55,315 hectares. According to 2015 census, the municipality has a total population of 47,470 from 10,562 households. New Bataan is highly agricultural, wherein 24.57% (13,591 hectares) of total land area is dedicated to agricultural use. As such, farming has been the prominent livelihood activity in the area. While half of the active population are farmers, the other half engage in teaching, government work and private work (New Bataan CLUP 2010).

New Bataan has a Type II Climate, which is characterized by no dry season with a very pronounced maximum rain period. Its average annual precipitation is 2648 mm while the average temperature is 25.7 °C (Climate-data.org). The monthly rainfall generally occurs in December to January and there is no single dry month in the regions (New Bataan CLUP 2010).

Barangay Andap was established at the head of the valley on high grounds at the mouth of a mountain drainage network. The valley was bounded by steeply sided slopes with deeply fractured rocks situated along the length of Mati Fault line. The location was not initially recognized as an alluvial fan (Rodolfo et al. 2016) where water drains. Its geological and geographical characteristics thus make the village susceptible to floods and landslides. Referring to the studies of Villanueva (2012) and Ferrer et al. (2014), Acosta et al. (2014) mentioned that New Bataan is in permanent danger due to its very high susceptibility to landslides and Andap in particular because it is situated in the path of potential debris flows. It was estimated that the flashflood deposits have an average thickness of 1-2 m and width of 50-70 meters (MGB 2012). More than 1,250 houses were either partially or totally damaged. The extent of the damage can be seen from Figure 2 below. The village center where school, health center, houses, resort, etc. were located was totally washed out by the flashflood and landslides, carrying along not only muds but also huge rocks from the adjacent mountain. Moreover, farmlands around the village center were similarly covered by these debris flow, making it impossible for farmers to cultivate.

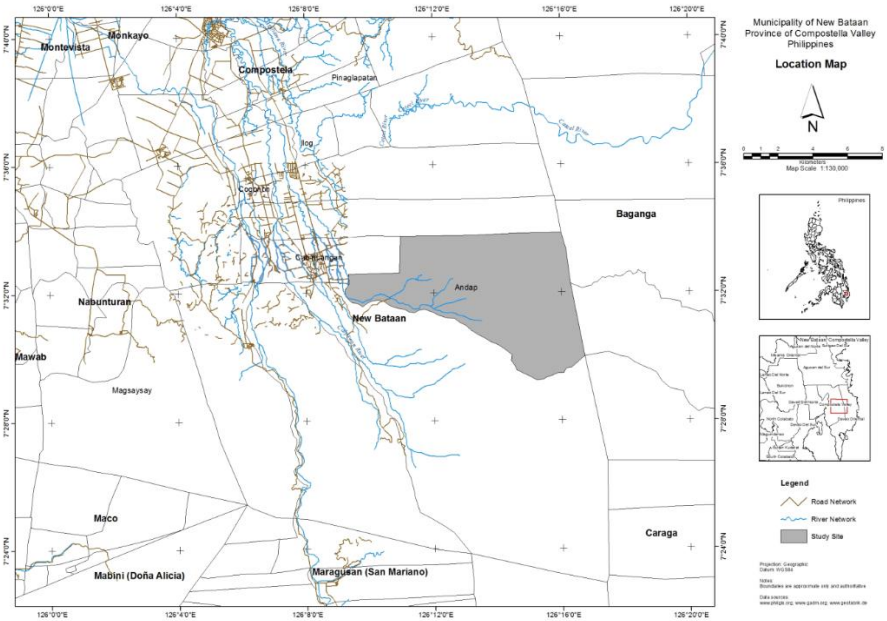

Figure 1. Location of Brgy. Andap in the municipality of New Bataan.

Figure 2. Photos of the village center of Andap before (left) and after (right) the floodflash and landslides.

Community demographics and Livelihood Patterns

In 2011, Brgy. Andap has a total population of 7,765 with 1,655 households (Andap Barangay Development and Security Plan 2011-2015). The average household size is 5. There are three ethnic groups in Brgy Andap: Mansaka (2,240), Surigaonon/Kamayo (277) and Mandaya (5,248). In 1959, the Bureau of Lands undertook cadastral survey in Brgy Andap followed by the release of cadastral land titles that attracted migrants from Visayas and Luzon (Brgy Andap Development and Security Plan 2011-2015) to settle in Brgy Andap. This also motivated the indigenous communities to develop agricultural farms within

the barangay. Farmers compose 23.6% of the total economically active population while school age make up 42%, employed population make up 22.2% while unemployed make up 11.5% of the population (Andap Barangay Development and Security Plan 2011-2015).

Barangay Andap, one of the 16 barangays comprising New Bataan, is a rural area that covers the largest area of the municipality with 11,240.55 hectares or 20.32% of the total land area of New Bataan (Fig. 1). The land suitability map of the Municipality of New Bataan shows that land in Andap is largely suitable for planting tree species (9,679 ha), diversified crops (1,225 ha) and rice crops (411 ha). A land area of 196 ha is suitable for urban use. Existing land use in Andap is predominantly agricultural and forested (7,990 ha). Brushlands is the second largest land use covering 2,972 ha. Mixed crops including vegetables and high value crops cover 1,656 ha. Lastly, built-up areas in the barangay cover 96 ha (Andap Barangay Development and Security Plan 2011-2015).

An example of output of the timeline activity during the conduct of PRA activities is shown in Figure 3. According to the PRA participants, the various sources of livelihood of the local community of Brgy Andap prior to the occurrence of Typhoon Bopha in 2012 were agriculture, rubber tree plantation, logging, fishing, mining, and tourism (Figure 4). The local community has depicted the landscape in Brgy. Andap from 1960-1980 as a rural area with forests in the hills and mountains; abundant trees including coconut, coffee, rubber and timber species; crops including abaca, corn, vegetables and medicinal herbs in the agricultural farms; abundant fish in the river; and birds and other wildlife (Figure 5a).

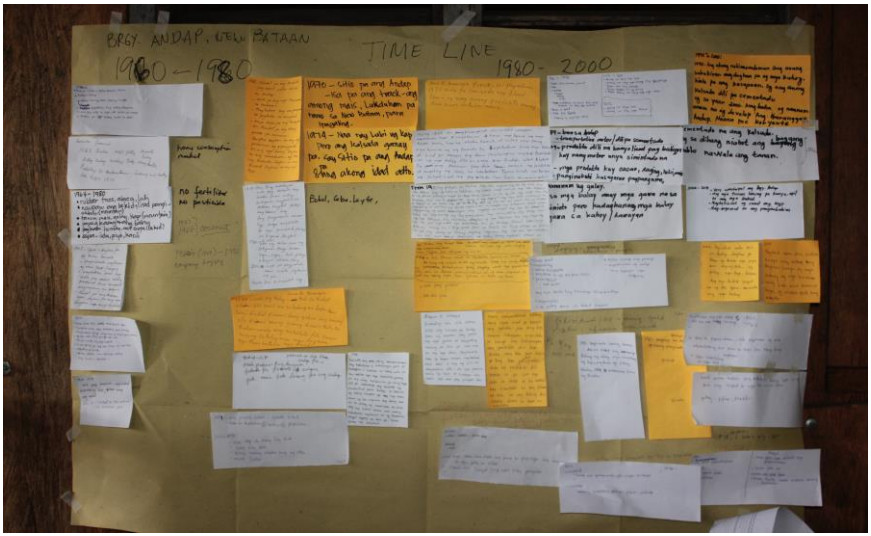

Figure 3. Results of timeline activity showing the metacards for 1960-1980 and 1980-2000 time periods.

Agricultural crops including abaca, vegetables, rubber, medicinal herbs, coconut, coffee,corn, rice were planted in Brgy. Andap since the 1960's (Figures 4, 5a). Vegetables are the major crops grown (as indicated by the thick line) in the area since the 1960 until 2012. Abaca was also populary grown in the 1960's but the intensity of planting declined through the decades.

There was massive logging of timber trees during the period of 1960-1980 (Figure 4). This is largely attributed to the logging activities of the Davao Corporation who acquired logging operations permit in the area in 1970 that opened up new roads and increased the population of Barangay Andap (Brgy Andap Development and Security Plan 2011-2015). These trees were replaced by coffee, banana, and cacao. Like logging activities, fishing was also a major activity in the community in the period of 1960-1980 (Figure 4). Further, many of the residents worked as hired labor in small-scale mining activities in the mountains from the 1960s until 2000.

The period of 1980 to 2000 was the golden years for agricultural activities in the area. There was widespread planting of coffee and corn (Figures 4, 5b). Peanut and cacao were also grown in the area during this period. Banana was initially planted in the area in the 1980s and is being grown up to 2012. This golden era of Barangay Andap started on March 10, 1978 when the Paglilikod ng Bagan Lipunan (PBL) program was launched under the regime of President Ferdinand Marcos that resulted to the creation of Barangay Andap as a Special Barangay. The economy of Barangay Andap started to grow under the leadership of the first elected barangay captain, Barangay Captain Ramon Tay on May 4, 1982 (Barangay Andap Development and Security Plan 2011-2015).

On the other hand, planting of abaca declined in the period of 1980-2000 and further declined since the early 2000's (Figure 4). Lalusin (2010) reported that abaca production in the Philippines rapidly declined since the 1980's due to a number of reasons including unavailability of improved varieties and diseases due to abaca bunchy top (ABT), abaca mosaic (AM) and abaca bract mosaic (ABM).

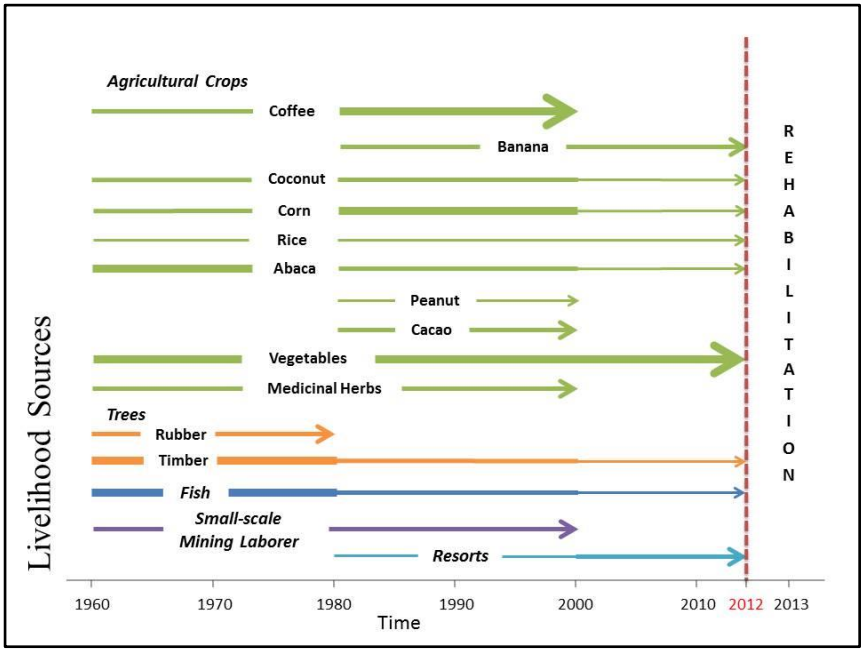

Figure 4. Timeline of livelihood sources in Brgy. Andap, New Bataan. Thickness of lines indicate intensity of livelihood activity: the thicker the line, the greater the intensity of the activity.

Additionally, the enormous decline of the trees in the forest and agricultural farms was accompanied by the decline of bird and wildlife population during this period (Figure 5b). Fishing activities continually declined since the 1980s while small-scale mining activities continued at the same intensity as the previous time period (Figure 4).

In the recent decades of 2000-2012, there were much less trees in the mountains and farms due to the cutting of forest trees and conversion of forest lands into agricultural areas that has been going on for several decades (Brgy Andap Development and Security Plan 2011-2015). Coconut and a few timber trees were left in the area. The major crops grown were banana and vegetables (Figure 4). Other crops grown were rice, corn and a few abaca. Coffee, cacao, peanut and medicinal herbs were no longer grown. Fishing activities continually declined due to dwindling fish resources in the area (Figure 4).

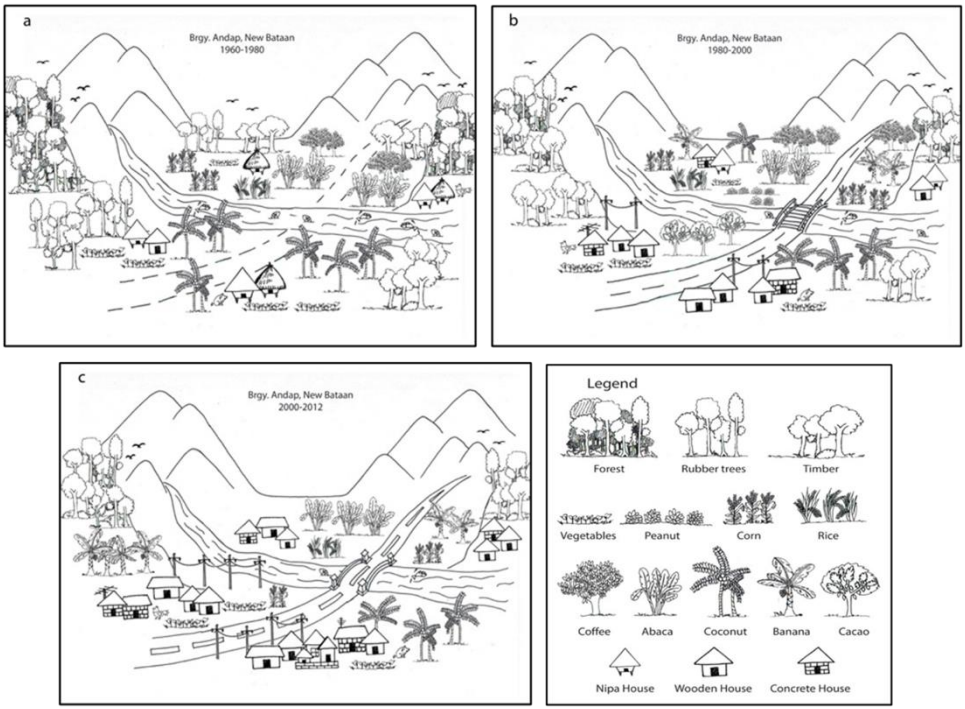

Figure 5. Community-based land use maps in Brgy. Andap, New Bataan in the periods 1960-1980 (Figure 5a), 1980-2000 (Figure 5b) and 2000-2012 (Figure 5c).

Many agricultural and non-agricultural livelihood activities were devastated by Typhoon Bopha on Dec 4, 2012 (Figure 4). Majority of the agricultural areas underwent rehabilitation while other areas that have been severely damaged and covered with rocks and boulders cannot be planted to agricultural crops anymore.

Community Development and Environmental Degradation

The information collected from the PRA reveals that the population of residents in Brgy. Andap, New Bataan continually increased since the 1960's (Figure 6). Nipa hut was the common form of shelter from the 1960's to 1980's. This was replaced by wooden houses in the 1980's to 2000's. Due to scenic landscape of the area, tourism started in the 1980's and was in boom in the beginning of 2000s.

By the year 2000, the local community started to use concrete and GI sheet roofing in the construction of their houses. Much of the community development started in the early 2000, including the construction of cemented road and bridge, installation of household water connection and establishment of the secondary school (Figure 5b). The main modes of public transportation were motorcycle and jeepney since the 1980s. This period also saw the rise of many resorts in Barangay Andap (Figure 5c). The village of Andap used to be the most vibrant village in New Bataan because it had resorts that were popular to local tourists.

Cutting of trees in the forest and mining activities in the mountains are the two main anthropogenic activities that contributed to environmental degradation in the area. In 1958, Brgy Andap was still thickly forested and was a sanctuary of wild animals including a pair of Philippine eagle (Andap Barangay Development and Security Plan 2011-2015). The primary forests of *Octomeles sumatrana* (locally known as Binauang) in Cabinuangan (old town name of New Bataan) attracted the logging industry as early as the 1950s (Ea et al. 2013). As the logging companies opened the road network, this paved the way to slash and burn farming. From the 1960s to 1975, logging activities resulted to massive deforestation (Andap Barangay Development and Security Plan 2011-2015). Logging activities continued, though at a lesser scale, until 2000 when the government imposed a logging ban. Vast areas of the cleared forests were converted to banana plantations (Preda 2012, Manuta et al. 2018) to supply markets in China, Iran and Japan.

Like many areas in Compostella Valley, Andap and its adjacent upland villages have not only fertile agricultural lands but also rich mineral deposits, so in addition to agriculture, gold is an important product generated from small to big scale mining industries (Eugenio et al. 2014). Mining activities have been on-going from the 1960's until the present time (Figure 6). However, mining activities were most rampant during the period of 1980 to 2000. This may partly be attributed to the downscaled logging activities from the 1980's, thus many of the residents resorted to mining activities. Data from Panalipdan Southern Mindanao, an environmental group, show that there are five companies in New Bataan mining for gold, silver, and copper covering about 13, 557 hectares (Davao Today 2012). Aside from these big mining companies, there are numerous illegal and poorly regulated small-time miners who have dug holes in many areas in the mountains in search for gold rendering the mountains unsafe for habitation (Preda 2012). There are thousands of illegal mining operations in Compostela Valley that provides 40% of the economic output of the province (Preda 2012) and New Bataan hosts a number of these illegal miners.

The local community experienced flooding after the occurrence of strong typhoons since late 1970s. There was drought in the community due to El Niño phenomenon in 1980 (Figure 6).

Drivers of Landslides and Floods in Brgy. Andap

Due to human population pressure and the increasing demand for food, many of the forest logged over areas areas were cleared through the practice of slash-and-burn logging in order to open up new areas for agriculture (Figure 7). Farmers cultivate subsistence crops like rice, corn, peanut, and vegetables

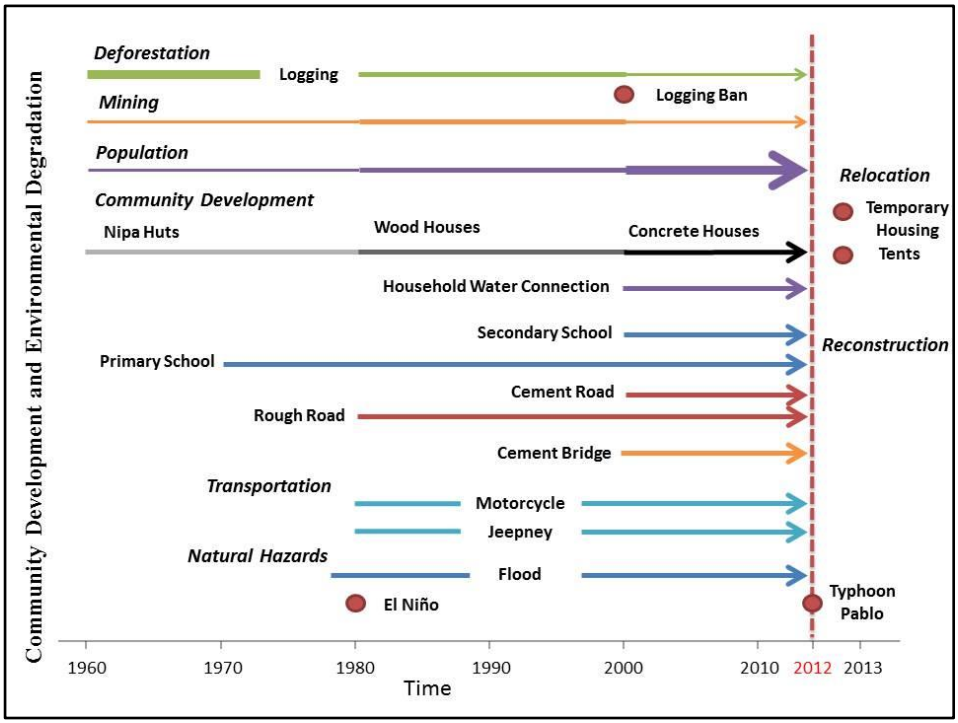

Figure 6. Timeline of community development and environmental degradation in Brgy. Andap, New Bataan. Thickness of lines indicate intensity of activity: the thicker the line, the higher the intensity of the activity. The dashed vertical line indicates the occurrence of Typhoon Pablo that caused much damage and required reconstration thereafter.

through the years. Also, due to the demand for income, some members of the community were engaged in small scale gold mining in the remote areas of the nearby mountains. These two anthropogenic activities (logging and mining) resulted to forest denudation. Manuta et al. (2018) and Rodolfo et al. (2016) had similar conclusions.

According to the local community, extreme climate variability and forest clearing are the two major driving factors of flashfloods and landslides in Brgy. Andap (Figure 7). Extreme climate variability includes the occurrence of super typhoons characterized by very strong wind velocity and enormous amount of precipitation. In the study conducted by Acosta et al. (2014), survey respondents in three villages in New Bataan including Andap have the opinion that climate change is related to the increasing intensity of typhoons. However, the level of awareness on the link between fragile environment and disaster events is relatively low in New Bataan. There are thus slight differences in the opinions of the PRA participants and survey respondents. The participants in the PRA also noted that the slash-and-burn logging and forest clearing may contribute to extreme climate variability due to the emissions of CO_2. The occurrence of super typhoons coupled with the lack of protective forest cover in the mountains result to water-run-off and soil erosion which may lead to flashfloods and landslides (Figure 7).

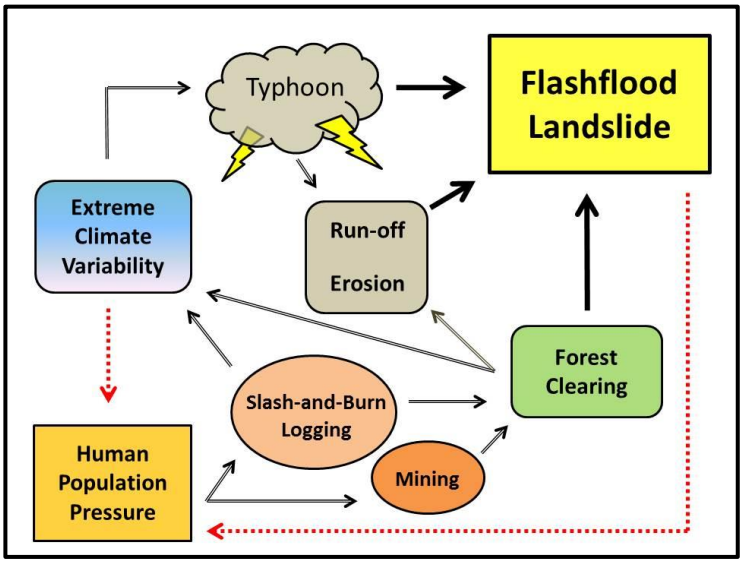

Figure 7. Community-based causal diagram showing drivers contributing to the occurrence of landslide and flashflood in Brgy. Andap, New Bataan.

After the flashflood and landslide events in Andap on December 4, 2012, the Mines and Geosciences Bureau immediately conducted geohazard mapping and assessment in some portions of Andap Watershed. According to their report (MGB, 2012), the following were the main causes of the flashfloods:

- High precipitation on the headwaters of Mayo River and Kalyawan Creek.
- Denuded watershed of Andap with relatively thin soil cover that promotes high surface run-off.
- Presence of landslide and debris along the slopes that contribute much on the over siltation of the river channel.
- Constrictions of river channel at the portion of converging Kalyawan Creek and Mayo River that results to damming and river migration.
- Constructions of low-lying bridge along silted river channels that blocks huge rock boulders and uprooted trees causing damming of floodwaters and diversion of river courses.
- Presence of old river channels along the floodplain deposit where floodwaters could easily migrate whenever there is blockage along the existing river course.

Moreover, according to the MGB report (2012), logging and mining have no direct contribution to the flashflood events in the area. Instead, MGB (2012) identified other natural factors including high drainage density, steep slopes that are highly susceptible to landslide, thin soil cover in the headwaters, high surface run-off, geology of the area, nature of river channel and the improper construction of waterways, roads and bridges along active river channel make the area prone to flash flooding. Thus, the assessments of MGB, which is the government agency responsible for the conservation, management,

development and proper use of the country's mineral resources including those in reservation and lands of public domains do not match with the opinions of the community living in Andap. However, independent reports (Environment Philippines 2012, Philippines Star 2012, Davao Today 2012, PREDA Foundation 2012, GMA Network 2012) disagree with that of MGB's by emphasizing that mining as well as logging cause landslides. Geologists from the National Institute for Geological Studies (NIES) of the University of the Philippines Diliman and research team from project NOAH (Nationwide Operational Assessment of Hazards) of the Department of Science and Technology (DOST) led by Dr. Kelvin Rodolfo conducted an assessment of the debris flow in Mayo River in Brgy. Andap brought by Typhoon Pablo. Rodolfo et al. (2016) described that the rocks in the watershed of Brgy Anday are extensively fractured as it lies on the left side of the Mati Fault which has numerous associated fractures in broad zones along its length. They also reported that steep slopes have been largely deforested by mining and logging, that enabled the incidence of numerous shallow and bedrock landslides, that were activated by Pablo's heavy rains. The MGB is responsible for promoting mining industries, so there seem to be conflict of interest that may have influenced the assessment report. On the other hand, DENR Secretary Paje (GMA News, Dec. 2012) stated that most of the illegal logging 'hot spots' are located in the areas hit by typhoon Pablo. Sec. Paje further stressed that the disaster brought about by flash floods during typhoon Pablo is a testament "that we must really stop timber harvesting from our natural forests", referring to the Executive Order 23 signed by President Benigno Aquino III on February 2011. Another interesting point here is that, while the MGB do not see the effects of logging and mining on flashfloods, the community was not aware that the infrastructures including roads and bridges, which block the otherwise natural flow of the water, has also contributed to the disaster (MGB 2012).

Impacts of Flashflood, Landslide and Debris Flow on Livelihood

Heavy rains brought by Typhoon Pablo triggered numerous shallow and bedrock landslides while strong winds uprooted trees on the upper watershed enhancing soils slips and erosion by run-off (Rodolfo et al. 2016). Tremendous amount of water rushed down from the mountains causing heavy mud floods and landslides (Manuta et al. 2018). The thick mud, logs and boulders blocked the roads, making the area inaccessible for the rescuers to reach the area (Acosta et al. 2016).

Rodolfo et al. (2016) assessed debris flow in Brgy. Andap using satellite images, LiDAR mapping and field measurements. They estimated that 25 to 30 million cubic meters debris flow were deposited measuring 0.2 to 1 km wide and 0.25 to 9 meters thick. This is the largest debris flow ever recorded in the world. About 500 hectares were covered with debris mixed with big boulders measuring up to 16 meters in diameter that buried Brgy. Andap up to 9 meters deep.

With the disaster caused by Typhoon Pablo that destroyed most of the infrastructure in the community, many residents were relocated in temporary housing and tent cities. Roads, schools, barangay hall were reconstructed. After a year, they reside in relocation sites far from the original location of the community along the river where they were provided with more durable housing units made of cement and GI roofing material.

Agricultural farms were buried in debris making the lands unsuitable for farming. They have to look for alternative suitable areas for farming in other parts of the village.

Rehabilitation of Livelihood

Based on the results of SWOT analysis, two strengths for livelihood rehabilitation as a means

for the community to adapt to the disaster impacts were identified (Table 1). The community has the capability to rehabilitate their banana plantations. Even though most of the bananas were devastated by Typhoon Bopha, banana plants will give rise to new suckers with proper management. People in Andap also have knowledge on organic farming. They are keen on putting up demonstration farms on organic farming. However, their weaknesses include the lack of means to procure the inputs (seedlings, fertilizers, and capital for livestock) necessary to rehabilitate their livelihoods and the inability to pay loans in their cooperatives (Table 1).

Table 1. SWOT analysis for livelihood rehabilitation in Brgy. Andap, New Bataan.

STRENGTHS	**WEAKNESSES**
• Rehabilitation of banana plantations • Creation of demonstration farms on organic farming	• Lack of means to procure the following: o Seedlings for the reestablishment of cacao, rubber, and coconut plantations o Agricultural inputs such as fertilizer and pesticide o Knowledge on new farming technology o Capital for livestock and other livelihood • Inability of members of cooperatives to repay loans
OPPORTUNITIES	**THREAT**
• Trainings and seminars on the following livelihood opportunities: o Organic agriculture o Poultry production o Handicraft utilizing Rattan by-products o Technology on processing coconut husk o Food processing o Livestock (goat, swine production) • Establishment of coconut cooperative • Availability of micro-credit financing	• Lack of extension services on agriculture

The locals were very hopeful that they can rehabilitate their livelihoods through the support of the local government and other organizations who can provide them with various opportunities. Participation in trainings and seminars on various topics including organic agriculture, poultry production, handicraft utilizing rattan by-products, technology on processing coconut husk, food processing, and raising livestock (goat, swine) are viable opportunities. They would like to be given the opportunity to establish another cooperative and to avail of micro-financing so that they can start all over again in their livelihood activities.

After the Typhoon Pablo disaster, the government launched recovery and reconstruction programs aimed at increasing the adaptive capacity of vulnerable communities. These programs include: (1) the “Moving up after Pablo (MAP) New Bataan Comprehensive Rehabilitation and Recovery Program (MAP New Bataan CRRP)” of the municipal government of New Bataan, (2) the “Reconstruction and Development Framework 2013-2016” of the regional government of Davao Oriental (Davao Oriental RDF 2013-2016), and (3) “Post-Pablo Livelihood Cluster Action Plan for Davao Oriental and Compostela Valley Province” of the Department of Agriculture (DA) (Post-Pablo LCAP) (Manuta et al, 2018). Specifically, the objectives of the “Post-Pablo livelihood cluster action plan for Davao Oriental and

Compostela Valley Provinces" were to rehabilitate and protect the typhoon-damaged agroforestry plantations, livestock, and fishery industries; and to provide livelihood opportunities and expand the income base of affected communities. The draft post disaster needs assessment report for typhoon Pablo Davao Region (Feb 2013) for the livelihood cluster include various strategies and major programs for the rehabilitation of the agriculture sector. These include the following: rehabilitation of damaged crop farms and provision of machinery, equipment and harvest facilities for the production of various crops including banana, coconut, rice, corn, cassava, sweet potato, cacao, coffee, peanuts, vegetables, soybeans, abaca, bamboo and rubber; reforestation of denuded mountain areas; and rehabilitation of damaged livestock farms and reconstruction of slaughterhouses. For the industry, trade and services sector, strategies include the provision of entrepreneurial and capacity training program, shared service facilities and credit assistance.

The Typhoon Bopha (Pablo) Humanitarian Handbook Region 13 CARAGA (OCHA 2013) reported that the livelihood cluster assisted affected communities with emergency interventions and mid-term livelihood opportunities, such as providing 1,900 farmers with tools and assets. They also provided cash for work and other income generating opportunities with long-term effects such as rehabilitation of agricultural lands for banana and corn production, vegetable farming and compost production.

Further, the PRA participants consider the lack of extension services on agriculture in the area as a threat to their livelihood rehabilitation (Table 1). Currently, the Local Government Unit through the Municipal Agricultural Services Office (MASO) provides extension services such as Cooperative Training and Agricultural services monthly or as the need arises (Andap Barangay Development and Security Plan 2011-2015).

Vulnerable communities in Brgy Andap have received immediate, medium and long-term assistance from the government, NGOs and civic communities. Relief goods including food, tents, clothing, medicine were immediately provided to them by the various sectors. Medium term assistance includes house and road reconstruction, and social support. Livelihood rehabilitation is the focus of the long-term recovery program and will be effective if a participatory approach by considering local community preferences has been implemented from the preparatory, implementation and monitoring and evaluation phases of the projects.

Adaptation and Mitigation Strategies to Landslides and Flashfloods

During the focus-group discussion on possible solutions to the driving factors of their problems in the area, the local community voiced several possible adaptation and mitigation measures (Table 2). To address deforestation, they suggested planting of trees, preferably fruit trees as they provide additional income when the trees start to bear fruits, particularly high value fruits. There is a need to effectively stop logging and mining activities by revoking their permits and imposing stricter laws and stiffer punishment against illegal loggers and miners. The introduction and development of viable alternative livelihood activities will provide the locals with much needed income to meet their daily needs that may encourage them to stop their illegal logging and mining activities.

The response of the community to reduce the impacts of landslides and flash flood is anchored on their local ecological knowledge, experience, and vigilance (Magcale-Macandog et al., 2011a). The findings of this study will be helpful to the LGU officials in creating local ordinances and programs to address landslides and flashflood in the Brgy Andap.

Table 2. Community solutions to landslide and flashflood problems in Brgy. Andap, New Bataan.

Problem	Solution

Deforestation	• Tree planting drives, preferably using fruit trees
	• Effectively stop logging activities by:
	  o Revoke logging permits
	  o Impose stricter laws and stiffer punishments against illegal logging

Mining	• Stop gold mining
	  o Revoke mining permits
	  o Impose stricter laws and stiffer punishments against illegal mining

Lack of income	• Introduce viable alternative livelihood sources o Encourage locals to stop engaging in logging and mining activities

CONCLUSION AND RECOMMENDATIONS

The Philippines is highly vulnerable and susceptible to natural disasters, particularly the occurrence of frequent typhoons. In 2012, Mindanao suffered catastrophic damages due to Typhoon Bopha and the province of Compostela Valley was one of the most severely affected areas. Participatory Rural Appraisal (PRA) activities were conducted in Andap, New Bataan, Compostela Valley to document community perception and local knowledge on the drivers and impacts of environmental degradation as well as relate the factors that contributed to the catastrophic 2012 flashflood and landslide, craft livelihood rehabilitation strategies and to craft adaptation and mitigation strategies to landslides and flashfloods.

Barangay Andap was established at the head of a valley on high grounds at the mouth of a mountain drainage network, which was later discovered to be an alluvial fan where water drains. The valley was bounded by steeply sided slopes with deeply fractured rocks situated along the length of Mati Fault line. Naturally, its geological and geographical characteristics make the village susceptible to floods and landslides.

Barangay Andap was thickly forested with primary forests dominated by *Octomeles sumatrana* in the 1950's that attracted logging companies. The area is also rich in mineral resources like gold, copper, and silver. As early as the 1960s, logging and small-scale mining activities have been practiced by the locals. The forests are currently severely denuded while mountains were destroyed due to small scale mining. Geographical setting, environmental degradation due to logging and mining, and extreme climatic events are the major factors that contributed to the occurrence of the catastrophic 2012 landslide, flood and debris flow in the locality.

Almost every main source of livelihood in the community was destroyed in the aftermath of the landslide and flash flood caused by Typhoon Bopha. Community recommendations to aid in the community's recovery include support for the restoration of farming activities in the form of subsidies for agricultural inputs, provision of trainings and seminars on modern agricultural practices and establishment of micro-credit financing institutions. Introduction of viable alternative livelihood sources is essential to encourage locals to stop mining and logging activities. Strict implementation of laws against logging and

illegal mining are needed to effectively stop logging and mining activities. The community also suggested that planting of fruit and timber trees should be a priority activity to bring back trees in the denuded forests.

Community-based methodologies such as participatory rural approaches provide an in-depth understanding of the local community members' view on the causes and impacts of natural hazards. Such PRA methodologies serve as avenues for community members to express their perceptions on environmental degradation and propose viable solutions to address these issues.

Climate change adaptation and mitigation strategies, and geological and geographical characteristics of the locality, should be integrated in the revision of the New Bataan Comprehensive Land Use Plan (CLUP) and the Barangay Andap Development and Security Plans to make the local communities climate change-sensitive and resilient. Alternative livelihood to logging and mining are key to stop these environmentally degrading activities in Barangay Andap. Capacity building and technical and support services from the government, NGOs and other related agencies are essential elements to improve their farming systems, processing, and marketing of their agricultural products. Participatory approach is being recommended for more effective long-term recovery programs for livelihood rehabilitation by involving local communities in all phases of the program from the conceptualization, implementation and monitoring and evaluation phases. The local communities are based on the site and they have experiences and local knowledge to effectively implement their livelihood rehabilitation programs.

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STATEMENT OF AUTHORSHIP

D.B. Magcale-Macandog, L.A. Acosta and E.K. Lin conceptualized the study; D.B. Magcale-Macandog, L.A. Acosta, P.B.M. Macandog, E.A. Eugenio, M.T. Gonzalo, J.M. Ambe, and E.K. Lin conducted the consultation meetings with LGU and PRA activities with local communities; J. delos Reyes assisted in the review of literature; P.B.M. Macandog processed the data, prepared the figures, maps and tables; D.B. Magcale-Macandog, L.A. Acosta, and P.B.M. Macandog drafted the manuscript; D.B. Magcale-Macandog revised the manuscript following the reviewer's comments.

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