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Livelihood Vulnerability to the Hazards of Climate Change: The Case of Selected Coastal Communities in Virac, Catanduanes

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Abstract

The geographical location of Catanduanes makes it known as the island of howling winds. As the years passed, typhoons came to the island more frequently and with higher magnitudes due to climate change. With this phenomenon, Catandunganons faced risks not just for their lives but for their sources of income. Mixed methods of research were used through a community-participatory approach and non-probability sampling method using a purposive sample to include participants who represent a wide range of experiences and perspectives related to the vulnerability, exposure, and sensitivity of the communities for the past ten years (October 2010- October 2020). Findings revealed that selected coastal communities in Virac experienced typhoons very frequently for the past ten years; Magnesia del Norte was considered highly sensitive in terms of biophysical and socioeconomic aspects while communities such as Magnesia del Sur, Marilima, and Batag were considered moderately sensitive. The coastal communities of Magnesia del Norte and Marilima have an extremely high adaptive capacity. This implies that these communities can easily adapt to the hazards of climate change; Magnesia del Norte and Marilima were the coastal communities that were extremely vulnerable to the hazards of climate change. It was further recommended that selected coastal communities be considered in providing sustainable livelihood programs since they are extremely vulnerable to climate change hazards. Furthermore, coastal communities must also be engaged in disaster-risk reduction training to raise their awareness of responding to a disaster; let vulnerable communities participate in planning, design, implementation, monitoring, and evaluation of disaster risk activities as they play key roles in identifying the risks they may face during a disaster, and enhance the capacities of the local communities to lessen the vulnerability.

Keywords— climate change, livelihood vulnerability, livelihood vulnerability index, resiliency, sustainability

1 Introduction

The Philippines is an archipelago surrounded by a vast amount of bodies of water composed of 7,641 islands with a total land area of 343, 448 square kilometers. The bulk of its growing population of 104 million lives in just 11 of these islands. Bicol region has a total population of more than 5.8 million as of 2015 with 2,574.91 square kilometers. Among the region's provinces, Catanduanes has the least population of 260,964. (Philippine Statistics Authority, 2017) The geographical location of the Catanduanes, in particular, facing the Pacific Ocean, is strategic to natural climatic and oceanographic hazards, including typhoons, storm surges, and tsunamis. Hazards may be categorized into natural and anthropogenic hazards. Natural hazards include climate and weather-related hazards such as typhoons, drought, and geophysical hazards like earthquakes, volcanic eruptions, and tsunamis. While deforestation, mining, and climate change were considered anthropogenic or man-made hazards.

Natural hazards are defined as a natural process or event that is potentially damaging in that it may result in loss of life or injury, loss of property, socioeconomic destruction, or environmental degradation. Meanwhile, geophysical hazards pertain to the part of the normal functioning of the planet's dynamics. These so-called hazards are due to the naturally occurring processes in the earth's interior, leading to other hazards like earthquake-induced landslides and tsunamis [1].

On the other hand, anthropogenic hazards are defined as the hazards brought about by human activities like climate change. Climate change affects sea level rise, heavy rainfall that leads to floods in low-lying areas, longer droughts, increasing typhoons, and global warming. The evidence indicates that the net damage of climate change increases over time.

The concepts of resiliency, vulnerability and adaptive capacity are used by different people interchangeably. Resilience is linked to the dynamics of social systems such as adaptability and transformability. Resilient communities were the ones who could withstand calamities. Vulnerability focuses on exposure, sensitivity and adaptive capacity. Adaptive capacity is the ability of the institutions and networks to learn and store knowledge and experience. The idea of coping and adapting to change (whether it is called resilience or adaptive capacity) may be seen as a component of vulnerability associated with social systems' capacity to respond to change [2]. Moreover, adaptive capacity seems to be a broader concept than resilience.

Numerous research studies have assessed the area's vulnerability to natural hazards. Cutter (2005) [3], presented the factors contributing to the vulnerability of a particular community. These are location or proximity to hazard-prone areas such as coastlines or floodplains (physical vulnerability/exposure), type of residential housing structures, public infrastructures and lifelines (roads, water, bridges or power), economic health of the community, and socio-demographic characteristics (age, gender, race, socioeconomic status, special needs populations, non-English speaking immigrants and seasonal tourists) [4, 5, 6]. In the study of Al Mamun et al., (2023); Das et al., (2023); Vo & Tran (2022) [7, 8, 9], vulnerability factors were identified such as social networks, food self-sufficiency, natural disasters, climate variability, lack of facilities and means of self-protection. With the high value of ecological degradation, the inhabited population in the research region is particularly susceptible to climate change. Due to impending calamities, weak awareness, low levels of education, and more poverty, many communities in flood-prone areas have limited and conventional adaptive capacities, which makes them incapable of adapting to environmental changes [10]. However, King summarized that specific groups of people may be identified as vulnerable such as the elderly and the young [4], single-parent households, newcomers to the community and those lacking communication skills but the relative vulnerability of each is difficult to assess. In addition, illness/disability, women, language barriers, low-income families, unemployment, low education, living at nursing homes and unskilled occupation belong to the vulnerable group [11, 12].

Few studies were conducted which focused entirely on the livelihood vulnerability of coastal communities [13, 14, 15]. Several factors were considered to assess the livelihood vulnerability index of coastal communities to the hazards of climate change, such as exposure, sensitivity and adaptive capacity. Studies reviewed used natural disasters and climate change as contributing factors in exposure. In terms of sensitivity, none of them included biophysical sensitivity and coastal resources as a contributing factor while in adaptive capacity, the researcher included degree of isolation and technological capacity, which are not included in the reviewed studies. These are the gaps that the researcher would like to address. In Catanduanes setting, no researcher studied the livelihood vulnerability of the coastal communities, particularly in the coastal areas covered which were recently made into fish sanctuaries and marine reserves. This made the life of the coastal communities somewhat more complex than when there were no limitations in their sources of food/income. Policymakers could use results to assist the coastal communities.

By quantifying human experiences on many aspects of probable disaster scenarios as well as social processes that increase a community's susceptibility to hazards, this index aimed to measure communities' vulnerability to hazards. The investigation intends to provide details that could aid local governments in better comprehending community risks and further implementing policies enhancing adaptive capacity. It is widely known that climate change affects not just the environment but also the ecological perspectives of humans, requiring adaptation to their habitat. Since coastal communities rely on natural resources as their primary sources of income, whatever changes in their environment significantly affect their livelihood. Being resilient is not enough to mitigate the effects of climate change. Strengthening the capacities may lessen the vulnerabilities of coastal communities.

2 Methodology

Mixed methods of research using embedded design were used in the study through a community participatory approach for livelihood. The gathering of qualitative and quantitative data was done simultaneously. The quantitative data pertains to the relevant information on the selected households of the selected coastal communities relating to their livelihood vulnerability and capacity using a scoring method to measure variables and came up with a vulnerability index [16, 17, 18]. Qualitative data pertains to the responses of the key informants and during the focus group discussions. To illustrate the quantitative findings, qualitative data was used, enabling the researcher to validate and triangulate the data (Figure 1).

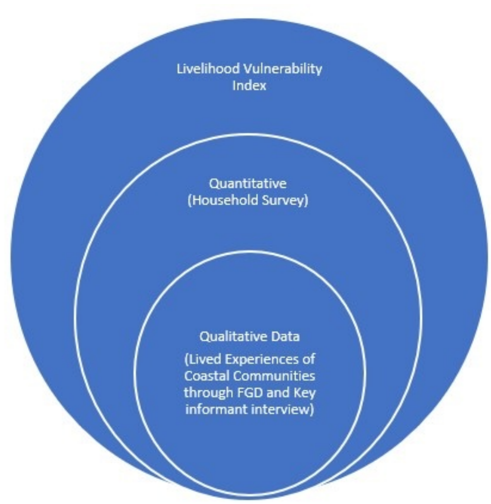

Figure 1.
Mixed Methods with Embedded Design

The primary data sources were taken from the responses on the structured interview guide to the selected coastal communities in Virac, Catanduanes, on the focus group discussions and key informant interviews. Secondary data was found from reliable sources like available data from Provincial Disaster and Risk Reduction Management Office (PDRRMO) relating to the hazard map of Catanduanes, the total population of each coastal community were gathered from Philippine Statistics Authority (PSA), the characteristics of the coastal communities stated in the Community-based Monitoring System (CBMS) from the Municipal Planning and Development Office, occurrence of typhoons from DOST-PAG-ASA Office and community/barangay profiles [19, 20, 21].

This study used a non-probability sampling method using the purposive sample to include respondents representing a wide range of experiences and perspectives related to the communities' vulnerability, exposure, and sensitivity for the past ten years.

The interview consists of the key elements of livelihood vulnerability: exposure, sensitivity, and adaptive capacity. Preliminary testing was conducted in the nearby coastal communities to test the reliability and validity of the structured interview guide.

The data was gathered using two surveys: the survey of the communities/households and the collection of information using Focus Group Discussion (FGD) and Key Informant Interview (KII) to enable the study to generate more in-depth and qualitative data on the character of livelihood vulnerability.

Frequency count was used to determine the total responses. Mean rating was used to get the average responses for each item. Vulnerability Index was used to get the average vulnerability to climate change of coastal communities [2, 18].

In symbols,

$$\text{Adaptive capacity Index (ACI)} = \frac{\textit{Total Adaptive Capacity score}}{\textit{Total Maximum Adaptive capacity scores}}$$

$$\text{Potential Impact Index (PII)} = \frac{\textit{Total Exposure scores} + \textit{Total Sensitivity Scores}}{\textit{Total Maximum Exposure score} + \textit{Total Max Sensitivity Score}}$$

$$\text{Livelihood Vulnerability Index (LVI)} = \frac{\textit{Adaptive Capacity Index (ACI)}}{\textit{Potential Impact Index (PII)}}$$

The interpretation of the index will be as follows:

Extremely High (VH) = 0.76-1
High (H) = 0.51-0.75
Moderately High (MH) = 0.26-0.50
Fair (F) = 0.1-0.25

3 Results and Discussion

3.1 Climate Change-related Hazards Experienced in the Coastal Communities in Virac, Catanduanes (Exposure)

The highest frequency of climate-related hazards was typhoon which was described as very frequent and obtained a score of 5. This implies that coastal communities experienced an average of ten typhoons in the past ten years. Heavier rains have a frequency of 4 experienced by the coastal communities and are described as rare and obtained a score of two (2) while drought has a frequency of occurrence of 2 and one storm surge, defined as very rare and obtained a score of one (1). However, coastal communities in Virac, Catanduanes do not experience floods and landslides. The total score of 9 indicates that this is the score for exposure (Table 1).

Table 1
Climate Change-related Hazards Experienced for the Past 10 years

Climate-related Hazards	Frequency of Occurrence	Description	Score
Typhoon	10	Very frequent	5
Storm Surge	1	Very rare	1
Flood	0	none	0
Landslides	0	none	0
Heavier Rains	4	rare	2
Drought	2	Very rare	1
Total Score			9

Exposure is one of the fundamental aspects of being vulnerable. Every household in a community may have different vulnerabilities depending on their exposure to hazards [3, 5, 8, 22]. Selected coastal communities in Virac, Catanduanes have high exposure to typhoons and storm surges while low exposure to flooding and landslides since the majority of households were residing near coasts or shorelines and only a few households were residing in flood-prone and landslide-prone areas. These findings were supported wherein it was emphasized that coastal communities have a greater potential threat and that these areas were susceptible to floods, sea storms and tropical depressions [9, 22].

3.2 Sensitivity of the Coastal Communities

The sensitivity of the coastal communities was divided into biophysical sensitivity and socioeconomic sensitivity [16, 18].

The biophysical sensitivity of the coastal communities refers to the sensitive area, crops, and coastal resources of the covered coastal communities (Table 2a). Since the coastal communities experienced frequent typhoons, this study focused on typhoons as climate-related hazards. Regarding the sensitive area, the researcher relied on the hazard maps provided by the Provincial Disaster and Risk Reduction Management Office (PDRRMO) [20]. It was found that the selected coastal communities were sensitive to storm surges and low hazards for flooding. The percentage of the affected area was gathered from the barangay profiles and validated by the focus group discussion. The percentage of the affected area was calculated based on the number of households residing on the shorelines and near the swamp where flooding may occur. In the percentage of magnitude of damage, the respondents refer to the past typhoons they experienced which were also validated in the data from Municipal Disaster Risk Reduction Office (MDRRMO) [19].

This was also reflected in the article of the United Nations Development Program (02 May 2017) [1], stating that coastal communities were the most vulnerable communities since they were the ones who were easily affected when there was a climate change. The ability to be resilient and adaptive to change is not enough if these coastal communities do not have ecological sustainability. They should not damage the ecosystem to the extent that they lose them to provide essential services, particularly in protecting them from disasters. Biophysical sensitivity is similar to exposure since coastal communities are sensitive to storm surges and tsunamis compared to communities living in upland/hilly areas that are sensitive to other hazards such as flooding, landslides, and typhoons.

Table 2a.1
Biophysical Sensitivity of the Community in terms of Area

Barangays	Sensitive Area	Percentage of Area Affected (A)	Percentage of Magnitude of Damage (B)	Total Biophysical Sensitivity (A+ B)/100
Batag	Coastal/Hilly	40%	90%	1.3
Marilima	Coastal	50%	90%	1.4
Magnesia del Norte	Coastal/Hilly	70%	80%	1.5
Magnesia del Sur	Coastal/Near swamp	70%	85%	1.55

In terms of sensitive crops, Magnesia del Sur and Magnesia del Norte have the highest percentage of affected crops. They planted crops such as sweet potato and other root crops and vegetable crops such as eggplant, corn, and rice.

During the conducted focus-group discussion, the respondents responded that rice plantation and rootcrops was the one which is affected most of the climate-related hazards. To describe the effect, one respondent said that for the past 10 years, "diit na sana ang gatanom ta diit na sana ang naani por dahil sa pagdakul ning mga peste"(some farmers did not plant because of pests). Another responded that "dai na naengganyo magtanom ang mga tawo ta gakulang na ang suplay ng tubig sa mga paluyan"(farmers were not motivated to plant because of lack of water supply). Likewise, in barangay Marilima, seventy-five percent (75%) the rice plantations were affected by the climate-related hazards. According to the respondent, for the past 10 years, "por dahil ta grabe ang lugi sa pagtanom, nag-iba na lang ning trabaho so mga farmers ta alog ng pagtricy or pagconstruction"(because of deficit in income of farmers, they tend to shift to other occupations like construction and tricycle drivers). "Dakul kita ng farmers buda ng tanoman, kaya lang kulang na ang gatanom"(we have many farmers but some don't want to plant), he added. However, in barangay Batag, only 40% were affected since most of the rice plantation by the farmers of Batag were situated at Barangay Marilima. According to the barangay captain of Batag, financial assistance coming from agriculture sector was hardly given by the agency because of the location of their rice plantation. This must be given considerations in giving financial assistance since not all of the real properties were situated inside the vicinity of the barangay.

In terms of the magnitude of damage, respondents from Batag and Marilima claimed that 90% of their plantations had been damaged by past natural disasters, including typhoons and drought which led to an insufficient supply of water in rice plantations. While 85% in barangay Magnesia del Sur and 80% in Magnesia del Norte. This implies that the majority of the affected crops were damaged during the past natural disaster.

In terms of coastal resources/fish catch, the respondents claimed that almost 100% of the coastal resources were affected by natural calamities. To describe the effect, one respondent said that "kapag igwa baga kalamidad, maski halayo pa ang bagyo, pigbabaton na ang mga sakayan kaya dai na nkalawod and pakatapos mn ning bagyo, dai mn baga nka asi-asi maglawod ta kung minsan nauyag ang bangka o kaya makosog pa ang lungso ning dagat". (If there's a typhoon approaching, the boat is sent to higher areas; after the typhoon, we can't sail abruptly because of the damaged boat). For the percentage of magnitude of damage, the respondents stated that the coastal resources decreased by almost half compared with the fish catch for the past ten years.

Most of their boats were damaged during typhoons, particularly on the past typhoon Nina (2016) and Tisoy (2019). If this trend continues, there will come a time when the fisherfolks will not have a fish catch. The government should look into this trend by adopting policies not to overexploit natural resources. An example of this policy was reflected in the article of Marten (2001), where the fisherfolks in Turkey adopted a rotation policy in fishing [23]. The fishing sites were divided into the number of fishers. On the first day, they fish on their allocated site and on the second day, they will fish on the other site, until they all fish on all the sites. This was done to obtain sustainable resource use in the village.

Cowan, H. Jr. et al., (2002) noted that "temperature changes in coastal and marine ecosystems will influence organism metabolism and alter ecological processes such as productivity and species interactions [24]. Species are adapted to specific ranges of environmental temperature. As temperatures change, species' geographic distributions will expand or contract, creating new species combinations that interact unpredictably. Species that cannot migrate or compete with other species for resources may face local or global extinction."

Magnesia del Norte obtained the highest biophysical sensitivity score of 4.55, Magnesia del Sur had 4.35, Marilima had 4.23 and the lowest was Batag with a total biophysical sensitivity of 3.8 (Table 2a.4). The biophysical sensitivity scores indicate that these coastal communities were highly sensitive to natural calamities such as typhoon, storm surge or tsunami. This is because majority of the communities were residing on the seashore since majority of them have fishing as primary source of income for the past years and eventually shifted to another source of income due to unsustainable fish catch for the past years.

Table 2a.4
Total Biophysical Sensitivity of the Community

Barangays	Area	Crops	Coastal Resources	Total Biophysical Sensitivity
Batag	1.3	1.1	1.40	3.8
Marilima	1.4	1.5	1.33	4.23
Magnesia del Norte	1.5	1.6	1.45	4.55
Magnesia del Sur	1.55	1.5	1.30	4.35

The socioeconomic sensitivity of the selected coastal communities is composed of the proportion of vulnerable populations, sources of income, and percentage of income from climate-related hazards. The ratio of vulnerable populations of the coastal communities in Virac, Catanduanes having an age 70 years old and above and seven years old and below, Persons with Disabilities (PWDs), and pregnant women [1, 25]. Findings show that barangays Batag, Marilima, and Magnesia del Norte have less than 20% vulnerable individuals which is described as very low and obtained a score of 1, while Magnesia del Sur has a low percentage of vulnerable populations which obtained a score of 2 (Table 2b.1).

According to Baker & Cormier (2014), older adults might be vulnerable not only for their physical health but also due to other factors such as livelihood, self-protection, social capital, lack of access to resources, susceptibility to abuse and violence, limited knowledge regarding the use of information technology and limited access to political power and representation.

In terms of sources of income, Magnesia del Sur has the highest number of households engaging in Agriculture, Forestry, and Farming with 51 households, while barangays Marilima and Magnesia del Norte have 38 and 24. Regarding professionals, barangay Magnesia del Norte has

Table 2b.1
Proportion of Community's Population

Barangays	Proportion of Community's Vulnerable Population	Description	Score
Batag	17.3	Very low	1
Marilima	19.3	Very low	1
Magnesia del Norte	14.3	Very low	1
Magnesia del Sur	21.3	Low	2

the highest number of households with 49 professional workers, followed by Magnesia del Norte with 24 professionals, Marilima with 16 professionals, and Batag with 11 professionals. Regarding transportation (tricycle drivers), Magnesia del Norte has 38, followed by Marilima with 21 and 20 in Magnesia del Sur and Batag with 13 households engaging in transportation. Most households in barangay Magnesia del Sur were laborers and skilled workers with 111 households followed by 89 from Magnesia del Norte, 42 from Batag, and 21 from Marilima. Twenty-five households from Magnesia del Sur have OFWs, seven from Batag, and two from Marilima. Other sources of income include sari-sari stores, food vending, and fish vending. Magnesia del Norte has 64, Magnesia del Sur has 31, Batag has 19, and 17 households from Marilima (Table 2b.2). This implies that the majority of sources of income of these barangays came from laborers and skilled workers. This number is increasing up to the present time for the farmers and fisherfolks shifted to being laborers or skilled workers because of the low income in farming and fishing. Farmers and fisherfolks in coastal communities were very eager to have other sources of income since farming or fishing only could no longer support the needs of their families. To achieve sustainable development, the government should provide sustainable livelihood opportunities for the farmers and fishers since they are the ones who produce food on our plates.

Table 2b.2
Source of Income

Barangays	Sources of Income						Total
	A	B	C	D	E	F	
Batag	24	11	13	42	7	19	116
Marilima	38	16	21	21	2	17	115
Magnesia del Norte	38	49	38	89		64	278
Magnesia del Sur	51	24	20	111	25	31	262

Legend: A- Agriculture, Forestry and Fishing; B- Professionals; C Transportation; D- Laborers and skilled workers; E- OFW; F- Others

These findings were supported by the study of Asrat, P. & Simane B., 2017), which indicates that the largest dependence on the climate-sensitive sector leads to the increased vulnerability of communities to climate variability and extremes. This was also represented in the article (Understanding Disaster Risk., 2017) [1] which stated that poverty is both a driver and consequence of disasters [5] (Ali, W, 2013; Bhatta et al., 2015; Susan Cutter et al., 2009). Several studies also have these findings that socioeconomic conditions of the communities such as weak demographic groups (e.g., poor and single-parent households), low-income level, and low level of education facilitate higher sensitivity [13, 22, 26]. Poorer communities tend to have low adaptability to climate change. They were the ones who had difficulty recovering from the damage brought about by the disasters.

Based on the respondents' responses, the income sources easily affected by climate-related hazards include agriculture, forestry, fishing, transportation, laborers and skilled workers and others (food vending, sari-sari stores, and fish vending). They excluded the professionals since according to them, they have a fixed income and have regular salaries even though natural disasters occurred in the area. Most respondents answered that one hundred percent of their income came from sources easily affected by climate-related hazards (Table 2b.3).

Table 2b.3
Percentage of Income from Climate-related Hazards

Barangays	Percentage of Income from Climate-related Hazards	Description	Score
Batag	84.5%	Very high	5
Marilima	84.3%	Very High	5
Magnesia del Norte	82.4%	Very High	5
Magnesia del Sur	81.3%	Very High	5

In terms of the total socioeconomic sensitivity of the selected coastal communities in Virac, Catanduanes, barangay Marilima has the highest total socioeconomic sensitivity score of 2.04 followed by 2.02 of barangay Batag and Magnesia del Sur while barangay Magnesia del Norte has the lowest socioeconomic sensitivity score of 1.96 (Table 2b.4).

Table 2b.4
Socioeconomic Sensitivity of the Community

Barangays	Proportion of Populations	Source of Income	Percentage of Income from Climate-related Hazards	Total Socioeconomic Sensitivity Scores
Batag	17.3	100%	84.5%	2.02
Marilima	19.3	100%	84.3%	2.04
Magnesia del Norte	14.3	100%	82.4%	1.96
Magnesia del Sur	21.3	100%	81.3%	2.02

Coastal communities of Magnesia del Sur was described as highly sensitive while Magnesia del Norte, Marilima and Batag were described as moderately sensitive in terms of biophysical and socioeconomic aspect (Table 2c). This is because Magnesia del Norte was the barangay with the lowest socioeconomic sensitivity among other communities. This implies that when a typhoon hits the province, the damage to the coastal community of Magnesia del Norte is higher compared with other coastal communities covered by this study.

Table 2c
Overall Sensitivity of Selected Coastal Communities

Barangays	Biophysical Sensitivity Scores	Socioeconomic Sensitivity Scores	Overall Sensitivity Scores	Description
Batag	3.8	2.02	5.82	Moderate
Marilima	4.23	2.04	6.27	Moderate
Magnesia del Norte	4.55	1.96	6.51	High
Magnesia del Sur	4.35	2.02	6.37	Moderate

3.3 Adaptive Capacity of Coastal Communities

In terms of physical capacity, coastal communities have an average of 2 labor force in a family. This means that only two of the family members worked for the consumption of the whole family, whether small or big. This implies that coastal communities have moderate availability in terms of physical labor and obtained a score of 3 (Table 3a).

Table 3a
Physical Capacity of the Community

Barangays	No. of Labor Force	Description	Score
Batag	2	Moderate Availability	3
Marilima	2	Moderate Availability	3
Magnesia del Norte	2	Moderate Availability	3
Magnesia del Sur	2	Moderate Availability	3

The article Understanding Disaster Risk., 2017 supported these findings, which stated that at the household level, capacity is internal, which means that households have control over their physical power. Vulnerability would be lowered if there was an increase in households' physical ability [1].

Regarding cognitive and linguistic capacity (literacy rate), most family heads were educated. Having a percentage of 81 – 100, the literacy rate was described as very high and obtained a score of 5 (Table 3b).

Table 3b
Literacy Rate of the Community

Barangays	Percentage	Description	Score
Batag	87.9	Very high	5
Marilima	89.4	Very High	5
Magnesia del Norte	90.5	Very High	5
Magnesia del Sur	90.2	Very high	5

The result of the study could be attributed to the findings of the study of Erich Striessnig et al.,(2013) [27] that education is the single social and economic factor associated with the reduction of vulnerability to natural disasters.

In terms of resource availability, majority of the coastal communities have their means of transportation and communication. Barangay Batag, Marilima and Magnesia del Norte have a high availability of transportation and communication. However, in barangay Batag, they have no cellphone signal but can go to higher places to have signal reception on their phones. In terms of transportation, most households have their motorcycle or tricycle, and every household has their cellphone and television for communication purposes. However, most of the Magnesia del Sur residents have moderate transportation and communication availability. Only 55 percent of its households have access to transportation and communication (Table 3c). This implies that most of the time, they don't have access to communication and transportation.

Table 3c
Resource Availability

Barangays	Percentage	Description	Score
Batag	63.5	High availability	4
Marilima	65.8	High availability	4
Magnesia del Norte	68.6	High availability	4
Magnesia del Sur	55.3	Moderate availability	3

Effective communication connects first responders, support systems, and family members with the communities and individuals immersed in the disaster. In the article posted, the author characterizes the importance of transport system and infrastructure in information sharing with decision making during an induced earthquake [28]. Increasing mobility and active communication systems tend to reduce vulnerability.

In terms of communication systems, it shows that selected coastal communities in Virac have a very good early warning system such as megaphone and microphone with speakers placed at the plaza or session halls, which is the center of the barangay, to be able to hear by the constituents. This is also their system of disseminating information. In addition, they also conducted house-to-house dissemination of information in case of households that are isolated among other households (Table 3d).

Table 3d
Communication Systems in the Community

Barangays	Presence, effectiveness and efficiency	Score
Batag	With, very good	5
Marilima	With, very good	5
Magnesia del Norte	With, very good	5
Magnesia del Sur	With, very good	5

Early warning systems must be interrelated between four key elements: disaster risk knowledge based on disaster risk assessment; detection, monitoring and evaluation of possible hazards and consequences; timely and accurate information dissemination on likelihood and impact; and preparedness at all levels to respond to the received warnings [1]. Failure of either of the key elements will result in ineffective warning systems in the community. Likewise, the study of

In terms of degree of isolation, Magnesia del Sur has the highest percentage of households that is isolated in the barangay. This is composed of one purok in the Labanay area and other households in San Lorenzo Ruiz Street. This implies that Magnesia del Sur has low percentage of isolation. However, barangay Marilima, Batag and Magnesia del Norte have a very low percentage of isolation which is 17.10%, 10.21% and 8.18%, respectively (Table 3e) This implies that majority of the households in this barangay is situated nearer to each other.

Table 3e
Degree of Isolation

Barangays	Percentage	Description	Score
Batag	10.21	Very low	1
Marilima	17.10	Very low	1
Magnesia del Norte	8.18	Very low	1
Magnesia del Sur	38.46	Low	2

Findings could be attributed to the study of John A. Staley et al., (2010), which presented that social isolation among the elderly is directly correlated with disaster preparedness levels of seniors.

In terms of strength of availability of support systems, Magnesia del Norte and Magnesia del Sur rated an average of seven out of ten, which is equivalent to 70% and described as high availability. Communities in barangay Marilima rated an average of 6.5 or 65%, also described as high availability. However, communities of barangay Batag rated an average of 6 or 60% which is described as moderate availability (Table 3f). This implies that coastal communities have a high availability of support from NGOs and other individuals such as neighbors.

Table 3f
Strength of Availability of Support Systems

Barangays	Percentage	Description	Score
Batag	60	Moderate availability	3
Marilima	65	High availability	4
Magnesia del Norte	70	High availability	4
Magnesia del Sur	70	High availability	4

The researcher asked the respondents for their known adaptation technology and described their income level as adaptation cost is concerned. The respondents responded that in terms of adaptation, they only knew that the adaptation like the construction of typhoon-prone houses was costly and they couldn't afford to have that kind of house. In terms of crops, they said that the agriculture sector must provide drought-resistant seedlings to adapt to the changing climate (Table 3g).

Table 3g
Economic Capacity

Barangays	Percentage	Description	Score
Batag	40.00	Low	2
Marilima	62.77	High	4
Magnesia del Norte	68.75	High	4
Magnesia del Sur	55.29	Moderate	3

These findings were supported by the study of Kim, S.K. et al., 2006; King & Macgregor, 2000 [4, 11] which presented that the low socioeconomic capacity of households leads to an increased livelihood vulnerability. Social factors, information and competence in the community, income security and institutional and human determinants were the significant factors in the community's adaptive capacity. Increasing adaptive capacity of households leads to the lowering of vulnerabilities. Studies suggest to have better cyclone shelters, more robust transportation and communication systems, infrastructure development and community empowerment in enhancing adaptive capacity [8, 14, 29].

Marilima and Magnesia del Norte Coastal communities obtained a percentage of 62.77 and 68.75 respectively, which is described as high economic capacity. Magnesia del Sur has a rating of 55.29%, defined as moderate economic capacity, while Batag has 40%, expressed as low economic capacity. This implies that most households in Barangay Batag have a low capacity for adaptation costs.

Regarding technological capacity, during the focus group discussion (FGD), the researcher asked the respondents about their known technologies when there is a calamity and its effectiveness. The respondents have varied available technologies, particularly in the indigenous knowledge of disaster preparedness. The common indigenous knowledge presented by the coastal communities was the bloody red sunset and the stinky smell of the sea indicate a typhoon will be coming. The ants' behavior suggests there will be rain in the next few days. One unique indigenous knowledge from communities of Marilima is the clear picture of an island near Mt. Mayon which indicates that there will be an approaching calamity/typhoon. From the communities of Magnesia del Sur, they said that once a coconut tree bears so many fruits, it also indicates that there will be a typhoon coming. With this knowledge, they said they could prepare for these coming calamities by tying their houses to the nearest trees or posts, placing pagabat on their roofs and keeping their important papers and things in a sealed container *(laton)*. They also said that it is effective because every time there was a typhoon, they did it and no casualties were recorded up to this time (Table 3).

Table 3a
Physical Capacity of the Community

Barangays	No. of Labor Force	Description	Score
Batag	2	Moderate Availability	3
Marilima	2	Moderate Availability	3
Magnesia del Norte	2	Moderate Availability	3
Magnesia del Sur	2	Moderate Availability	3

Overall, barangays Marilima and Magnesia del Norte have the highest score of 31 for the overall adaptive capacity followed by barangay Magnesia del Sur of 30 and the lowest overall adaptive capacity of 28 for the barangay Batag (Table 3).

3.4 Livelihood Vulnerability Index of the Coastal Communities in Virac, Catanduanes

Livelihood vulnerability index was computed by dividing the adaptive capacity index (ACI) and the potential impact index (PII).

Magnesia del Norte and Marilima have extremely high livelihood vulnerability while Magnesia del Sur and Batag have high livelihood vulnerability. This implies that their livelihood sources were easily affected by the hazards of climate change (Table 4).

Table 4
Livelihood Vulnerability Index of Selected Coastal Communities

Barangays	Livelihood Vulnerability Index	Interpretation
Batag	0.71	High
Marilima	0.76	Extremely High
Magnesia del Norte	0.77	Extremely High
Magnesia del Sur	0.73	High

3.5 Significant Difference of Livelihood Vulnerability Index Among Selected Coastal Communities in Virac, Catanduanes

The p-value of 0.89 higher than 0.05 level of significance leads to the acceptance of the null hypothesis that there is no significant difference between the livelihood vulnerability of the selected coastal communities. This means that the difference in the livelihood vulnerability index's numerical value was insignificant (Table 5). This implies that livelihood vulnerability index among the selected coastal communities was the same.

Table 5
Summary of Test of Difference of the Livelihood Vulnerability Index

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.677859722	3	0.559287	0.202168	0.894547	2.739502
Within Groups	188.1180278	68	2.766442			

This was also reflected in the study of Mekonen & Berlie (2021), which states that the disparities of livelihood vulnerabilities were due to the differences in the interaction of exposure, sensitivity and adaptive capacity components [30]. A high level of exposure and sensitivity combined with low adaptive capacity leads to an increased livelihood vulnerability.

4 Conclusion

In lieu of the findings, it can be concluded that the barangays covered by this study were vulnerable in terms of their livelihood since most of their sources of income came from sources that are easily affected by climate-related hazards. The livelihood vulnerability index among the selected coastal communities was not significant. This means that the livelihood vulnerability index among the barangays was the same. Having the available vulnerability information, the government units can adequately design and implement programs and policies that could effectively be implemented. It is therefore recommended that these barangays be the priority in giving livelihood assistance for them to raise their level of adaptation in terms of hazards of climate change.

5 Recommendations

In the light of the findings and conclusions, the following were recommended by this study:

1. Coastal communities should be considered in giving livelihood assistance since they are highly vulnerable to climate change hazards.

2. Involve the coastal communities in disaster-risk reduction training to raise their awareness on responding to a disaster.

3. Let the vulnerable communities participate in the planning, design, implementation, monitoring and evaluation of disaster risk activities since they are the ones who can identify the risks they are facing when a disaster happens.

4. Enhance the capacities of the local communities to lessen the vulnerability by providing better access to livelihood programs and improved healthcare facilities.

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