PLANNING FOR COASTAL COMMUNITY CLIMATE CHANGE ADAPTATION: AN ECOSYSTEMS-BASED APPROACH

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ABSTRACT

Adaptation to climate change is seen as the immediate response of people anywhere in the world. However, there is still a problem in its implementation as no solution fits all problems. Coastal communities’ vulnerable situation is not exempted from climate change impacts, but the fact that it has numerous ecosystems provide basic life support. Thus, this paper is guided by the following objectives 1) determine ecosystems and socioeconomic sectors reliant and dependent on strategies and policies of coastal communities; and 2) examine the current adaptation strategies and activities. Focus group discussions among key officials and document analysis were carried on. After a rigorous examination, it was discovered that coastal communities are reliant on fishery and water resources ecosystem services. In this regard, adaptation options are geared toward the protection of these services to continually provide to local communities. Alternative livelihoods are also seen as a long-term response to climate change adaptation apart from policy and ordinances to protect and conserve the ecosystems.

Keywords: Climate Change Adaptation, Ecosystem Services, Adaptation Strategies, Climate Environmental Protection Laws And Policies, Coastal Communities.
INTRODUCTION

Many coastal communities rely on natural resources (Evariste, Denis Jean, Victor, & Claudia, 2018), yet because of their physical location, they are vulnerable to climate change consequences. Sea-level rise and storm surge are two immediate impacts of climate change on island coastal settlements, in addition to a slew of other severe repercussions for the biophysical environment and observable effects on ecosystem service flows (Jha, Negi, & Alatalo, 2022; Major et al., 2021). Climate change and extreme weather events have put many ecosystems at risk, necessitating rapid action (Leal Filho et al., 2021). Climate change impacts, on the other hand, vary based on social, physical, economic, and other factors (Major et al., 2021), therefore coastal communities respond to climate change in different ways and under varied environmental stresses (Fernandino, Elliff, & Silva, 2018). As a result, adapting to climate change necessitates considering the specificity, numerous functions, systems, and coexisting sectors that are increasingly endangered by climate change, particularly sea-level rise (Losada, Toimil, Muñoz, Garcia-Fletcher, & Diaz-Simal, 2019). Furthermore, population growth, strong leadership skills (Birchall & Bonnett, 2021), social support mechanisms, natural resource availability, low information awareness, and dissemination, as well as local institutional challenges and limited resources, all obstruct the adoption of adaptation strategies (Antwi-Agyei, Wiafe, Amanor, Baffour-Ata, & Codjoe, 2021; Birchall & Bonnett, 2021; Fitton et al., 2021; Macusi, Macusi, Jimenez, & Catam-isan, 2020). As a result, it is critical to disseminate knowledge to promote people's adoption of methods. Poor awareness influences farmers to seek off-farm income rather than engage in soil conservation (Antwi-Agyei et al., 2021), which makes it difficult for a community to be resilient and adaptive to climate stresses. To be able to respond to crises caused by extreme climate change, its adaptation operations must be prepared with not only financial resources but also skills and personnel (Doust et al., 2021).

Coastal communities provide ecosystem services that are beneficial to prevent impacts on climate change. This fact is supported by the findings that ecosystem services play a key role in supporting climate change adaptation efforts (Leal Filho et al., 2021). Recognizing diverse ecosystem services enhances ecosystem management and influences participation in the conservation practices and protection programs (Celeste et al., 2020; Chanza & Musakwa, 2021). Most of the current evidence supports the use of indigenous knowledge and practices (Chanza & Musakwa, 2021) ecosystem-based adaptation as a way to become more resilient in climate change, especially if done participatory with a bottom-up approach (Jha et al., 2022). There is some evidence to suggest that incorporating coastal defense in coastal communities as an adaptation measure will result in a coastal squeeze leading to reduce natural-based protection and its ecosystem services provided by coastal areas (Kirby, Masselink, Essex, Poate, & Scott, 2021). As claimed by (Khadka et al., 2018), many tools only focus on assessing vulnerability context but fail to incorporate the importance of the availability of resources the ecosystem services provided. As a consequence, a faster approach to climate change adaptation is desired. The Philippines ranked eight (8) as the high risk and vulnerable country to climate change and risk (Aleksandrova et al., 2020) due to its archipelagic location. This led to initiatives to mitigate and adapt to climate change, guided by the principle: “to strengthen community adaptive capacity and natural ecosystem resistance to climate change, and maximize mitigation opportunities toward sustainable development” (CCC, 2010). Coastal adaptation to climate change is still lagging behind other developed and developing countries (Birchall & Bonnett,
Adaptation efforts should be comprehensive and should not exclude any sector, but rather complement it. This is to guarantee that one sector's climate change measures do not hinder other sectors' adaptation (CCC, 2010). According to Guzman (2012), as cited by (Balangue, 2013), the country comprises 70% coastal communities where 1,500 municipalities lie within the 32,400-kilometer coastline, which makes the country more vulnerable to climate change. It is also undeniable that many low-income sectors lived in coastal communities where fishing is the main source of livelihood and survival and other related activities. There is ample evidence supporting the vulnerability of coastal communities since income diversification is low (Evariste et al., 2018) and their adaptation options are only to rely on family and friends for support (Antwi-Agyei et al., 2021). Because of this, people's livelihood activities, health, and food security are at stake when calamities and disasters are due to climate change impacts.

Objective/Significance of Study
The paper asserts that development planners should have trustworthy data on ecological services, socioeconomic situations, environmental initiatives, and community practices as vital baseline data and information for all communities, but particularly for coastal areas. These are crucial variables in climate policy that contribute to the achievement of the SDGs; therefore, policymakers should recognize the benefits of joint efforts to implement climate policies and impact socioeconomic development. Thus, this paper is guided by the following objectives 1) determine ecosystems and socioeconomic sectors reliant and dependent on strategies and policies of coastal communities; and 2) examine the current adaptation strategies and activities. Finally, there is a need to develop a more comprehensive plan for adaptation activities for coastal communities in Calbayog City.

METHODOLOGY
Research Design
The study relies heavily on document analysis (Křištofová, Lehnert, Martinát, Tokar, & Opravil, 2022) to gather barangay (brgy.) profiles of coastal communities. Focus group discussions were conducted to gather relevant data about the ecosystem and socioeconomic services in coastal communities, which were attended by village (a.k.a barangay) key officials and representatives, were conducted to gather relevant data on the ecosystem and socioeconomic services in coastal communities. To make adaption possibilities, this process was carried out.

The study was conducted in Calbayog City, Samar Philippines. It covers the coastline communities of about 71 kilometers length and consists of 36 barangays stretching from Brgy. Caglanipao Sur of the northern part to Brgy. Carayman of the southern part of the city facing Samar Sea (Figure 1). Most of the coastal community have a vulnerability index from less vulnerable to highly vulnerable due to its geographic location.
RESULTS AND DISCUSSION

Ecosystem Services of the Coastal Communities in Calbayog City

The United Nations Environment Programme (UNEP) defines ecosystem services as the benefits that people obtain from the ecosystem. The focus group discussion of the 36 coastal barangays arrived at the following ecosystem services. The table below shows the summarized ecosystem service category as provided by the ecosystem-based on the categories provided by the UNEP on ecosystem services. Provisioning services of coastal community ecosystem services provide people with food, water, timber, and medicinal benefits. Regulating services, on the other hand, provide storm protection and water regulation and serve as a sanctuary of birds and fish species. Coastal communities also have the following cultural services aesthetics, recreation and tourism, and cultural heritage. As in the US, enhancing the ecosystem can improve human well-being (Sánchez, Marcos-Martinez, Srivastava, & Soonsawad, 2021). It is well-known in the local area the presence of a ridge and natural park. Being the city of waterfalls, one of the tourist attractions is the Tarangban Falls, which is visited by many local, and international tourists. Besides natural falls, it is also an island that attracts local tourist visits. Based on the FGD, several issues appeared like low water supply and quarrying near riverbanks. Regarding food provisioning services, the coastal communities also had issues with dynamite fishing in previous years. As such, it should have the protection of fish accessory devices to avoid catching small fish.

Table 1

| Ecosystem Services of Coastal communities in Calbayog City |
|-----------------------------------------------------------|
| **Provisioning Services**                                  | **Regulating Services** | **Cultural Services** | **Supporting services** | **Remarks** |
| Springs Water                                             | Water regulation Riverbanks | Aesthetic Malajog Ridge and Natural Park | Nutrient Cycling | Quarrying (e.g. rocks, sand) in river banks Low water supply No water connection |
Socioeconomic Sectors of Coastal Communities

The results of this work will unravel and shed light on the understanding of climate change adaptation viz ecosystem services and socioeconomic services. Socioeconomic sectors important in the barangay were public health facilities (e. g. birthing station and health centers), water sources (e. g. Calbayog City Water District, refilling stations), SAMELCO, education (e. g. elementary schools, high schools, daycare center), infrastructure (e. g. farm to market roads, dams, dikes), water refilling stations, agriculture, and forestry. These sectors are responsible for delivering basic access goods and services to residents.

Strategies and Policies of Coastal Communities

Based on the FGD, the strategies, policies, and programs that the coastal communities are currently undertaking to adapt to climate change are the following:

1. Solid Waste Management Plan
2. Disaster Risk Reduction Management Plan
3. Flood and river control like dikes and seawall
4. Prohibition of quarrying activities
5. Prohibition of Illegal dynamite fishing
6. Imposing penalties for sand quarrying
7. Material Recovery Facilities
8. Identification of Buffer zone
9. River and coastal clean-up drive
10. Mangrove planting
11. Workshop for barangay development council on solid waste management
12. Ordinances on Water Management
13. Prohibition of defecating on the seashore
14. Protection of fish accessory devices (MOA)
15. Ordinances on anti-illegal logging
16. Reforestation Programme (mangrove plantation/reforestation)
17. Seminar on coastal protection
18. Ordinances on the burning of garbage
19. Ordinance on the illegal cutting of mangroves
20. Construction of an evacuation center
21. Shoreline tree planting

**Current Adaption Strategies and Activities**

Following the adaptation framework, the adaptation strategies and activities can be categorized based on organizational capacities such as governance, people, technology, and process.

**Governance**

In terms of governance, most of the coastal barangays have solid waste management plans, barangay disaster risk reduction management plans, and different ordinances to regulate the use and misuse of environmental resources. Ordinances like solid waste segregation and prohibition of quarrying are also imposed in some barangays like Brgy. Ba-ay and even imposed penalties for those who violate it. However, this may be somewhat untrue to Brgy. Bugtong, where although they may have the ordinances about quarrying, the activity is continuing in the village. Like other countries, in Mati, most of the fishing communities surveyed lacked separate garbage bins for biodegradable and non-biodegradable wastes (Macusi et al., 2020). Although there is an ordinance about ‘No burning of Garbage’, this is strictly implemented to places nearby city premises.

**Peoples**

In terms of people's capacity, a workshop, seminar, and training regarding DRRM and SWM were mostly referred by the participants of the 36 barangays. This capacity-building was important to the residents because of their coastal situation. However, similar to another study, there is no other solution for fisherfolk than to help restore damaged reefs and find alternative jobs away from fishing or create value-added innovations for their fish products (Macusi et al., 2020) aside from prohibiting the use of the fish accessory device. Alternative livelihood options from various ecosystem services may augment income among coastal communities and thus needs to be included in the local planning as adaptation measures. Training and seminars are geared toward disaster response, not in adaptation and mitigation. This is an interesting finding, and it could be hypothesized that adaptation planning is absent at the regional level incorporating bottom-up and top-down approaches (Křištofová et al., 2022) and lack of understanding of the impacts of climate change to mitigate the consequences (Asmus et al., 2019).

**Technology**

In this paper, technology refers to the use of DRR equipment or indigenous knowledge to adapt to climate change impacts. Indigenous practices have significant conservation potential because they are obligated to protect ecosystems that to them have supernatural powers to change and influence climate (Chanza & Musakwa, 2021). As a traditional mode of transportation in Calbayog City, a center car, otherwise known as a modified motorcycle-like-car that has a setting capacity of 10 persons. In Barangay Cag-olango center car is for an emergency response instead of a patrol car like the ones used in Brgy. Rawis and Brgy. Trinidad. A cart for solid waste collection is being used in Brgy. Ba-ay. Early warning systems were also present in some
barangays like Brgy. Basud and Brgy. Capoocan. The results obtained here may have implications for understanding the available resources of communities in addressing adaptation options which could be interpreted as local institutional challenges (Birchall & Bonnett, 2021). As posited in various works of literature, adaptation to climate change varies by location and resources (Fernandino et al., 2018). Like this study, the barangay used what is available to them.

**Process**

Meanwhile, process as organization capacity deals with the activities of the community people to fast-track mitigation and adaptation processes. Small coastal communities must develop knowledge sharing and network with other communities and organizations to implement adaptation options (Fitton et al., 2021). Most coastal communities have lobby and linkaging with LGU and NGOs, which was seen as a big factor in the adaptation process. Other processes such as clean-up drive twice a month to restore the status of the river in Brgy. Tomaliguez, and river control in Tinambacan Sur. Public hearings through general assembly and community clean-up “pintakasi” were also conducted for all barangays. The most significant observation of this study is that adaptation strategies are mostly geared toward infrastructure. At some point, the advantage of this approach will become marginal compared to the non-structural approach. Focusing on a structural approach in an adaptation is costly thus a combined effort in the adaptation would benefit most and reduce cost (Bonnett & Birchall, 2020).

Our findings are somewhat surprising since ecosystem services in coastal communities are supposed to be exposed to climate change impacts (Leal Filho et al., 2021). However, ecosystem services in coastal communities in Calbayog City are facing not just the risk of climate change but the anthropogenic activities that are using unsustainable practices in extracting natural resources.

Gleaning from the results, it appears that most are legal ordinances or policies. Policies that have direct and indirect relationships toward ecosystem-based adaptation. It is unsurprising to find that there is a considerable mismatch of the adaptation strategies about ecosystem services provided. Firstly, there are no data available locally about the extreme impacts of climate change. Authors suggest that an evidence-based, data-driven is necessary to complement the contribution of ecosystem services in CCA (Bhattarai, Regmi, Pant, Uperey, & Maraseni, 2021). Second, at some point, lack of knowledge and competence among local officials in understanding and implementing adaptation measures (Křištofová et al., 2022) hinders the development of strategies to mitigate CC (Asmus, Nicolodi, Anello, & Gianuca, 2019). This pointed toward the importance of indigenous knowledge or best practices in coastal communities in adapting to climate change.

**Adaptation Options**

From the above list, the ecosystem services that depend on the policies and strategies that the barangays are currently undertaking are the regulating and provisioning services. These include mangroves, fish sanctuary, water sources (e.g. springs and deep well), and water regulation. Socioeconomic sectors reliant on programs, on the other hand are forestry and agriculture.

**Fish Sanctuary**

Like other vulnerable coastal communities, one of the adaptation strategies is to rehabilitate mangrove areas (Evariste et al., 2018). Currently, there is no MPA in the area but due to a decrease in fish catch, the prohibition of fishing in the marine protected area should be implemented. The fact that there are no clear adaptation and mitigation measures to mitigate
the impacts of climate change in the fisheries sector (Macusi et al., 2020), the result is consistent with the findings which suggest that alternative livelihood should be provided when fishing is impossible. A diversified source of income must be provided.

**Water Regulation**

Building sea walls and dikes are also seen as an adaptation option to address sea-level rise and denudation of riverbanks (effect of quarrying). As evident in this study, there is a high need of training people to other sources of income, especially those reliant on sand and rock quarrying. Not only that are they destructive, but they are unsustainable. The more people use unsustainable practices, the more vulnerable they are socially and environmentally.

**Water Resources**

There is looming water stress in the coastal communities due to a reduction in rainfall patterns. The number of dry days is expected to increase by 2020–2050. Carefully, examining the data, rational water management should be implemented by the water service provider as an adaptation option. Capacity building to manage water resources at the household level, establishing rainwater collection facilities, where possible. Alternative water sources are encouraged for those without a direct water service connection from a water service provider. Forestry. In terms of forest resources, these coastal communities have additional alternative livelihood. Aside from this, strict implementation of local laws be enforced. The local government with the help of national government may develop and explore possible program for payment for ecosystem services for the protection of mangrove forest like in the case in Calbayog Pan-as Hayiban Protected Landscape (CPHPL) (Celeste, Malabarbas, Lonzaga, Morallos, & Tarrayo, 2020).

Table 2

| Adaptation Options of Coastal Communities |
|------------------------------------------|
| **ES-SES** | **High-Risk Impacts to ES-SES** | **Organizational Capability** | **Adaptation Options** |
| Fish sanctuary | Decrease in fish catch | Governance | Prohibition of fishing in marine protected areas |
| | Migration of fish to cooler and deeper waters | People | Training for alternative livelihoods when fishing is not available during typhoons. |
| | | Technology | Use only allowable means to catch fish (e.g. standard fishnets) |
| | | Process | Protection and rehabilitation of mangrove areas |
| Water regulation | Denudation of riverbanks (effect of quarrying) | Governance | Ordinances on Quarrying |
| | Sea-level rise | People | Training on alternative livelihoods to those relying on quarrying as the main source of income should be introduced. |
| | | Technology | Early warning System should be present in barangays that are prone to landslide and flooding |
| | | Process | Build sea walls and dikes |
| Water resources (e.g. springs and deep well) | Water Stress - Reduction in rainfall patterns affects water supply. | Governance | Rational water management, |
| | | People | Capacity building to manage water resources at the household level. |
| | | Technology | Establishing rainwater collection facilities, where possible |
| | | Process | Alternative water sources are encouraged for those without a direct water service connection from CCWD |
Forestry

Governance

People

Strictly implement policies for illegal logging
Involve the community in land-use planning, offer and provide alternative and sustainable livelihoods to those relying on forest (e.g. timber and mangrove areas)

Technology

Introduce sustainable resource use practices (e.g. indigenous practices)

Process

Assess viable means to provide an incentive for protecting mangrove areas.

*High-risk impacts are based on climate change scenarios in the Philippines (PAG-ASA, 2011).

The results demonstrated in this work provide a new perspective on the adaptation process of coastal communities using an ecosystems-based approach. Despite the success demonstrated, a significant limitation is that indigenous knowledge about climate adaptation is less explored due to the limited time. Although some aspects in the adaptation were covered using focus group discussions, further study will still be needed as to what is the community’s adaptation in terms of climatic changes, especially those reliant on coastal natural resources for their living. This is something that should be borne in mind in future studies.

**CONCLUSION**

There are considerable ecosystem and socioeconomic services found in coastal communities. This helps the coastal communities adaptive and resilient to climate change one way or the other. However, since there is a presence of unwanted activities like mangrove exploitation and quarrying, local government and barangay residents should protect and maintain their ecosystem services. This can be done through a sound and effective implementation of ordinances inhibiting the cutting of mangroves and quarrying near riverbanks and roads. Since all coastal communities are vulnerable, adaptation measures like improvement of drainage system to avoid flooding, livelihood opportunities for the fisherfolk who solely depend on fishing; alternative in-demand skills related job to replace quarrying should be given priority in planning for human capital development. To top it all off, there is a need to develop a more comprehensive plan for adaptation activities for coastal communities in Calbayog City.

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No conflict of interest has been declared by the authors.

Author Contributions
Novlloyd E. Celeste, project leader of the research, resource person of the FGD. Responsible for the research conceptualization, reporting, analysis, and write-up.

Gerald T. Malabarbas, co-project implementer, facilitator of the FGD, supervisor of the data gathering. Made handful contribution in literature reviews, results, and discussion.