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Climate Change Community-Based and Ecosystem-Based Adaptation Strategies in Selected Coastal Barangays in Masinloc, Zambales, Philippines

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Abstract

Climate change continues to intensify existing disaster risks and vulnerabilities in the Philippines. Thus, implementation of climate change adaptation strategies is vital to counter the effects of climate change. It is in this context that this study was undertaken to analyze the need or urgency to adopt community and ecosystem-based adaptation strategies among selected coastal barangays (villages) of Masinloc, Zambales, Philippines. Various methods of data collection were utilized such as secondary data collection, primary data collection through household survey, key informant interviews, and focus group. Results of the study indicate that in terms of community-based adaptation strategies, all of the seven barangays in Masinloc have moderate necessity. However, only Barangays Bani and Collat have high adaptation capacity in terms of infrastructure and disaster preparedness. The execution of several community-based adaptation strategies helps these barangays to respond immediately and appropriately to the moderate risk posed by floods and storm surges. On the other hand, in terms of ecosystem-based adaptation strategies, all of the seven barangays have moderate necessity which implies that they have moderate vulnerability and risk to flood and storm surge but have high adaptation capacity in terms of the conservation and protection of coastal resources (mangroves and sea grasses). The barangays implemented the necessary ecosystem-based adaptation mechanisms that they might need in the future. This only means that when they are faced with disaster, the local communities are prepared to respond appropriately and to cope up with the effects of extreme weather events which lead to floods and storm surge. Even though most of the ecosystem-based adaptation strategies are conducted by the seven barangays, there are several community-based adaptation strategies

that are still lacking which will protect them from the effect of floods and storm surges. Hence, carrying out the missing adaptation strategies, both community-based and ecosystem-based, will help in improving the adaptive capacity of the affected barangays and will help them become more resilient to the amplified effects of climate change.

Keywords

Climate Change, Necessity, Community-Based Adaptation Strategies, Ecosystem-Based Adaptation Strategies, Disaster Risk Assessment

1. Introduction

The broad-ranging effects of climate change compel communities to adapt for decades. However, with limited alternatives and actions coming from various sectors of society, the impacts of climate change continue to intensify, exacerbating current catastrophic risks and vulnerabilities in the Philippines (Paz-Alberto et al., 2018). Communities' adaptation plans and tactics are incapable of keeping up with the quickly changing environment. Changes in weather patterns induced by climate change, which influence rainfall and temperature, are expected to have a substantial impact on the products and services that people enjoy. As a result, developing and applying adaptation strategies is important to reducing the effects of climate change (Glantz, Gommes, & Ramasamy, 2009; IUCN, n.d.). In this paper two types of climate change adaptation strategies are considered: ecosystem-based adaptation (EbA) and community-based adaptation (CbA).

Resilient ecosystems are essential to human well-being and are rapidly becoming recognized as crucial to aiding communities in adapting to climate change. The Convention on Biological Diversity's and the United Nations Framework Convention on Climate Change's legislative bodies have advised parties to use ecosystem-based adaptation (EbA) techniques. Ecosystem-based adaptation, which includes habitat restoration, long-term sustainability, and recovery, looks to be a low-cost approach to aiding people in adapting to the consequences of climate change (Colls et al., 2009; Boer & Clark, 2012). Restoration and conservation approaches will not only help to mitigate the effects of climate change, but will also offer people with more sustainable sources of food and income. These techniques include mangrove restoration to defend against storm surges, river protection against droughts and floods, grassland conservation to offset desertification, and sustainable fisheries and forest management to provide food security (Chong, 2014). EbA also makes use of biodiversity and ecosystem services to enhance stability and minimize susceptibility to climate change in human habitats and natural surroundings, all while supporting long-term growth (CBD, 2015). The advancements and benefits of EbA have been acknowledged by governments, civil society organizations, and global agencies which can be influen-

tial in catalyzing international and national responses (Chong, 2014). There is an evidence that EbA can be a cost-effective adaptation solution, as well as significant evidence that it can provide a slew of social, economic, and environmental co-benefits, as long as knowledge gaps about how it works, why it works, and why are filled in order to fully appreciate EbA's true potential (Rao et al., 2013; Doswald et al., 2014; Reid, 2015). With the help of EbA, ecosystems will grow and replenish the shoreline, preventing catastrophes from affecting the local coastal vulnerable communities. Recognizing and using local and traditional skills, and understanding the requirements of vulnerable stakeholders such as women, the elderly, and the impoverished, are critical to the success of ecosystem-based interventions. Moreover, EbA aids to biodiversity conservation and local economy by providing robust habitat preservation. More financing, and the incorporation of EbA into climate policy, are required for ecosystem management techniques to successfully contribute to large-scale global climate change adaptation efforts (Reid, 2015). Because EbA is a developing discipline, more scientific evidence and field experience are required to prove its utility and cost-ef- fectiveness. This necessitates the use of concepts and techniques derived from field experiences.

Despite the benefits brought by EbA in mitigating climate change, it is also timely for humans to do their part in averting such disasters. As a result, the word "community-based adaptation", or CbA, was introduced. CbA is a method of adaptation that helps local people to decide the goals and methods of adaptation. It is focused on a participatory evaluation of the threats posed by climate change and highlights disadvantaged societies' development needs (Reid & Huq, 2007; Reid et al., 2009).

CbA is most often associated with developing countries. It is built on the assumption that local communities have the knowledge, experience, local awareness, and networks to engage in locally relevant practices that improve resilience and mitigate vulnerability to various causes, including climate change (Islam & Winkel, 2017). CbA emerged when there was a growing recognition that adaptation to climate change was necessary; that adaptation work highlights the drivers of social vulnerability and the local contexts of poverty, particularly in developing countries; and that there was the presence of community-based natural resource management, which provided a framework for empowering local stakeholders to adapt.

CbA has both benefits and drawbacks (Forsyth, 2013). On the upside, CbA aims to engage with vulnerable and more disadvantaged local communities, allowing them to recognize and form strategies to the threats posed by climate change. This will mean that adaptation is more responsive to local needs and, as a result, more capable of reducing vulnerability to climate change. As CbA grows and becomes more visible, it has essential benefits in making adaptation approaches more applicable to vulnerable populations and considering the variety of social, political, and economic influences that contribute to vulnerability. These measures will reduce risk more explicitly and maximize the chance of

adaptation interventions succeeding.

Amidst the optimism around CbA, there have been a series of critiques and challenges that have called into question CBA's potential to solve long-term climate threats or be mainstreamed within more comprehensive climate change policies (Forsyth, 2013). The drawbacks of CbA are that it can be time-intensive and impossible to do without investing in time and learning. Moreover, without the adequate mandate of local government units and sufficient financial assistance, this policy is deemed impossible to implement and costly (Mearns, 2011; Forsyth, 2013).

While communities, especially coastal communities, see CbA as time-consuming and costly, this becomes the reason why disasters continue to impact communities, and they take no action (Forsyth, 2013). Moreover, lack of awareness and absence of clarity of climate adaptation planning processes were the most common barriers to engagement (Rudge, 2021). Coastal areas should have as much CbA as possible to reduce, fight, and deter the effects of climate change (storm surges, floods, and extreme weather events), including storms and typhoons (Ensor, 2009; Forsyth, 2013). This may be a positive way for these societies to be well-informed of the disasters it causes and to take steps to prevent them. Furthermore, it will inspire them to be robust, contributing to food stability and resilience in the long run.

According to the 2015 Global Risk Index, the Philippines is the most vulnerable country to disasters caused by severe weather conditions caused by climate change, and the seventh most vulnerable country to natural hazards caused by climate change, according to the 2017 World Risk Report (Climate Change Commission, 2018). Climate change is having a massive impact in the Philippines, causing increasing economic problems, threats to biodiversity and food security, public health concerns, and endangering vulnerable communities such as women and indigenous people, all of which could jeopardize the country's pursuit of sustainable growth.

As a result, the Climate Change Act (Republic Act 9729) was passed in the Philippines in 2009, tasked local government authorities with developing, planning, and implementing climate change acts in their respective cities. The legislation mandates the development of appropriate response plans, and all Local Government Units must develop a local climate change action plan or LCCAP. As a result, various adaptation strategies must be adopted and developed in every barangay in the Philippines for climate change adaptation and mitigation. Several municipalities and local communities in the Philippines are implementing already both adaptation techniques (Paz-Alberto et al., 2018, 2021). This approach validate the importance of mainstreaming adaptation strategies to national planning and policy for local responses (Reid & Huq, 2014).

Thus, this study was performed in this context to analyze the need or urgency of selected barangays in Masinloc, Zambales, Philippines to adopt community and ecosystem-based adaptation strategies and to identify and describe these adaptation strategies to further increase adaptive capacity and resiliency of local

communities to climate change impacts as a response to LCCAP.

2. Methodology

The research study was done in the seven (7) selected coastal barangays of Masinloc Zambales, Philippines namely Bani, Collat, Taltal, Baloganon, Inhobol, North Poblacion and San Salvador due to data availability which are necessary for this study (Figure 1).

To obtain data for this study, the researchers conducted interview, focus group discussions (FGD), and key informant interviews (KII) with residents of Masinloc, Zambales to determine their level of awareness and perception of climate change impacts and to assess the communities' existing adaptation methods. Climate change-related incidents in coastal barangays were emphasized during this interview, and the communities employed adaptation strategies. Local residents of Masinloc, Zambales, who live along the coast, are among those who have responded. Random sampling was used in the selection of respondents. The researchers used guided questionnaires for the survey, FGD and KII.

2.1. Data Collection

The study gathered information through primary and secondary data collection via household survey, key informant interviews with local government unit and barangay officials, and focus group discussion with the local communities.

The researchers obtained socioeconomic data from Masinloc, Zambales. Municipal and provincial development plans, municipal socio-demographic statistics, land use plan, and other vital information from Masinloc's various institutional stakeholders are among the other sources. Moreover, historical data on natural disasters such as severe typhoons, storm surges, floods, coastal erosion, tsunami, and other occurrences were obtained from the Municipal Disaster Risk Reduction Management Office in Masinloc, Zambales (MDRRMO).

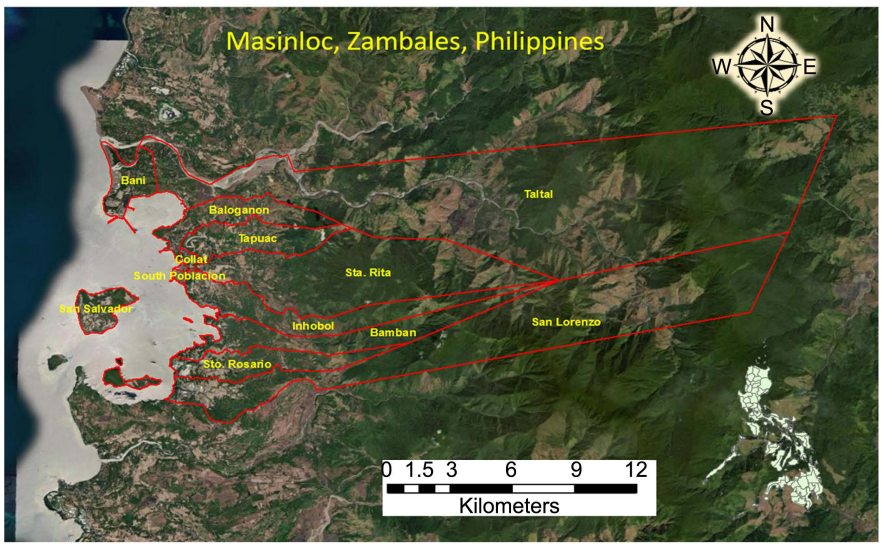

Figure 1. The coastal barangays in Masinloc, Zambales.

Local communities and barangay officials in selected coastal barangays participated in a survey questionnaire to determine their perceptions on the monthly incidence of sea level rise, temperature increase, heavy rains, and intense typhoons in their coastal areas for they the ones that experienced and who are directly affected by these events. A focus group discussion was also conducted to determine the climate change impacts and existing adaptation strategies.

The unit heads of Masinloc's Agriculture Office, Disaster Risk Reduction Management Office, and Coastal Resource Management/Environment and Natural Resources Office were interviewed by the researchers for the key informant interview. Data from the Provincial Agricultural Office (PAO), the Provincial Disaster Risk Reduction Management (PDRRM), and the Philippine Red Cross of Zambales were also gathered by the researchers.

2.2. Analysis of the Necessity of Community-Based and Ecosystem-Based Adaptation Strategies and Adaptive Capacity in Selected Barangays of Masinloc, Zambales

Analysis of the necessity or urgency of barangays to adopt community-based or ecosystem-based adaptation strategies to cope with the climate change impacts and to become resilient climate communities was done through secondary data gathering from the study of Paz-Alberto et al. (2021) particularly the data on flood and storm surge vulnerability and disaster risk assessments as well as the vulnerability and disaster risk maps. Moreover, data were also gathered from the municipality of Masinloc specifically the following: municipal agricultural profile, population disaster risk reduction and mitigation plans, history of destructive events in the municipality such as flooding and storm surge, Comprehensive Land Use Plan (CLUP), areas (barangays) that are affected by the natural hazards.

The criteria involved in the analysis are whether the barangay has a low, moderate, and high vulnerability to flood and storm surge and low, moderate, and high disaster risk to flood and storm surge. Those barangays that scored high and moderate in both flood and storm surge were chosen to be analyzed in the municipality. Then afterwards, the community and ecosystem-based adaptation strategies being implemented, planned to implement and not implemented in each barangay were identified from the gathered data in the survey, focus group discussion, and key informant interviews that were performed in various barangays and local government units (LGUs).

Using the data gathered, each barangay was evaluated according to their vulnerabilities and disaster risks to flood and storm surge and whether these risks addressed urgent needs and if the barangay has adaptive capacity to cope with floods and storm surge. The relative urgency or necessity for each barangay selected was assessed using the vulnerability and disaster risk assessment results for each barangay with moderate and high scores only (Paz-Alberto et al., 2021). On the other hand, in the evaluation of the relative adaptive capacity, a low score was given to barangays that do not implement CBA or EBA; moderate score was

given to those with planned CBA or EBA and high score to those barangays that are implementing CBA or EBA. These engagements were then represented in an inter-relational diagram or matrix where their scores for necessity and adaptive capacity (CBA or EBA) were shown (Alino et al., 2013). Specifically, in the diagram the x-axis represents the necessity or urgency of each barangay from their vulnerability and disaster risks from flood and storm surge with medium and high categories against the y-axis, which is the adaptive capacity of each barangay in terms of community-based or ecosystem-based adaptation strategies for flood and storm surge with low, medium and high categories as well. Each action was scored based on whether there is a pressing need for each barangay due to risks of flood and storm surge and if there is adaptive capacity for CBA and EBA.

3. Results and Discussion

Local government units in Zambales are implementing the Climate Change Act of 2009, which mandates these units to be the frontline authority in developing, planning, and implementing climate change policies in their districts (Official Gazette, 2009). Under this national legislation, local governments and barangays are trained and compelled to comply with the act and create climate change adaptation programs to enhance community resilience and reduce climate change impacts by decreasing greenhouse gas emissions (Climate Change Commission, 2011). Their perspective and awareness of climate change are improved as a result of this law.

3.1. Perception of Local Communities on the Monthly Occurrences of Sea Level Rise, Increase in Temperature, Heavy Rains, and Strong Typhoons

The Philippines is one of the world's most disaster-prone countries and climate change tends to worsen the likelihood of typhoons and severe rainfall in the country (more than 20 typhoons a year). Because the global mean sea level is expected to increase by 2 meters by the end of the century, the country's anticipated sea level rise in 2100 is between 0.5 and 1.2 meters (PAGASA, 2011). Sea level rise arises from the melting of ice sheets and glaciers causing seawater to expand and warm, which is exacerbated when it reaches tropical places. As a result of sea-level rise, more frequent coastal flooding is predicted during the rainy season.

Results revealed that the local communities of Masinloc perceived that sea level rise occurred during the months of June to September in their coastal areas as shown in **Figure 2**. These are the rainy months in the Luzon areas of the Philippines when heavy rains and strong typhoons happen (PAGASA, 2011). The local communities did not observe sea level rise during the months of January to April and November to December which are considered to be the dry months in the country.

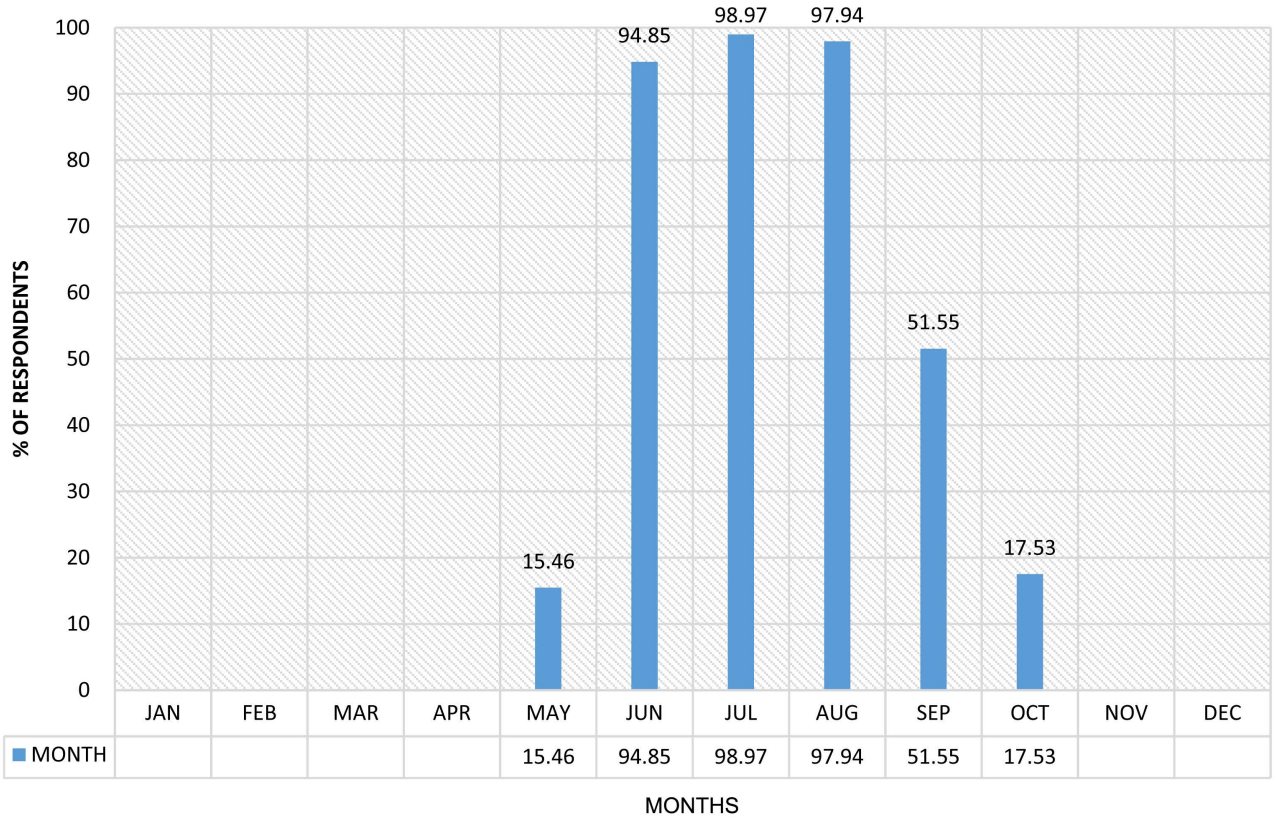

Figure 2. Occurrence of sea level rise in the coastal areas of Masinloc, Zambales per month as perceived by the local communities and barangay officials.

Figure 3 depicts the perceptions of the local communities in Masinloc, Zambales, on the incidence of temperature increases. According to the data, the months of January to March had the highest proportion of rising temperatures, while the months of June to September were believed to be the coolest months due to incidence of heavy rains in their areas. This view reflects a significant change in climate from previous years, when January and February were the coldest months in the Philippines due to the "Amihan" season, or northeast monsoon (PAGASA, 2011).

The bulk of Masinloc local communities have experienced heavy rains from June to July, with some also receiving substantial rains in August. In the municipality, the rainy season extends from May to September, while the rest of the year is considered the dry season (**Figure 4**).

Figure 5 illustrates the months of May to September as having intense and strong typhoons as perceived by the Masinloc community. Typhoons and heavy winds are more prevalent during these months as the rainy season approaches, endangering the livelihoods of fishermen.

The perceptions and observations of the Masinloc communities confirm the data from PAGASA (2020) that 19 - 20 typhoons enter the Philippine Area of Responsibility (PAR) with 8 - 9 typhoons making landfall during the peak of typhoon season from July to October. Usually during the rainy season typhoons

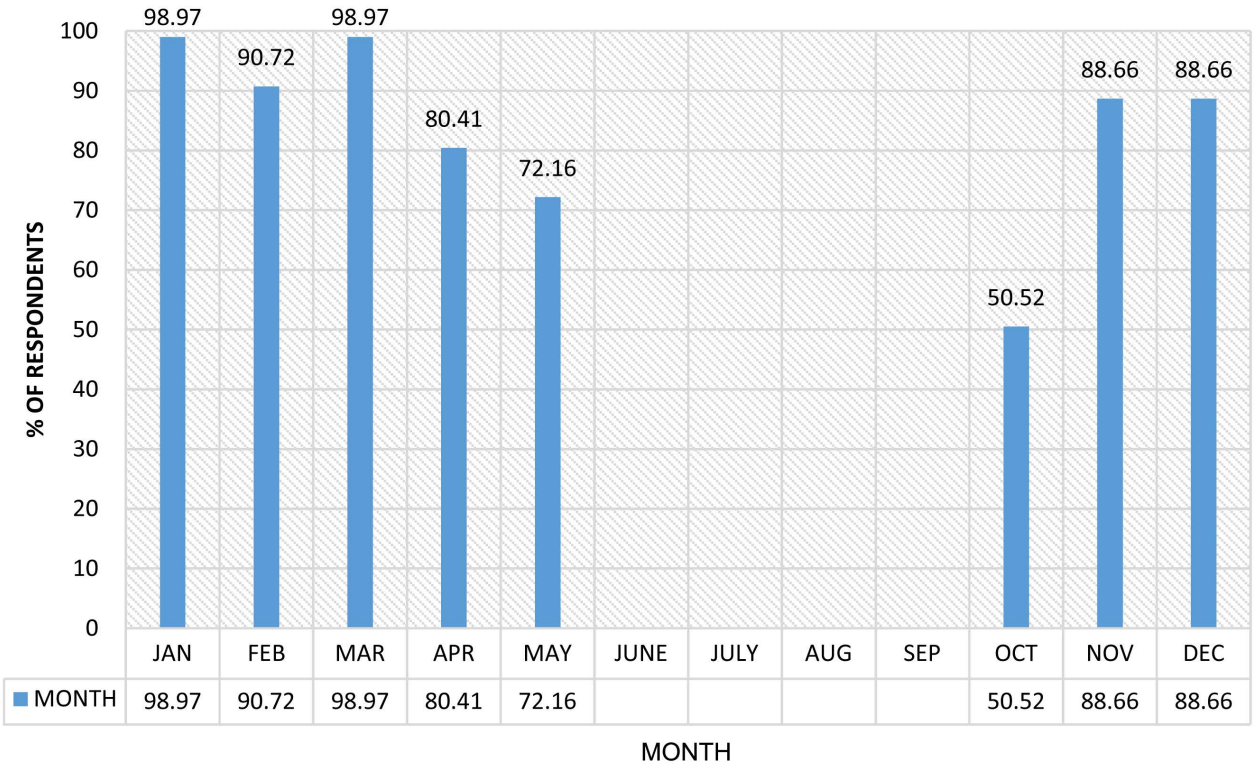

Figure 3. Incidence of temperature increase in the coastal barangays of Masinloc, Zambales per month as perceived by the local communities and barangay officials.

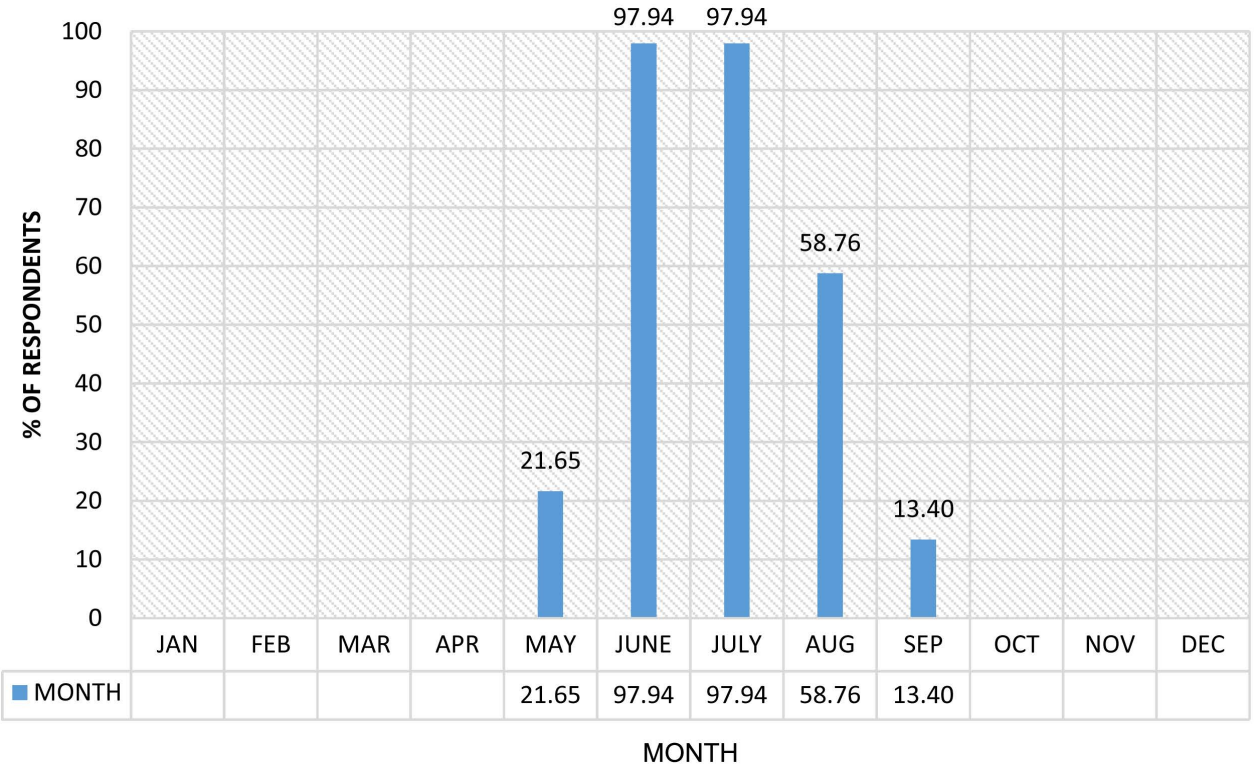

Figure 4. Prevalence of heavy rains in the coastal barangays of Masinloc, Zambales per month as perceived by the local communities and barangay officials.

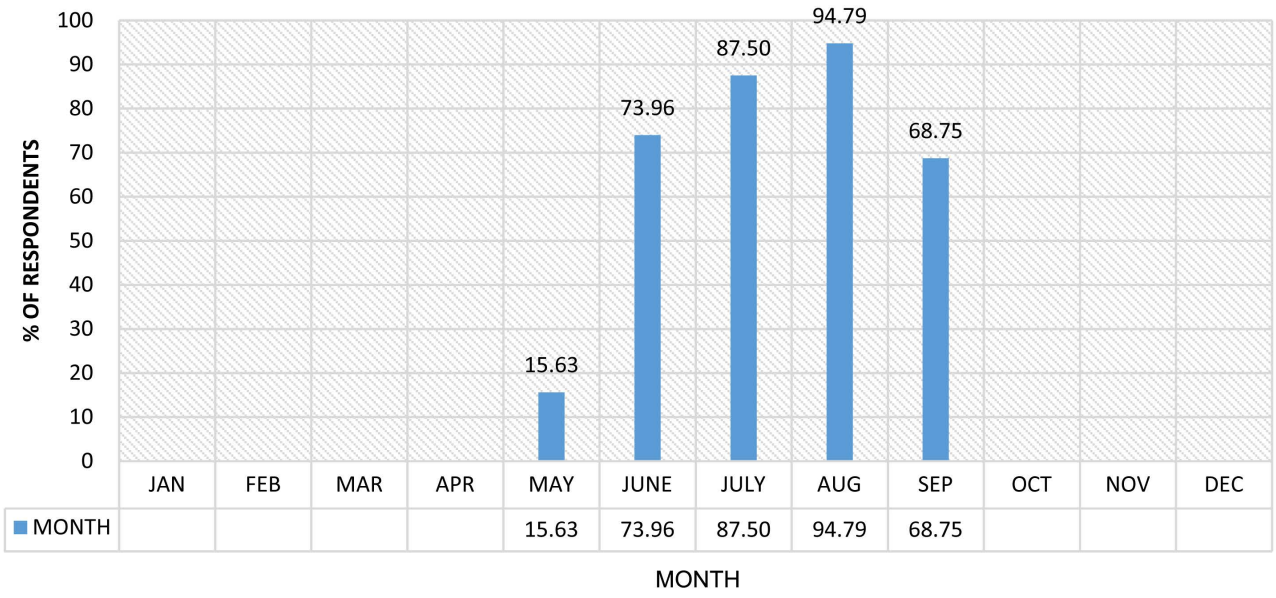

Figure 5. Incidence of strong typhoons in the coastal barangays of Masinloc, Zambales per month as perceived by the local communities and barangay officials.

enter the country and these typhoons are being aggravated by winds and southwest monsoon hence, the current typhoons are now so intense and powerful with maximum wind speed exceeding 185 kph exemplified by Super Typhoon Noru (local name Karding) which devastated the Central Luzon last September 25-26, 2022 (PAGASA, 2022).

3.2. Climate Change Impacts as Perceived by the Respondents

Climate change impacts such as heavy rainfall, sea-level rise, temperature increases, and intense typhoons are the most notable impacts that the local communities have experienced as perceived by them (**Figure 6**) which corroborate and validate with the results of their perception on the incidences of sea level rise, temperature increase, heavy rains and strong typhoons in their coastal areas as shown in **Figures 2-5**. People who live and work in coastal areas face unusual natural hazard threats due to their proximity to the ocean. Natural hazards have the potential to do much more devastation as more residents head to the coast. Coastal areas are vulnerable to devastating disasters such as typhoons, strong waves, storm surges, tsunamis, floods. Consequently, high winds associated with weaker and less intense storms can now pose significant risks to those who live along the coast (Paz-Alberto et al., 2019; Palomares & Pauly, 2014; De Guzman et al., 2016). Climate change then has an influence on coastal populations due to the enhanced effects of catastrophes such as severe typhoons, storm surges, and floods.

The coastal barangays of Masinloc, Zambales, suffer severe typhoons and moderately significant rainfall from June to August, resulting in the occurrence of coastal flooding from sea level rise during the same months. When these strong typhoons accompanied by heavy wind gusts and rainfall strike, the

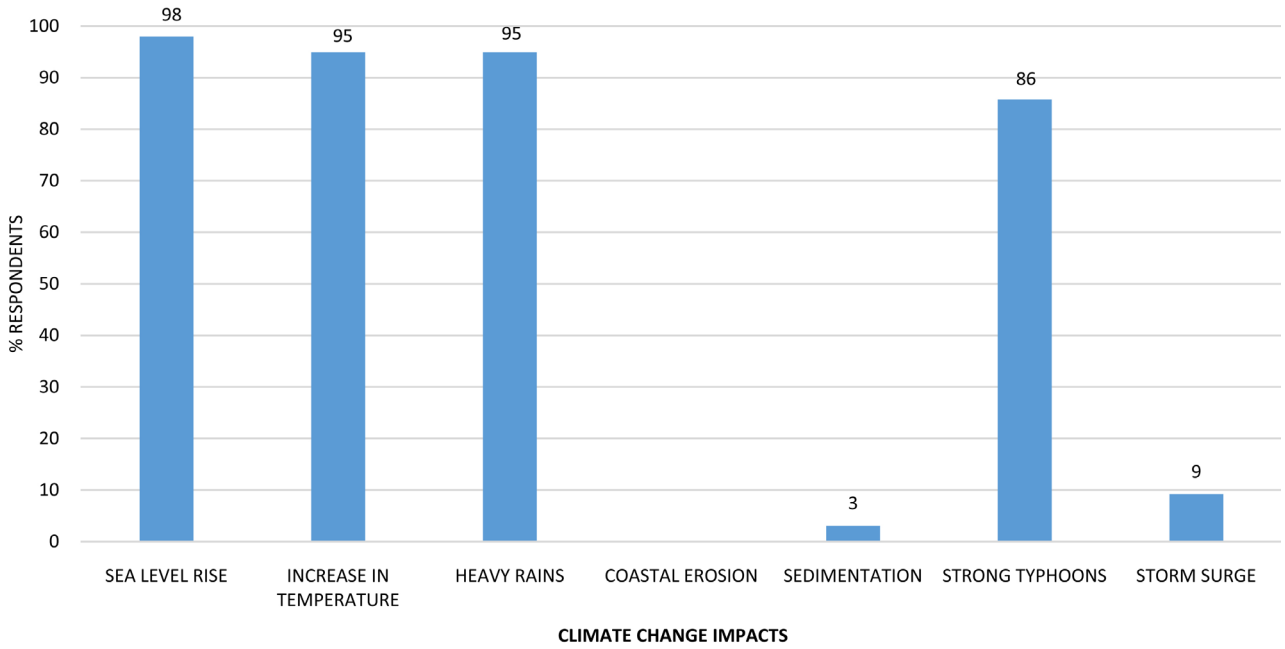

Figure 6. Climate change impacts experienced and observed in the coastal areas as perceived by the Masinloc communities.

livelihoods of the fisherman suffer considerably. These months are considered the rainy season, which explains the extraordinary heavy rainfall that locals have endured. Meanwhile, the months of January to March had the greatest percentage of temperature increase in Masinloc. The warm heat felt by communities throughout these months, commonly known as the dry season, is exacerbated by El Niño.

3.3. Analysis of the Necessity of Climate Change Community-Based Adaptation Strategies and Adaptive Capacity of Selected Barangays in Masinloc, Zambales

Based on vulnerability and hazard risk assessments for floods and storm surges, Figure 7 highlights the analysis of the urgency of enhancing community-based adaptation strategies and adaptive capacity in Barangays Bani, Collat, Taltal, Baloganon, Inhobol, North Poblacion, and San Salvador, Masinloc, Zambales. Because of their moderate susceptibility and risk to flooding and storm surge, the seven barangays require community-based adaptation measures, even if the barangays may suffer a low to moderate catastrophic risk from flooding and storm surge (Paz-Alberto et al., 2021). Based from the results of the analysis, the seven barangays have medium necessity/urgency to undertake community-based adaptation strategies for flood and storm surge but these barangays have high adaptation capacities to cope with these climate change impacts based on the different strategies they have done in their coastal barangays (Figure 7). So despite of the moderate risk posed by these disasters, the seven barangays with high adaptation capabilities have developed community-oriented adaptation strategies such as disseminating flood hazard maps, warning systems, forming rescue teams, making rescue vehicles available, and conducting disaster drills.

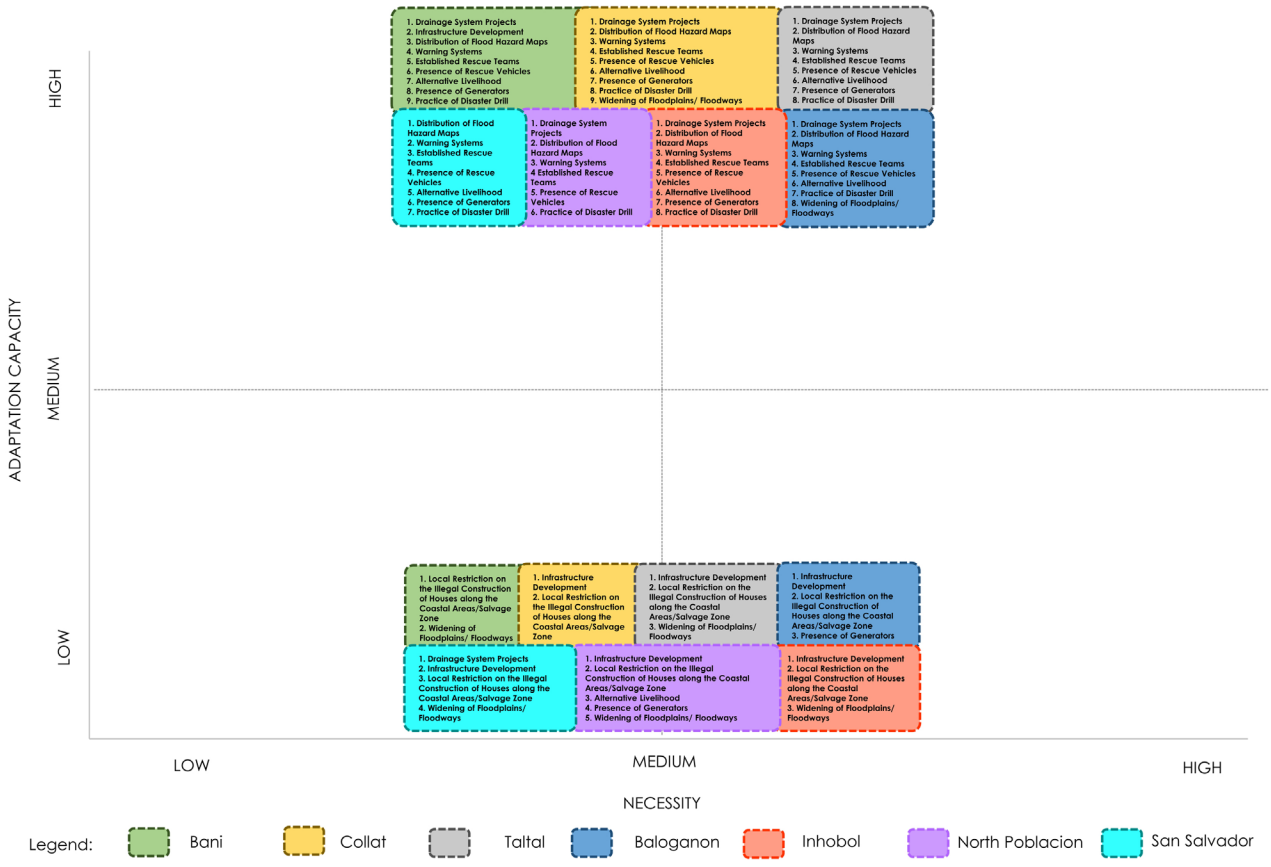

Figure 7. Analysis of necessity and community-based adaptation capacity of selected barangays in Masinloc, Zambales.

The flood hazard maps were circulated during the dissemination of information and delivery of IEC materials to chosen coastal municipalities in Zambales (Paz-Alberto et al., 2021). Barangays that have been significantly hit by disasters such as floods and storm surges, on the other hand, have been better equipped as a result of the implementation of alarm systems. Early warning systems that work properly allow authorities and rescuers to respond swiftly, minimizing the consequences of floods by sending out accurate, effective, and intelligible signals to communities in a timely way. Furthermore, by training regions on anticipated flood consequences, the establishment of alarm mechanisms in barangays has helped to minimize economic losses and reduce the number of casualties and deaths (Climate Information, Disaster Management, and Early Warning Systems, 2021). Because floods and storm surges are unavoidable, forming rescue teams and purchasing rescue vehicles in barangays is equally as important as doing city-wide emergency exercises. Drilling during an accident or crisis assists in determining the efficacy of the emergency operations plan and processes, as well as the services, supplies, and rescue vehicles. The drills will also put the emergency response teams' training and readiness to the test (Perry, 2009). Because of their enhanced speed and mobility, rescue vessels such as inflatable rescue boats are meant to assist the rescue crew during rescue operations. Flood rescue teams are trained to follow exact methods in order to save

more lives and avoid more injuries. They may also offer first aid when rescuing trapped persons during the rescue effort. The rescue operation will continue until all trapped persons have been safely relocated (SHM Group, 2018; Dove, 2020). When disaster hits, the barangays that have embraced these community-based adaptation strategies have a competitive advantage because they are more organized (Bapulu & Sinha, 2005; Cumiskey, 2015; Prakasam et al., 2021).

Improvements to drainage systems were also made in Barangays Bani, Collat, Taltal, Baloganon, Inhobol, and North Poblacion. Since rainfall gathers faster in the absence of an adequate irrigation system, some local communities install a functioning drainage system to prevent flooding, particularly in coastal locations (Lo et al., 2008; Putra et al., n.d.). In contrast, the six barangays (Bani, Collat, Taltal, Baloganon, Inhobol, and San Salvador) created alternate livelihoods as a kind of adaptation to the effects of climate change. With the exception of Baloganon and Poblacion, the five barangays (Bani, Collat, Taltal, Inhobol, and San Salvador) have adopted the use of generators to better respond to floods and storm surge. When floods and storm surges occur, people's daily activities will definitely be affected, necessitating the use of a backup power source as well as a backup revenue source. While alternative livelihoods will not only assist individuals when a catastrophe devastates a community, they will also aid in the reduction of over-exploitation of marine resources, which are the population's primary source of income (Hanh & Boonstra, 2019).

Sea walls prevent seawater from entering coastal communities during heavy typhoons, whereas dikes regulate water flow during floods caused by strong typhoons or storm surges. Floodplains can assist minimize floods even further by collecting and storing excess precipitation and then slowly releasing it across land and into groundwater in the presence of sea walls and dikes (Maness, 2015; Mitra & Biswas, 2016). Similarly, two barangays (Collat and Baloganon) worked on floodplain/floodway expansion, while Barangay Bani worked on infrastructure development in response to the moderate threat posed by floods and storm surges. Natural defenses aid local communities in reducing the effects of disasters. However, as a result of numerous structures and the growth of floodplains, the people will experience considerably fewer catastrophic repercussions.

Several community-based adaptation strategies, on the other hand, are not being implemented in Masinloc's coastal barangays hence, these barangays have low adaptation capacities (**Figure 7**). Not one of the seven coastal barangays accepted the local restriction on illegal construction of homes near coastal areas/salvage zones. Because there is no such law, it appears that unlicensed housing development near coastal areas/salvage zones is still permissible. The risk of coastal flooding increases as housing development and human population in coastal zones increase (Lumbroso, 2017) which can result in property loss since coastal erosion is a serious hazard to property, not to mention that if a storm surge happens, the homes will be instantly exposed to seawater.

Consequently, no infrastructural development has occurred in the five barangays (Collat, Taltal, Inhobol, North Poblacion, and San Salvador). Recognizing

that the water level will rise more in the next years, action was required. The failure to adapt increases the likelihood of being harmed by natural disasters. and residents have a decreased chance of escaping floods if dikes, bridges, drainage basins, and the presence of rock beams, rock rip-rap, sandbags, and floodplains are not present (Alcoforado, 2018).

On the other hand, two of the seven barangays (Baloganon and North Poblacion) did not use generators as a backup power source in the case of a power loss. Even if power generators can only offer a limited quantity of electricity, charging gadgets and utilizing minimal equipment to aid sick or disabled persons is still beneficial. Even evacuation centers, which require an emergency contingency system, are unable to function in the absence of one. Among the seven coastal barangays, North Poblacion has the lowest adaptability potential for the implementation of alternative livelihoods. It is difficult enough to survive in disaster-stricken places, and without food, people would take longer to recover. Fishers are less motivated to go fishing when other sources of income are available (Wedathanthrige et al., 2013). As a result, it is important to have new and other sources of income since people cannot rely solely on fishing to live, especially during strong typhoons.

3.4. Analysis of the Necessity of Climate Change Ecosystem-Based Adaptation Strategies and Adaptive Capacity of Selected Barangays in Masinloc, Zambales

Figure 8 portrays an analysis of the necessity of ecosystem-based adaptation strategies and adaptive capacity of seven barangays in Masinloc, Zambales, namely, Bani, Collat, Taltal, Baloganon, Inhobol, North Poblacion, and San Salvador, for the flood and storm surge that may harm them as the effects of climate change intensify. Results revealed that the seven barangays have also medium necessity/urgency for ecosystem-based strategies for floods and storm surges but with high adaptation capabilities to manage these impacts of climate change based on the various adaptation approaches they have carried out in their coastal barangays (**Figure 8**).

The seven coastal barangays implemented ecosystem-based adaptation strategies, such as mangrove planting/reforestation, annual/quarterly coastal clean-up drives, tree planting, fishing restrictions and limitations, regular monitoring of marine biodiversity and ecosystem status, implementation of solid waste management, the Clean Air Act of 1999 and Marine Protected Area (MPA), and seagrass monitoring, as forms of high adaptation capabilities (**Figure 8**).

The restoration and maintenance of natural habitats such as mangroves and seagrasses is one of the alternative coastal defense intermediation options (Del Valle et al., 2019). Mangroves are the first line of natural protection for local populations from the devastating effects of floods and storm surges (Narayan et al., 2019). They safeguard coastal areas by decreasing waves and storm surges in many tropical and subtropical locations, including the Philippines (Menéndez et al., 2020). More significantly, during a storm, mangroves can lower the intensity

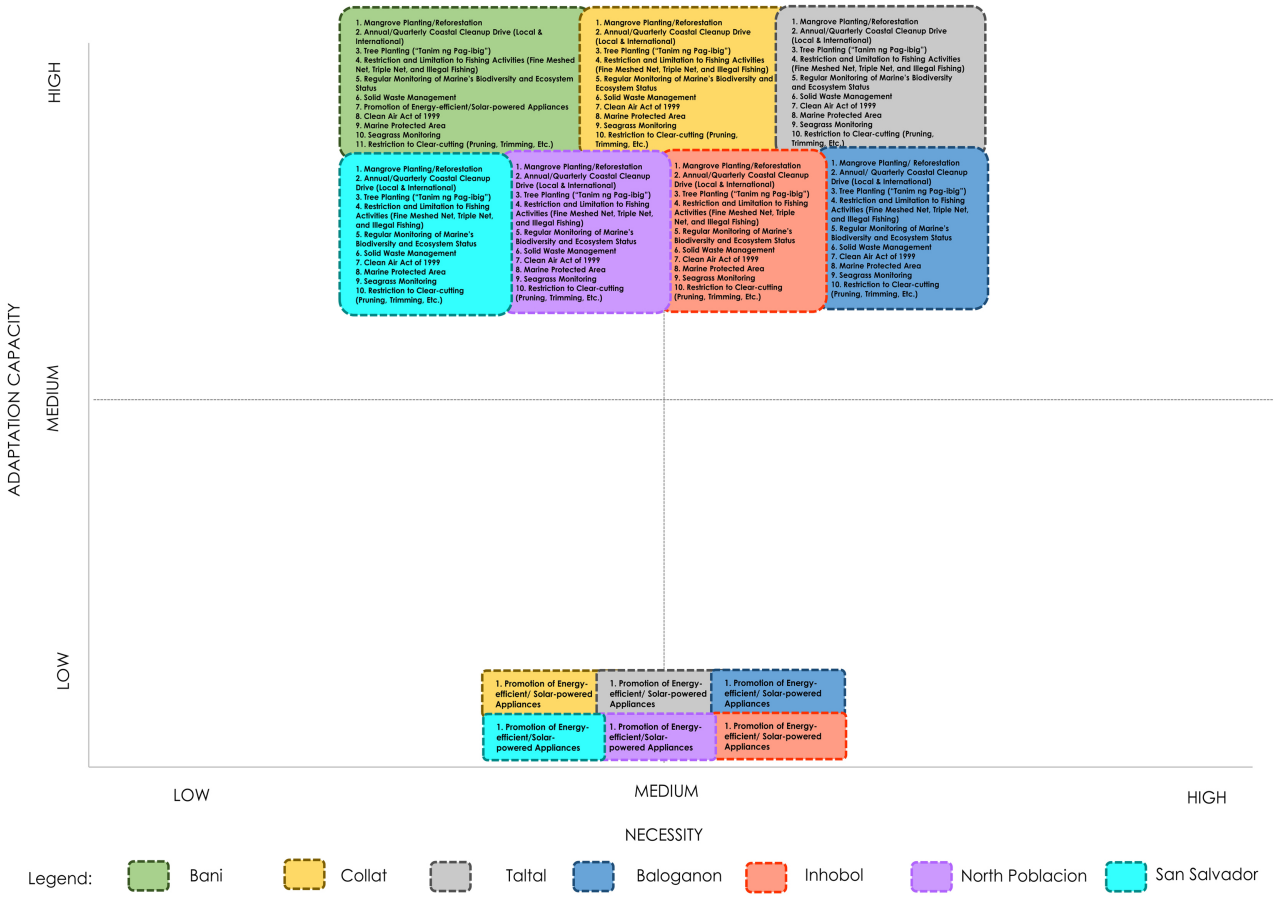

Figure 8. Analysis of necessity and ecosystem-based adaptation capacity of selected barangays in Masinloc, Zambales.

and height of the winds and huge waves that travel through them. Mangroves, with this capacity, help protect buildings such as dikes and sea walls from wind and wave damage (Spalding et al., 2014).

Likewise, by absorbing wave energy, seagrasses mitigate the increased effect of typhoons induced by climate change (Ramesh, 2018). The presence of mangroves and seagrasses offers natural protection to barangays in addition to infrastructure that may be built to withstand the effect of disasters. Furthermore, tree planting and clear-cutting limitations are natural defense mechanisms against natural disasters such as floods because tree leaves catch rainfall. As a result, the precipitation rate flowing into the river is slowed (Kemp, 2019), and the storage capacity of catchment regions is enhanced, increasing the lag time and reducing water release and the subsequent flood hazard (Dixon et al., 2016). The tree roots also absorb rainfall after a storm, which helps minimize water runoff from flooding low-lying regions where residential homes are located (Businessmirror, 2018).

Conversely, overfishing prevents healthy fish reproduction and survival in the water (National Geographic, n.d.). The ever-worsening consequences of climate change will definitely have an impact on the livelihoods of fishermen and their families. As a result, when natural disasters strike their barangays, restrictions and limitations on fishing operations, as well as continuous monitoring of ma-

rine biodiversity and ecosystem state, ensure that people continue to have an adequate supply of fishes, which are both sources of food and a source of livelihood. Further, the establishment of MPAs will help to conserve depleted, vulnerable, and endangered fish species by protecting their habitats (Becker, 2001).

Furthermore, strict adherence to the Clean Air Act of 1999, yearly or quarterly coastal clean-up campaigns, and efficient solid waste management maintain the neighborhood clean and encourage excellent health. As a consequence, diseases and illnesses can be avoided, and storms can carry away less trash. Specifically, coastal clean-up campaigns keep plastic and other waste from sinking to the ocean floor, making it more difficult to collect. By preventing plastics from degrading into microplastics, the less likely it is that the microplastics would be ingested by marine creatures, potentially harming consumers such as coastal populations (Owyoung, 2020). Microplastics appear to have the potential to pollute not only water, but also land, air, and groundwater. This may be both aesthetically and environmentally damaging to plants, animals, and humans (Amelia, 2021). Preserving the cleanliness of the environment through the deployment of ecosystem-based adaptation methods, then, implies maintaining the health and wellbeing of communities while also reducing health problems during disasters.

In addition, Barangay Bani has pushed energy-saving/solar-powered gadgets. These devices utilize less energy and hence generate less greenhouse emissions (Steffan, 2020). When used, the appliances help to reduce pollution while also improving community readiness in the event of a disaster.

Six of the seven coastal barangays did not encourage energy-efficient/solar-powered equipment (Collat, Taltal, Baloganon, Inhobol, North Poblacion, and San Salvador) therefore, these barangays have low adaptation capacities in this ecosystem-based strategy (**Figure 8**). Solar-powered appliances are energy-independent, which means they can be used even if the power goes out (GreenMatch, 2022). Nonetheless, its absence will make it more difficult for residents to manage during a crisis because this technology is prohibitively expensive for the majority of residents.

Analysis of community and ecosystem-based strategies for various barangays (villages) in every municipality is deemed very crucial and essential to undertake and implement in order to identify strengths, weaknesses and gaps and determine appropriate local responses to cope with the climate change impacts and attain resiliency for proper planning process and effective management. Furthermore, integration of this approach could be useful and valuable in local climate change policies, plans and actions.

4. Conclusion

According to the findings of this study, all seven barangays in Masinloc have moderate need for community-based adaptation methods. Only Barangays Bani and Collat, however, have a high level of adaptation capacity in terms of infra-

structure and disaster readiness. Several community-based adaptation strategies are being put in place to help these barangays respond swiftly and appropriately to address the moderate risk posed by floods and storm surges.

In terms of ecosystem-based adaptation strategies, all seven barangays (Bani, Collat, Taltal, Baloganon, Inhobol, North Poblacion, and San Salvador) have high adaptive capability in terms of natural defense against the effects of flood and storm surge due to conservation and protection of their coastal resources (mangroves and sea grasses). Despite their moderate susceptibility and risk to floods and storm surge, the barangays have established ecosystem-based adaptation mechanisms that they may require in the future. This indicates that the local communities are ready to act and deal with the consequences when disaster hits. Despite the fact that the seven barangays have adopted the majority of ecosystem-based adaptation strategies, there are still numerous community-based adaptation strategies that are needed in order to safeguard them from the effects of floods and storm surges. As a result, adopting the missing adaptation methods, both community-based and ecosystem-based, would aid in increasing the adaptive capacity of the afflicted barangays and making them more robust to the exacerbated impacts of climate change.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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