# Proposed Adaptation Strategies on Sea Level Rise in Buug, Dumanquillas Bay, Philippines

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## ABSTRACT

Sea level rise affects coastal communities through coastal flooding, coastal soil erosion, saltwater intrusion, and land subsidence. The coastal areas of Buug in Dumanquillas Bay is not exempted on sea-level rise and its impact. Given the enormity of these impacts, the need for relevant and meticulously planned adaptation is needed as it is pressing. This paper determined the proposed adaptation strategies among the coastal barangays on sea-level rise in Buug, Dumanquillas Bay, Philippines. Key informant interviews among the Barangay Captains, elders, and women were done on November 2020. Data were analyzed through content analysis. The proposed adaptation measures for sea-level rise among the coastal barangays of Buug were planting of mangroves, construction of sea walls, livelihood assistance, and relocation. The result of this study would be incorporated on the crafting of Buug Sea Level Rise Adaptation Plan.

**Keywords:** adaptation, climate change, coastal area, Dumanquillas Bay, sea-level rise

## Introduction

Climate change is a modification in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to continual anthropogenic changes in the composition of the atmosphere or in land use [Intergovernmental Panel on Climate Change (IPCC), 2012]. The effects of climate change include variations in biospheric ambient temperature, which could result in heat stress, change in rainfall patterns, sea-level rise, saltwater intrusion, loss of biodiversity, drought, habitat loss, and

freshwater depletion and pollution (Philander, 2008). Vadhel (2020) described sea level rise as a silent disaster on the effects of climate change. Sea level rise can be portrayed as an increase in the mean level of the surface of Earth's oceans from which heights and depths are measured. It is believed to be caused mainly by anthropogenic global warming, which leads to ocean thermal expansion and increased glacial melting in high-latitude regions (Warrick & Oerlemans, 1990; Withey et al., 2016). In terms of impacts, sea-level rise could result to increased occurrence of flooding to human settlements, land, infrastructure and coastal habitats; thus causing direct loss of economic, ecological, cultural and subsistence values as well as other effects related to changes in water management, salinity and biological activities (Klein & Nicholls, 1999).

The rate of global mean sea level (GMSL) rise has increased in the late 19th to early 20th century compared to the past 2,000 years, as reported by the IPCC in Fifth Assessment Report (AR5) with high confidence (Stocker et al., 2013). Through concerted proxy records used as data for the past two thousand years, it was determined that between 1905 and 1945, global sea level started to rise faster than the late Holocene background rate (Church & White, 2011; Gehrels & Woodworth, 2013). In the most latest years from 1993 to 2010, the sea level rose by around 3.2 [2.8 to 3.6] mm per year (Ablain et al., 2009; Beckley et al., 2010; Church & White, 2011; IPCC, 2013). These values imply accelerating rates of GMSL over time. Moreover, IPCC (2013) reported that GMSL increased by 0.19 [0.17 to 0.21] m from 1901 to 2010. It is estimated with high confidence that the rise in GMSL during 1993 to 2010 can be explained by ocean thermal expansion, melting of the Greenland and Antarctic ice sheets, and changes in land water storage and glaciers (IPCC, 2013).

The Philippines ranked third among sixty-seven countries in the world as the most vulnerable country on the changes of climate (Paun et al., 2019). Satellite observations from 1993 to 2015 show that the tropical Western Pacific region, to the east of the Philippines, has experienced a sea-level increase of 5-7 mm/yr, which is about double the global average (Kahana, et al., 2016). Moreover, Kahana et al. (2016), presented sea-level changes of the Philippine regions from 1993 to 2015 produced from the AVISO satellite observations that the south of Zamboanga in Mindanao island has a sea-level increase of 4.5-5 mm/yr which is still higher from the global average. The coastal areas of Buug are not exempted on the rising sea level's impact (Kahana et al., 2016).

Given the enormity of these impacts, and given that the rate of sea-level rise is not expected to slack anytime shortly, the need for timely and meticulously planned adaptation is evident as it is pressing. This paper determined the proposed adaptation strategies among the coastal barangays on the impact of sea-level rise in Buug, Dumanquillas Bay, Philippines. The result of this study would be incorporated on the crafting of Buug Sea Level Rise Adaptation Plan.

# Methodology

## Study Area

Buug is one of the municipalities of Zamboanga Sibugay in Mindanao island, Philippines. It has 27 barangays, 4 of which are located in the coastal area. The four coastal barangays of Buug are San Jose, Bawang, Pamintayan, and Pulog (Figure 1).

San Jose and Bawang's dominant ethnic group is Visayan, and its dominant religion is Christianity, while Pamintayan and Pulog is Maguindanaon and its dominant religion is Islam. The livelihood among the people of the four coastal barangays are mainly on fishing related activities and some engaged in upland farming, and livestock raising.

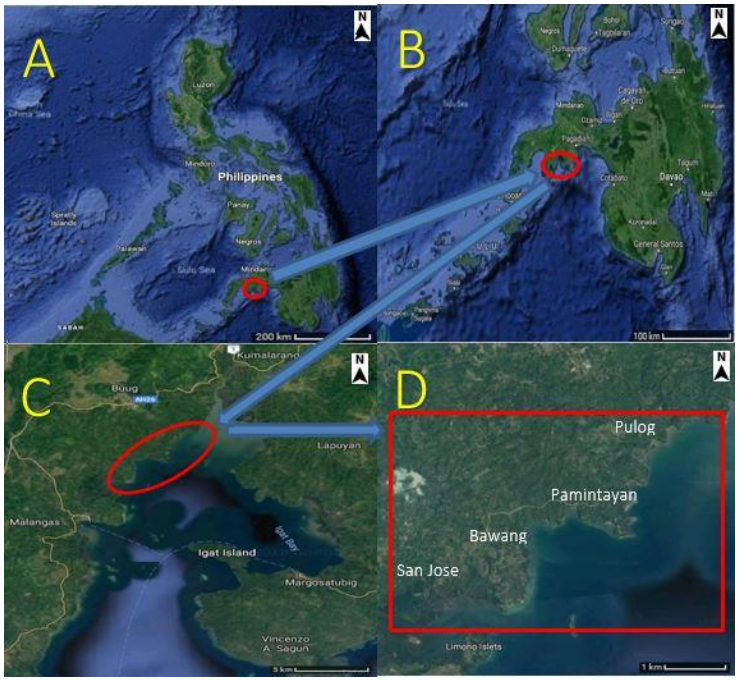


**Figure 1.** Map showing the study areas: A. Map of the Philippines; B. Map of Mindanao; C. Map of Dumanquillas Bay Protected Landscape and Seascape; D. Map of the coastal barangays of Buug where the study was conducted (https://www.maps.google.com.ph).

## Data Gathering Procedure

The data gathering on this study was through key informant interviews (KII) via personal interviews and phone calls. KII's were undertaken to the Barangay Captains and other barangay officials, elderly, and women. They were selected as the sources of data because they have the most knowledge about the condition of their barangays and in the position to pass development proposals and resolutions, and implement and supervise projects. The Focus Group Discussions (FGD's) were not undertaken due to the restrictions on crowd gathering of the barangay and

municipal local government unit of Buug to prevent the spread of Covid-19. It is timely that the Municipality of Buug got positive cases of Covid-19 at the onset of this particular study. The MLGU of Buug tighten their restrictions by strictly enforcing the no gathering policy in the entire municipality. Barangay Captain of Bawang and other key informants who were under quarantine due to contact on Covid-19 positive patients were interviewed via phone calls. Other informants who were "safe" were interviewed personally in observance of the health protocol through mask and 1 meter distance. Personal consents were taken from the informants before they were interviewed. A total of 8 key informants, 4 of it were women were interviewed in the study, constituting 2 informants per barangay.

## Results and Discussion

### Proposed Adaptation Strategies

Increasing ocean temperatures cause thermal expansion of the oceans and in combination with meltwater from land-based ice, leading to sea-level rise (Bindoff et al., 2007). This phenomenon is harmful to coastal communities. Thus, adaptation on the rising sea level is an important action for human communities to survive and thrive. “Adaptation refers to any activity that lessen the negative impacts of climate change and positions us to take advantage of new opportunities that may be presented" (Warren & Egginton, 2008). The adaptation goals are to ease current impacts, reduce sensitivity and exposure to climate-related hazards, and increase resistance to stress factors (Warren & Egginton, 2008). Below were the proposed adaptation strategies of the coastal barangays of Buug regarding sea-level rise (Table 1).

**Table 1. Proposed Adaptation Strategies of the Coastal Barangays of Buug**

| Barangays | Proposed Adaptation Strategies |
|---|---|
| San Jose | - Mangrove planting<br>- Prohibition of mangrove cutting converted to charcoal<br>- Livelihood assistance (provision of carabao, horse, cow, coconut)<br>- Tree planting (upland)<br>- Road concreting from Purok 1 to 3. |
| Bawang | - Sea wall construction in Purok 3 and 4.<br>- Livelihood assistance (provision of agal-agal, cow, horse, carabao, coconut, and fishing-related activities)<br>- Mangrove planting<br>- Relocation site among inundated communities |
| Pamintayan | - Relocation site among inundated communities<br>- Mangrove planting<br>- Sea wall construction in Purok 1, 2, 3, 4, 6, and 7<br>- Livelihood assistance on fishing-related activities |
| Plug | - Road concreting with sea wall from Purok 2, 3, to 4.<br>- Relocation site among inundated communities<br>- Livelihood assistance (animal raising, gardening, sardines making)<br>- Mangrove planting |

Of the above proposed adaptation strategies with regards to sea-level rise, four strategies emerged as major themes. These were mangrove planting, livelihood assistance, seawall/dike construction, and relocation site.

**Mangrove Planting**

Mangrove forests in the marine intertidal zone are influenced by regional sea-level rise and coastal geomorphology. They are not passive to changes affecting them; rather, mangroves maintain a strong ability to change their environment, promote habitat persistence naturally and serve as engineers for coastal adaptation (Cheong et al., 2013).Coastal ecosystems such as mangroves can decrease risk to people and infrastructure from wave damage and flooding. The continued provision of these coastal defence services by mangroves is dependent on their ability to adapt to sea-level rise, either through an increase in soil surface elevation or by colonising more landward areas (McIvor et al., 2013). The number of hectares of mangrove areas in the coastal barangays of Buug were: San Jose - 66.65 hectares; Bawang - 73.19 hectares; Pamintayan - 9.81 hectares; and Pulog - 0.15 hectares (NAMRIA, 2010). Two barangays of Buug (San Jose and Bawang) had a large area of mangrove and Barangays Pamintayan and Pulog had small areas of mangrove. Although the barangays had mangrove areas in its jurisdiction, key informants sees its importance in coastal protection towards the effect of climate change, especially sea-level rise. All four coastal barangays of Buug proposed to plant mangroves as defense to sea-level rise. Although mangrove habitats are affected by sea-level rise, it maintain stability in the coastal area by reducing coast and soil erosion (Macintosh et al., 2010; Barbier et al., 2011 ) as well as defend the coast from the onslaught of waves, winds and floods (Malik et al., 2015; Barbier, 2016).

**Livelihood Assistance**

In the climate change vulnerability and adaptation arena, it is now widely accepted that enhancing the capacities of societies to deal with present conditions not only serves present and near-future needs but also represents an important contribution to adapting to longer term climate change. It is also increasingly recognized that adaptations are not likely to be undertaken to climate change alone (Huq & Reid, 2004; Schipper & Pelling, 2006), but they can be built into development programs to improve people's livelihoods and capacities.

In Subarnabad, Indonesia, villagers' ability to access a non-government organization (NGO) services and become an NGO beneficiary was found to be an important key in mediating a person's ability to access adaptation measures and adopt new livelihood activities. Via the NGO, villagers were provided with training and technical support to start out upon new livelihood strategies and access to loans and a savings bank. The initiatives undertaken in Subarnabad for income generation and food production included livelihood activities such as goat and fowl rearing, crab fattening, tree planting, halophytic (salt water-tolerant) vegetable gardens and

handicraft production (Pouliotte et al., 2009). These strategies were found to meet immediate needs for food and income and raise householders' capacity to address other stresses by improving their financial assets. These strategies were not exclusively, nor even mainly, directed at future climate change. Rather, the represented initiatives which would aid them adapt to their immediate and future realities, including conditions related to climate, economy, and politics (Pouliotte at al., 2009).

As in the case on the coastal barangays of Buug, the proposed livelihood programs which are provision of cow, carabao, and horse for transport of agricultural crops, animal raising like chicken, sardines making, gardening of vegetables, agal-agal farming, coconut assistance, and assistance in fishing-related activities will provide a practical means of improving people's immediate well-being, and also provides them with increased capacities to deal with future climate change in particular sea-level rise.

**Seawall/dike Construction**

Sea walls are solid engineered structures with a special function of preventing shoreline erosion. They are built parallel to the shore and intent to hold or prevent sliding of the soil while protecting wave action [United Nations Framework Convention on Climate Change (UNFCCC), 1999]. Although their main function is erosion reduction, they have a secondary function as coastal flood defenses. The physical shape of the structures is highly variable – they can be vertical or sloping and constructed from a wide variety of materials. They are sometimes also called revetments (UNFCCC, 1999).

Construction of sea walls on the coast where human settlements resided were the proposed adaptation measures on the three barangays of Buug, namely, Bawang, Pamintayan, and Pulog, to adapt the rising sea level. The three barangays had communities living along the coast that were very susceptible to sea-level rise like coastal erosion, flooding, and land subsidence. On the other hand, Barangay San Jose had no human settlements living along the coast. Instead, large tract of beach forest occupy most of the coastline of the barangay.

Sea walls provides a high level of protection against coastal erosion, flooding, and extreme water levels (Van der Meer, 1998). They involve less space than other coastal defense such as dikes, particularly if a more vertical design is used. When considering climate change adaptation, an advantage of sea walls is that it is possible to progressively upgrade the structures by increasing the structure height in response to rising sea level (Van der Meer, 1998).

**Relocation**

Local relocation or "on-site" relocation (Asian Development Bank, 1998) occurs inside national boundaries. In the context of the Pacific, where relocation could be closely related to sea levels in coastal areas, local relocation could mean relocating communities to more elevated land positions close to their existing locale (United Nations Higher Commission for Refugees, 2008).

At the regional level, relocation has been identified as a primary priority for climate change adaptation alongside food security, crop improvement, water security, and resilient infrastructure (Padma, 2012). On the other hand, Moser and Ekstrom (2010) said that individual's decision to relocate can take place as "adaptive transformation" to avoid intolerable risk, "They may be related to threats to core social objectives associated with health, welfare, security, or sustainability" (Renn, 2008; Dow et al., 2013).

Three barangays namely, Bawang, Pamintayan, and Pulog had relocation as proposed adaptive strategy to sea-level rise. The said barangays who lived along the coast were willing to relocate in higher land area given by the government to them wherein they can call it as their own. Their willingness to relocate is rooted on this. The land they are presently living are not their own. They just rent out the land or asked permission to the owner to reside in the land. Most of the occupants in the coast of the three barangays were just tenants on the land they are living. They were renting it per month. The idea of relocating to higher elevated land by the government gives them hope that they may find comfort on the land where they feel safe and they can call their own.

The affected individuals in local relocation can be compared to internally displaced persons (IDPs), who share the same legal status as any other citizen and for whom the State has a duty to respect, protect and fulfil the realization of rights. A durable solution is defined as a condition in which a displaced person no longer needs any specific assistance and protection related to their displacement and can enjoy their human rights without discrimination (Inter-Agency Standing Committee of the United Nations, 2010).

**Protect, Accommodate, Retreat, and Avoid (PARA) Framework**

The Coastal Zone Management Subgroup of the first IPCC climate change assessment report outlined three approaches (Dronkers et al., 1990) which coastal communities could use to prepare for climate change-related sea level rise ("protect, accommodate, and/or retreat"), and a fourth "avoid" option has since been added by practitioners and researchers (Harford, 2016; Middle, 2018).

Protect places emphasis on preventing the occurrence of sea-level rise impacts using hard engineering structures such as seawalls, and dikes (King et al., 2016); soft engineering structures such as nourished beaches, dunes and created or restored wetlands (Nicholls, 2011); and indigenous options such as afforestation, coconut-leaf walls and coconut-fibre stone units (Sterr et

al, 2003). Accommodate seeks to allow the continued or extended use of hazard-prone areas but with decreased sensitivity or exposure or both to sea-level rise (Harman et al., 2015). Often, there is little or no attempt to prevent the land from being flooded, rather current designs are altered through various measures to allow the infrastructure system to stay intact. Natural system effects are allowed to happen in this strategy, and impacts on humans are minimized by adjusting human use of the coastal zones via flood-resilience measures (Nicholls, 2011). Retreat refers to the planned or managed withdrawal from hazard-prone portion of the coast (Alexander et al., 2012). It may involve the actual or planned removal of present development and the prevention of future development in high-risk areas (South Florida Regional Planning Council, 2013). The concept is to pull back from the sea and seek refuge behind natural ecological defenses (Abel et al., 2011). Lastly, avoid approaches are those which attempt to proactively prevent homes, communities, facilities, or infrastructure from being built in hazard-prone areas in the first place (Doberstein et al., 2018).

Table 2 shows the proposed adaptation measures of the four coastal barangays of Buug and falls under the PARA (protect, accommodate, retreat, avoid) framework.

**Table 2. Proposed Adaptation Strategies in the PARA Framework**

| Barangays | Adaptation Approach to Sea Level Rise | | | |
|---|---|---|---|---|
| | Protect | Accommodate | Retreat | Avoid |
| San Jose | - Mangrove planting<br>-Prohibition of mangrove cutting converted to charcoal<br>-Tree planting (upland)<br>- Road concreting from Purok 1 to 3 | -Livelihood assistance (provision of carabao, horse, cow, coconut) | | |
| Bawang | - Sea wall construction in Purok 3 and 4.<br>- Mangrove planting | - Livelihood assistance (provision of agal-agal, cow, horse, carabao, coconut, and fishing-related activities) | - Relocation site among inundated communities | |
| Pamintayan | - Mangrove planting<br>- Sea wall construction in Purok 1, 2, 3, 4, 6, and 7 | - Livelihood assistance on fishing-related activities | - Relocation site among inundated communities | |

| | | | |
|---|---|---|---|
| Plug | - Road concreting with sea wall from Purok 2, 3, to 4.<br>- Mangrove planting | - Livelihood assistance (animal raising, gardening, sardines making) | - Relocation site among inundated communities |

The proposed adaptation measures in the four coastal barangays of Buug is similar under the PARA Framework. No adaptation strategies were proposed under the avoid approach. Their differences are on the type of livelihood each barangays should undertake although there are some similarities like raising of animals. The similarities of their approaches could be attributed on the similarities of the geopolitical condition of the area.

## Conclusion

The proposed adaptation strategies towards sea level rise among the four coastal barangays of Buug are: planting of mangroves, construction of sea walls, livelihood assistance, and relocation.

Under the PARA Framework, planting of mangroves and construction of sea walls are under the Protect Approach, while livelihood assistance is under Accommodate Approach, relocation is under Retreat Approach, while no adaptation strategy proposed under Avoid Approach.

For further study, it is recommended to include in the interview the Local Disaster Risk Reduction Officer, the Planning Officer, and the Mayor of the municipality to get a wholistic views, suggestions, and adaptation strategies towards sea level rise not only in the barangay but also in the municipal level.

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