Gulf of Mottama Project

Economic Valuation of Coastal Ecosystems in Bago Region of the Gulf of Mottama

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Economic Valuation of Coastal Ecosystems in Bago Region of the Gulf of Mottama

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EXECUTIVE SUMMARY

The Gulf of Mottama (GoM), situated on the southwestern coast of Myanmar, is a dynamic intertidal system with distinct hydrological features. The area is shaped by the influence of the Sittaung, Thanlwin, Irrawaddy, and Yangon Rivers, resulting in a unique turbid environment characterized by fast-moving tidal bores. The complex tidal regimes contribute to the erosion of the coastline and the formation of expansive intertidal mudflats, covering over 130,000 hectares. These mudflats, rich in nutrients, sustain benthic communities and support diverse marine species, making the GoM a critical habitat for both residents and migratory birds. The ecosystems surrounding the gulf, including coastal grasslands and sparse mangroves, further enhance its ecological significance. However, the GoM faces threats including erosion, overexploitation of resources, and ecosystem degradation due to conversion into farmland. To address these issues, the Gulf of Mottama Project (GoMP) focuses on sustainable resource management, alternative livelihoods, and community-based conservation efforts. Given the complexity of its ecosystems and their significance, the information on economic values of ecosystem services is crucial for effective decision-making. The study aims to determine the economic values of key coastal ecosystems (mangroves, mudflats, coastal grasslands, rivers/sea) and compare these values with those generated by converted rice fields.

The study informed that coastal ecosystems within the GoM offer substantial economic value to local communities, particularly in provisioning and regulating services. Through an assessment of six villages across the Bago Region, each household on average receives services valued at approximately around 5.37 million MMK (~ 2,558 USD) of which provisioning service accounted for 4.29 million MMK (~ 2,041 USD) and regulating for 1.09 million MMK (~ 512 USD). These findings varied across villages, influenced by proximity to coastal ecosystems and resource reliance. However, rivers and the sea consistently serve as vital sources of harvestable resources. Among these services, provisioning holds the most economic importance, contributing significantly to the overall value. The mean annual household income from provisioning services from mangrove is accounted for 21,000 MMK (~ 10 USD), 952,776 MMK (~ 453 USD) from mudflats, 309,429 MMK (~ 147 USD) from grassland, and 3 million MMK (~ 1,430 USD) from river/sea. In regions with extensive mangrove cover, protection against natural hazards gains economic significance. Amid these benefits, many households perceive negative changes in coastal ecosystems over the past decade. Comparing economics value to agricultural land to coastal ecosystems was unfeasible in Bago as the ecosystems are not yet converted into farmlands. In addition, due to the coastal changes, the sediments were starting to accrete on the western bank of the GoM or Bago Region. Therefore, the land tenure for agricultural use or conservation use on newly formed land will become one of the land use issues in the Bago region.

Above all, it is critical to protect and possibly extend the coastal ecosystems and these efforts should include local community through sustainable resource management. Such measures may include regulation of fishing activities, development of community managed conservation zones, as well as creating wider stakeholders' awareness on the values of the ecosystems. Optimizing conservation efforts necessitate a cost-benefit analysis approach to target areas with high ecosystem service values relative to costs. It is also needed for further investigations into the socio-economic consequences of conservation measures that are applied in these coastal areas and identification of appropriate conservation approaches through inclusive consultation procedures. The collective information will be utilized as an advocacy tool; to seek out the government support and collaboration with stakeholders; for developing comprehensive land use plan, putting priority on sustainability instead of converting coastal areas to farming and reclamation of degraded land without compromising coastal habitats.

ACKNOWLEDGEMENT

The research project was supported by Gulf of Mottama Project (GoMP) which is funded by the Swiss Agency for Development Corporation (SDC). Therefore, we would like to provide our sincere acknowledgement to SDC for supporting the research through the GoMP. Most importantly, we would like to appreciate the participants in the communities who involved in the interviews and discussions for their meaningful and valuable contributions. Then, we would like to thank Dr. Tara Sayuri Whitty for initiating fundamental background of the research as well as continuous guidance throughout the project. In addition, we want to thank the townships and clusters coordinators (TCCs) and the community facilitators and monitors (CFMs) of the project for their supports in development of the project as well as coordination for field activities. Finally, we would like to appreciate field researchers and research assistants from Myanmar Coastal Conservation Lab (MCCL) @ Point B Design + Training, who actively participated throughout the research process.

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1 INTRODUCTION

1.1 Social Ecological System in the Gulf of Mottama

The Gulf of Mottama (GoM), the funnel-shaped area sitting on the southwestern coast of Myanmar comprising administrative boundaries of Yangon Region in the west, Bago Region in the north, Mon State in the east, and the Andaman Sea in the south, is one of the most dynamic intertidal systems in the world (GoMP, 2019). The dynamic turbid area is due to annual transportation of about 350 million tonnes of sediments from Sittaung River, Thanlwin River, Irrawaddy River and Yangon River (Robinson et al., 2007). The magnitude of water flowing from the rivers create a "tidal bore", a tide at a speedy flow which can temporarily reverse the flow of the river (Ramaswamy et al., 2004). As a result, the waves flowing upstream with a tidal range of 7 metres erode the coastline and create a highly productive yet largest known area of perennial turbidity with up to 4,500,000 Ha (Arcadis, 2018; GoMP, 2019).

This dynamic hydrological regime creates one of the largest intertidal mudflats in the world which expands over 130,000 Hectares (Aung et al., 2023). The mudflats are rich in nutrients supporting food for bottom dwelling benthic communities including commercially important mud crab (*Scylla serrata*), calms, molluscs and a variety of estuarine fish species (MacKay, 2017; MacKay et al., 2021). Therefore, it attracts 150,000 residents and migratory shorebirds especially from East Asian Australian Flyway (EAAF) to winter in the GoM including critically endangered Spoon-billed sandpiper (*Calidris pygmaea*) and other IUCN red list migratory bird species (Zöckler et al., 2014). On the boundaries of the stabilised mudflats are coastal grassland which is dominated by *Oryza minuta* (locally known as Nat Sa Pa). Although there is about 35,000 Ha of coastal grassland (Aung et al., 2023), the species, distributions, ecological roles, and functions of coastal grassland in the GoM are poorly understood but there is local ecological evidence of habitat use from shorebirds and mud crabs. The mangroves in the GoM are in the phase of active accretion and therefore, only sparse distribution of patches of mangroves occur in the mouth of the gulf. So, there are no mangroves in Bilin and Kyaik Hto townships of Mon State and Waw and Thanatpin townships of Bago Region. In total, there are about 12,810 Ha of mangroves in the GoM with about 13 true mangrove species distributed on the eastern bank of the gulf and mostly dominated by *Avicennia* species (Maw et al., 2021).

Surrounded by these coastal wetland ecosystems, the waters of the gulf are important habitats as well. The waters of the upper GoM are largely brackish, with substantial freshwater discharge and turbidity, while the lower GoM is more marine (GoMP, 2019). They are important habitats for aquatic and marine species including commercially important fish stocks. There are about 39 fish species (Htet, 2017) and 3 marine mammal species (Hte et al., 2023).

Due to the unique ecosystems and enriching biodiversity of the gulf, about 70,000 people in about 86 villages are inhabiting within 2km - 5km from the coast and creating social ecological systems of the gulf (Myanmar Information Management Unit (MIMU), 2020). Many of these coastal villages are relatively remote. Major livelihoods are fishing, farming, livestock rearing, as well as casual wage labour depending on work opportunities.

The gulf supports major source of income by supporting capture fisheries of economically important fish species and mixed species of prawns. Fishing grounds include river channels, seasonal riverine lakes, estuaries, inundated paddy fields and low-lying areas, perennial lakes and tanks, irrigation canals and tributaries, and the sea. In Bago Region, fisheries are primarily freshwater, while coastal fisheries are much more important in Mon State (Salagrama, 2015). In addition, the mudflats and coastal grassland support mud crab harvesting as a valuable source of income for small-scale fishers, women, and landless households. Although the mangroves in the GoM are in the early successional stage and occur in low diversity, mangrove patches are still locally important as recognized by local community members. The local people recognize that mangroves are important habitat for fisheries species including mud crab, provide firewood for household use, protect from coastal erosion, and support some medicinal plants and edible plants (Environmental Defence Fund (EDF), 2019) Therefore, the GoM is not only supporting important ecosystems for its biodiversity but also providing resources required for well-being of coastal communities and these social ecological systems are closely linked and interdependent to each other. The importance is recognized as the fourth Ramsar site of Myanmar expanding an area of 161,030 Ha of the GoM in 2017.

1.2 Threats to Ecosystems

The coastal wetland such as GoM plays a significant role to improve socio-economic conditions by growing household income, provide food security, and support overall well-being of the community dependent on its ecosystems. However, the excessively dependence of social systems on the ecological system imposes greater conservation threats for the sustainability of these ecosystems. In the GoM, the major threats are identified as change in the geophysical system of the gulf, overexploitation of coastal natural resources, and alteration and degradation of coastal ecosystems (GoMP, 2019).

Naturally dynamic geophysical and hydrological system of the gulf is a major factor for substantial erosion cycles causing one side of the bank to erode and accrete sediments and form new land on the other side of the bank. This natural threat caused over 10 villages and thousands of hectares of agriculture to wipe out and resulted in displacement of local communities.

Unsustainable extraction of openly accessible resources in the gulf is regarded as one of the immediate threats to the biodiversity of the gulf. In the past decade, the increasing demand on fishery products led to overfishing and appliance of different types of illegal fishing gears which resulted in declining fish stocks. The widespread use of different gears also causes bycatch of marine megafauna such as sea turtles and marine mammals.

In addition, the conversion of coastal ecosystems into farmland for rice cultivation is a major cause for ecosystem change and degradation. From 2016 to 2022, about 17,645.19 Ha of coastal ecosystems are converted into cultivated land (Aung et al., 2023). However, these lands are mostly acquired by wealthy and influential people in or outside of the community and exposed to conflicts in land tenure among groups in the communities. The adverse impacts of alteration of ecosystems not only eliminate biodiversity but also endanger the livelihood opportunities of communities especially marginalised people whose income mainly depends on extraction of resources. Moreover, the other factors affecting the degradation of the ecosystem include construction of bridges, sand mining, pollutants from upstream sources, and deforestation within catchments of the waterways especially Sittaung River.

1.3 Critical Knowledge Gaps

In order to conserve the unique biodiversity of the GoM from anthropogenic threats and sustainably develop the well-being of communities, Gulf of Mottama Project (GoMP) is advocating the wise use of natural resources by supporting sustainable natural resource management activities, alternative livelihood opportunities to strengthen the resilience of local communities and community-based conservation initiatives.

Starting in 2021, the project initiated the Ecosystem Approach to Fishery Management (EAFM) for more integrated management of coastal resources from ecosystem approach. As EAFM is an integrated approach for coastal management through the lenses of ecosystems, more in-depth knowledge regarding the ecosystem services in the GoM need to be well documented and shared effectively through different stakeholders.

In addition, the dynamic nature of the tidal channels in the gulf resulted in severe coastline regression, at immense rates and over large distances. It creates erosion in one side of the bank while creating accretion on the other side due to sedimentation. These changes are as frequent as the cycles repeats each 10 to 15 years according to anecdotal reports. These issues raise on how to allocate villages in eroded regions and how the new land should be managed in accreted regions. Therefore, more intensive knowledge to support decision making for thousands of hectares of newly formed land for effective coastal land use planning.

The above information suggests a need to understand the economic values of coastal ecosystems in the GoM to support decision making for the coastal land use planning in the area.

1.4 Ecosystem Services

The concept of ecosystem services provides a useful framework to identify the importance of the natural environment to humans. The term "ecosystem services" has been defined in several different ways but put most simply, they are the variety of benefits that humans obtain from the environment.

Ecosystems contribute to human well-being in a wide variety of ways and the processes by which ecosystems provide benefits to people has been described as an "ecosystem services cascade" in which bio-physical structures and processes ("ecosystem functions") can deliver inputs (ecosystem services) to the production of goods and services that are consumed by people.

The Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2005) classified ecosystem services into four categories, as follows:

- Provisioning services are the "products obtained from ecosystems" (e.g., food and raw materials),
- Regulating services are the "benefits obtained from the regulation of ecosystem processes" (e.g., protection from flooding and storms, nutrient recycling),
- Cultural services are the "non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences" (e.g., recreation, inspiration for art and design, and appreciation of the existence of diverse species), and
- Supporting services "are necessary for the production of all other ecosystem services" (e.g., soil formation and oxygen production).

The inclusion of supporting services in ecosystem service assessments can potentially lead to double counting of values (Fisher et al., 2009) and this category has therefore been omitted from more recent classification systems (e.g., The Economics of Ecosystems and Biodiversity – TEEB; Common International Classification of Ecosystem Services – CICES; and the System of Environmental Economic Accounts SEEA EA reference list).

1.5 Total Economic Value

The concept of Total Economic Value (TEV) is used to describe the comprehensive set of utilitarian values derived from a natural resource. It is useful for identifying the different types of value that may be derived from an ecosystem. TEV comprises use values and non-use values. Use values are the benefits derived from physical use of the resource. Direct use values may derive from on-site extraction of resources (e.g., fish, crabs, molluscs, fuel wood) or non-consumptive activities (e.g., recreation). Indirect use values are derived from off-site services or other processes that are impacted by the resource (e.g., protection from coastal flooding). Option value is the value that people place on maintaining the option to use a resource in the future (e.g., the option to develop ecotourism).

Non-use values are derived from the knowledge that an ecosystem is maintained without regard for any current or future personal use. Non-use values may be related to altruism (maintaining an ecosystem for use by others), bequest (for future generations) and existence (preservation unrelated to any use) motivations. The constituent values of TEV are represented in Figure 1.5. It should be noted that the "total" in Total Economic Value refers to the inclusion of all components of utilitarian value rather than the sum of all values derived from a resource i.e., the TEV framework can be used to assess marginal changes in value as well as total values.

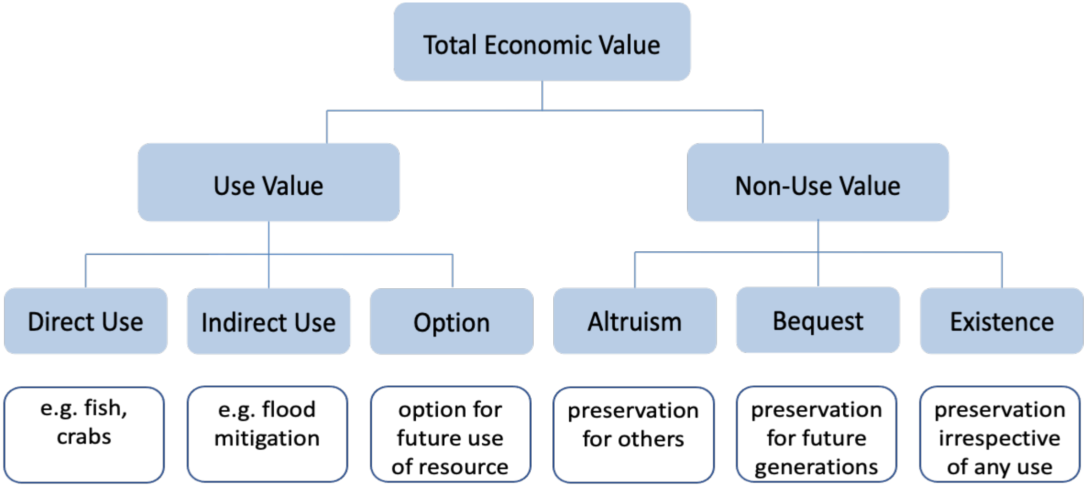


Figure 1.1. Components of Total Economic Value. Adapted from (Pearce & Turner, 1990).

1.6 Economic Valuation of Ecosystem Services

Economic value is simply a means to describe how important the things we use are to us, including our use of the natural world or "natural capital". In the case of ecosystem services from the coastal and marine environment, there are often no prices that reflect their value, since the services that are provided are not traded in markets (e.g., subsistence use of harvestable resources, climate regulation, coastal protection, biodiversity). As a result, we tend not to take the value of ecosystem services into consideration when we make decisions that affect the marine and coastal environment. When we investigate the consequences of environmental change (e.g., climate change, development, marine accidents) we need to fully understand the effects on ecosystem services and human well-being. Economic valuation tries to measure the importance of environmental change, usually in monetary terms, in order to communicate the scale of impacts to human well-being. Such information can be used to raise awareness of the economic importance of marine ecosystems, set fees for the use of marine ecosystem services, or determine compensation payments for environmental damage.

Economic valuation of ecosystem services involves identifying and quantifying the contribution of environmental resources to human well-being; and incorporating this information into decision-making and the design of financing mechanisms and policy instruments. It builds on the conceptualisation of nature as a productive asset - natural capital - which provides humanity with a flow of inputs into production and consumption - ecosystem service (Dasgupta, 2021). Economic values are generally measured and communicated in monetary units in order to enable comparison with the value of other resources, costs and investments in the economy.

Economic valuation methods do not stand alone but are often used in combination with other methods for assessing environmental change and the provision of ecosystem services. The added value of using economic valuation methods is that the importance of ecosystem services is expressed in terms of human welfare and measured in common units (i.e., money), allowing values to be aggregated across ecosystem services and directly compared with the values of other goods and services in the economy.

Estimating the economic values of ecosystems can help to support better decision-making and resource management. Ecosystem services contribute substantially to human welfare and, in some cases, are fundamental to sustaining life (e.g., climate regulation and nutrient recycling).

The underlying natural capital is, however, finite and cannot necessarily be regenerated or replaced. With growing human populations, and consumption per capita increasing over time, it is often the case that the human use of renewable resources outstrips their natural rate of regeneration (i.e., human use is ecologically unsustainable).

Such resource limitations mean that we must constantly choose between alternative uses of available resources. Every time a decision is made to do one thing, this is also a decision to avoid another – value is implicitly placed on each option. If the valuation of alternative resource uses is unavoidable in making decisions, it is arguably better to make these values explicit and ensure that decisions are transparent and well informed.

1.7 Goals and Objectives

The Gulf of Mottama Project (GoMP) is working to facilitate integrated, ecosystem approach management of natural resources in the area. To develop more compelling, evidence-based decision-making in land use and other natural resource management decisions, a stronger base of information and analysis about the value of various ecosystems in the GoM. Therefore, the study is conducted with the aim to identify the economic values of four major types of ecosystems in the GoM: mangroves, mudflats, coastal grasslands, and rivers and/or sea and compare how these values may be provided by rice fields. The key objectives of the study are as follows:

- To assess the status and condition of the coastal ecosystem including local extent, trends over the past 10 years and the drivers of the trend,
- To identify the total economic values of coastal ecosystems in the Gulf of Mottama with emphasis on direct use of the ecosystems (primarily includes "provisioning" services) and other services provided by the ecosystem (less directly tangible ES such as protection, regulation and supporting services), and
- To compare these economic values with the revenues provided by rice fields converted from the coastal ecosystems.

2 METHODOLOGY

2.1 Study Area

In this research, the study sites were identified based on where four major ecosystems: mangroves, mudflats, coastal grassland, and river/sea are located. In coordination with township clusters coordinators (TCCs) and community facilitators and monitors (CFMs) of the Gulf of Mottama Project (GoMP), the study conducted data collection from 5 villages in 2 townships of Bago Region as shown in Figure 2.1.

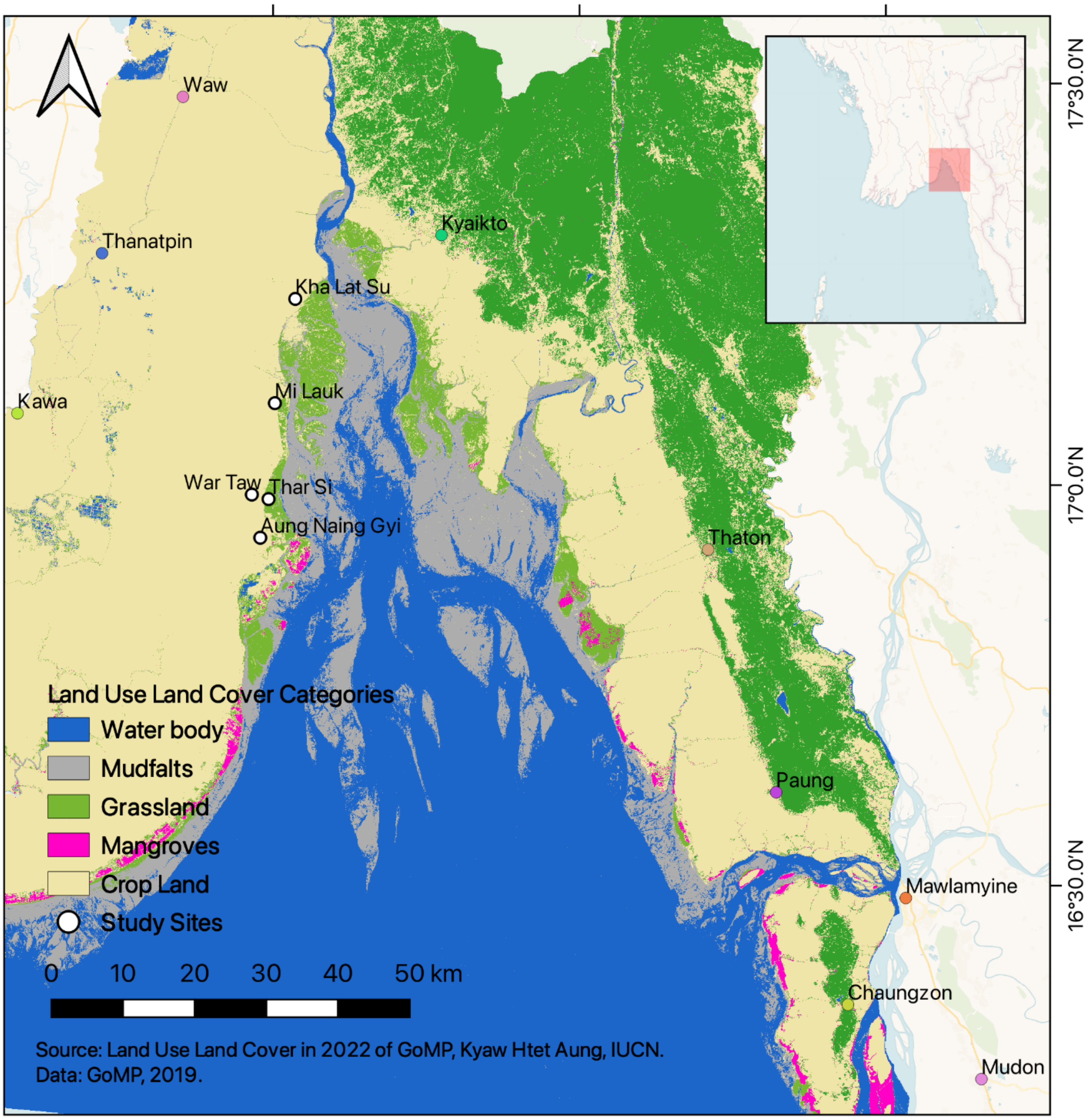


Figure 2.1. Map showing the villages where the study was conducted. The base map shows different types of ecosystems in the study area.

2.2 Methods

The study applied quantitative methods to identify the economic values of ecosystem services from four major types of ecosystems and comparable values if these ecosystems are converted into farmland. It also equipped a qualitative approach to understand community values, experiences, and perceptions on these ecosystems as well as to explore community feelings on converting these ecosystems as farmland. The field survey applied two methods: key informant interview (KII) and household in-depth interviews (HH). The field visits were conducted from April to May 2023 in Bago Region. In conducting field research, the field researchers from MCCL @ Point B Design + Training were trained in the economic valuation process of ecosystems, interviewing, and data enumerations. The field activities, data enumerations, data management and quality control were supervised and managed by the research officer of the GoMP.

Table 2.1. Sampling frame showing total number of households, sample size and percentage of total household for questionnaires conducted in the study.

Villages	Townships	Total households*	Sample size	Percentage of total household
Kha Lat Su	Thanatpin	227	20	9%
Mi Lauk**	Kawa	224	30	13%
War Taw**	Kawa	383	30	8%
Thar Si	Kawa	60	7	12%
Aung Naing Gyi**	Kawa	315	25	8%

*Data updated by GoMP in 2020.

**The key-informant interviews suggested that the village is a relatively large village with diverse livelihood activities. There are less than 80 households who directly use coastal ecosystems.

2.2.1 Key Informant Interviews

In order to gain general context of the community and ecosystems, 1-2 key informant interviews were conducted with village leaders and/or community leaders in each village. The interview is to gain an overview description on resource use patterns, problems and conflict resolution in resource use and extraction, economic importance of the habitats, service and benefits provided by the ecosystems. In addition, to get market prices of trading goods extracted from resources, market interviews were conducted to local traders, fish, and crab collectors in each village.

2.2.2 Household Surveys

The research team designed semi-structured questionnaires to collect personal information of respondents, household income, sources of income, and wealth, dependence on ecosystem services (mainly focused on provisioning services and regulating services), changes in ecosystems and feelings on converting of these ecosystems as farmland. In order to get information on revenues from farmland, separate interviewers for farmers who are currently working in converted farmland are also surveyed.

In each village 20-30 households were selected through convenient sampling. Representatives from different livelihoods, social status, gender, religion, and social groups were selected to gain diverse perspectives from the community. The sample size for each village is shown in Table 2.1. Each interview was conducted by 2-3 trained interviewers and took from 30 – 45 minutes to complete the questionnaire.

2.3 Data Analysis

The field data were entered into Excel immediately following data collection. The quantitative data were analysed in SPSS and Excel using simple descriptive statistics. To analyse qualitative data, the team mainly applied thematic analysis by coding the data using Excel. For each piece of qualitative information, different codes were assigned from a standardised list of codes to identify the main theme covered by that piece of information. Then, they were quantified and evaluated the insights provided by the data.

2.3.1 Household Income from Resource Harvesting

The household survey data were used to quantify total household income from resource harvesting. Total household income comprises of components that are received in money (e.g., from paid employment, remittances, sale of harvested natural resources and other sources) and those that are received directly in the form of natural resources that are consumed by the household (i.e., subsistence use of harvested natural resources) – see Figure 2.1.

The analysis in this study focuses on income from natural resources (coastal ecosystems), including both money income and subsistence income. Money income is computed using data on the quantities of each resource harvested, the proportion that is sold, and the market price of the resource. Prices were obtained from a market survey and key informant interviews. Subsistence income is computed in a similar way using data on the quantities of each resource harvested, the proportion that is consumed or given away, and the market price of the resource. This approach to estimating subsistence value is based on the assumption that, in the absence of the harvestable resource, households would replace the harvested resources that they consume with a marketed equivalent.

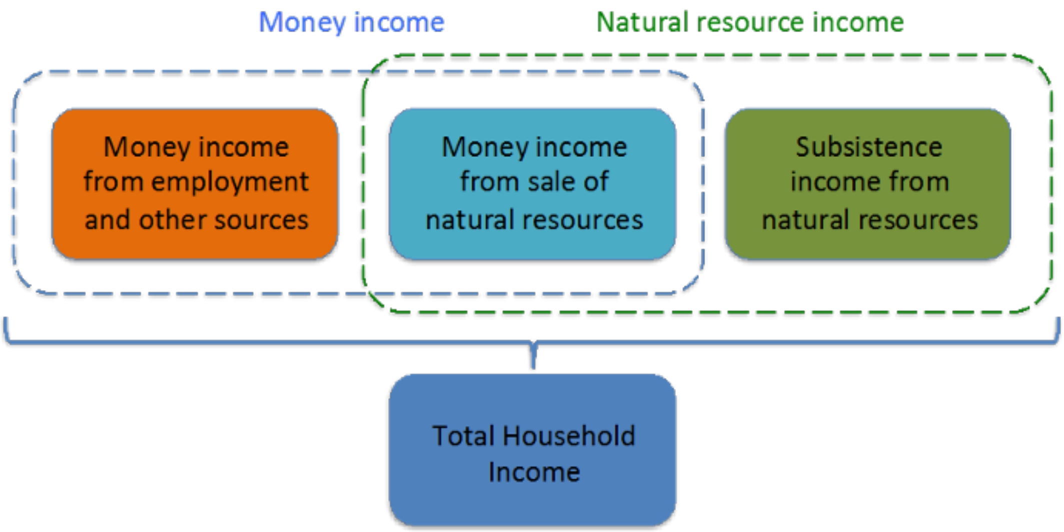


Figure 2.2. Components of total household income.

2.3.2 Avoided Damage Costs

Mangroves and other coastal ecosystems mitigate tidal inundation and storm surges. The level of provision of this service is dependent on a number of biophysical factors (e.g., bathymetry, tidal range, slope, storm profile etc.) and socio-economic factors (e.g., population exposed, assets at risk, adaptive capacity etc.). Koch et al., 2009 describe how variation in this ecosystem service is influenced by ecosystem type, extent, condition, and configuration to the assets that are protected.

The value of coastal protection provided by ecosystems is the savings from avoided damages attributable to the role of the ecosystem in mitigating flooding and other hazards. The avoided damage cost method looks at different types of avoided costs including property damage, loss of crops and livestock, missed days of work, and health impacts. The approach involves an assessment of the difference in the extent and value of damages under the current level of protection (with existing ecosystems) versus a baseline or counterfactual level of protection (without ecosystems). The avoided damage cost method requires information on (i) the population, property, and human infrastructure at risk from flood damage, and (ii) the reduction in probability or extent of damages given the presence of ecosystems.

In this study we obtain information on the value of damage costs from natural hazards incurred by households in the sampled villages from the household survey. This provides an estimate of damage costs under the current level of protection provided by coastal ecosystems. To quantify the reduction in the extent of damage attributable to coastal ecosystems, we use a non-linear function derived from Koch et al., 2009 that relates the extent of mangrove cover to the value of avoided damages. We generalise this function to relate the percentage of mangrove cover to the % reduction in damages. This non-linear function reflects a declining marginal effect of additional mangrove extent on avoided damage costs. Although all coastal ecosystems can have a functional (and complementary) role in the mitigation of flood damage, this analysis focuses on mangroves because the literature on the role of mangroves is more developed and provides the necessary quantitative information to measure the relationship between ecosystem extent and reduced damage costs. This approach is therefore conservative and avoids potential double counting of values of protection provided by combinations of coastal ecosystems.

3 RESULTS

3.1 Ecosystem Services from Coastal Ecosystems in GoM

The ES from the coastal ecosystems of GoM identified in the key informant interviews of the study are summarised in Table 3.1. The mentioned ecosystem services are provisioning, regulating and some of cultural services. The provisioning services from mangroves, mudflats and coastal grassland are very similar but mangroves reportedly provide more regulating services.

Table 3.1. Identified ecosystem services from four major types of ecosystems in GoM from FGD with communities.

Ecosystems	Provisioning services	Regulating services	Cultural services
Mangroves[1]	• Mud crabs • Fish (small fish such as mullets) • Firewood (dry branches of mangrove)	• Storm surge • Wave attenuation • Protect from erosion.	
Mudflats[1,2]	• Mud crabs • Fish (fishing of mullets, Pama croaker, Striped dwarf catfish, etc. during high tide) • Shrimps and prawns	• Wave attenuation	
Coastal grassland[1,2]	• Mud crabs • Fish (fishing of mullets, Pama croaker, Striped dwarf catfish, etc. during high tide) • Shrimps and prawns • Frogs • Rats	• Wave attenuation	
Rivers/ Sea[1]	• Fish (variety of economically important species including Hilsa shad, Pama croaker, Paradise threadfin, Bombay duck etc.) • Shrimps and prawns • Firewood (drifted from elsewhere)		• Transportation, Navigation

[1]All the ecosystems provide important supporting service for being habitat of species in the area (e.g. spawning, nursery, etc).

[2]These ecosystems are intertidal and therefore, communities also extract fishery resources (fish and shrimps) when the water is submerged.

3.2 Household Survey Demographic Overview

The study conducted a total of 112 household interviews, 5 key informant interviews in a total of 5 villages in Bago region. A total of 82 men (73.2%) and 30 women (26.7%) in Bago region participated in household interviews. The age group of most respondents were 41 - 50 years (n = 41) and the second was 51 - 60 years (n = 28).

The mean annual household money income for Bago region from all livelihood activities for the whole sample is 2,507,696 MMK (~1,194 USD)[1]. The mean annual household money income from each village is shown in Figure 3.2. There is no significant variation in income among the five villages. War Taw has higher annual income (2,710,000 MMK/ ~1,290 USD) and Thar Si has the lowest with 2,185,714 MMK (~1,040 USD) annually.

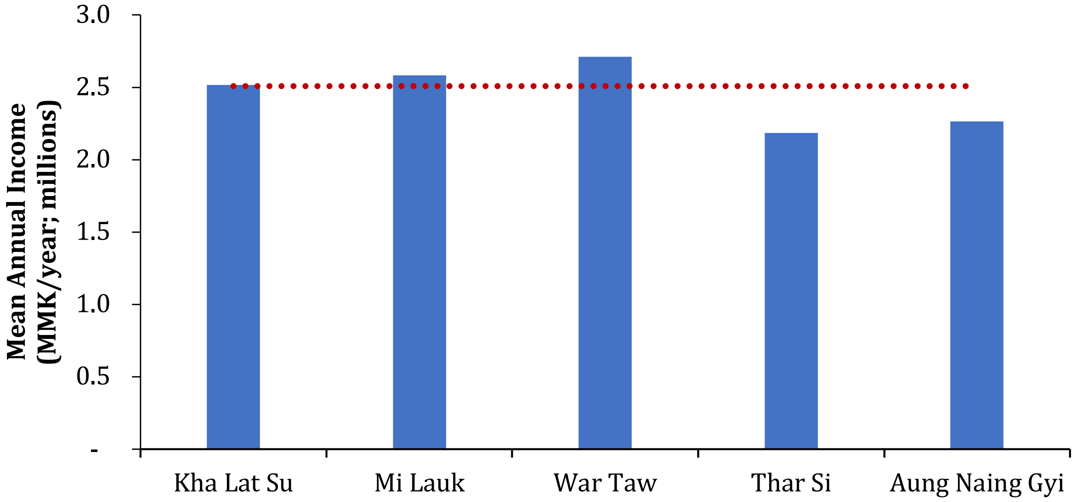
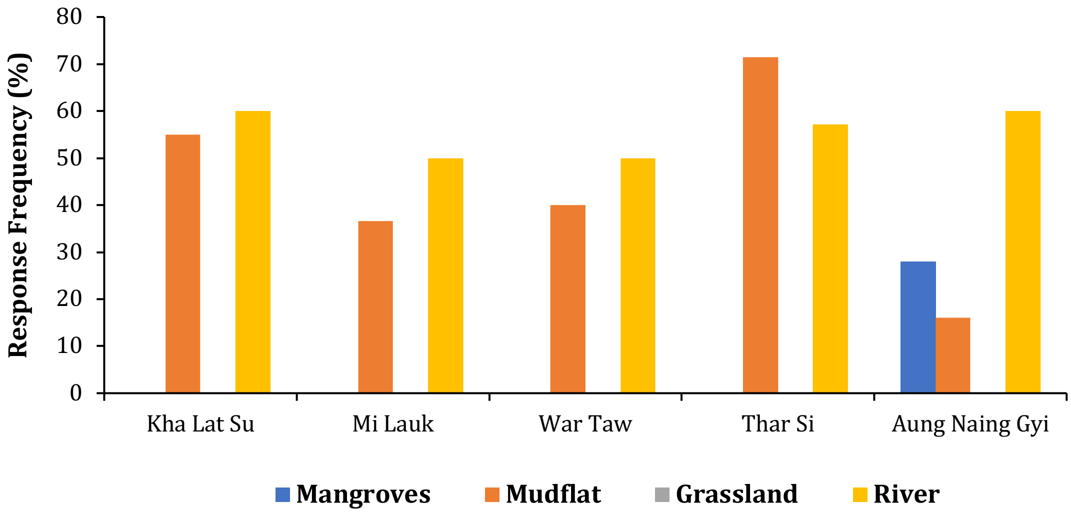


Figure 3.1. Mean annual income of the whole village per village in Bago Region. The red dotted line represents the mean annual income.

3.3 Economic Values of Provisioning Services

3.3.1 Resource harvesting

The proportion of households that harvest resources (fish, crabs, mollusc, and shrimps) from each ecosystem type are presented in Figure 3.2. This shows that a high proportion of household harvested resources from coastal ecosystems and that some ecosystems are more widely used than others. In all villages, a high proportion of sampled households (50-60%) harvest resources from rivers and the sea.



[1] Exchange rate: 1 USD = 2,100 MMK

Figure 3.2. Proportion of households extracting resources from each ecosystem from each village in Bago.

The mean annual income from harvesting natural resources (selling fish and mud crab) is shown in Figure 3.2. In Bago, people do not get molluscs and shrimps from the coastal ecosystems are negligible. Annually, the mean income per household from fishing is 628,9565 MMK (~ 300 USD), and from crab fishing is 239,923 MMK (~ 114 USD). Aung Naing Gyi village has the highest income from fishing (846,979 MMK (~ 403 USD), and Kha Lat Sun in crab fishing (343,389 MMK (~ 164 USD)).

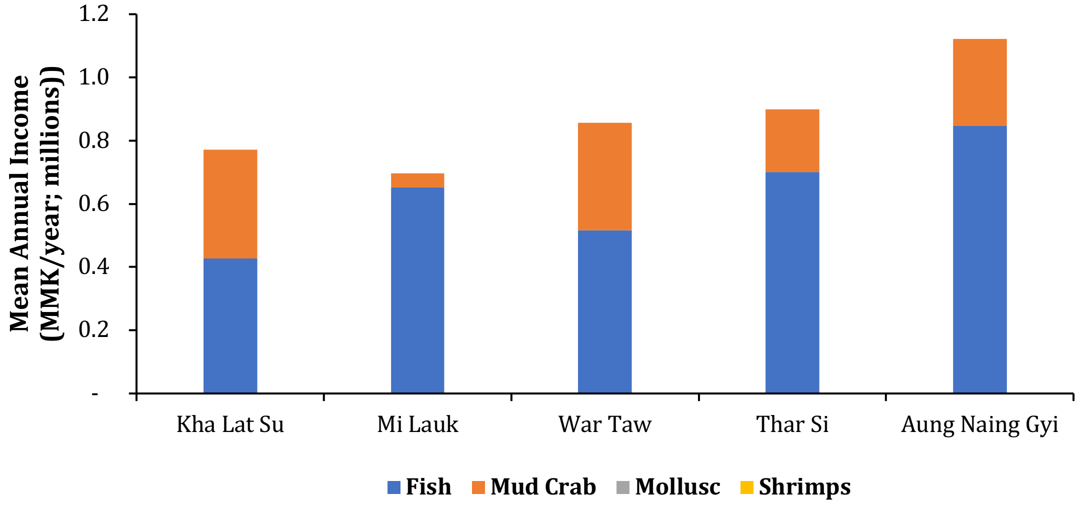


Figure 3.3. Mean annual income per household from harvesting of resources from four types of ecosystems in Bago.

3.3.2 Mangroves

In the Bago region, only Aung Naing Gyi engages in comprehensive mangrove resource utilization in fishing crabs which is about 20 kg annually per household. The extraction is exported to be only for commercial use by directly selling them. The mean annual household revenue from resources extracted from mangroves in Bago is calculated as 21,054 MMK (~ 10 USD).

Extrapolating across all the households in sampled village, the annual revenue from mangroves is 456,177 MMK (~ 217 USD). The mean mangrove cover area where people are extracting resources in the study area is 80 Ha. Therefore, the economic value from provisioning services provided by mangrove in the study area is estimated as 53,961 MMK (~26 USD)/Ha.

3.3.3 Mudflats

On average, communities in Bago extracted about 226 kg of fish from intertidal mudflats. Aung Naing Gyi leads fish extraction (335 kg), trailed by Mi Lauk (238 kg), War Taw (196 kg), Thar Si (168 kg), and Kha Lat Su (11 kg). The average mud crab extraction is 31 kg per household annually, with War Taw at 118 kg and Aung Naing Gyi at 1.85 kg. Only Mi Lauk acquires about 36 kg of shrimps from mudflats.

Resource extraction from mudflats is predominantly for commercial use or directly selling of products. On average, 96% is intended for sale (Figure 3.8). Aung Naing Gyi stands out with 0% subsistence use and 100% commercial use. Remaining villages designate 1-5% for household consumption or subsistence use.

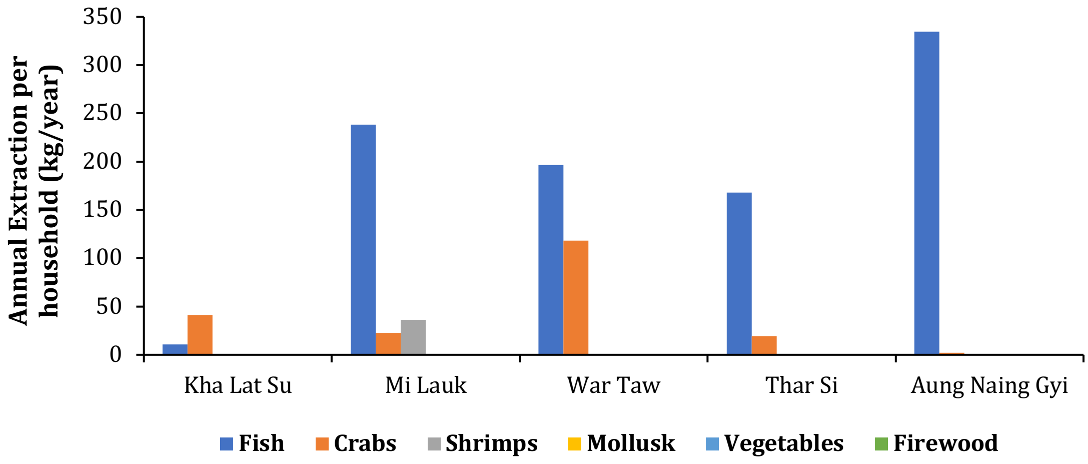


Figure 3.4. Annual extraction of resources per household in kg from mudflats in Bago Region.

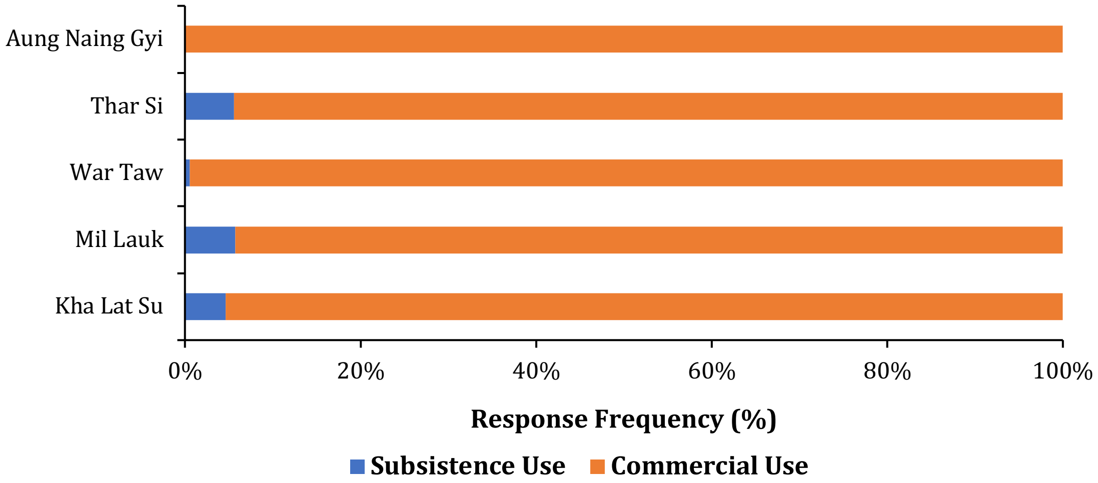


Figure 3.5. The proportion of subsistence (household consumption) and commercial uses (direct selling) of extracted resources from mudflat.

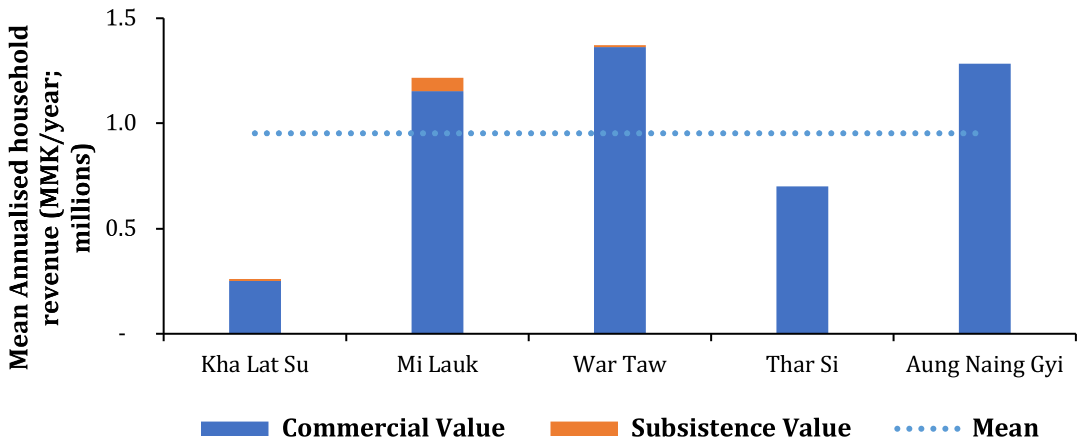


Figure 3.6. Mean annualised household revenues from total use of provisioning services from mudflat ecosystems in each village. The blue dotted line represents the mean revenue for the whole sampled villages in the study (952,776 MMK (~454 USD)).

According to Figure 3.9, the average annual household revenue from commercial mudflat resource use is only 950,186 MMK (~453 USD). Each household's average subsistence value is 28,777 MMK (~14 USD). Thus, the collective provisioning value from mudflats across the sample equals 952,776 MMK (~454 USD) per household (Figure 3.9). The extrapolated mean annual mudflat value stands at 24,324,673 MMK (~11,579 USD). With an estimated mean mudflat area of 739 Ha in the study area, the annual revenue from each hectare is approximated at 51,795 MMK (~25 USD).

3.3.4 Coastal grassland

As the coastal grassland are adjacently existing with intertidal mudflats, the resource uses are very similar. Fishing occurs in coastal grasslands in all villages except Aung Naing Gyi, with the highest proportion of 72 kg in Mi Lauk, followed by 39 kg in War Taw, 29 kg in Kha Lat Su, and 3 kg in Thar Si. The average mud crab extraction stands at 38 kg per household annually, with the highest in War Taw (99 kg) and Aung Naing Gyi (4 kg). Mi Lauk also annually extracts about 5 kg of shrimps from grasslands (Figure 3.10).

The extraction is majorly for commercial uses (95%) and Thar Si has highest subsistence use of extracted resources as 15% of the resources are use in the household as shown in Figure 3.11.

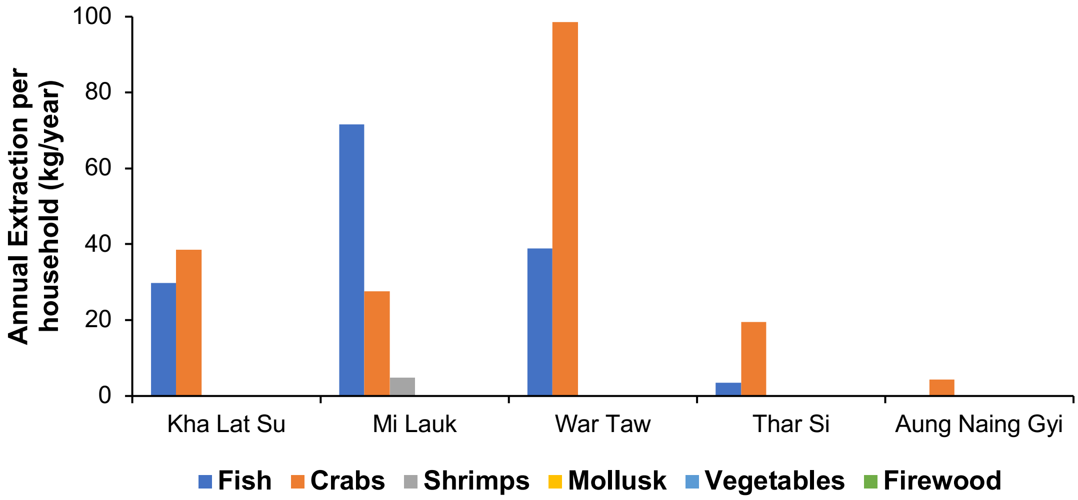


Figure 3.7. Annual extraction of resources per household in kg from coastal grasslands in Bago Region.

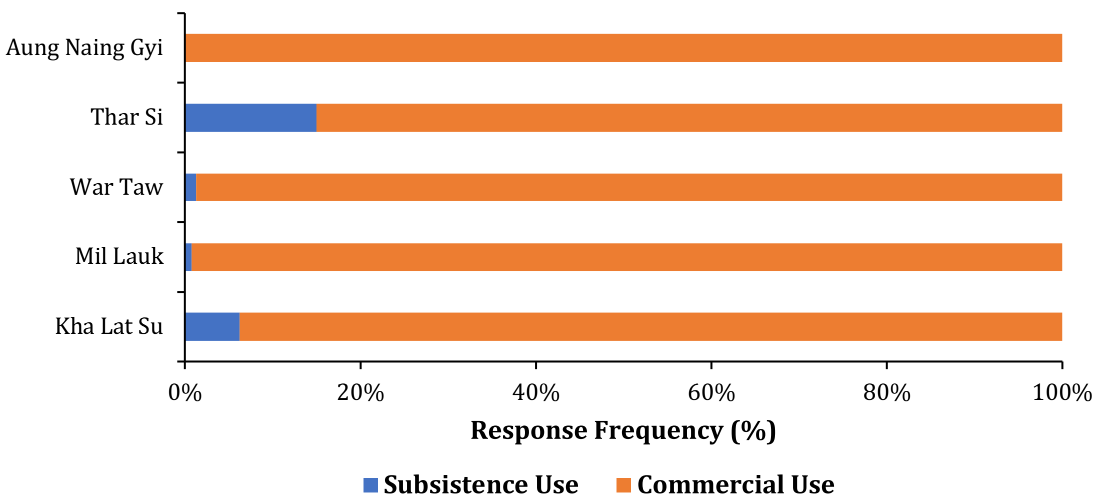


Figure 3.8. The proportion subsistence (household consumption) and commercial uses (direct selling) of extracted resources from coastal grassland.

Annually, the mean revenue from commercial uses of resources from coastal grassland in Bago is 309,420 MMK (~147 USD) per household. The mean subsistence value is 12,841 MMK (~ 6 USD). The total economic value for provisioning services of grassland is 303,333 MMK (~146 USD) as shown in Figure 3.12 which ranged from 662,127 MMK (~ 315 USD) in War Taw and 22,740 MMK (~ 11 USD) in Aung Naing Gyi.

By extrapolating these figures, the average value per village is estimated as 7,655,036 MMK (~3,644 USD)). The mean cover of coastal grassland where people go fishing is about 712.85 Ha. Therefore, the value for direct use of resources from coastal grassland is 7,246 MMK (~ 3 USD) per hectare.

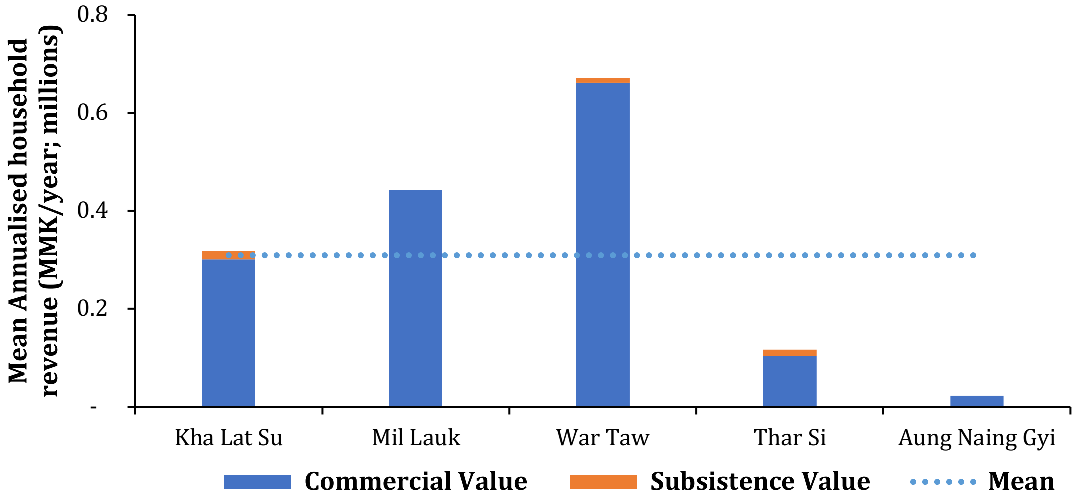


Figure 3.9. Mean annualised household revenues from total use of provisioning services from coastal grassland ecosystems in each village in Bago. The blue dotted line represents the mean revenue for the whole sampled villages in the study (309,420 MMK (~147 USD)).

3.3.5 River/sea

All study villages engage in resource extraction from rivers and/or the sea, depending on their location. Aung Naing Gyi attains the highest fish proportion at 1,744 kg, while the remaining villages average at 424 kg. Catch quantities are illustrated in Figure 3.13. Similar to the use of resources from other ecosystems, most of the catch is intended for commercial purposes, as depicted in Figure 3.14. About 96% of the resources gathered from rivers/sea were sold directly and only 4% were used in the household.

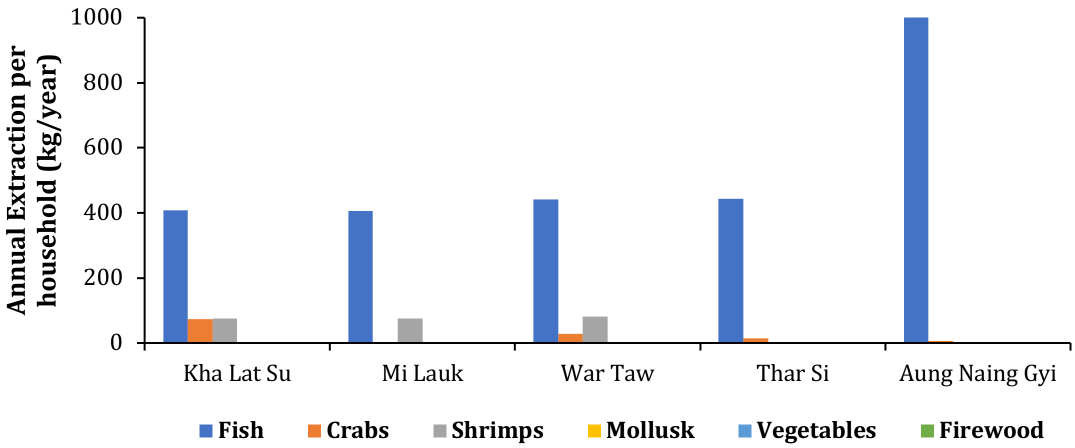


Figure 3.10. Annual extraction of resources per household in kg from rivers/sea in Bago Region.

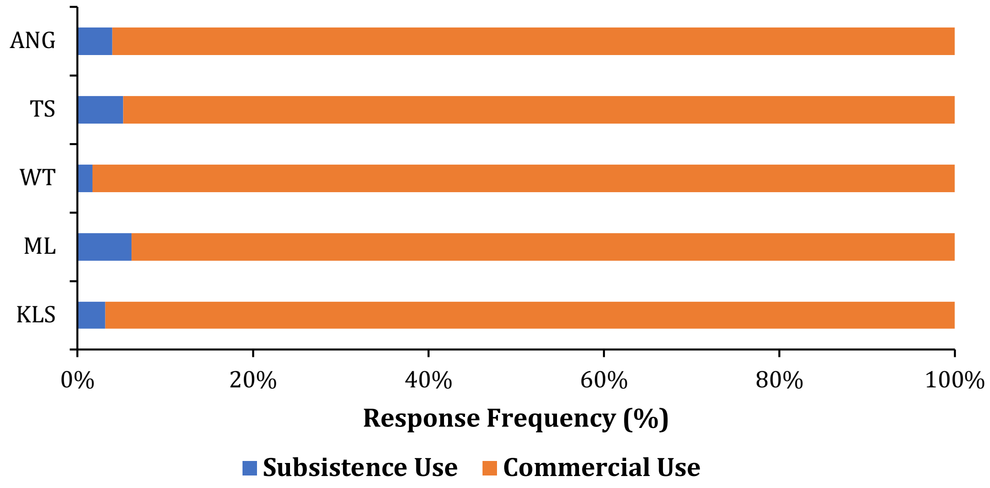


Figure 3.11. The proportion of subsistence (household consumption) and commercial uses (direct selling) of extracted resources from rivers/sea.

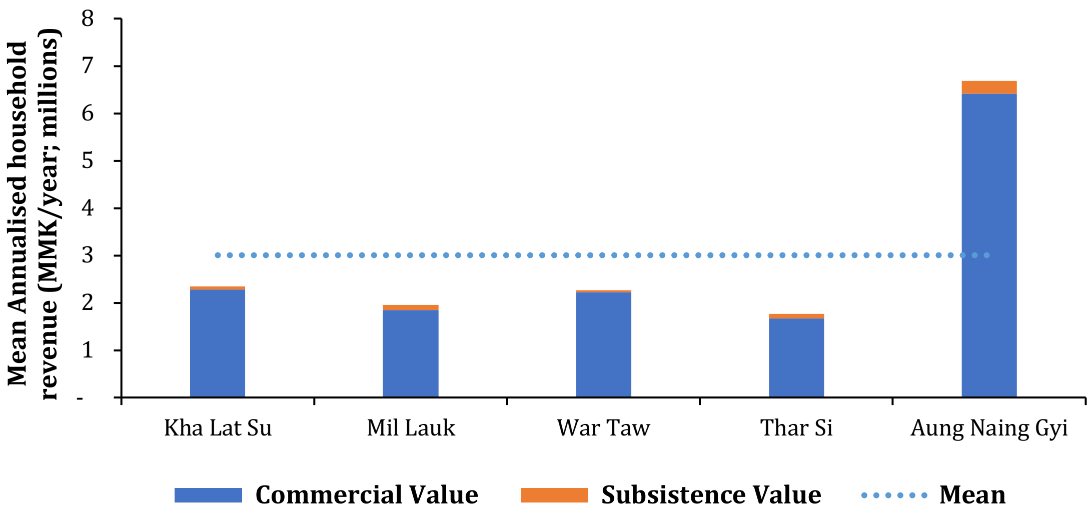


Figure 3.12. Mean annualised household revenues from total use of provisioning services from rivers/sea ecosystems in each village. The blue dotted line represents the mean revenue for the whole sampled villages in the study (3,003,436 MMK (~ 1,430 USD)).

In term of annual revenue from rivers/sea, Aung Naing Gyi leads with the highest revenue at 6,416,983 MMK (~ 3,182 USD), while Thar Si records the lowest at 1,761,941 MMK (~ 834 USD). The economic values of resources from rivers/sea generates the highest annual household income among the four ecosystems, amounting to 3,003,436 MMK (~ 1,430 USD). Among them, the mean revenue from direct selling is 2,887,683 MMK (~ 1,375 USD) and products amounted to only 115,744 MMK (~ 55 USD) are used in the households. From extrapolation of these values, the values across all the households in sampled villages in Bago, the mean annual values from rivers/sea per village is estimated to be 153,100,704 MMK (~ 72,907 USD).

3.3.6 Summary of provisioning service values

The provided data in Table 3.2 reveals significant variation in provisioning values from natural resources across the surveyed villages and their respective ecosystems. The rivers/sea provide highest revenues for communities in Bago. Notably, Aung Naing Gyi generate substantial revenues, particularly in the rivers/sea ecosystem, contributing 411 million MMK (~ 191,821

USD). Mi Lauk and War Taw also displays noteworthy values across multiple ecosystems, with 117 million MMK (~ 56,178 USD) and 122 million MMK (~ 58,242 USD) were extracted respectively from the rivers/sea.

Additionally, the mudflats ecosystem proves economically important ecosystems, with average value of 24 million MMK (~ 11,583 USD). Waw Taw has reported to have a considerable 46 million MMK (~ 21,926 USD), while Mi Lauk notably contributes 40 million MMK (~ 18,961 USD).

However, the due to lack of presence of mangroves in all the villages except Aung Naing Gyi, the provisioning services in Bago region from mangroves are the lowest among all other ecosystems.

Table 3.2. Summary of provisioning service values extrapolated for the whole population of sampled villages in Bago Region (MMK/year; millions).

Village	Mangrove	Mudflats	Grassland	Rivers/Sea	Total
Kha Lat Su	0.00	8.14	8.16	92.85	109.15
Mi Lauk	0.00	39.82	7.17	117.97	164.96
War Taw	0.00	46.05	22.34	122.31	190.93
Thar Si	0.00	11.06	0.50	29.57	41.14
Aung Naing Gyi	0.46	16.56	0.10	402.82	419.94

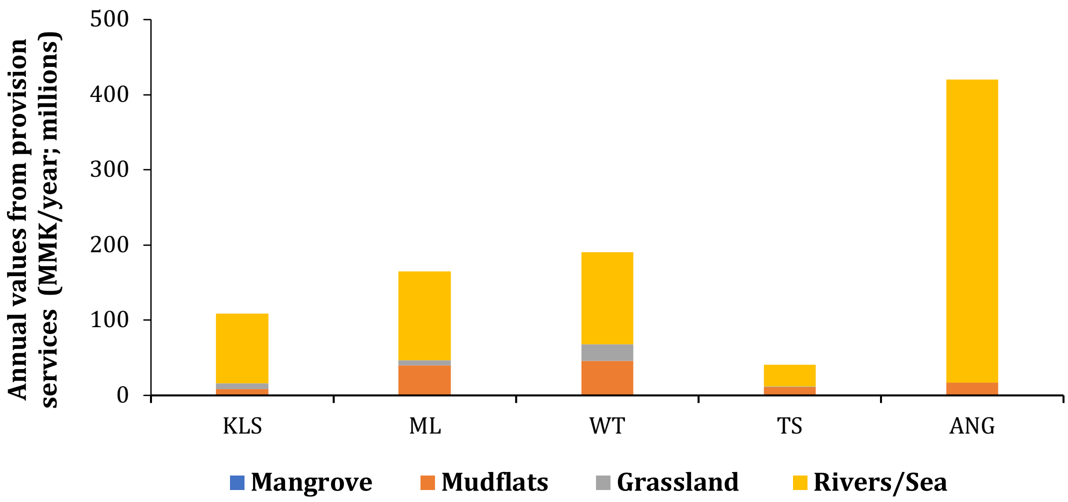


Figure 3.13. Annual value of provisioning services per village in Bago (MMK/year; millions).

3.4 Economic Values for Regulating Services

The value of flood damage mitigation by mangroves is estimated as the avoided damage costs attributable to the presence of mangroves surrounding each study site. For each village, Table 3.3 reports the area of mangrove within a 5 km radius and the current total annual damage from natural hazards (extrapolated from the household survey). The counterfactual level of damage that would occur in the absence of mangroves is computed using an empirical function derived from Koch et al. (2009). The difference between the current and counterfactual levels of damage gives an estimate of the annual avoided damage costs attributable to mangroves. The results show that villages with zero or very small mangrove extent naturally receive no benefits from this service, whereas the benefits can be substantial for villages with extensive mangroves.

The value of this service can also be expressed per hectare of mangrove extent to enable more direct comparison across sites and with estimates as recorded in the Ecosystem Service Valuation Database (ESVD.net). As only Aung Naing Gyi has mangroves, the value for regulation service is 21.37 MMK millions/ha/year (~10,177 USD/ha/year).

3.5 Total Economic Value of Coastal Ecosystems in Bago Region

In this section we provide an overview of the value of ecosystem services provided coastal ecosystems in the Gulf of Mottama by aggregating the values estimated in this report. It is important to recognise that this is a partial estimate of the total economic value of ecosystem services since it includes only the values of provisioning services from coastal ecosystems and coastal protection by mangroves. Other potentially important ecosystem services, such as cultural services (e.g., recreation and tourism) and other regulating services (e.g., climate regulation), are not included.

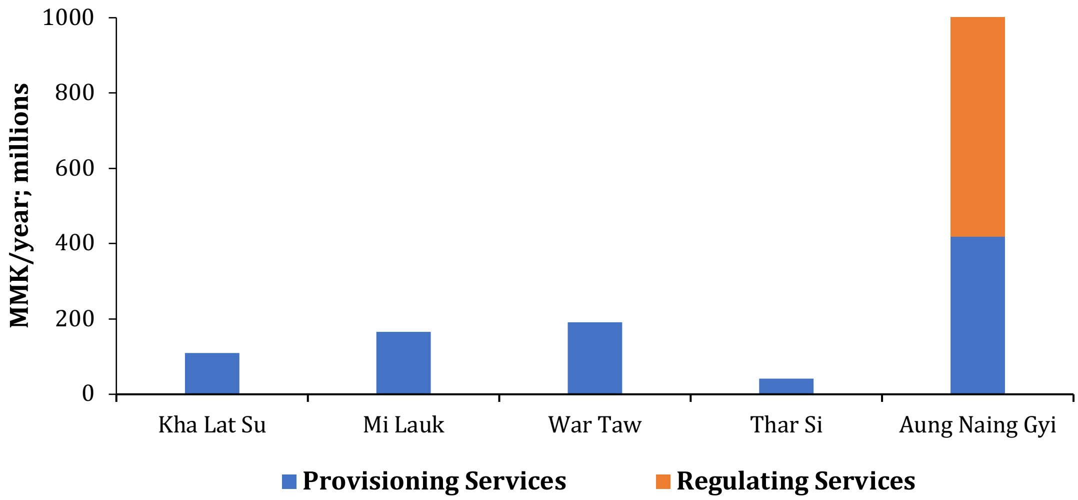


Figure 3.14. Annual values for provisioning and regulating services across study villages in Mon and Bago.

3.6 Comparison of Economic Values of Ecosystems and Converted Farmland

To inform decisions regarding ecosystem conservation and land use planning, the study attempted to make an explorative comparison between the economic values derived from farmland, mangroves, mudflats, and grasslands. However, there were no converted farmland in Bago region and therefore, the comparison is unable to calculated for Bago.

3.7 Feelings and Perceptions on the Conversion of Coastal Ecosystems

To understand the community perceptions on the trends in changes of natural resources, the impacts to the communities if negative changes occurred and their willingness for conversion of coastal ecosystems to other development activities especially farmland are discussed in the following sessions.

3.7.1 Changes in Ecosystems

Most respondents (87%) noted ecosystem changes in the past decade. As Aung Naing Gyi only has mangroves, the change in mangroves is not recorded in other villages. In Aung Naing Gyi, 18 people reported that the mangroves are expanding. Despite the expansion, 9 reports also stated that the expansion is reduced due to erosion from strong waves. In addition, people stated that the mudflats are getting wider, more stabilize and the elevation is higher than before. However, some of the lands were still being eroded and forming new land through alluvial formation and sedimentation. Subsequently, people reported that, on these stabilized mudflats, grassland are growing. Also, the vegetations in grassland are changing due to lower influence of saltwater as the land get higher and more stabilize. So, people indicated that, in coming years, this land will be arable for rice.

Furthermore, there were also changes in rivers and sea. The respondents reported that sea and tidal channel of Sittaung River is moving seaward and getting further from the village. It also crates narrower and shallower tidal channels and creeks as resulted from alluvial formation and sedimentation from erosion. The resources are reported scarce due to increased illegal fishing activities. However, there were less impacts from flooding and erosion to the communities.

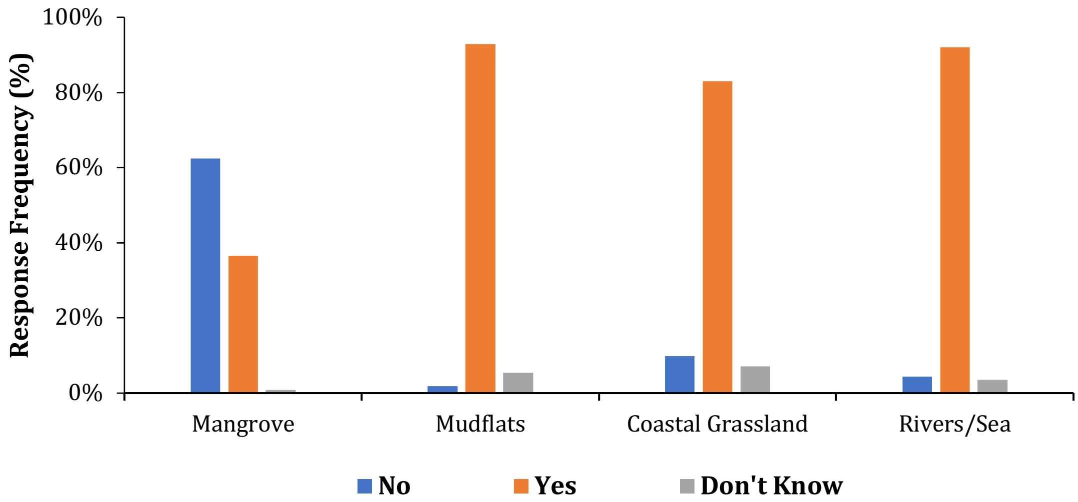


Figure 3.15. Frequency of responses per ecosystem from Bago to the question “Have the ecosystems changed in the past 10 years in your area?”.

3.7.2 Perceptions on the Degradation of Ecosystems

About 67% of respondents, with 21% strongly agreeing and 46% agreeing, expressed concern that degradation in each ecosystem would negatively impact household livelihoods, incomes, and well-being. People reported the highest impacts will be from degradation of mudflats (78%) and river/sea (59%) as these are major ecosystems for their livelihoods.

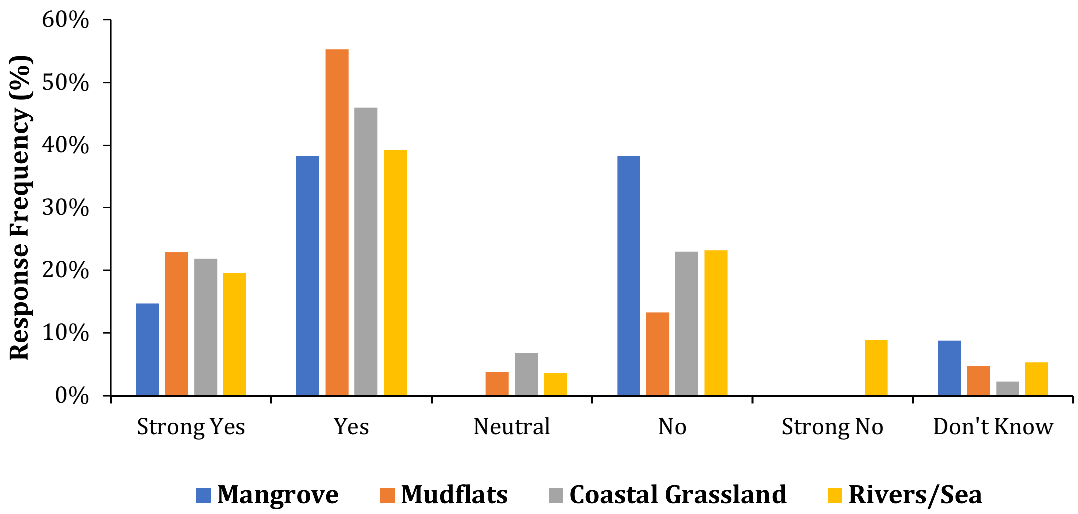


Figure 3.16. Frequency of responses per ecosystem from Bago to the question “For your household, do you think a degradation in the following ecosystems in the area is a problem?”.

The degradation of mudflat and grassland ecosystems, with 69% (67 responses) and 58% (77 responses) respectively, would result in limited access to extract resources and challenge the survival and well-being of the household. It will force them to seek refuge in other places for the collection of resources which may take more time and effort to travel and cost more. The degradation of rivers and canals might decrease in fish catch and result in lower income for people who depend mainly on fishing activities according to the reports from 61% of the respondents (55 responses). Eventually, the respondents argued that fishing grounds will disappear from fish extinction due to degraded river systems. It will lead fishers to travel further to extract resources. Moreover, about 21% (18 responses) of the respondents reported that there will be higher risk for saltwater intrusion to the farmland if the rivers are degraded.

Approximately 53% in Bago believed that degradation of mangroves will have negative consequences as the mangroves are nursery habitats for resources they are extracting (fish, crab, and prawn). So, the respondents worry that they will no longer access provisioning services for their incomes if mangroves are degraded and no longer support aquatic animals.

In general, the Figure 3.21 highlighted that the majority of the communities accepted the degradation in coastal ecosystems will lose opportunities for households who depend on them to extract resources and degrade their well-being. Furthermore, people described that the presence of coastal ecosystems is vital to protect communities from natural disasters. Therefore, the respondents noted a loss of these ecosystems would lead to more floods, stronger wind, waves, tides, saltwater intrusion, and erosion. Consequently, farmers will lose farmland or reduce yield due to saltwater intrusion and erosion from lack of protection mudflats, grassland, and river and sea. As a result of being directly prone to disasters, communities may displace and/or change livelihoods to adapt to the degradation of ecosystems. Some expressed loss in cultural services is declination of important species such as shorebirds and wildlife from destruction of natural ecosystems.

Around 25% of respondents believed their households would not be affected by degradation, often due to non-dependence on these ecosystems or alternative mitigation opportunities. This is partly rooted in the belief that ecosystems can regenerate naturally or have extensive coverage, mitigating the impact of localized degradation.

3.7.3 Feelings on the Conversion of Ecosystems into Farmlands

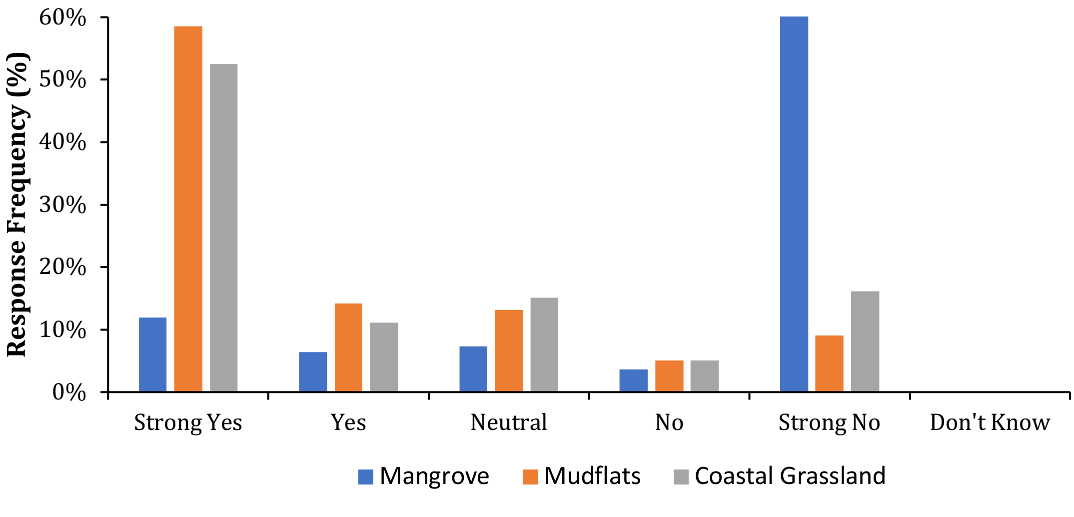


Figure 3.17. Frequency of responses from Bago on feelings about converting to farmland or development per ecosystem.

A significant proportion of respondents (74%) from Bago villages do not support the conversion of mangroves into farmland. In contrast, Bago Region reveals a divergent sentiment, with a majority strongly agreeing or agreeing to the conversion of mudflats (73%) and grassland (64%). The communities identified themselves as farmers and they are opportunistically become fishers because their farmlands were eroded. Therefore, if the new land were formed, they are preferred to proclaim their farmlands and do the agriculture.

Conversely, those opposing conversion in Bago express concerns about heightened vulnerability to natural disasters and adverse impacts on their resource extraction-based livelihoods.

4 DISCUSSION AND CONCLUSION

The research presented in this report provides information on the economic values of ecosystem services provided by coastal ecosystems in Bago Region. In this section we summarise the key insights, identify the main limitations of the study, and make recommendations for policy and further research.

4.1 Key Insights

- Coastal ecosystems in the Gulf of Mottama (GoM) comprised in Bago Region deliver services with substantial economic value to local communities. The average household in the five villages across were assessed in this study receives provisioning and regulating services worth approximately about 5.37 million MMK (~ 2,558 USD) annually.
- The results are highly village specific. The economic value of both provisioning and regulating services varies greatly across villages depending on the extent of coastal ecosystems in the vicinity of each village and the level of dependence on resource extraction. This variation in values across villages means that it is not straightforward to generalise the importance of ecosystem services or extrapolate results to other areas of the GoM.
- Similarly, the relative importance of different ecosystem types varies greatly across villages. In all cases, however, rivers and the sea are the most important source of harvestable resources (fish).
- Provisioning services contribute the largest share of the total economic value of coastal ecosystems. The revenue per household from provisioning services was 4.3 million MMK (~ 2,041 USD) per year, of which 21,054 MMK (~ 10 USD) was from mangroves (as fish and crustaceans), 952,776 MMK (~ 454 USD) from mudflats (mud crabs), 309,420 MMK (~ 147 USD) from grasslands (mud crabs and other crustaceans), and 3 million MMK (~ 1,430 USD) from rivers and sea (fish and shrimps).
- Harvested resources are primarily sold but a substantial proportion is also used for subsistence consumption.
- In villages with large areas of neighbouring mangrove cover, the value of protection from floods, storms and erosion is also of economic importance.
- In the past 10 years, a high proportion of households that coastal ecosystems have changed negatively (in extent, condition, and access). The communities in Bago regarded these changes as natural phenomena. One of the significant changes is the deposition of alluvial and sediments and forming new lands. Therefore, communities are interested in converting the newly formed mudflats and grass land into farmland or reclaiming their agricultural lands which were eroded.
- The comparison between the annual value of coastal ecosystems and agricultural land could not be done in Bago as there is farmlands converted from coastal ecosystems.

4.2 Limitations

The analysis and results described in this report are constrained by several limitations and uncertainties that are identified here to transparently frame the robustness of the results and identify avenues for future research.

- The valuation of provisioning services in this report provides a snapshot of the current harvest level but does not assess whether this level is sustainable (i.e., exceeds the capacity of the ecosystems to provide this service in the long term). An assessment of the sustainability of resource harvesting would require understanding and projection of harvests and ecosystem dynamics over time.
- Related to the previous point, the coastal ecosystems in the Gulf of Mottama are changing over time due to a combination of natural and human processes, which has consequences for the provision of ecosystem services. The perceptions of these changes by the local communities are captured through in the household survey. The valuation results presented in this report, however, provide a snapshot of the current level of provision. Further research could develop scenarios for the future extent, condition, and accessibility of coastal ecosystems, and how the economic value of ecosystem services changes accordingly.
- The study only estimates the value of a limited set of ecosystem services. Other regulating services and recreation could also be relevant to land use decisions.
- Only a small number of villages are included in the assessment. These show considerable variation in terms of the extent of coastal ecosystems and dependence on ecosystem services. This provides too narrow a basis to extrapolate the results to other villages in the Gulf of Mottama.

4.3 Key Recommendations

- The coastal ecosystems are proven to be providing the significant economic values to well-being of local communities as well as mangroves provide high value coastal protection service. Therefore, it is advisable to protect, restore and possibly extend the area of this ecosystem through safeguarding measures of the ecosystems with participation of local communities and establishment of sustainable resource management practices. The sustainable resource management should include sustainable fishing practices by regulating illegal fishing activities, and establishment of community managed conservation zones such as fishery conservation zones (FCZs), public protected forests (PPFs), and community forests (CFs).
- The information and results from the study should be advocated to the wider stakeholders including the communities. It is essential to raise these evidence-based awareness information to local communities and stakeholders about the importance of the ecosystems to their well-beings and the urgent need for conservation. In addition, the long-term benefits of ecosystems with being converted into farmland should be promoted.
- Given the observed variation in the value of coastal ecosystem services across locations, there is a need to target conservation efforts to areas that would deliver high ecosystem service values relative to the costs (i.e., deliver high net returns). Such a cost-benefit analysis (CBA) approach to ecosystem conservation would require, in addition to the valuation of benefits, measurement of the effectiveness of various conservation actions and their respective costs, including both implementation costs and the opportunity costs of restricted activities.
- Additional questions for future research projects include: What are the social impacts of conservation interventions, especially for communities that use coastal ecosystems for subsistence and/or cultural activities? How can local communities be engaged and involved to support ecosystem conservation?

- After collecting such comprehensive information, it should be applied as advocacy tool for policies and gain government supports in collaboration with local communities, NGOs, and stakeholders in development of comprehensive land-use plans that consider the value of coastal ecosystems alongside agricultural lands. It should be aimed for sustainable development that avoids conversion of coastal ecosystems into agricultural land and seeks ways to reclaim eroded agricultural lands without compromising coastal habitats.

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6 APPENDIX

6.1 Supplementary Data

Table 6.1. Mean price per kilogram (in MMK) of each resource extracted from ecosystems in each village in Bago Region. The prices are direct selling prices to the local collectors and/or wholesalers.

Resources	Kha Lat Su	Mi Lauk	War Taw	Thar Si	Aung Naing Gyi
Fish	2,799	4,638	4,516	-	3,265
Crab	2,755	6,736	-	-	6,429
Shrimps	5,266	5,281	5,613	-	-
Firewood*	-	-	-	-	1,000

*Unit = stack

Table 6.2. The extent of coastal ecosystems (Ha) within 5 km radius of the villages

Village	Mangrove	Mudflat	Grassland
Kha Lat Su	-	323	1424
Mi Lauk	-	1079	1188
War Taw	-	366	932
Thar Si	-	1670	1249
Aung Naing Gyi	80	257	1086
Mean Extent	**97.49**	**781.24**	**727.42**