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Effectiveness of Climate Resilience Strategies for Coastal Barangays in Zamboanga City

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Abstract— *Climate change effects are a severe menace to the coastal areas owing to the elevation of the sea levels, storm surges, and typhoons as well as the deterioration of coastlines. This research aims to assess the efficiency of climate resilience measures that were put in practice in the coastal barangays of Zamboanga City in the Philippines. The research method used in this study involves two hundred (200) self-administered residents' questionnaires, interviews with local leaders and officials, and observation in the form of field trips to assess strategies such as mangrove vegetation, coastal barriers, community-based disaster preparedness, and the availability of evacuation centers and early warning systems. Consequently, the study shows that mangrove reforestation reduces coastal erosion and increase local species, but it is limited by the problems of funding and its maintenance. Coastal barriers offer reasonable level of protection through and through their reliability and coverage are affected by structural imperfections. Disaster preparedness programs implemented within communities have proven to be very effective in increasing the levels of knowledge and preparedness in the communities; however, the aspect of sustainability and participation of the residents remains a challenge. Evacuation centers and early warning systems have been established which has enhanced safety but there is still a problem of maintenance and accessibility. Based on the study, these strategies have greatly contributed to the improvement of climate resilience, but more efforts are required in order to solve the issues concerning funding, maintenance, and community participation. This study recommends the increase of funding and resources, encourage community involvement, incorporate modern technology with the indigenous knowledge, ensure policies to protect the coastal ecosystems, and develop monitoring and evaluation frameworks. These measures intend to establish strong and adaptive coastal communities in Zamboanga City in preparation to future climate change effects.*

Keywords— *Climate Resilience, Coastal Barangays, Strategies, Effectiveness, Zamboanga City.*

I. INTRODUCTION

Climate change is one of the most significant issues in the contemporary world that affects ecosystems and human societies with the focus on coastal areas. These areas are also exposed to a number of climate change related risks such as sea level rise, storm surge, storm intensity and frequency and coastal erosion. The Philippines, an archipelagic country with a long coastline, is also very vulnerable to these effects. The coastal barangays of the city which are the smallest administrative units of local governments are most affected by climate change. The purpose of this paper is to identify the extent of implementation of climate change resilience strategies in the coastal areas of Zamboanga City, a major urban center in the Zamboanga Peninsula of Mindanao. Zamboanga City, a highly-urbanized independent city located in the southern part of Mindanao in the Philippines, and whose economy depends on the sea, reflects the general environmental and socio-economic problems existing in many coastal areas in the Philippines, particularly in Mindanao. Fishing, aquaculture and tourism industries are prominent here, and they form the main source of income for the people as well as the national income. However, these sectors are much vulnerable to climate change and natural disasters, meaning that there is need to embrace proper and timely measures that enhances the sectors' resilience. Climate resilience stressors to withstand the impacts of such events and recover from them in a sustainable manner. The Philippines has identified as well as addressed climate change threats and has come up with several measures and policies at the national and local levels. These include the physical as well as the other measures that are taken to minimize the susceptibility and increase resilience. These include structural measures like construction of sea walls and evacuation centers, ecological measures like mangrove planting and, community-based disaster risk reduction and management.

The general objective of this study is to determine the effectiveness of these climate resilience strategies in Zamboanga City's coastal barangays. In order to effectively inform future policy and practice, it is important to know which strategies are effective, what problems arose during their application, and what consequences the strategies brought to the local population. Thus, this study aims to contribute to the limited literature on climate resilience at the local level in the Philippines and hopes that the findings can be applicable in other vulnerable coastal communities in the Philippines and other similarly situated countries. For the purpose of assessing the above strategies, we use both quantitative and qualitative research data collection and analysis tools. Questionnaires are conducted to two hundred (200) respondents in five (5) chosen coastal barangays for the quantitative data on the perception of the community and the effects. The questionnaire survey and focus group discussions with personnel from local government and non-governmental organizations (NGO), as well as community leaders offer rich description of the processes and experience with resilience measures. Moreover, field surveys allow getting more precise data on the actual state of physical factors and the efficiency of barriers such as sea walls and mangrove forests. In this context, the research examines several key areas: the success of mangrove stand restoration in preserving coastal areas and increased species diversity; the efficacy of coastal barriers in

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reducing storm surge and coastal erosion; the significance of community-based disaster preparedness in raising people's awareness and preparedness; and the performance of the evacuation centers and early warning systems in minimizing the loss of lives and properties. Thus, this study provides a further insight into the climate adaptation and resilience issues, both positive and negative aspects. In this paper, we strive to present targeted recommendations based on the assessment of Zamboanga City's coastal barangays to help these communities prepare for the challenges posed by climate change and achieve development. Hence, this research presents data and recommendations to contribute to the continued endeavors of policymakers, practitioners, and communities to strengthen coasts. This study will not only be useful for Zamboanga City but also for other coastal areas which are in a similar situation with regards to climate change issues, thus contributing to the global effort in the establishment of societies that are more resistant to the effects of climate change.

II. Methodology

To assess the effectiveness of the climate resilience strategies in the coastal barangays of Zamboanga City, this research study employs a mixed-methods research design to data collection methods in order to get the comprehensive results. The focus of this research study is on five (5) vulnerable coastal barangays in Zamboanga City. The areas include Mampang, Talon-Talon, Arena Blanco, Mariki and Rio Hondo. These barangays are very vulnerable to climate change related disasters such as storm surges, floods, and erosional coastlines. A mixed-methods design was used to take advantage of the quantitative and qualitative approaches. This approach enables the assessment of more aspects and to a greater extent of the effectiveness and challenges of climate resilience measures. Self- administered structured questionnaires were distributed to two hundred (200) residents of the five (5) barangays. The surveys used questions on demographic characteristics, the knowledge of climate change, the effectiveness of certain resilience measures (for instance, mangrove plantation, coastal barriers, among others), and the respondent's experiences with climate change and disasters. The main purpose of the survey data was to estimate the attitudes and events of the community. This research study also used semi-structured interviews to gather data from local government officials, barangay officials, non-governmental organizations' (NGO) representatives, and other significant community stakeholders. The interview questions were based on the planning, execution, and effectiveness of resilience measures, and the problems encountered and results achieved. The features of qualitative data analysis helped to reveal the attitudes of different stakeholders and to get the comprehensive understanding of the situation. Field visits and observations were conducted on the physical state as well as the efficiency of resilience structures like sea walls, mangroves, and evacuation shelters.

The research study employed a standard observation form to assess aspects such as the structural and physical condition, maintenance, and whether the structure is in use or not and if it has been affected in any way. The observations were recorded with the help of photographs and notes. To carry out the analysis of the survey data, statistical tools like SPSS were utilized. Frequency and percentages were used to describe the data collected from the subjects. Moreover, analytical statistics, which include t-tests and chi-square tests were also used to compare and analyze the relationship between the variables. For the analysis, interview transcripts and field notes were subjected to a process of thematic analysis. This entailed analyzing the data to determine the themes and patterns that emerged concerning the effectiveness, difficulties, and consequences of the resilience strategies. The qualitative data helped in giving detailed information and explained the findings of the quantitative data. This study considered ethical processes. The participants were told about the objective of the study and the procedures they would be undergoing and then consent was sought from them. The aspect of confidentiality and anonymity was well maintained all through the process of conducting the study. Although this study used a mixed-methods approach to ensure a holistic view of the problem, there is still some drawbacks. There could be some biases in survey and interview data that are collected from the respondents. Finally, the study was conducted in only five barangays, which might not capture all the aspects of the coastal areas within the Zamboanga City and other areas. In this case, through the use of questionnaires, interviews, and field surveys, this methodology provides a comprehensive and, therefore, more reliable assessment of the climate resilience options that have been implemented in the coastal barangays of Zamboanga City.

III. Results

The findings of this study give a detailed assessment of the climate resilience strategies adopted in the coastal barangays of Zamboanga City. The analysis is divided into several key areas which include mangrove reforestation, coastal barriers, community-based disaster preparedness programs, evacuation centers, and early warning systems. The findings were drawn based on the questionnaires, interviews and observations made in the entire research process.

TABLE I. Mangrove Reforestation

Effectiveness	Challenges	Field Observations
Mangrove reforestation has proved highly effective in reducing coastal erosion and providing additional environmental benefits, such as enhancing biodiversity and supporting local fisheries. Approximately 85% of survey respondents reported noticeable improvements in coastal protection due to mangroves.	About 60% of respondents noted issues related to funding and maintenance. Many mangrove projects rely on intermittent funding, leading to inconsistent maintenance and replanting efforts. Additionally, community involvement has been limited, with only 40% of the surveyed population actively participating in reforestation activities.	Field visits confirmed that areas with well-maintained mangrove forests experienced significantly less coastal erosion compared to areas without such initiatives. However, some reforestation sites showed signs of neglect, underscoring the need for continuous care and local engagement.

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TABLE II. Coastal Barriers

Effectiveness	Challenges	Field Observations
Coastal barriers, such as sea walls, have provided moderate protection against storm surges and coastal flooding. About 70% of respondents in areas with these barriers reported reduced flooding and property damage during storm events.	Structural integrity and coverage were highlighted as concerns. Approximately 45% of respondents expressed concerns over occasional structural failures of sea walls, often attributed to inadequate construction materials or poor maintenance. Furthermore, the extent of coverage is insufficient in some barangays, leaving certain areas exposed.	Field observations revealed that well-constructed and maintained sea walls effectively reduced wave impacts during high tides and storm events. However, in areas where sea walls were poorly constructed or maintained, the benefits were significantly diminished.

TABLE III. Community-Based Disaster Preparedness Programs

Effectiveness	Challenges	Interviews
Community-based disaster preparedness programs have shown high effectiveness. About 90% of survey respondents reported increased awareness and preparedness for climate-related disasters. These programs have facilitated better communication and coordination during emergencies.	Sustainability and participation are ongoing challenges. While initial participation rates were high, long-term engagement has fluctuated, with 50% of interviewees citing a decline in program activities over time due to funding cuts and volunteer fatigue.	Interviews with community leaders revealed that consistent training and educational programs significantly enhanced readiness during disasters. Respondents praised the community drills and emergency planning sessions.

TABLE IV. Evacuation Centers and Early Warning Systems

Effectiveness	Challenges	Field Visits
Evacuation centers and early warning systems have played a crucial role in safeguarding lives during extreme weather events. Around 75% of respondents acknowledged the importance of these facilities in providing safe refuge and timely information.	Maintenance and accessibility remain issues. About 40% of respondents noted that some evacuation centers require repairs and upgrades to remain fully operational. Moreover, early warning systems occasionally fail due to technical glitches or power outages, as reported by 30% of the respondents.	Field visits to evacuation centers confirmed that most facilities were functional but some required urgent maintenance. Early warning systems were generally effective, but there were instances of communication breakdowns, particularly in more remote areas.

The findings of the study reveal that the implementation of climate resilience strategies in the coastal barangays of Zamboanga City has been beneficial especially in the areas that have engaged the community and have sustained funding. Mangrove reforestation and community-based programs are the most effective while the coastal barriers and early warning systems are also quite effective even with some limitations. To ensure the effectiveness of these efforts, community participation, sustainable resources, and proper maintenance of structures should be sustained.

IV. Discussion

The findings of the study reveal that different climate resilience measures introduced to the coastal barangays of Zamboanga City are effective and but have some challenges. The discussion integrates the findings, identifies the significance of the results, and suggests recommendations for future enhancement.

A. Mangrove Reforestation

The above findings about the high level of success of mangrove reforestation in combating coastal erosion and improving local ecosystems justify the use of Ecological Approach in Climate Change. Mangrove also offer physical protection from storm surges and contribute to the support of biodiversity and fishery for the people's sustenance. However, some problems concerning funding and maintenance should be solved. This haphazard funding schedule weakens the long-term stability of the project; there is also a lack of community participation, which means that the organizers should find better ways to attract people. Measures that include involving the community in general and management of the planted trees can help sustain the plantations. Also, because the future success of the organization depends on continuous funding from government and non-government entities, it is crucial to have a stable stream of income.

B. Coastal Barriers

Coastal barriers have proved to be fairly effective in reducing the effects of storm surges and coastal flooding. The good responses from the residents of the areas with good sea walls show that they are useful in the protection of such areas. Hence, issues of structure and scope indicate major opportunities for enhancement. Hence it is important to ensure that the construction is done to high standards and normal checks are done to all buildings for them not to develop structural faults. Increasing the length of structures in each barangay to cover more vulnerable areas could provide a larger protective shield and minimize people's access to risk. All of these measures call for integration and proper management of resources by the local governments.

C. Community-Based Disaster Preparedness Programs

The success of the community-based disaster preparedness programs is an indication that community-based approaches are most effective. People's knowledge and preparedness on disasters have improved thus improving the ways of response and recovery. However, the problem of maintaining the high levels of engagement is a critical issue that needs to be solved. Such programs have to be interesting so that the learners are motivated to stick to them for the long time. To ensure that the involvement of the communities is well maintained, the stakeholders should consider the following strategies; this is, they should involve the communities in planning, they should make sure that they hold training meetings frequently, and they should ensure that there are feedback mechanisms in place. Also, having a steady source of funding and support from both the local and international organizations can help sustain these programs.

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D. Shelters and the Early Warning Systems

The provision of evacuation centers and early warnings has immensely enhanced safety and preparedness of coastal barangays. These facilities and systems have been very essential in these calamities as they have helped in minimizing the number of deaths and also passing information on time. However, maintenance and accessibility issues require solutions at this time. This paper reveals that periodic assessment and maintenance of the evacuation centers, and further improvements are important to make them functional in the event of disasters. Technological flaws and power outage problems are some of the main factors that can be worked on to make early warning systems more efficient. It is equally important to extend these systems to the remote areas of the country.

V. CONCLUSION

The research study has also shown that focused initiatives and continued community involvement help to build up people's ability to cope with climate shocks. In this regard, based on the study, the integrated approach of infrastructure improvement, community awareness, and improved policies specific to coastal barangays decreased the vulnerability and increased the adaptive capacity. The successful use of modular seawalls, mangrove planting and emergency management measures have not only reduced effects of disasters but have also created awareness in the communities. Also due to this approach of involving community in the development and implementation of these strategies, the communities have owned these resilience strategies.

The research study also reveals that the strategies need to be vigilantly implemented and changes need to be made whenever the challenges of climate change shift. This has shown that there is a need to have the local knowledge integrated with scientific knowledge in the formulation of these strategies. For the future, policy makers and other stakeholders should guarantee the funding in the long-term, increase the cooperation between the regions and support the further research on the possibilities how to develop these efforts in the way that they will be more effective in building the resilience. Thus, coastal barangays in Zamboanga City can be taken as an example for other similar vulnerable coastal areas to show how important it is to implement preventive and inclusive climate change adaptation plans for the protection of people's lives and the environment.

RECOMMENDATIONS

Based on the findings and discussion, the following recommendations are proposed to enhance the effectiveness of climate resilience strategies in Zamboanga City's coastal barangay:

1. Design initiatives which encourage local communities in the identification, realization and management of the resilience measures. It has also been noted that educational campaigns and incentives can help encourage people to be more active and engaged.
2. Secure sustainable sources of funding from the government, NGOs, and international organizations for the long-term resilience projects. Good financial management is one of the best ways to increase trust and to maximize the usage of the available resources.
3. Integrate both the modern approaches like the remote sensing for mangrove health check with the indigenous practices to design better and culturally suitable coping strategies.
4. Increase the coverage of coastal barriers to other sensitive areas and make sure that they are constructed to very good standards. The following should be made a culture in the organization:
5. To reduce the impact of the disasters, conduct regular maintenance of the evacuation centers and enhance the early warning systems notably in the hard-to-reach areas. Infrastructure improvement, power system reliability can also improve the overall organizational resilience.
6. In this regard it is necessary to establish a comprehensive system for the further monitoring of the resilience strategies. It is, therefore, appropriate to conduct periodic assessments and modifications according to the current climate information and demographics.

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