



COMMUNITY-BASED HAZARD AND VULNERABILITY ASSESSMENT OF COASTAL IN COMMUNITIES OF THE FIRST DISTRICT OF ORIENTAL MINDORO

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ABSTRACT

One of the posing threats to humans is climate change. The effects of climate change cause damages to lives and properties and disruption of economic activities particularly to those living in the coastal zone. The Coastal Zone is the earth's most dynamic part that provides ecosystem services to humanity. This study assessed the vulnerability and exposure to the hazard of the coastal communities in the first district of Oriental Mindoro by using the Pressure and Release (PAR). This study utilized the descriptive research method in a quantitative approach. To analyze the data, the study used the Statistical Package for Social Science (SPSS) as the statistical tool. Results revealed that there is an 18.80 percent increase in population from 2007 to 2015 in this coastal zone. Records of DOST-PAGASA showed that there is a high frequency of typhoons visited in the area bringing a heavy amount of rainfall. While the result of the assessment of the three groups of respondents indicated that exposure to vulnerability moderately happened while on the exposure to the hazard, they had a different perception, LGU employees and environmentalists' composite mean is higher compared to moderate rating by the households. Analysis indicated that there is a significant difference in respondent's assessment of vulnerability and hazard. Finally, the foregoing findings necessitated developing a community-based action plan following the principle of the integrated coastal zone management.

Keywords: Coastal communities, vulnerability, hazard, PAR Model, Oriental Mindoro

INTRODUCTION

Climate change is one of the present threats to the human race and its effects are unprecedented that causes death, injury, damages to properties, and disruption of economic activities. To lessen serious consequences that affect the environment and the human population, climate change impacts must be properly addressed. This serious threat in conjunction with other pressures may affect other factors such as poverty, poor healthcare, and inequitable distribution of natural wealth. This inevitable change brings a serious impact on those people living in the coastal zone.

The Coastal Zone is considered as the earth's most dynamic parts that provide ecosystem services to humanity (Mukhopadhyay et al. 2012). Compared to the upland areas, coastal regions are more densely populated (Neumann, Vafeidis, Zimmermann, and Nicholls, 2019). Anthropogenic activities lead to an imbalance in the natural process that existed within the coastal areas. When the balance disturbed the natural process, the result is the occurrence of a hazard. Hazard brought a situation where there are a lot of damages to the human population as well as in the aspect of the environment. When this phenomenon occurred in a populated area, unfortunately, the result is a disaster. In evaluating disaster risk, what is



important is the aspect of the social production of vulnerability that should be the same level as the degree of understanding with hazard. When it comes to the view on the risk that people are facing with it is important to know that this is the crosscutting combination of vulnerability and hazard that in the end, the result is a disaster.

The word vulnerability becomes popular that this concept started along the line of disaster risk. This originated from the Latin word "*vulnerable*" which means "wound" (Ford et al. 2018). Vulnerability is the failure of the human being to stand with the impact of disaster (Ciurean, Schröter, and Glade, 2013). There are three important components in the progression of vulnerability; these are the root causes, dynamic pressure, and unsafe conditions. Root causes are the set of interrelated factors that affect the society's socio-economic condition (Wisner et al. 2003 as cited in Awal, 2015). The dynamic pressure is a situation wherein the effect of root causes which translated through the process into an unsafe condition (Hamis, 2018). The unsafe condition is the result of the combination of these two, dynamic pressures and the root causes (Ahammed and Pandey, 2019). On the other hand, hazard means as phenomena that in the process posing dangers to the human being. Hazard risk is the unwelcome result of the disasters brought to humanity (Gunawan, Mooney, and Aldridge, 2017). It is the product of communities' vulnerability and exposure to hazard (Bolletino et al. 2018). Hazard impact possesses intensity, frequency, and location or position that brought risk to humanity (Djalante, 2018).

The Philippines belongs to the places vulnerable to climate change both in the present and the future time (Alcayna et al. 2016; Cramer and Szilagy, 2019). Strategic approaches are needed to properly address the decades-old problems that will solve both the environmental issues and the socio-economic condition of the people (Department of Environment and Natural Resources (DENR), 2013). In this aspect, the law known as Executive Order No. 533 series of 2006 was promulgated to adopt the strategies that will cater to the sustainable development of the coastal zone and the resources found

therein. DENR Administrative Order No. 2016-26 supports this approach which primarily aims to effectively manage the country's coastal ecosystem.

Reviewed works of literature revealed that most of the locale of the study conducted on vulnerability and hazard are those outside the Philippines. Some authors researched vulnerability and hazard in the Philippines but rare are those conducted on the coastal zone. In the case of the island of Mindoro, no studies were found similar to this topic conducted along the coastal zone.

This makes the assessment of these coastal communities' vulnerability and hazard became imperative. By using the Pressure and Release (PAR) Model as a framework, this research determined the vulnerability and hazard exposure of the communities in the northern bay of the first district of Oriental Mindoro. This is in many ways expected to provide the government particularly the local government unit (LGU) of this province with information that can be used in developing the strategies in addressing disaster risk reduction brought by climate change extreme and variabilities.

OBJECTIVES OF THE STUDY

The specific aims of this research are enumerated as follows: 1) determine the present status of coastal communities in terms of population, typhoon frequency, and rainfall amount; 2) assess the vulnerability of the respondents in terms of root causes, dynamic pressure, and unsafe condition; 3) assess the exposure to hazard of the respondents in terms of risk and impact; 4) determine the significant difference of the assessment with regards to vulnerability and hazard; 5) propose an action plan that matters to effective coastal zone management.

MATERIALS AND METHODS

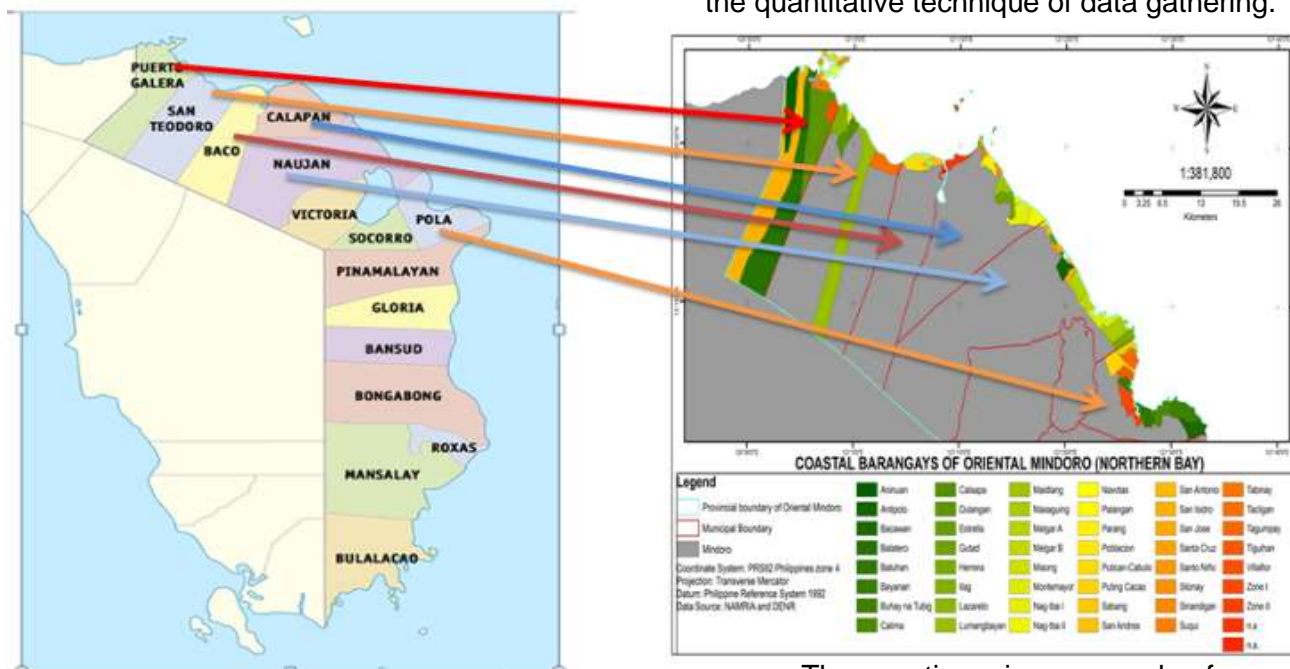
The Study Site. The study site is located between 13°15'0" N to 13°25'30"N and 120°50'0"E to 121°40'0"E. There are five (5) municipalities and one (1) city comprising this coastal area.



These are the Municipalities of Baco, San Teodoro, Puerto Galera, Naujan, Pola, and Calapan City (Figure 1). The biggest among these is the Municipality of Naujan with a land area of 528 square kilometers while the smallest is Pola consisting an area of 120.20 square kilometers (Provincial Planning and Development Office (PPDO), 2011). These coastal communities are exposed to hazard hence vulnerable to climate change. This area serves an important function in the food security of Metro Manila and the adjacent places since the province of Oriental Mindoro is known as the food basket of the Southern Tagalog region.

households. The size of the sampling population is 24,075 by using the Raosoft sample size calculator at a 4.46% margin of error, the study generated a total sample size of 474 distributed as follows: 240 Households, 120 LGU employees, and 114 Environmentalists. To determine the distribution of the sample from the three stratum, the study utilized a disproportionate stratified sampling procedure.

Data collection, processing, and analysis. Data gathered were secondary and primary data. Secondary data were sourced from the office of different government agencies. For the primary data, this study utilized a survey questionnaire as the quantitative technique of data gathering.



Source: File: Ph fl oriental mindoro.png /commons.wikimedia.org

Figure 1. Study site (Map of First District of Oriental Mindoro (Northern Bay))

Research Design and Respondents of the Study. A descriptive research method in a quantitative approach was utilized in this study. This method is deemed appropriate to use because the study is concerned with the realities taking place in the environment of the study. The respondents of the study were grouped into three strata: the environmentalists, the local government unit employees, and the

The questionnaire was made of one part that contains the two variables, the vulnerability, and hazard. For the analysis and statistical treatment of data, the study utilized the Statistical Package for Social Sciences (SPSS). Statistical tools used are the mean and analysis of variance.

RESULT AND DISCUSSION

1. Status of the coastal communities

1.1 Population



Table 1 shows that from 81,189 individuals in 2007, the populations in the coastal communities' increases to 96,454 individuals in 2015 or an increase of 18.80 percent for eight years.

Table 1
Populations of the coastal communities in the first district of Oriental Mindoro

Municipality/City	Number of Population		
	2007	2010	2015
Baco	3,278	3,319	4,187
Calapan City	31,977	32,348	36,437
Naujan	7,875	8,220	8,982
Pola	12,122	12,128	12,729
Puerto Galera	19,389	22,236	27,210
San Teodoro	6,548	6,133	6,909
Total	81,189	84,384	96,454

Source: Philippine Statistics Authority (PSA)

Calapan City and Puerto Galera registered the biggest increase in the number of populations from 2007 to 2015. According to Duraiappah et al 2015 in the long run, not only the poor communities will be affected by the increase in population but also the group of well-to-do or rich people due to the competition for resources and spaces. This scenario might happen to the coastal communities of this area if the increasing population will not be controlled. However, Pulhin J.M., F.B. Pulhin, and Gebana (2017) stressed out that the role of the local communities in the preservation and protection of the coastal environment is important hence they need to be treated as a partner for environmental protection and development.

1.2 Typhoon Frequency

Figure 2 displays the record of typhoon frequency occurred in this province from 1948-2019. This indicates that typhoon mostly happened in June and October to December of every year. Based on the present record of the Oriental Mindoro Provincial Disaster Risk and Reduction Management Office typhoons that hit the first district incurred heavy damages to the

agricultural sector and infrastructures amounting to billions of pesos.

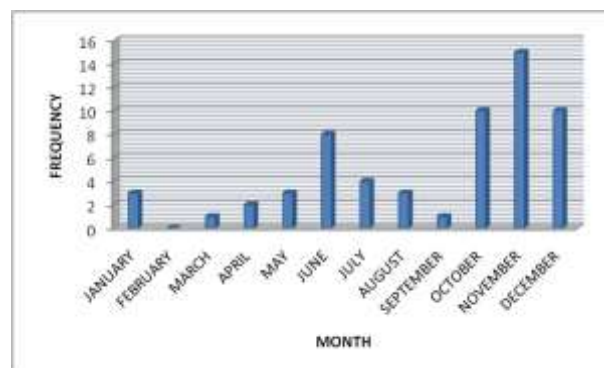


Figure 2. Typhoon Frequency in the first district of Oriental Mindoro (1948-2019) (Source: DOST-PAGASA)

1.3 Rainfall Amount

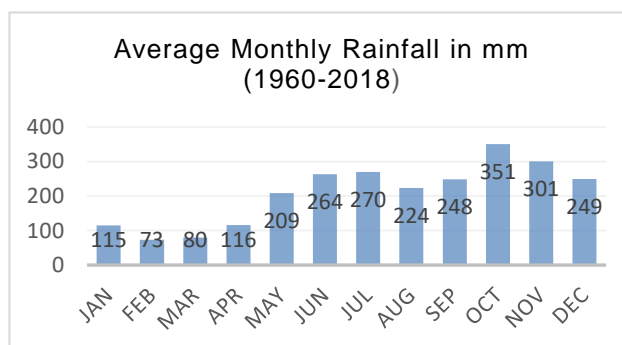


Figure 3. Average monthly rainfall in millimeter (1960-2018) Source: DOST-PAGASA, 2019

The Northern part of Oriental Mindoro falls under Climatic Type III of Corona Classification that has no distinct dry season however maximum rainfall occurs in January then from May up to December of every year (Department of Science and Technology-Philippine Atmospheric Geophysical Astronomic services Administration (DOST-PAGASA, 2019). (Figure 3 illustrated the average monthly rainfall recorded from 1960-2018 in the area with the highest average occurred during October and the lowest one is during February. Given this climatic data, this part of the province is blessed with abundant water supply thus making this area a good source of water for rice, fruits, and vegetable productions.



The area located in a low point valley is sensitive to the amount of rainfall making many parts prone to flooding (Yumul et. al 2012; Catane et al. 2012). This area, though blessed with a fertile valley, some parts found in the coastal area with low elevation hence sensitive to the heavy amount of rainfall. These coastal communities should develop strategies to prevent heavy damages from the flooding caused by the heavy amount of rainfall. Raemakers and Sowman, 2015 and Sharma et al. 2018 advocated that the community should have adaptive capacity and strategies to address flooding to help improve the people's socio-economic condition.

2. Vulnerability of the respondents in terms of root causes, dynamic pressure, and unsafe condition

Table 2
Assessment of the respondents' vulnerability

Sub-variables	Households		LGU Employees		Environmentalists	
	WM	VI	WM	VI	WM	VI
Root Causes	1.96	M	2.12	M	2.04	M
Dynamic Pressure	2.26	M	2.45	M	2.25	M
Unsafe Condition	2.46	M	2.59	H	2.26	M

Table 2 shows the assessment of the respondents in the sub-variable root causes the assessment of income, livelihood, and social participation in decision-making was conducted. The weighted mean score obtained for households is 1.96, LGU employees' is 2.12, and 2.04 for environmentalists. This means that in general, their deep-rooted factors such as the economic conditions have moderately attended. Two hundred sixty (260) or 54.85 percent of the respondents earned a household income of Php 10,000.00 (US\$ 205.97) and below. This income falls below the estimated poverty threshold for the MIMAROPA Region of PhP 23,229 (US\$ 476.46) according to the Philippine Statistics Authority (PSA, 2018). Despite their income falls within the poverty line these people managed to live a modest life. This is because this area is a food basket hence the prices of basic

commodities are lower thus making them purchased basic food necessities needed by the family. Alternative livelihood is also moderately available in these coastal communities. This livelihood is more on fishing activities. While on the social participation these communities were cooperative to the barangay officials in responding to the disaster. This behavior implies that cooperation has a positive impact and good cohesion towards managing the hazard events thus reducing social vulnerability (Witvorapong, Muttarak, and Pothisiri, 2015). The local government unit in this coastal area supports the well-being of the community and attending to their economic needs. This makes the people resilient and has a strong adaptive capacity to climate extremes and variability.

In dynamic pressure, the following were assessed; the educational attainment, skills of the people, support by the national and local government unit on people's sources of livelihood and basic needs, an increase in the number of population, and environmental degradation. These situations are perceived by the respondents as moderately attended as indicated from the score obtained on the composite mean value of 2.26 for households, 2.45 for LGU employees, and 2.25 for the group of environmentalists (Table 2). Every nation relies on its human capital consisting of knowledge, skills, and competencies. In the aspect of education, 254 or 54 percent of the respondents reached tertiary education. Higher education contributed to the nation's economic growth (Jung, 2015; Wang and Liu, 2016).

Recognizing this, the Philippines provided free education for elementary, secondary, and tertiary education in the public schools run by the state. While the Technical Education and Skills Development Authority trained members of the community who are mostly out of school youth to give them a competitive advantage in the labor market. Investment in the first district increases as noted with the development of subdivisions, sprouting of malls, and car showrooms. Progress is also noted with the relocation of all regional offices of national government agencies to Calapan City. Even Puerto Galera, a world-renowned tourist



spot due to beautiful beaches and clear seawater has surged the coming of vacationists both from local and international visitors.

As a way of establishing public trust in government, public infrastructures were given attention. Development of the farm to market roads added to the advantage of farmers to bring their crops to the market. Excess products from local consumption are brought to the nearby provinces and the City of Manila thus giving the regular supply chain beneficial to the people. However, the rapid development of this district coupled with the increase in the number of populations put pressure on the coastal zone. Migrants coming to this district looking for a better job end up occupying the public areas such as the coastal zone. This causes the removal of mangrove species resulting in the deforestation of the coastal zone. Thus, despite the good factors attained this makes the dynamic pressure moderately happen.

The focus was given on the following to determine the unsafe condition of the coastal communities, to wit: a. practices on personal hygiene; b. protection on storm surge, typhoon, tidal wave; c. strength and location of houses; good water supply and d. knowledge, attitude, and perception of vulnerability as an indication of disaster preparedness. Assessments on these factors reveal that the mean score of 2.46 by households and 2.26 by the environmentalists have a moderate verbal interpretation. On the other hand, the LGU employee's score of 2.59 is verbally interpreted as high (Table 2). The connotation implies that the consciousness of LGU employees on vulnerability needed safe conditions in this district. The existing location of these coastal communities revealed that their exposure leads to be prone to disasters thus making these people in unsafe conditions. Exposure rather than vulnerability gives a higher degree of magnitude to the damages in the community (Andres et al. 2015). Full reduction from the vulnerability of these coastal communities from natural events such as typhoon, strong wind, and storm surge need the assistance of the government to make themselves in a safe condition. This assistance can be in the form of assessment, the

establishment of natural barriers, and policy mainstreaming.

According to the Asian Development Bank (ADB, 2009), assessment of the communities in the coastlines as part of the coastal ecosystem management added information about the mitigation practices to reduce the impact of calamities. The establishment of natural barriers is important in the coastal environment since this may reduce the possible impact of the natural disaster hitting the community. A natural disaster is destructive to humanity, bigger or smaller (Dahl and Millora, 2016). According to Anbumozhi, 2012; Sajise, Sombilla, and Ancog, 2012; Tuladhar et al. 2015 support of the government and mainstreaming of policy for local adaptation are necessary for strengthening adaptive capacity as well as in coping up with disasters. Hence, it is important in this concept that the coherence of the adaptability of the proper responses to the complex problems in this district coastal communities reduced destruction brought by the disaster. Above all, preparedness becomes the key to reducing the possible damages hence reducing the people's vulnerability (Bagarinao, 2016).

3. Assessment of respondents' exposure to hazard in terms of risk and impact

This study determined the respondents' assessment in terms of knowledge in hazard, the magnitude of hazards such as typhoons, tidal wave, and storm surge, and the frequency of occurrence of these events.

Table 3
Assessment of the respondents' exposure to hazard

Sub-variables	Households		LGU Employees		Environmentalists	
	WM	VI	WM	VI	WM	VI
Risk	2.82	H	2.72	H	2.64	H
Impact	2.23	M	2.03	M	2.42	M

Results revealed that the hazard risk in the situation of the coastal communities in this area is higher as indicated by the result of the assessment by households of 2.82, LGU



employees of 2.72, and environmentalists of 2.64 (Table 3). The hazard, which hit in this area, is characterized by strong intensity compounded by the location of the housing settlement, which has affected the people's economy and livelihood. Some of the effects of these destructive events damaging lives and properties are flooding, destruction of crops, and death. Yumul et. al 2011, Lagmay et. al 2015, and Espada, 2018 found the same result when the community experiences calamities such as typhoons. To reduce the risk occurring in the coastal communities there is a need to have an effective integrated coastal zone management (World Bank, 2014). Sari, Innaqa, and Safrilah (2017) support this with the belief that the community has a significant role in reducing the risk in the coastal zone. The community should be better educated to raise awareness of the preventive measures on the effect of disaster risk (Rasquinho, Liu, and Leong, 2013; Hoffmann and Muttarak, 2017). Education and knowledge have a great contribution in addressing the disaster risk brought by climate change (Petal, 2008; Muttarak and Pothisiri. 2013; Weichselgartner and Pigeon, 2015; Torani, et al. 2019). Even networking and collaboration with other government agencies are necessary to improve people's safety (Arias et al. 2016).

The hazard impact of these coastal communities was assessed in terms of the damages and injury to life and properties, loss of communication and power supply, destruction of the road system, and coastal erosion. The results indicated that hazard impact is moderately happening as shown by the mean score of households 2.23, LGU employees 2.03, and the environmentalists 2.42 (Table 3). Even though the hazard risk is higher, the people survived with these adversities. Although hazard impact has been assessed as moderate, there is still a need to lower this by devising strategies and adaptive capacity to cope with and protect their economic interest (Lasco et al. 2011). Conversion of this coastal zone into different uses such as housing settlements, tourist spots, and recreational facilities destroyed mangrove and beach forests that serve as natural barriers protecting the people from the impact of the

disaster. This act against nature should be limited to the level that can be tolerated by the coastal ecosystem.

To ward off the impact and eradicate the effects of a hazard, good support for the adaptive strategy in dealing with the effect of climate change is necessary, embracing good governance and capacity building are needed to be employed by these communities' sufferings from disaster (Baybay and Hindmarsh 2019). This is timely and needed that effective coastal zone management must be prepared for the coastal communities of the first district of Oriental Mindoro. These communities must increase their preparedness for the coming of the natural disaster as what Bronfman et al. 2019 advocated. This is another way that socio-economic activities in these coastal communities will not be hampered by the impact of hazard events.

Preservation of the coastal environment is necessary for mitigating the impact of climate change. The role of the local government's action in this district to protect the coastal water from overutilization to avoid the collapse of food production can help conserve marine resources in this northern bay and avoid increasing global warming. An effective measure such as a moratorium in a certain period for fishing in the coastal water has a positive impact to conserve these resources (Altenburg, 2017).

4. Significant differences in the respondents' assessment of vulnerability and hazard

Table 4
Significant difference in the respondent's assessment on vulnerability and hazard of coastal communities

Sub-Variab	p-value	Decision on Ho	Verbal Interpretation
Root Causes	.026	Reject	Significant
Dynamic Pressure	.010	Reject	Significant
Unsafe condition	.000	Reject	Significant
Risk	.035	Reject	Significant
Impact	.000	Reject	Significant



To know the acceptability of the assessment of the three groups of respondents on vulnerability and exposure to the hazard, their assessment was compared on the posited null hypothesis that they would not differ in their assessment of vulnerability and hazard.

The computed p-value of root causes, dynamic pressure, and unsafe condition are all less than the 0.05 level of significance (Table 4). Thus, the null hypothesis was rejected hence accepted the alternative hypothesis.

In sub-variable root causes, Households and LGU employees have greater experiences on hazard and vulnerability in the area compared to the group of environmentalists. In the aspect of dynamic pressure, the LGU employees edge out the households and the environmentalists. This may be because most of the programs implemented to support the needs of the community are being attended by the local government unit particularly on the distribution of basic services necessary to their day-to-day living. In the situation of the unsafe condition, the response of LGU employees tops among these three groups of respondents simply because the safety of the communities is one of the local government unit's primary concerns during calamities.

While the computed risk and impact p-value are similarly below the 0.05 level of significance thus the null hypothesis was rejected hence accepted the alternative hypothesis (Table 4).

In hazard risk, the households topped among the respondents in this situation since most of them experienced the magnitude and degree of hazard occurred in the coastal communities of the first district of Oriental Mindoro. Finally, on impact, the environmentalist's edge out other respondents based on the computed weighted mean. The main reason for this is that they have a clear analysis and understanding of the impact of the disasters on many coastal areas planted with mangrove and beach forests that needed to be preserved and protected.

5. Proposed Coastal Zone Action Plan

The proposed coastal zone action plan was expected to reduce the vulnerability and exposure to the hazard of the coastal communities in the northern bay of Oriental Mindoro. Vulnerability sub-variable root causes obtained the lowest weighted meanwhile in hazard, risk needed to be lowered to reduce the impact of the disaster events hitting the first district.

On the aspect of vulnerability, the following are needed to be taken. First is the organization of the community into people's organization to unify their actions. This is followed by the introduction of livelihood opportunities and enhancing their skills that can be used in the new livelihood development and production. Last is the preparation of the project proposal for livelihood funding opportunities.

In hazard, these activities are needed. First is the capacity building of the coastal communities needs to be increased hence the role of the local government unit matters to this condition. Second is that government agencies should develop an effective Information, education, and communication campaign to disseminate effectively the proper mechanism and strategies to counter the effect of hazard events. Third, to increase the coastal communities' defense from the strong impact of strong wind, storm surge and tidal wave, rehabilitation of the coastal areas by planting mangrove species is needed.

CONCLUSIONS

The following findings are found in this study, to wit:

1. There is an 18.80 percent increase in the number of populations in the coastal communities from 2007 to 2015.
2. The amount of rainfall falling in the area is higher as well as this area is a typhoon belt prone to disaster as shown by the records of DOST-PAGASA; despite this scenario, the vulnerability of these coastal communities is moderately experienced.



3. Even though the hazard risk is higher, the people managed to lower the level of impact to a moderate level.
4. Respondents have a different assessment of vulnerability and hazard.
5. The proposed coastal zone action plan emphasizes the management of the coastal communities to lessen their vulnerability and exposure to hazard.

RECOMMENDATIONS

Lowering the coastal communities' vulnerability and exposure to hazards requires actions both by the community and the government. Enumerated are the proposed recommendations, to wit;

1. The population increases hence migration should be carefully monitored by the government agency concern to prevent intrusion in the protected area along the coastline of the first district of Oriental Mindoro.
2. It is recommended that alternative sources of livelihood must be devised that fit in with the existing custom and tradition of the coastal communities in the first district of Oriental Mindoro.
3. Enhancement of the adaptive capacity strategies to counter the higher magnitude of risk to further reduce the impact brought by hazard events is needed.
4. Respondents differ on their assessment hence it is suggested that 117 municipality should conduct its hazard and vulnerability assessment to adopt the proper measure that seeks to protect the coastal communities along the area of their jurisdiction
5. The proposed coastal zone action plan should be carefully evaluated by the local government unit, the residents, and the agencies' concern to protect the coastal environment and the people living therein.
6. Future researchers may undertake similar studies according to their needs

and ecology that in the end will always give benefits to the coastal communities of the first district of Oriental Mindoro.

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