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Assessment of Natural Assets in the Agricultural and Aquatic Ecosystems in Sogod Bay, Southern Leyte

Ma. Salome B. Bulayog, Humberto R. Montes, Jr., Suzette B. Lina, Teofanes A. Patindol, Adelfa C. Diola, Eliza D. Espinosa, Analyn M. Mazo, Julissah C. Evangelio, Art Russel R. Flandez, Marianne A. Gesultura, and Ris Menoel R. Modina

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ASSESSMENT OF NATURAL ASSETS IN THE AGRICULTURAL AND AQUATIC ECOSYSTEMS IN SOGOD BAY, SOUTHERN LEYTE

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EXECUTIVE SUMMARY

This study looked at the existing natural resources in Sogod Bay, Southern Leyte, Philippines, and determined how the quality of these natural assets has been affected by production and other economic activities in the area. The study's soil physical analysis revealed that some nutrients in the study sites are deficient, particularly phosphorus since it is the most sensitive element highly affected by the topography of the area. Soil nutrient availability tended to decrease from high elevation to low elevation because of runoff, which erodes the nutrient from the soil. Accordingly, proper maintenance and improvement in the management of the soil resources for sustainable agricultural use could be a useful strategy to protect agricultural land biodiversity from agricultural land expansion. The results of the soil fertility assessment could also be useful in formulating soil test-based fertilizer recommendations that would enable researchers and stakeholders to monitor properly the soil health status in the area. This study further recommends strengthening the technical support of the local government, through the municipal agriculturist office, to farmers in ameliorating soil nutrient quality and in practicing methods that would improve soil condition.

A diverse species of mangrove were found at the study sites (19 species). Macroinvertebrates also abounded Sogod Bay. The sites with marine protected areas (MPA) had good coral covers and had high life-form diversity indices, while most of the non-MPA sites had poor coral covers and species diversity. However, there were also non-MPA sites that exhibited good coral covers and rich species diversity.

The results of the study also showed that the natural resources in Sogod Bay are no longer as productive as they have been before, as manifested by the declining farm productivity and fish catch. This may be due to the decrease in the quality of these resources as manifested by the nutrient deficiency in the soil and declining fish population. Based on the survey results, most households are less dependent on fishery as an income source, and the same picture was observed for farming as a livelihood source. Most households have alternative nonfarm income sources, which are the largest contributors to household income.

The results of the valuation indicate that the provisioning services of the natural assets in Sogod Bay are important. The local communities and government should therefore initiate more activities to improve the quality of the ecosystem services provided by the natural resources in the bay. The results also indicate that the value of provisioning function is higher in sites with MPA and in farms with adequate nutrients and proper cultivation. Hence, marine sanctuaries should be established in those sites where diverse species abound.

1.0 INTRODUCTION

1.1 Background and Rationale

Boyce and Pastor (2001, p. 3) cited that natural assets include the "…land on which we live and grow our food and fiber; the water we drink and use to irrigate crops, generate electricity, and dispose of wastes; the air we breathe, into which we also emit wastes; the fish in the ocean and the trees in the forest; other animals and plants, both wild and domesticated; the atmosphere that envelops our planet; the ores, minerals, and fossil fuels beneath the earth's surface; and the solar energy that powers the biosphere."

Despite their importance, however, there has been an overwhelming body of evidence that points to the detrimental impacts of human activity on the environment. In many countries around the world, economic growth is attained at the expense of natural capital, and it is the low-income communities that face the brunt of confronting the challenges of economic development and environmental sustainability (Boyce and Pastor 2001). In rural areas, farming and other production activities have caused the depletion of natural resources. This consequently diminishes the capacity of these assets to provide livelihoods to people. Approximately 60% of the ecosystem services that support life on earth—such as fresh water, capture fisheries, air, water regulation, and the regulation of regional climate—are being degraded or used unsustainably (MEA 2005). It is therefore predicted that the harmful consequences of this degradation could grow significantly worse in the next 50 years.

Ecosystem, a basic unit of nature, is a special form of wealth that can be considered as a stock of capital that provides services (Barbier 2011, 2012). It involves the dynamic and complex interactions between the living (i.e., plant, animal, and microorganism communities) and the nonliving environment, and operates as a functional unit (MEA 2005).

The Convention on Biological Diversity (2013) defined natural capital as the living and nonliving resources of society, which can be renewable (e.g., living species), nonrenewable (e.g., petroleum), and cultivated (e.g., crops and forest plantation). Natural capital constitutes the stocks from which environmental goods and services flow into economic production. Natural capital contributes to human well-being by supporting the flow of valuable ecosystem services to the local and nonlocal populations. Meanwhile, ecosystem services are the benefits that people derive from functioning ecosystems, which include ecological characteristics, functions, or processes that indirectly or directly contribute to human well-being (Constanza et al. 2011; MEA 2005; UK National Ecosystem Assessment 2011). These functions can be classified as provisioning services, regulating services, habitat services, and cultural and spiritual amenities services.

From an economic perspective, ecosystem services are those contributions of the environment to society, such as the goods that people generate from these ecosystems to improve human well-being (Harrington et al. 2010; Bateman et al. 2011). These goods include physical products and less tangible goods such as food production, nutrient cycling, carbon sequestration, and recreational experiences (Carpenter et al. 2006). Ecosystem services also include items that produce use-value and nonuse-value goods that are valued based on their existence.

Bateman et al. (2013) designed approaches that integrated ecosystem services into the economic decision-making process of land-use management in the United Kingdom by using economic models to analyze the consequences of land use. They found out that decisions based on all ecosystem services had robust economic values and were clearly better than those based on the pursuit of market-price goods only. Moreover, land-use decisions based on market prices alone tend to reduce the overall value of the sum of the agricultural and monetizable ecosystem services at the national scale.

The Philippines is one of the most important biodiversity hotspots in the world; however, it is also one of the most biologically threatened countries in Southeast Asia due to its high rate of loss of natural forest and species richness (Myers et al. 2000). Guiang and Castillo (2006) reported that more than 50% of the country's forest cover has been lost. Likewise, Heaney et al. (1998) and Myers et al. (2000) approximated that only 3% of the primary rainforest cover remains in the Philippines from the 95% forest cover reported in 1916. During the 1980s and the 1990s, average deforestation rate was estimated at 200,000 hectares (ha) per year (Pasicolan 2007). Deforestation is the main cause of forest loss; its detrimental effects have disrupted the ecological functions in the uplands, thereby causing soil erosion, water scarcity, flash floods, and landslides. Accordingly, upland farmers significantly suffer from the income loss caused by environmental degradation. The indications of environmental degradation due to decrease in forest cover and unsustainable farming include nutrient loss, soil degradation, soil erosion and desiccation, proliferation of farm pest and diseases, unstable and insufficient food production and income generation, and inefficient use of land for production. This, in turn, will result in food scarcity, biodiversity loss, and climate change (Weidner et al. 2011).

This study focused on Sogod Bay, which is a large bay in the southern part of Leyte, Philippines. Southern Leyte is the second smallest province in the Visayas region in terms of area and population. The flatlands of the province are found along the coastal area; but toward the interior parts, the terrain becomes rugged and mountainous. The entire province is almost covered by the Philippine Fault System, with the major fault lines running along the municipalities of Sogod, Libagon, St. Bernard, San Juan, and Panaon Island. The natural and geological features of the province make it vulnerable to landslides and flooding. Despite its location, the province is endowed with natural resources, including two rivers that provide water supply to households and for agricultural and other industrial uses. The Hinabian River in Silago and the Lawigan Forest reserve in St. Bernard serve as the watershed of the province.

At present, the local residents use Sogod Bay as a fishing ground and as a source of livelihood. Farming is also an important economic activity in the area, being a source of income to most of the local communities. Sogod Bay is also a popular tourist destination, being a favorite diving site of tourists. In recent years, however, Sogod Bay has been facing challenges in the form of decreasing productivity in the traditional agricultural and fishery resources in the area, which stems from both natural and anthropogenic influences. The quality of the natural resources in the bay (i.e., marine and terrestrial resources) has deteriorated, especially those along the coast, because of natural calamities. Most of the coastal communities have experienced coastal erosion due to storm surges and sea level rise caused by climate change. Riverbanks have also been damaged due to flooding and quarrying activities in some communities. Drought can also be felt in certain periods of the year, which has consequently affected the availability of irrigation water for the dry months. Consequently, farm productivity has been affected, particularly that of rice production. Rice farms in some areas have also been damaged by the major landside in 2006, which practically wiped out one rice-producing *barangay* (village).

Approximately 10% of the total populace in the area are engaged in fishing. Armenia et al. (2012) revealed that households in the municipalities of Sogod, Bontoc, Tomas Oppus, and Silago (especially in the uplands) have fragmented farms, with coconut as the common agricultural crop grown. Abaca used to be an important agricultural crop; but very few farms are now growing abaca due to the bunchy-top virus infestation that devastated the province, which practically wiped out the abaca farms in the area. As a result, farmers have shifted to other crops such as fruit trees and root crops.

Ecosystems, through its services, contribute to the well-beings of humans. However, human beings' pursuit of economic development is usually accompanied by the deterioration of these ecosystems. The natural capital in Sogod Bay is not exempted to this scenario, and this has significant socioeconomic implications on the area since Sogod Bay's economic and social wealth is deeply woven into its natural resource base. Maintaining this base requires that the bay's natural assets remain healthy, and that the ecosystem services that these assets provide are viable. Over the years, Sogod Bay's marine and terrestrial ecosystems have been sources of food and income of the local communities, and they have been exploited due to the increasing demand for food and housing by the increasing population. Products derived from them have also diminished, and local communities have become less dependent on these natural assets as a source of livelihood.

The present study assessed the status of the natural resources in Sogod Bay and determined how the quality of and the ecosystem services provided by these natural assets (i.e., land or the marine resources) have been affected by the agricultural production and other economic activities in the area. The use of natural assets to reduce poverty should not be an automatic recipe for environmental degradation. If the quality of the natural assets is maintained through the communities' efficient use of these resources, then the communities will benefit from them in the form of better returns. Accordingly, the results of this study's assessment will help policy and decision makers in Sogod Bay to identify and formulate specific strategies that would help restore or maintain the viability of these natural assets. Likewise, the results of this project can help communities and scientists to learn together on how to relay research results to policy makers and concerned agencies in an effort to promote sustainable use of the natural assets to alleviate poverty in the region.

This study also determined the provisioning values of the services provided by Sogod Bay's marine and terrestrial ecosystems. Since ecosystem services are not traded in the markets, human beings think of them as free and limitless and always available for exploitation. Accordingly, their values are not considered in the development of policies related to environment and natural resources; economic valuation of natural resources increases their economic visibility (Barbier 2011). The results of this study's valuation of the provisioning services of Sogod Bay's natural assets will enable policy makers to compare the strategies that are usually valued in financial terms. The planning and implementation of policies that aim to prevent degradation of natural assets will be facilitated if their values are estimated and incorporated in the decision-making process. This study's valuation results can therefore serve as a benchmark for analyzing the impacts of future interventions to improve natural resources quality and for estimating the payment of environmental services provided by the natural assets in Sogod Bay.

1.2 Objectives of the Study

This research project aimed to achieve the following objectives:

1. To identify and assess the available natural assets in Sogod Bay and their corresponding ecosystem services;
2. To identify the range of goods and services that the local communities value and produce from the aquatic and agricultural systems in Sogod Bay;
3. To ascertain how dependent these goods are on the various ecosystems services provided by the natural assets in the area;
4. To estimate the provisioning values of the ecosystem services provided by the natural assets and;
5. To recommend policies that would enhance the capacity of these natural assets in providing livelihood opportunities to the local communities surrounding Sogod Bay.

1.3 Scope of the Study

The study covered 5 of the 11 municipalities surrounding Sogod Bay, namely, Liloan, Libagon, Sogod, Tomas Oppus, and Padre Burgos (Figure 1). Liloan was identified as a research site because it is located at the mouth of Sogod Bay and is facing the municipality of Padre Burgos. Libagon is adjacent to Liloan and Sogod, which is the center municipality of Sogod Bay. On the south, Tomas Oppus was also selected as a study site because it is in between Sogod and Padre Burgos. These sites were distributed this way to capture the agricultural and aquatic ecosystems in Sogod Bay. From each of the identified municipality, two barangays were selected as specific sites of this project as follows:

1. Liloan – Brgy. (Barangay) Gud-an and Brgy. Himay-angan
2. Libagon – Brgy. Pangi and Brgy. Biasong
3. Sogod – Brgy. Mac and Brgy. Tampoong
4. Tomas Oppus – Brgy. San Isidro and Brgy. Higusuan
5. Padre Burgos – Brgy. San Juan and Brgy. Buenavista

The authors inventoried and assessed the status of the natural assets in Sogod Bay, namely, (1) marine and aquatic resources, (2) agricultural land by evaluating the soil characteristics and crops grown, and (3) the forest flora and fauna present at the project sites. The research team used the following data gathering methods: focus group discussions (FGD); actual resource assessments; household surveys; and personal interviews with fisherfolk and farmers, LGU officials, and other stakeholders.

The environmental services valuated in this study included the provisioning function only of the ecosystems existing in the water, land, forests, and marine resources in Sogod Bay.

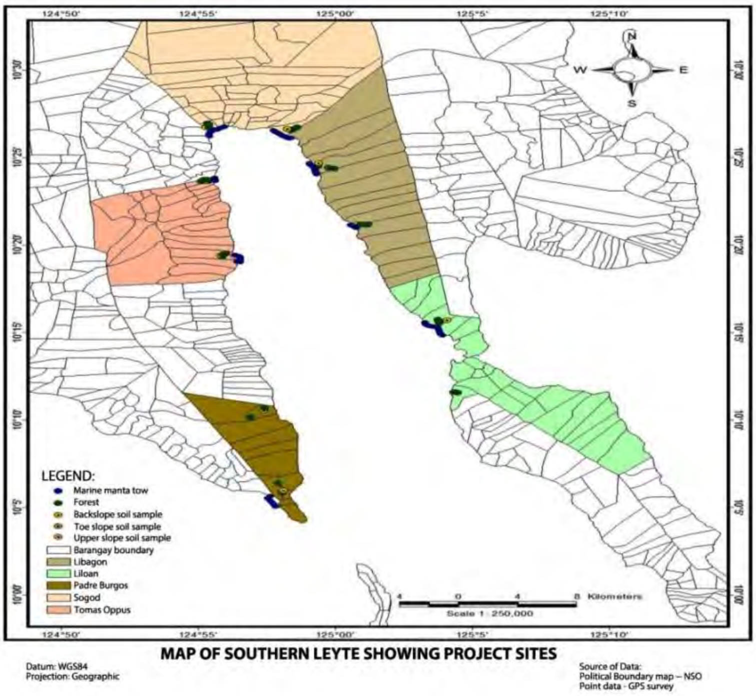


Figure 1. Map location of the project site

1.4 Natural Resources Initiatives in Southern Leyte

The province of Southern Leyte (particularly Sogod Bay) has been a research interest of a number of government and nongovernmental organizations (NGO). Numerous international organizations have conducted natural resource-related research projects and programs in the area that address management, utilization, conservation, and rehabilitation of these resources. These initiatives include resource and biodiversity assessment, providing assistance to LGUs in managing the resources, conservation education for the fisherfolk, and capacity building of provincial government employees.

For one, the Coral Cay Conservation and the Philippine Reef and Rainforest Conservation Foundation Incorporated, together with the Provincial Government of Southern Leyte, implemented the Coral Reef Conservation project from September 2002 to July 2010. The main objective of the project was to assist Southern Leyte in conserving and preserving the coral reefs in Sogod Bay in order to assure the long-term benefits and food security of the province. The project successfully established community-based marine protected areas (MPA) and trained local government officials, scholars, and qualified community representatives to dive and conduct scientific surveys. The project also established free data source for resource managers of Southern Leyte through geographic information system using global positioning system.

The results of the project's assessment indicated that hard corals were higher toward the mouth of the bay due to the sediments received at the bay's head on the northern part. Hard coral covers were also diverse in some parts, some of which were rare. A total of 257 species of hard coral were identified. Commercially important fish species and some invertebrates were no longer abundant, which indicates severe overfishing at the coral reefs of the bay. Overfishing, the use of destructive techniques, nutrient enrichment of the coastal areas, sedimentation, and other anthropogenic impacts have threatened the health and diversity of the coral reef ecosystem in Sogod Bay. Sand was identified as the major benthic substrate of Sogod Bay.

Fauna and Flora International (2012) conducted a biodiversity assessment in selected municipalities of Southern Leyte, namely, Silago, Hinunangan, Libagon, Sogod, Tomas Oppus, and Malitbog. The project aimed to improve forest policies and develop incentives for forest protection and rehabilitation, reduction of greenhouse gases, conservation of biodiversity, and building the capacities of stakeholders toward these initiatives. It focused mainly on policy reforms and REDD-Plus (Reducing Emissions from Deforestation and

Forest Degradation-Plus) activities in and around selected protected areas. Accordingly, in its final report, the project proponents reported that they were able to:

1. Identify and compare habitat types based on natural and land-use stratification,
2. Determine anthropogenic factors influencing overstorey and understorey vegetation,
3. Identified the patterns of fauna-habitat associations,
4. List species baseline for future protected-area management plans and monitoring programs,
5. Provide a guide for the design and implementation of management interventions for specific species' survival within and across their range in Southern Leyte, and
6. Develop a model of species responses and/or communities to various land-cover uses.

The project recorded a total of 229 flora species in 65 families, with 31 Philippine endemics, 10 IUCN (International Union for Conservation of Nature) critically endangered species (mostly Dipterocarp species), and 20 IUCN-vulnerable species. The project implementers also inventoried the terrestrial vertebrates present in the area, which totaled 112 species of birds, 36 species of mammals, and 64 species of herpetofauna. The results of the survey also indicated that species accumulation curves were asymptotic and that distribution of species and diversity was the combined result of anthropogenic and natural factors. Based on the results, the general pattern of the species accumulation curves of the vertebrates approached toward the asymptote. It also showed that the combination of anthropogenic and natural factors played a major role on species distribution and diversity. Highly disturbed areas were low in biodiversity.

The major accomplishment of this project was that it facilitated the declaration of Mt. Nacolod as a protected area on 7 May, 2012. This was based on the findings of the project team that two new frog species under the genus *Playmantis* existed in the area. The Flora and Fauna International also found out that the forests of Mt. Nacolod was pristine, and that an impressive flora and fauna could still be found in the area.

The Coral Cay Foundation and the Philippine Reef and Forest Foundation likewise conducted a resource assessment of Sogod Bay from 2002 to 2003 (Taylor et al. 2004). In particular, the project implementers surveyed the coral reefs in the bay and provided both training and conservation-education initiatives to the organizations' project counterparts and to the local communities. The results of the rapid reef assessments suggested that the east coast of the bay had richer coral reef environment, which maybe because the location is less prone to anthropogenic impacts. The reef-check surveys of the two fish sanctuaries and one unprotected reef site revealed that the unprotected site had the most abundant and highest diversity of fish species.

Meanwhile, Dimalanta et al. (2006) studied the geology of Southern Leyte in order to decipher the geological history of Central Philippines. Their investigation revealed that the litogic units, which are mapped in Southern Leyte, offered various clues to help understand the evolution of the province (in particular) and Central Philippines (in general). The geology of the province revealed the progressive shallowing of the environment of deposition of different formations—from the Tigbauan Formation deposited in a neritic to bathval environment to shallow marine, fluviatile, and terrestrial settings.

Meanwhile, Armenia et al. (2013) assessed the environmental awareness, behavior, and participation of households in environment-related activities at the REDD-Plus sites in Southern Leyte. The authors found out that households within and in the adjacent barangays of the project sites, including those in the other areas of Southern Leyte, were highly aware of the environmental conditions existing in the province. There were no observed differences between the sample households' environmental awareness and behavior, indicating that a person is aware of the environmental impact of an activity but is not behaving accordingly. The study also found out that the location of the households at the REDD-Plus project sites, membership in organization, experience in environmental risk, access to natural resources, household size, and total on-farm income were the factors that characterized the sample's participation in environmental activities. Nonfarm-related factors positively affected household income, with only a few farm-related factors influencing household income.

The research project implemented by the Philippine Department of Environment and Natural Resources (DENR), with funding from the Deutsche Gesellschaftfür Internationale Zusammenarbeit (GIZ) and the Federal Ministry for the Environment and Nature Conservation of Germany, focused on pilot testing forest carbon and on forest resource assessment in Southern Leyte. Specifically, the project assessed the above-ground tree biomass and the biodiversity in the province, with particular focus on the occurrence of vascular plants and the frequency of tree species. Based on the results of the research project, the average above-ground biomass in Leyte reached 255 tons per hectare, which is equivalent to 1,227.4 tons of carbon per hectare. Forest tree carbon accounted for 96.7% of all forest carbon; deadwood carbon accounted for 1.7%; litter, 1.3%; and mangroves, 0.3%. Plant biodiversity in the open forest was slightly lower than that in closed forest, with an average of 26.9 and 32.6 species, respectively. Dipterocarps species still dominated, accumulating around 43% of the overall volume. The findings reflected a severe degradation of the original biodiversity and ecosystem.

Armenia et al. (2012) conducted a socioeconomic baseline study for the REDD-Plus project sites in Southern Leyte. Their study covered the municipalities of Sogod and Tomas Oppus—also two of the sites of the present study. Their results showed that upland farm households had various sources of income, which were classified as farm, off-farm, and nonfarm. The average income of households from all sources was PHP 118,761 per year, which fell below the average annual income for Southern Leyte (PHP 141,641 per year). The low-average income of all households was attributed to their location since most of the upland barangays had limited access to nonfarm opportunities. The findings also indicated that the upland households were participating in environmental activities such as tree-planting and environmental clean-up activities. Access to natural resources was also difficult, especially to those naturally occurring plants and wildlife resources. Logging was rarely practiced by the local residents; but for those who did, they harvested exotic plant species such as mahogany and yemane. The study further revealed that the rate of deforestation decreased in the area since there were no longer harvestable trees within the immediate vicinity of the barangays. The only remaining stock of timber tree species that could be harvested was located in the forest remnants, which were situated far from the barangays, thereby making logging technically difficult.

2.0 RESEARCH METHODS

2.1 Conceptual Framework

Ecosystems are capital assets that provide a wide range of services, and these services are the link between ecosystems and human welfare. They include provisioning services that provide direct inputs to livelihoods and the economy; regulating services such as flood and disease control mechanisms; cultural services that provide opportunities for recreation and spirituality and for promoting history; and supporting services that sustain and fulfill human life (MEA 2005). Ecosystem services are usually taken for granted because they are accessed freely. Accordingly, they are not incorporated in the estimation of the benefits and costs of a development project, particularly when monetary-based decision tools are used such as the benefit-cost analysis. Understanding and estimating the values of the public and private goods provided by ecosystems is crucial to ascertain what is lost whenever a development project is chosen at the expense of a natural resource.

There are three aspects of looking at the economic value of ecosystems as follows (MEA 2005):

1. Ecosystems as assets (i.e., natural capital) that if conserved and managed sustainably would yield benefits
2. Ecosystems as the flow of economically valuable goods and services; they are the returns on investments in conservation
3. Ecosystems as positive economic and human well-being outcomes, the indicators of which are used to judge the progress in economic growth and human development

This study adopted the model used by The Economics of Ecosystems and Biodiversity (TEEB), in which the relationship between ecosystem services, economic values, and human well-beings are put together in one framework. As shown in Figure 1, the four categories of ecosystem services and the total economic value (i.e., direct use, indirect use, and non-use value) are incorporated into a single framework. However, only the provisioning values of the ecosystem services derived from the agricultural lands, marine, and forest watersheds were estimated in this study due to data and time constraints. Provisioning services are the easiest to estimate and the most frequently valued ecosystem service. Only water for household use was estimated; the authors did not include other uses such as water for agriculture and industrial purposes. Likewise, other ecosystem functions like supporting services, regulatory, and cultural functions were not included since the estimation procedures and data requirements are complicated and cannot be done within the timeframe of the study.

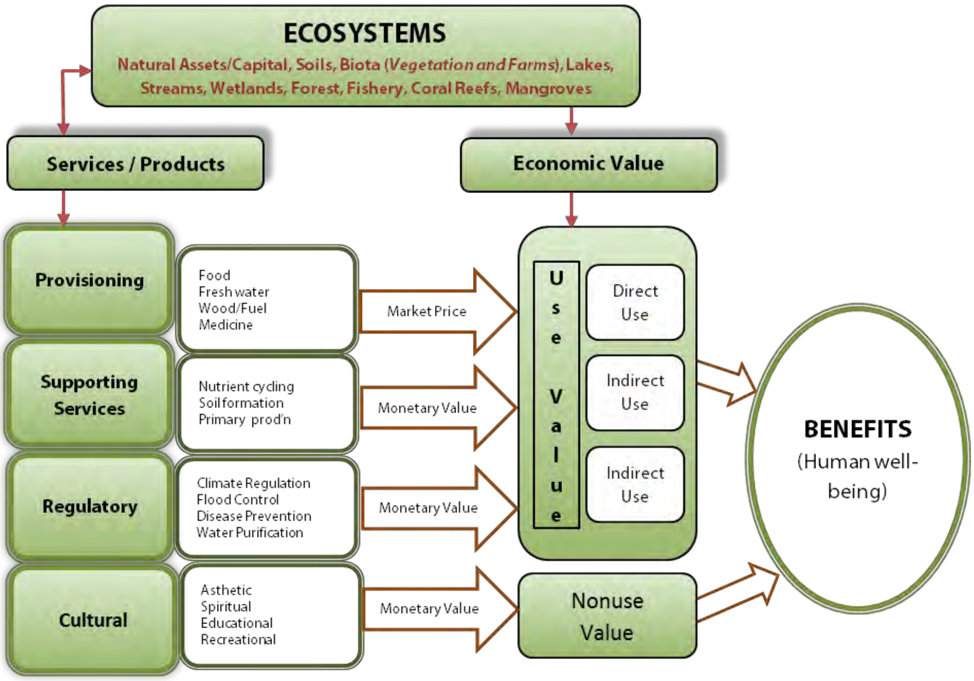


Figure 2. Framework for valuing ecosystem services

Provisioning services is a direct use, and it is valued using the market price. In this study, water for household consumption was valued by using the amount (per month) paid by households for the water supply, whereas products harvested from agricultural lands were valued using the market price. Regulating and support services are the indirect uses of ecosystems, and thus require using valuation methods that convert services into monetary terms. The last component of economic value is the nonuse value, which includes educational, recreational, cultural, and spiritual values. Valuation methods that can be used are contingent valuation method and travel cost method.

2.2 Data Collection and Analysis

2.2.1 Primary data

The research team designed the household survey questionnaire based on the objectives of the study. The prepared questionnaire was pretested to eliminate any ambiguity in the items, and were accordingly revised based on the results of the pretest. In particular, the survey questionnaire inquired about (1) household demographic characteristics and farm attributes, (2) sources of livelihood, (3) natural resources available in the vicinity and their uses and status in the community, and (4) physical infrastructure and facilities existing in the area.

The study team (composed of specialists in resource economics, forestry, fishery, agriculture, and soils) inventoried the natural resources present at the research sites. Transect walk, quadrat methods, and other appropriate tools were used in the assessment.

2.2.2 Secondary data

Sources of secondary data included the local government unit (LGU) agricultural offices, water districts, barangay offices, and the Provincial Office of Southern Leyte. Data on agricultural production and marine resources were sourced from the agricultural offices, whereas data on water use among households were gathered from the LGUs' water districts. Meanwhile, data on the previous research studies conducted in Southern Leyte were sourced from the Provincial Office.

2.2.3 Sampling Procedure

Of the 11 municipalities surrounding Sogod Bay, five were purposively selected based on the municipalities' population, economic status, economic activities that are dependent on natural assets, and location. The households included in the sample were those whose livelihoods were dependent or partially dependent on natural assets in the chosen municipality.

The authors used the following formula to determine the sample size to be obtained using simple random sampling

$$n_0 = \frac{{Z_{\alpha/2}}^{2} * \sigma^2}{e^2} \qquad \text{Equation (1)}$$

where:

n_0	=	sample size to be determined,
$Z_{\alpha/2}$	=	confidence interval,
σ^2	=	population variance, and
E	=	margin of error.

The study employed a 99% confidence interval, which means that the sample is certain 99% of the time. The established z-value for a 99% confidence interval is 2.58. The household respondents were chosen using the following procedures:

1. The list of households heads were sourced from the Municipal Planning and Development Offices or from concerned barangay officials.
2. Random sampling procedure was conducted using the softwares Statistical Package for Social Science or MS Excel to ensure that every household was given equal chance to be selected.
3. Reserve sample households were drawn in every barangay as alternatives in cases when the primary selected households could not be contacted or if the households refused to cooperate in the study.

2.2.4 Data analysis

The data gathered from the household surveys were analyzed using descriptive statistics (e.g., frequency counts, range, percentages, and averages). To assess soil nutrients, the researchers collected soil samples at depth range of 10–20 centimeters from the surface, and accordingly analyzed the samples for their nutrient contents. For the forest flora and fauna, actual counts per sampling were done to determine species richness and biodiversity. The researchers did the same for the fishery resource. All of the assessments accounted for the ecosystem services provided by these assets and the rate by which these assets were accessed and utilized by humans in their economic activities.

To estimate the benefits of the natural resources in the research sites, the authors first used gross margin analysis to estimate the direct-use values of the goods and services obtained from using the natural resources. The results of the analysis were then used to estimate the provisioning function of the ecosystems such as agricultural lands, forests (water only), and coral reefs. The net present values (NPV) of the services provided were estimated using the BCA formula

$$\text{NPV} = \sum B_t \left(\frac{1}{1+r}\right)^{-t} - C_t \left(\frac{1}{1+r}\right)^{-t} \qquad \text{Equation (2)}$$

where:

NPV	=	net present values of the net benefits,
$B_t I$	=	benefit earned from the resource in period *t*,
C_t	=	variable costs in period *t*, and
R	=	discount factor.

3.0 RESULTS AND DISCUSSION

3.1 Natural Resource Assessments

3.1.1 Soil characteristics of agricultural land

The landscape of the study sites includes the areas from the ridges to the reefs. Soil morphology is an important method for determining the soil origin and fertility of an area, and it is best done through an in-situ examination of a soil profile (Buol et al. 1997). Coconut is the most dominant and common agricultural commodity in Sogod Bay. Accordingly, the researchers examined the soil profile of the coconut lands in all of the barangays under study. Soil profiles were located either at the lower backslope or footslope topographic position.

The typical landform of Sogod Bay is high-gradient mountain or high-gradient hill-to-plain. Except for Brgy. Gud-an in Liloan, which has a moderately steep landform with a small flatland located close to the shore, the other sites are characteristically mountainous with undulating landforms extending toward the lowlands planted with agronomic crops. Most of the agricultural activities are concentrated near the uplands, which has a shallow surface soil due to the continuous erosion conditioned by the topography. This is true in Brgy. Gud-an in Liloan, where big gullies can be observed in the hilly agricultural sections. This indicates that erosion frequently occurs in the area.

The shallow surface soil was evident in most of the profiles examined. In the soil profiles of Brgys. Biasong, Higusuan, and San Isidro, the researchers identified the sequence of the horizons as Ap-AB-Bt-Bw-BC, which indicate that soil formation is in the advance stage because of the accumulation of clays in the B-horizon. The presence of B-horizon indicates a highly weathered soil with low nutrient contents. On the other hand, the profiles in the other villages were poorly developed as indicated by the horizons Ap-Bw-BC-C. This means that the weathering process is still active because of the exposure of the unconsolidated parent materials in the C-horizon. Most of the nutrients released during the weathering process would easily erode down the landscape because of the hilly topography. This is also one of the reasons why such soils have a shallow surface. Keeping the surface soil covered with vegetation (agronomic crops or any leguminous creeping plants) would lessen the effect of soil degradation through soil erosion.

The dominant crops grown in Sogod Bay area are coconut, rice, banana, fruit trees, root crops, and abaca. Rice is the staple food for most of the residents, while coconut is an important source of income. However, the coconut trees at the study sites had been infested with bruntispa, which consequently affected coconut farmers' yield. Crop farmers have also reported that yields of the dominant crops have decreased in recent years.

Soil texture plays an important role in the movement of air and water in soil. It is also important in tillage/cultivation of the soil. The nutrient-holding capacity of the soil is also influenced by soil texture. Results of the soil analysis showed that the major textural classes of the surface composite soils from each study site were sandy clay loam, loam, clay loam, loam, and clay. Most of the areas had good to very good drainage as indicated by the high percentage of sand particles present in the samples examined. Almost 50% of the areas would favor root growth and good entry/movement of air and water. In the upper elevation, however, the shallow surface would not provide good root anchorage.

There were no significant differences in the soil pH of the surface soil samples collected from the research sites. The soil pH ranged from 5.31 to 6.75 from the upper part of the landscape to the flatlands, respectively. The soil was strongly acidic to very slightly acidic. An acidic soil condition hinders plants from getting the most essential nutrients. These are the soils that would likely cause aluminum and manganese toxicity or calcium and magnesium deficiencies if planted with acid-sensitive species.

Some areas of Sogod Bay have hilly topography, which make them prone to soil erosion. This then makes the land in those areas become less fertile due to soil nutrient loss, which consequently results in farmers' low yield of most agronomic crops. Soil erosion control measures, either through biological or mechanical methods, should be done in hilly areas to avoid further depletion of soil nutrient that will eventually lead to soil degradation. It is also recommended for farmers to ameliorate those slightly acidic areas by augmenting the essential nutrients in the soil through applying organic or inorganic fertilizers.

Generally, the soils examined at the study sites contained sufficient amounts of nutrients. However, the nutrient requirement may differ among plants, which is an important consideration in fertilizer application. For soils that are already sufficient with the essential nutrients, half of the plant nutrient requirement still needs to be augmented in order to attain the maximum potential yield of the crop planted. Among the soil nutrients examined by the research team, phosphorus was deficient in almost all of the barangays studied, especially in those areas in the upper elevation. Soil nutrients tend to decrease from higher to lower elevation due to possible runoff that carries the top nutrients of the soil. Soil phosphorus is the most sensitive element that is greatly affected by the topographic position of the area.

The results of the chemical analysis showed that the soils in these areas were shallow, especially the coconut lands. This is because the coconut lands are located in those areas with rolling topography, which enhances soil runoff of nutrients. Generally, soil pH in the tested areas ranged from strongly acidic to slightly acidic soil, except for Brgy. Buenavista. Most of the soil profiles were poorly developed resulting in shallow soil. However, in this condition, parent material significantly contributes to the availability of nutrients. The topography of the soil also influences the accumulation of nutrients in the lower elevation and its depletion in the upper topography, as exemplified by soil phosphorus. Among the nutrients evaluated in this study, soil phosphorus deficiency was highly noted; total nitrogen and exchangeable potassium were in moderate to sufficient amounts. Accordingly, proper maintenance and improvement in the management of the soil resources for sustainable agricultural use would be important strategies that could help protect the biological diversity in the project sites from agricultural land expansion. The results of this study's soil fertility assessment can be used to formulate soil test-based fertilizer recommendations for the proper monitoring of the soil health status in these areas (Appendix Table 1). The municipal agriculturist office should be more active in their extension activities to provide farmers with the appropriate technical support, especially in maintaining soil fertility and farm productivity. One reason why farmers are not applying the right amount of fertilizer is the lack of funds. Thus, mechanisms that would make fertilizer more affordable to farmers (e.g., fertilizer subsidy) are recommended. Using organic fertilizer should also be promoted as this can be sourced from local materials.

3.1.2 Marine resource assessment of Sogod Bay

Ten coastal barangays in five municipalities of Sogod Bay were selected as study sites, namely, (1) Brgy. Gud-an (with MPA) and Brgy. Himay-angan in Liloan; (2) Brgy. San Juan and Brgy. Buenavista (with MPA) in Padre Burgos; (3) Brgy. Biasong (with MPA) and Brgy. Pangi in Libagon; (4) Brgy. Higusuan and Brgy. San Isidro in Tomas Oppus; and (5) Brgy. Mac (with MPA) and Brgy. Tampoong in Sogod. The research team conducted a reconnaissance survey at the study sites using manta tow in order to identify the areas for detailed sampling. Mangroves, seagrasses, seaweeds, and invertebrates were assessed using transect-quadrat method; corals, with line-intercept method; and fish-visual census for fishes.

Mangrove in the identified sites of Sogod Bay. Of the 10 study areas identified in the bay, three did not have mangroves, namely, Brgy. Gud-an in Liloan, Brgy. Biasong in Libagon, and Brgy. Tampoong in Sogod. The research team found a total of 19 mangrove species in the seven sampled sites of Sogod Bay (Table 1). Brgy. San Juan in Padre Burgos had the highest number of species with 10 species; Brgy. Higusuan in Tomas Oppus followed closely with 9 species. Mangroves in Brgy. Mac in Sogod had the lowest number of species, but had the biggest stands of *Sonneratia* (GBH = 400 cm) and *Avicennia* (GBH = 280 cm), which indicates that these species are old and primary growths. There are 70 species of mangroves worldwide, of which some 35–40 are found in the Philippines (Primavera et al. 2004). This means that some 48%–54% of the identified mangrove species in the Philippines can also be found in Sogod Bay. There could be even more than 19 species in the entire bay considering that only representative sites were sampled.

Table 1. Mangrove species found in the sampled sites of Sogod Bay

Species	Himay-angan, Liloan	Buenavista, Padre Burgos	San Juan, Padre Burgos	Pangi, Libagon	Mac, Sogod	San Isidro, Tomas Oppus	Higusuan, Tomas Oppus
Acanthus ilicifolius				+			
Aegicerascorniculatum							+
Aegicerasfloridum						+	+
Avicennia marina	+	+	+	+	+		+
Avicenniarumphiana	+			+		+	+
Bruguieragymnorrhiza			+				
Bruguierasexangula							+
Ceriops decandra							+
Ceriops tagal			+				
Excoecaria agallocha			+			+	+
Heritieralittoralis			+				
Lumnitzeraracemosa	+		+				
Nypafruticans	+						
Rhizophoraapiculata		+	+	+	+	+	+
Rhizophoramucronata		+	+				
Rhizophorastylosa	+			+			
Sonneratia alba	+	+			+		+
Sonneratiacaseolaris			+	+			
Xylocarpusgranatum			+				
Subtotal	**5**	**4**	**10**	**6**	**3**	**4**	**9**

Note: Three of the 10 barangays did not have mangroves; thus, only seven barangays are presented in this table.

In some parts of the project sites, the local people had initiated transplantation activities but with minimal success (only about 10% survival rate). This was because the species of the seedlings used for transplantation did not fit with the type of substrate present in the areas where they were transplanted. To increase the survival of transplants, it is important to consider the natural substrate requirement of the species to be transplanted. A species that usually grows in the middle zone of the mangrove area with sandy-muddy substrate will have stunted growth if planted in a coralline-rocky substrate in the seaward zone. Furthermore, transplanted seedlings need to be maintained and monitored to ensure high survival rate. These and some other requirements need to be met in transplanting mangroves.

Seagrasses and associated macrofauna. The Philippines has the second highest number of seagrass species in the world with 16 species, second to Australia with 30 species (Fortes 1990). Seaweeds and seagrasses are major primary producers in the marine environment. Along with mangroves and coral reefs, they are important components of the marine ecosystem. Their value in the marine ecosystem can be viewed from two perspectivs—from the ecological-value perspective and from the economic-use perspective (Fortes 1990). Seaweeds are valued as food for humans, sources of gels, and sources of chemicals used in every commodity (Ohno and Critchley 1993). Seagrasses, on the other hand, also serve as alternative feeding sites for young fish and as nursery ground for turtles, seacows, and many invertebrates of commercial value (Meñez, Phillips, and Calumpong1983; Fortes 1990). It is one of the most productive ecosystems that produce as much as 10–20 grams of carbon per day for the seagrass component alone.

Marine invertebrates associated with mangroves, seagrass, and coral reef ecosystems are both ecologically and economically important. Ecologically, they are integral for supporting the function and stability of the food chains and ecosystems upon which other animals rely. Invertebrates are directly involved in ecosystem stabilization, shoreline protection, energy and nutrient transfer, and provision of habitat. They also play an important role in nutrient cycle, breakdown of plant matter and other detritus, and in providing habitat for other species (e.g., coral reefs). Commercially important invertebrates have provided livelihoods to millions of people, particularly to those living in coastal communities. The products derived from this high-value species contribute billions of dollars to the world economy. Marine invertebrates such as bivalves (clams), gastropods (shells/*kinhason/annicad*), crustaceans (crabs, *lambay*, *alimango*), sea cucumbers (*bat/balat*), and sea urchins (*tuyom*) usually inhabit the intertidal—from the mangroves to the seagrass beds. They are mostly collected and harvested through gleaning, crab trap, and cages.

Seagrass and seaweeds are the least-studied coastal habitats, although they are as important as coral reefs and mangroves. Hence, the surveys conducted in this study evaluated their values, compositions, abundance, and status.

A total of 36 species of macroflora were identified and recorded in only six coastal barangays. None of them were found in the other four barangays (i.e., Brgys. San Juan, Tampoong, San Isidro, and Biasong), and thus the four barangays were not included in the analysis. Among the 36 species identified, 8 species were seagrasses and 24 species were seaweeds (Table 2). Among the six sites, Brgy. Himay-angan in Liloan had the highest number of species (24), of which 19 species were seaweeds and 5 species were seagrass. This was followed by Brgy. Gud-an (14 species of seaweeds, no seagrass species); Brgys. Buenavista, Pangi, and Higusuan (6 species each). Brgy. Mac had the least number of species with 2 species of seagrass but no seaweed species (Figure 3). In terms of distribution, most of the seaweed species were found in Brgys. Gud-an and Himay-angan, while seagrasses were found in Brgys. Himay-angan, Buenavista, Pangi, Mac, and Higusuan.

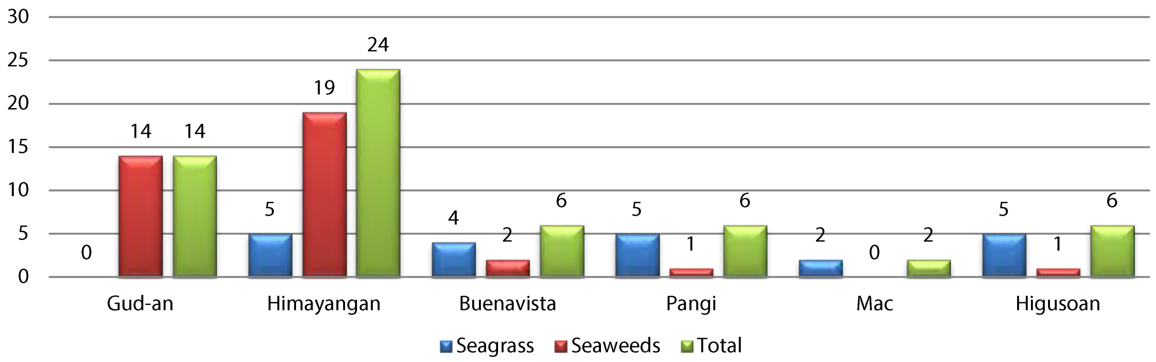
Table 2. Species composition and distribution of macroflora, Sogod Bay, Southern Leyte

No	Species	Gud-an	Himay-angan	Buenavista	Pangi	Mac	Higusuan
Seaweeds		**14**	**19**	**2**	**1**	**0**	**1**
1	*Acanthophoraspicifera*	X					
2	*Acetabularia* sp.						X
3	*Actinotrichiafragilis*	X	X				
4	*Amphiroaanceps*		X				
5	*Amphiroarigida*	X	X				
6	*Amphiroatribulus*	X					
7	*Dictyotacervicornis*		X				
8	*Dictyotalinearis*		X				
9	*Dictyota patens*		X				
10	*Digenea simplex*	X					
11	*Enteromorpha clatharta*		X				
12	*Galaxaura oblongata*		X				
13	*Galaxaura rugosa*	X					
14	*Gelidiopsis* sp.		X				
15	*Gracilaria salicornia*		X				
16	*Gracilaria* sp.	X					
17	*Halimeda macroloba*		X	X			
18	*Halimeda opuntia*		X				
19	*Hypnea nidulans*	X					
20	*Mastophora rosea*	X					
21	*Neomeris* sp.		X				
22	*Padina australis*		X				
23	*Padina minor*	X	X		x		
24	*Sargassum cristaefolium*	X	X				
25	*Sargassum oligocystum*	X	X				
26	*Sargassum polycystum*	X	X				
27	*Sargassum* sp.			X			
28	*Turbinaria ornate*	X	X				
Seagrass		**0**	**5**	**4**	**5**	**2**	**5**
29	*Cymodocea rotundata*		X	X	X		X
30	*Cymodocea serrulata*		X				
31	*Enhalus acoroides*		X				X
32	*Halodule pinifolia*		X	x	x		x
33	*Halodule uninervis*			x	x	x	x

Table 2 continued

No	Species	Gud-an	Himay-angan	Buenavista	Pangi	Mac	Higusuan
Seagrass		**0**	**5**	**4**	**5**	**2**	**5**
34	*Halophila dicipiens*				x	x	
35	*Halophila ovalis*						x
36	*Thalassia hemprichii*		x	x	x		
Total Number of Species		**14**	**24**	**6**	**6**	**2**	**6**

Note: None of the 36 species listed in this table were found in Brgys. San Juan, Tampoong, San Isidro, and Biasong; thus, only six barangays are presented in this table.

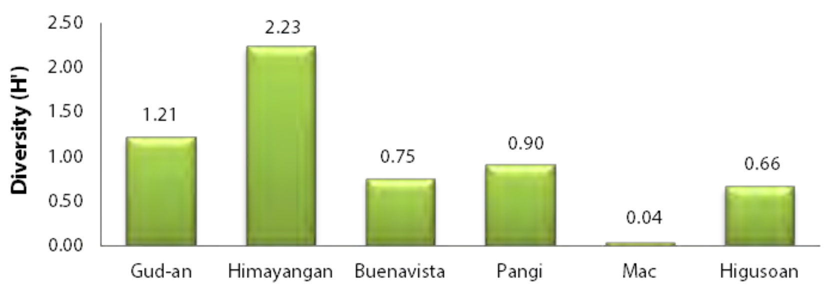


Note: None of the 36 species analyzed were found in Brgys. San Juan, Tampoong, San Isidro, and Biasong; thus, only six barangays are presented in this figure.

Figure 3. Species composition of macroflora in six sampling sites, Sogod Bay, Southern Leyte

The absence of seagrass in Brgy. Gud-an and seaweeds in Brgy. Mac may be due to the type of substrate present in these two areas. Most seagrasses thrive on sand-dominated substrate (e.g., *Cymodocea rotundata*, *C. rerrulata*, *Halodule pinifolia*, *H. uninervis, Halophila dicipiens,* and *H. ovalis*); muddy substrate (e.g., *Enhalus acoroides*); and rocky to coralline substrate. Moderate water movement will also allow good growth of seagrass and seaweeds (Mazo, Germano, and Ilano 2013). For these reasons, seagrasses and seaweeds were not present in these two sample areas.

Species diversity. In terms of the species diversity of the macroflora in the sampled areas, the results of Shannon-Weaver diversity index showed that Brgy. Himay-angan had the highest diversity index (H′ = 2.23) among the six barangays under consideration. Brgy. Gud-an (H′ = 1.21) had a higher species diversity index than Brgy. Buenavista (H′ = 0.75). Brgy. Mac (H′ = 0.04) had the lowest species diversity (Figure 4).



Note: None of the 36 species analyzed were found in Brgys. San Juan, Tampoong, San Isidro, and Biasong; thus, only six barangays are presented in this figure.

Figure 4. Species diversity of macroflora in six sampling sites, Sogod Bay, Southern Leyte

The authors classified the species composition of the macroinvertebrates in Sogod Bay into seven major taxa/groups as follows: (1) Cnidaria (corals and sea anemone); (2) Crustacea (hermit crabs); (3) Echinodermata (sea urchins, sea stars, brittle stars); (4) Mollusca (gastropod shells); (5) Platyhelmintes (flatworms); (6) Poriferans (sponges); and (7) Polychaeta (tubeworms). These seven groups were well-represented in the different study areas.

The research team identified four groups of invertebrates in the area, which included sea urchins (*tuyom*), gastropod (shells/*kinhason*), corals, and sea anemone. Coral colonies were observed all throughout the transect line, and had the highest density of 8.33 individuals per square meter (indiv/m^2). This was followed by sea anemone and sea urchins with average densities of 2 indiv/m^2 for both organisms. The substrate type of the study site was rocky, and coral patches were observed at approximately 5 meters from the shoreline. The corals and sea anemone provided very good habitats for other organisms in the area. These results can indicate the effectiveness of MPA in Brgy. Gud-an.

Coral reefs in Sogod Bay. Although coral reefs have very low nutrient and energy contents, they have very high productivity; hence, they are known as the “oasis of the ocean.” They are extremely efficient in capturing nutrients and sunlight, and subsequently, in cycling them for the use of many different organisms. They often occur in association with other ecosystems, particularly seagrass beds and mangrove forests, which provide nursery and feeding areas for many reef creatures.

The Philippines is near the center of coral diversity in the world, with at least 430 different species of corals (Gomez et al.1994). Coral reefs in the Philippines constitute an area of about 10% of the country’s total land area. However, most of these reefs are already degraded; more than 70% of the coral covers have been assessed as poor or fair in quality and quantity. Less than 5% can be categorized under “excellent condition” (Gomez et al.1994). A variety of factors have been attributed to this degradation, including factors related to the increasing dependence of the growing Philippine population (annual growth rate 2.3%) on the finite fishery resources provided by reefs (Pauly 1990). Hence, stakeholders have implemented initiatives to protect the remaining reefs, particularly through establishing MPAs. MPAs have helped damaged reefs to recover and to become resilient to both natural and anthropogenic stressors.

Understanding the benthic community structure is critical in understanding coral reef health. Measuring the proportion of live coral cover for assessing reef degradation is an important indicator for comparisons among coral reef health (Burke, Selig, and Spalding 2002). Accordingly, the benthic communities of the 10 coastal barangays of Sogod Bay were assessed in this study. Several areas in the coastal barangays under study have been declared as MPAs. Thus, the information on the coral cover generated from this research, both live and dead, can provide insights on the effectiveness of the said MPAs, assess the effects of natural and anthropogenic impacts on MPAs versus non-MPA areas, and suggest potential areas to be included as MPAs.

Table 3 shows the percent cover of the encountered benthic life-forms in the barangays under study. Only 9 out of the 10 sites had corals; Brgy. Tampoong had no coral covers at all due to the solid wastes that have accumulated in the area. Accordingly, five of the nine barangays indicated poor coral cover.

Table 3. Percent cover of corals and other resources in the reefs, Sogod Bay, Southern Leyte

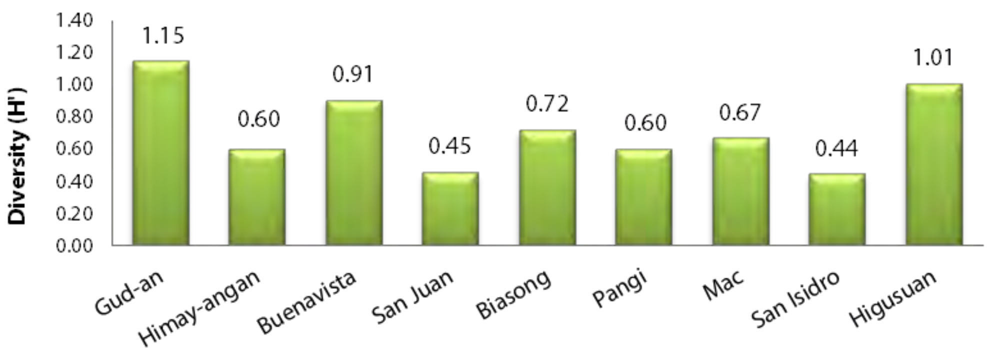
Stations	Percent Cover (%)								Category
	Live Coral	Dead Coral	Sponge	Algae	Rock	Sand	Water	Others	
Gud-an*	57.8	25.5	0.7	8.4	0.3	5.3	0.0	1.7	Good
Himay-angan	21.4	38.9	0.0	3.9	13.3	2.3	19.1	1.1	Poor
Biasong*	37.3	26.0	0.0	0.0	8.3	14.7	13.7	0.0	Fair
Pangi	12.0	1.6	0.0	0.0	2.9	80.2	0.0	3.3	Poor
San Isidro	25.1	27.7	0.0	0.0	0.0	12.0	33.6	1.6	Fair
Mac*	22.2	5.7	0.0	0.0	15.3	49.9	5.2	1.7	Poor
Buenavista*	34.5	3.7	0.0	0.0	0.8	44.1	15.6	1.3	Fair
San Juan	13.1	0.0	0.9	0.0	4.0	80.7	0.0	1.3	Poor
Higusuan	42.2	3.5	0.0	0.1	15.5	0.0	37.8	0.0	Fair

Note: (1) Brgy. Tampoong did not have coral covers due to the garbage deposits in the area; thus, only nine barangays are presented in this table. (2) * are municipalities with MPAs.

There are many reasons for poor live coral cover, which may be due to both natural and anthropogenic. Substrate type can influence the health of the coral cover since a particular type can provide stable substrate for benthic organisms like corals and seaweeds. In Brgys. San Juan, Pangi, and Higusuan, sand was the dominant cover. This may have influenced the poor coral covers in the areas. Dead corals were very common in the sites; however, this may have been due to the devastation caused by the super typhoon Yolanda (international name: Haiyan). Protected reefs have higher coral cover than unprotected reefs (Mc Clanahan 1994). Accordingly, those sites with MPAs had the most coral cover with Brgy. Gud-an in Liloan having the highest living coral cover (57.8%). Brgy. Higusuan in Tomas Oppus was the only non-MPA site with a high living coral cover of 42.2%.

MPAs were equally affected by natural stressors as evidenced by the high percentage of dead coral cover at the study sites with MPAs. However, those barangays with MPAs were more resilient to these stressors, and hence had higher percentage coral cover than those sites with no MPAs. The non-MPA sites were the ones that had poor percentage coral covers. Aside from the natural factor such as the substrate type, these non-MPA sites have been subjected to anthropogenic stress such as trawling, blast fishing, drive-in nets, and cyanide fishing. These destructive methods grossly affect reef ecology by destroying either the physical or biological structure of the reefs. On the other hand, MPAs are free from these stresses since these are no-take zones.

The results of the Shannon-Weaver diversity index showed that the sites with MPAs had the highest diversity index (Figure 5). Brgys. Gud-an (H' = 1.15), Buenavista (H' = 0.91), Biasong (H' = 0.72), and Mac (H' = 0.67) had MPAs, which may have influenced their higher diversity indices as compared to the others. Again, Brgy. Higusuan (H' = 1.01) was the only non-MPA site with a high diversity index.



Note: Only nine barangays were sampled for coral reef assessment because Brgy. Tampoong had no coral cover due to the garbage deposits in the area.

Figure 5. Life-form diversity of living coral in nine sampling sites of Sogod Bay

Tridacna, which is an economically important bivalve, was also found in Brgys. Biasong and Pangi. There were also dead *Tridacna* found, which may be due to poachers or due to the strong current and waves brought by typhoon Yolanda. The local people in one of the barangays found a way to make use of the dead corals and shells of the dead *Tridacna* that drifted along the shore by making display decorations out of them.

The results of the assessment indicate that MPAs have high life-form diversity, the highest life-form composition, and highest live coral cover. Because MPAs are no-take zones, they are less prone to anthropogenic influences. These findings reinforce the importance of MPAs in preserving reef ecosystems. MPAs should then be established in non-MPA sites, especially in Brgy. Higusuan in Tomas Oppus, since it had the highest percent coral cover and biodiversity. It even surpassed those found in some of the MPA sites. Likewise, the fact that almost all surveyed barangays have similar life-form components indicates that they are all candidates for MPAs.

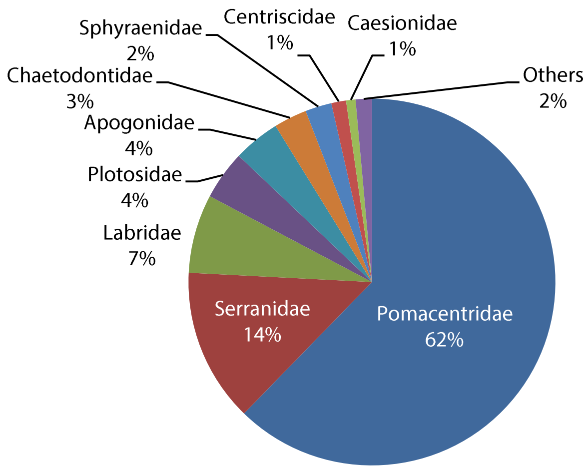
It was also observed that there were fish traps in the existing MPAs, which reflects weak law enforcement in the locality. Thus, the local government should strictly implement MPA regulations to prevent encroachment in those sites. Continuous monitoring of the MPAs' coral growth, recruitment, and mortality is also recommended.

Reef fishes in Sogod Bay, Southern Leyte. Fishing remains to be an important souerce of food and income to many of the coastal residents. Sogod Bay is rich in commercially important species, including tuna, flying fish, herrings, anchovies, Spanish mackerel, lobsters, and various shellfish (Taylor et al. 2004). Despite the many ecosystem services provided by the mangrove, seagrass, and coral reef ecosystems in Sogod Bay, the area remains one of the least-studied habitats in the Philippines. Overexploitation of these resources could result in local depletion or even local extinction, especially if these will not be managed properly.

MPAs or marine sanctuaries are known to preserve reefs that have been damaged and to enhance productivity of marine ecosystems. Several sanctuaries have been established in the area, but many areas also have the potential to be included as sanctuaries. Hence, assessing the coral reefs of Sogod Bay is important because such investigation will provide researchers and other stakeholders the relevant information regarding species composition, diversity of reef fishes, and the health status of the ecosystem in the area. The information provided by this research could then be used to recommend conservation measures. Reef-fish assessment was conducted in this study to (1) identify the reef fishes in Sogod Bay, (2) determine fish diversity indices in the different sites, (3) compare species assemblages in the different sites of Sogod Bay, and (4) propose conservation measures for the protection of the biodiversity in coral reef ecosystems in Sogod Bay.

Fish species were inventoried using SCUBA, following the standard Fish Visual Census (FVC) method outlined by English, Wilkinson, and Baker (1994) and Uychiaoco et al. (2001). FVC can detect differences in assemblages of reef fishes at different sites. The researchers identified the fish species using books and the identification guides provided by Allen et al. (2003), White (2001), Halstead (2000), Lieske and Myers (1994), and Myers (1991). Likewise, the authors also used the online species identification tool in FishBase (www.fishbase.org). The English common names used in this study are based on FishBase (Froese and Pauly 2014).

The researchers had identified and counted at the nine study sites a total of 76 reef fish species belonging to 46 genera and 23 families. No FVC was done in Brgy. Tampoong because of the garbage deposits in the area, which made diving impossible. Of the 23 families, the top three were from Pomacentridae (62%), followed by Serranidae (14%) and Labridae (7%) (Figure 6). These three families were also reported by Taylor et al. (2004) to be the most abundant groups in their assessment of Sogod Bay. Appendix Table 2 shows the reef fishes found in the different sites of the present study.



Note: The group "Others" includes Nemipteridae, Lutjanidae, Scorpaenidae, Pinguipedidae, Zanclidae, Acanthuridae, Blenniidae, Pomacanthidae, Aulostomidae, Balistidae, Fistulariidae, Mullidae, and Tetraodontidae (n = 3,009).

Figure 6. Major fish families found in Sogod Bay, Southern Leyte

The researchers found a total of 13 commercially important or target species during the conduct of the census. These belonged to families Acanthuridae (surgeonfishes), Balistidae (triggerfishes), Caesionidae (fusiliers), Labridae (wrasses), Lutjanidae (snappers), Mullidae (goatfishes), Nemipteridae (breams), and Sphyraenidae (barracudas). Brgys. Pangi and San Isidro both had five target species, followed by Brgys. Biasong and San Juan with four and three target species, respectively. The lemon damsel (*Pomacentrus moluccensis*) was the most common fish in Sogod Bay (n = 371). *P. moluccensis* and *Thalassoma lunare* (moon wrasse) were also present in all study sites. Although these two were nontarget species, they perform various ecological roles that are important for the health of the coral reef ecosystems.

Table 4 shows the different biological indices that were calculated in this study. Brgy. Biasong has the highest diversity of reef fishes. In general, MPA sites have higher diversity indices (*H', d, J'*) than the non-MPA sites. Brgy. Pangi, which was a non-MPA site, is a potential candidate for protection because of its high species richness and diversity as reflected in its *d* and *H'* values.

Table 4. Diversity indices among the different sites in Sogod Bay

Site	Total Species (S)	Total Individuals (N)	Margalef's Species Richness (*d*)	Pielou's Evenness (*J'*)	Shannon- Wiener (*H'*)
Gud-an*	26	729	3.793	0.796	2.595
Himay-angan	18	201	3.206	0.705	2.037
San Juan	26	623	3.885	0.755	2.458
Buenavista*	19	236	3.294	0.772	2.273
Biasong*	30	227	5.346	0.825	2.807
Pangi	31	246	5.449	0.772	2.650
Mac*	25	135	4.893	0.774	2.492
San Isidro	25	420	3.973	0.689	2.217
Higusuan	16	192	2.853	0.694	1.923

Note: (1) * are municipalities with marine protected areas (MPA); (2) Brgy. Tampoong was not included in the analysis due to the garbage deposits in the area, which made diving very difficult; thus, only nine barangays are presented in this table.

Brgys. San Isidro and Higusuan had the lowest *J'* values. Highly stressed environments often show relatively low levels of equitability (or evenness) as these ecosystems become dominated by disturbance or pollution-tolerant species (Henderson 2003). Based on the different indices used in this study, the non-MPA sites surveyed can improve the fish biodiversity in the area, and this can be achieved through establishing MPAs. Having more protected areas is in line with the concepts of MPA networks, which is considered to be more effective than fewer MPAs. Protection improves coral reef covers, and this would eventually lead to increase in fish biomass. Likewise, rehabilitating the degraded coral reefs in some study sites is also recommended through coral transplantation. Deploying artificial reefs could also enhance natural coral reef recovery and improve fish biomass. Moreover, existing MPAs should be marked properly with buoys and should be constantly monitored and censused.

3.2 Community Dependence on Natural Resources

The household survey conducted in this study covered a total of 500 households, which were distributed equally among the five municipalities. Each municipality had 100 respondents. Table 5 shows the profile of the respondents based on their farming activities.

Table 5. Respondent profile, by farming activity

Municipality	Barangay	Total Number of Respondents	Number of Crop Farmers	Number of Livestock Farmers	Number of Fish Farmers
Libagon	Biasong	51	38	1	10
	Pangi	49			
Liloan	Himay-angan	86	81	50	25
	Gud-an	14			
Sogod	Mac	50	73	37	29
	Tampoong	50			
Tomas Oppus	Higusuan	21	44	2	24
	San Isidro	79			
Padre Burgos	Buenavista	50	62	50	39
	San Juan	50			
Total		**500**	**298**	**140**	**127**

3.2.1 Occupation and income sources

Among the 500 respondents surveyed in the five municipalities, about 50% were engaged in farming as their primary occupation (Figure 7). Sogod had the most number of respondents engaged in farming as a primary occupation (68%) and the lowest was in Tomas Oppus with only 33%. More respondents in Sogod (24%) and Padre Burgos (15%) considered fishing as their primary occupation. About 23% and 10% of the households in Libagon and Padre Burgos, respectively, worked as farm laborers; while some (8% in Tomas Oppus and 10% in Padre Burgos) were working as service workers. About 10% of all households did not have primary source of income. These were the families who depended on remittances from household members working in the urban areas and in foreign countries. Only one-third of the 500 household heads surveyed had secondary income sources.

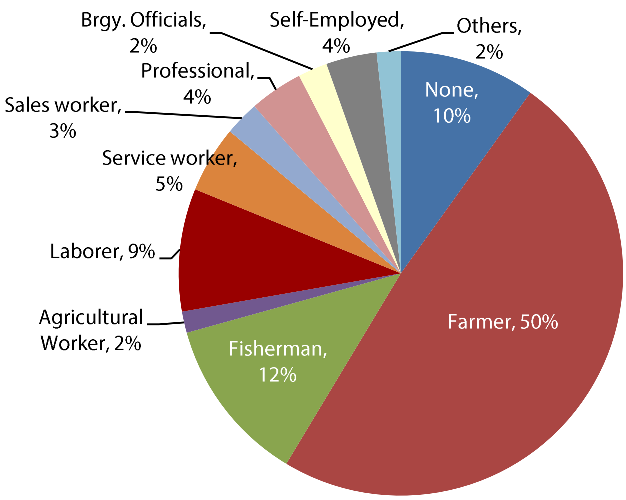


Figure 7. Primary occupation of respondents in the five municipalities, Sogod Bay (n = 500)

Household income came from various sources. The respondents from Brgys. Gud-an and Himay-angan in Liloan reported that a bigger part of their income comes from salaries earned from either working in the government or in private firms (PHP 63,676 annually) (Figure 8). This translates to 56.36% of the total household income and almost 20% of the total income from salaries and wages earned by the households in the five municipalities. Income earned from wholesale and retail businesses had an annual contribution of PHP 56,778.97 per year or 50.25% of the total household income. Meanwhile, income earned from forest and agricultural products contributed PHP 33,578 annually or 29.72% of the total annual household income, while income from marine products had only 6.47% (PHP 7,308.33 annually) contribution. Remittances from relatives working abroad and from domestic economy also had a significant share in the total household income, amounting to an average PHP 33,284.48 (29.46%) annually. The share of income from off-farm activities was PHP 19,610.71 per year or 17.36% of the total household income. Income earned from pensions and rental of buildings and from services-related activities also contributed to the total household income.

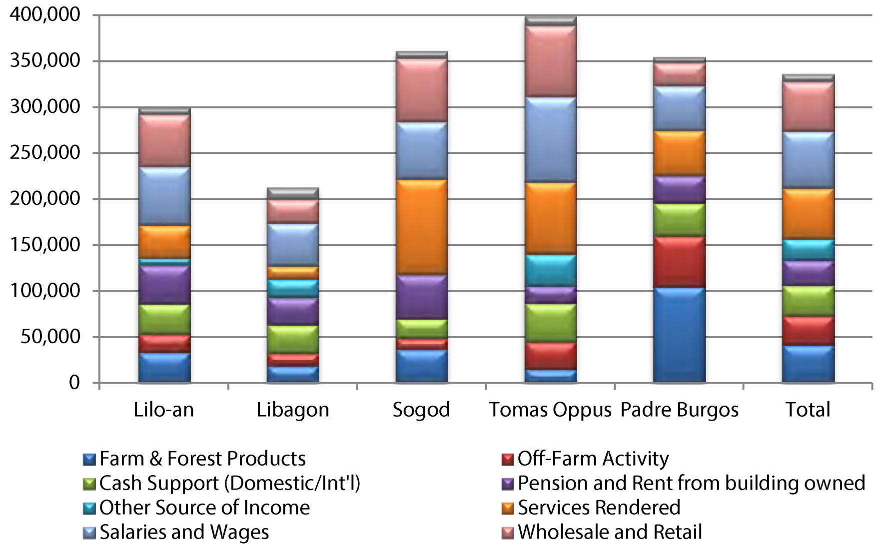


Figure 8. Households' annual income, by income sources, by municipality (n = 500)

In Libagon, the average household income was only PHP 60,220 per year; the biggest chunk came from salaries and wages, which represented 77.46% of the total household income. This was followed by remittances from relatives, pensions and rent, inheritance and winnings, forest and agricultural products, and other sources. Note that income from selling agriculture and marine products had lesser contribution than the others, although the household heads interviewed considered farming and fishing as primary and secondary occupations.

In Sogod, income from wholesale and retail businesses had the biggest contribution to the respondents' household income. This was expected since Sogod is the center of trade in Sogod Bay. The barangays covered in the survey are only a few kilometers away from the town proper, which make it easy for them to engage in businesses. Salaries and wages and pensions and rentals significantly contributed to the respondents' total household income. Income from agriculture and marine products contributed PHP 36,921.34 and PHP 7,360.74 per year to the total income, respectively. In Tomas Oppus, income from agriculture and forest products earned only an average of PHP 15,335.53 annually, while that from marine products contributed some PHP 10,121.52 per year. The biggest contributors to the total household income were income from salaries and wages, remittances, pensions and rentals, and wholesale and retail businesses.

In Padre Burgos, the same trend was observed. Most of the respondents' household income came from nonfarm-related sources such as business, remittances, and salaries and wages. This implies that households along Sogod Bay are less dependent on their marine, agriculture, and forests products for their livelihood. The results of the FGD also revealed a similar output; agricultural production has been declining over the years because of soil fertility loss and aging coconut trees. Abaca production, which used to be an important source of income, has been affected by the bunchy-top virus. Marine and fishery resources have also been declining due to overfishing, which has been triggered by the rising demand of the growing population for marine food products.

Based on these findings, the local government needs to initiate interventions in the area to restore the productivity of the agricultural and aquatic ecosystems in Sogod Bay. Replanting coconut trees and re-establishing the abaca farms can be done with the support of government agencies like the Philippine Coconut Authority and the Department of Agriculture. Such technical support should be geared toward restoring the important sources of household incomes. The results also show that household members are engaged in different nonfarm activites to earn a living. Access to nonfarm type of work could be enhanced by training and empowering the local residents with skills that will improve their employability.

3.2.2 Crop farming activities

Among the 500 respondents interviewed, 298 (60%) of them were crop farmers (Table 5). Table 6 summarizes the profile of the crop-farmer respondents in the municipalities under study. A total of 184 crop-farmer respondents (61.74%) owned the land they were tilling; while 114 (38.83%) crop-farmer respondents did not own their own lands (i.e., farm laborers).

Table 6. Respondent profile, by type of crop farmer, by municipality

Type of Crop Farmer	Number of Crop-Farmer Respondents per Municipality					Total
	Libagon (n = 38)	Liloan (n = 81)	Padre Burgos (n = 62)	Sogod (n = 73)	Tomas Oppus (n = 44)	
Land ownership						
Did not own land	10	28	24	37	15	114
Landowners	28	53	38	36	29	184
Individual ownership	*35*	*19*	*19*	*37*	*18*	*128*
Partnership	*2*	*0*	*1*	*1*	*22*	*26*
Communal	*1*	*37*	*14*	*17*	*11*	*80*
Conjugal	*0*	*8*	*13*	*6*	*0*	*27*
Farm practice*						
Practiced crop rotation	0	9	1	6	2	18
Planted trees in farm	14	55	11	36	31	147
For home consumption	*12*	*52*	*10*	*23*	*31*	*128*
For lumber	*1*	*1*	*1*	*3*	*1*	*7*
To prevent flooding	*1*	*2*	*0*	*0*	*0*	*3*
Prevent erosion	*1*	*8*	*0*	*4*	*1*	*14*

Note: (1) * means that the figures under the category are multiple responses; (2) The total number of respondents in each municipality is 100; thus, total sample size for the five municipalities is 500. In this table, "n" pertains to the number of crop-farmer respondents in each municipality.

Among the 184 farmer-landowner respondents, ownership varied from individual ownership, partnership, communal, to conjugal. Landowners with individual type of ownership were the most common, with 128 respondents (43% of the farmer-landowner respondents). Table 6 also shows that Sogod has more individual landowners than the other municipalities, with 37 (50.68%) respondents. On the other hand, 50% of the landowners in Tomas Oppus were part owners. Communal ownership existed in Liloan, which happens if the land has not yet been subdivided among the heirs; this constituted 69.81% (37 respondents) of all the farmer-landowner respondents in the municipality. Conjugal ownership was common in Padre Burgos, with 13 (21%) respondents.

The number of parcels per household ranged from 1–2 parcels. On average, each respondent in Libagon, Tomas Oppus, and Padre Burgos owned two parcels of land. In terms of farm area, the crop-farmer respondents in Tomas Oppus had the largest land area averaging 2.10 ha, while each household in Padre Burgos and Liloan had average farm areas of 1.70 ha and 1.50 ha, respectively. The crop-farmer respondents in Sogod had the lowest farm area, with an average of 1.07 ha only.

Most of the crop-farmer respondents reported that they could access their farms on foot. The same trend was observed in the other municipalities. The forest could not be accessed easily from their farms because the former could be reached only by walking as well. Meanwhile, almost half (46.4%) of the total 500 respondents cited that a rough farm-to-market road is present in their area, while 42.7% mentioned a paved road connecting the farms to the nearest market. A few also said that a semi-cemented road connect the farms to the market.

When asked whether they practiced crop rotation, only 11.1% of the crop-farmer respondents in Liloan and 8.22 % in Sogod answered positively (Table 6). In Tomas Oppus, only two crop-farmer respondents (4.5%) practiced crop rotation, while only one respondent in Padre Burgos practiced the same. Farmers in Brgy. Gud-an in Liloan may have been practicing crop rotation due to the limited area for agriculture in the barangay. Most of the lands in Brgy. Gud-an are elevated because the flatlands are those close to the shore, which are not suited for crop cultivation.

About 68% (55 out of 81) of the crop-farmer respondents in Liloan said they planted trees in their farms; in Sogod, 49%; Libagon, 37%; Padre Burgos, 18%; and Tomas Oppus, 70%. In Tomas Oppus, all of those who planted trees (87%) said they use the wood from these trees for home consumption. Note that there were more farmers in Liloan who planted trees as compared to their neighbors. Most of the respondents who planted trees did for home consumption either for fuel wood or lumber. Only 2% (3 crop-farmer respondents) said they grew trees on their farms to prevent flooding and erosion. Liloan had experienced flooding in the early 2000s, which caused several casualties.

A total of 58 crop-farmer respondents in Liloan said that they have not encountered any soil-related problems in their farms. Likewise, all of the crop-farmer respondents in Libagon said that they have not experienced any problems in terms of deficiency in soil nutrients. Only the crop-farmer respondents in Sogod (9.4%), Tomas Oppus (4.5%), and Padre Burgos (1.1%) admitted they have encountered soil-related problems in their farms.

Despite some of the respondents' reports of not having encountered any soil-related problems in their farms, the soil analysis revealed otherwise. Based on the results of the soil analysis, some areas in the study sites had acidic soil and were deficient in some of the essential nutrients, especially nitrogen, phosphorus, and potassium. These macroelements are very essential to crop growth. Likewise, the location of the study sites makes them vulnerable to soil erosion; but the farmers did not consider it as a problem. Likewise, they did not consider nutrient deficiency as a problem; but the lack of funds to buy fertilizers was considered as one.

Based on the survey results, coconut was the most commonly grown crop in all of municipalities under study (Table 7). Next to coconut were *palay* (paddy rice), banana, root crops, and abaca. Coconut production was the main source of farm income of most of the crop-farmer respondents. Only a few of the study sites are suited for planting rice due to their location; cultivating coconut, root crops, and abaca are more suitable in those areas. The results of the soil analysis can explain the choice of crops. The farms are located in hilly lands, which are prone to erosion; these crops (i.e., coconut, root crops, and abaca) are resistant to erosion, are less input intensive, and can thrive in nutrient-deficient areas.

Table 7. Crops planted by municipality, 2013

Crops Planted	Number and Percentage of Crop-Farmer Respondents per Municipality											
	Liloan n = 81		Libagon n = 38		Sogod n = 73		Tomas Oppus n = 44		Padre Burgos n = 62		Total N = 298	
	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
Coconut	75	92.6	33	86.8	40	54.8	37	84.1	61	98.4	246	82.6
Palay	18	22.2	8	21.1	48	65.8	10	22.7	0	0.0	84	28.2
Banana	3	3.7	2	5.3	1	1.4	2	4.5	1	1.6	9	3.0
Root crops	3	3.7	1	2.6	1	1.4	2	4.5	0	0.0	7	2.3
Abaca	1	1.2	2	5.3	2	2.7	0	0.0	0	0.0	5	1.7

Notes: (1) Figures reported in this table are multiple responses; (2) The total number of respondents in each municipality is 100; thus the total sample size for the five municipalities is 500. In this table, "n" pertains to the number of crop-farmer respondents in each municipality, while "N" represents the total number of crop-farmer respondents in all five municipalities. (2) *Palay* = paddy rice.

Rice yield (per hectare) in Liloan was 58.97 cavans (3.25 tons), which is lower than the 4.28 tons reported national average yield per hectare in the Philippines (FAO 2013). Accordingly, the average selling price in Liloan was PHP 537.71/cavan (Table 8). Libagon had a higher yield per hectare (150.54 cavans/ha) with selling price at PHP 542.50/cavan. Sogod rice farmers yielded an average of 55.67 cavans/ha sold at

PHP 451.04/cavan. Tomas Oppus rice farmers produced 50.95 cavans/ha with an average selling price of PHP 718.17/cavan.

Rice farms in Libagon are irrigated and are situated in flatlands. On the other hand, Liloan has limited areas suitable for rice cultivation, and most of these rice farms are rain-fed. Rice fields in Tomas Oppus are also rain-fed, which explains the low yield per hectare of the farmers. This is also due to nutrient deficiency (i.e., nitrogen) in most of the rice fields in the area, as indicated by the results of the soil analysis.

In Liloan, copra yield was 574.49 kg/ha per year with an average selling price of PHP 23.84/kg; in Libagon, it was 1,775.21 kg/ha and was sold at PHP 22.67/kg (Table 8). This indicates that coconut farms in the latter municipality are approximately three times more productive than in the former. Meanwhile, copra yield per hectare in Sogod was 842.29 kg/ha, sold at an average price of PHP 24.83/kg. In Tomas Oppus, copra yield per hectare was 368.19 kg and sold at an average price of PHP 25.09/kg. Padre Burgos coconut farms produced 461.31 kg/ha of copra, which was sold at a relatively higher price of PHP 35.90/kg.

Among the five municipalities under study, only three had abaca production. Liloan had the highest fiber yield of 200 kg/ha, which was sold at PHP 50/kg. Selling prices of abaca fiber in Sogod and Libagon were lower, averaging at PHP 32.00/kg and PHP 31.25/kg, respectively. Abaca production was low because most of the farms at the time of the study were still recovering from the bunchy-top virus that devastated the province.

All municipalities except Padre Burgos were harvesting bananas. Sogod was the number one producer, with average banana production of 2,000 pieces per hectare. Root crops were produced at a minimal level in all the municipalities under study because they were not considered as primary crops, and thus less input were used for their production.

3.2.3 Livestock farming activities

Among the 500 respondents surveyed, 140 were raising livestock (Table 5). The most common livestock raised were carabaos as work animals, pigs (backyard type only), and poultry such as chicken (Table 8). A few raised cows and horses. The livestock raised by the respondents were mostly for home consumption. Likewise, the respondents raised farm animals for additional income and for leisure. Carabaos were used for farm operations, such as cultivating the land.

About 33.6% (47 respondents) of the livestock farmers reported that they have constructed septic tanks to manage animal wastes, while 81.4% (114 respondents) were not doing anything to dispose them properly; some were utilizing them as a source of fertilizer.

Livestock-raising was only practiced by a smaller percentage of the households surveyed, and yet this activity is a potential source of alternative income for the farmers and fisherfolk in the study sites. Raising chicken and swine can be a good potential source of income since the market for such products is good. The province buys dressed chicken and pigs for slaughter from nearby provinces such as Bohol and Cebu and Mindanao. Accordingly, government and NGOs could provide technical and financial assistance to farmers and fisherfolk in livestock-raising, particularly on how to establish piggery or poultry farms, similar to how the Department of Science and Technology help budding entrepreneurs. Likewise, raising carabaos should be supported because carabao population is declining not only in the province of Southern Leyte but also in the entire country. Carabao dispersal programs could then be revived. Through this, households can have alternative source of income through processing of dairy products.

Table 8. Per hectare yield of crops grown of households, by municipality, 2013

Crops	Municipality									
	Liloan		Libagon		Sogod		Tomas Oppus		Padre Burgos	
	Quantity (per ha)	Price (per unit)	Quantity (per ha)	Price (per unit)	Quantity (per ha)	Price (per unit)	Quantity (per ha)	Price (per unit)	Quantity (per ha)	Price (per unit)
Palay (cavans)	58.97	537.71	150.54	542.50	55.67	451.04	50.95	718.17	0.00	0.00
Coconut (kg)	574.49	23.84	1,775.21	22.67	842.29	24.83	368.19	25.09	461.31	35.90
Abaca (kg)	200.00	50.00	190.00	32.00	108.33	31.25	0.00	0.00	0.00	0.00
Banana (pcs)	6,111.11	1.50	1,000.00	1.00	2,000.00	2.00	185.00	1.50	0.00	0.00
Root crops (kg)	76.00	11.33	88.00	22.00	12.00	15.00	24.44	15.00	0.00	0.00

Table 9. Distribution of livestock raised of households and purpose of raising, by municipality

Livestock's Raised*	Municipality									
	Liloan n = 50		Libagon n = 1		Sogod n = 37		Tomas Oppus n = 2		Padre Burgos n = 50	
	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
Chickens/Poultry	30	60.0	0	0.0	32	86.5	1	50.0	40	80.0
Pigs	25	50.0	0	0.0	7	18.9	1	50.0	16	32.0
Cow	2	4.0	1	100.0	2	5.4	0	0.0	14	28.0
Carabao	11	22.0	0	0.0	3	8.1	1	50.0	11	22.0
Goats/Sheep	1	2.0	0	0.0	0	0.0	0	0.0	3	6.0
Horse	0	0.0	0	0.0	0	0.0	0	0.0	3	6.0
Purpose of Raising										
Consumption	19	42.0	0	0.0	24	64.9	1	50.0	42	85.7
Additional Income	29	58.0	0	0.0	15	40.5	1	50.0	22	44.8
Working Animal	8	16.0	1	100.0	2	5.4	1	50.0	12	24.5

Note: (1) Figures reported in this table are multiple responses; (2) The total number of respondents in each municipality is 100; thus the total sample size for all five municipalities is 500. In this table, "n" pertains to the number of livestock-farmer respondents in each municipality.

3.2.4 Fishing Activities

Of the 500 respondents, 127 were engaged in fish farming (Table 5). Table 10 briefly describes the respondents' fishing activities. On average, the distance from the respondents' house to the shoreline ranged from 0.02 to 0.56 kilometers (km). Households in Tomas Oppus are very close to the shoreline (0.02 km), while it is about 0.56 km in Padre Burgos.

Table 10. Attributes of fishing activities, by municipality

Attributes	Municipality				
	Liloan	Libagon	Sogod	Tomas Oppus	Padre Burgos
Distance of house to shoreline (km)	0.08	0.20	0.07	0.02	0.56
Amount of time it takes to fishing area from shoreline (hour)	1.33	0.82	0.68	0.66	1.76
Distance of fishing area from shoreline (km)	2.29	0.31	1.28	1.67	1.42
Amount of time spent per fishing trip (hour)	3.83	2.05	6.82	4.15	34.61
Number of fishing round trips in a day	1.42	1.07	1.42	1.05	1.18
Number of days fishing in a month (days)	16.14	12.33	23.21	16.65	10.26
Number of months fishing in a year (months)	9.81	9.67	17.70	9.26	6.54

Fishers in Padre Burgos spent an average of 1.76 hours to reach the fishing area from the shoreline; in Liloan, 1.33 hours; Libagon, 0.82; Sogod, 0.68; and Tomas Oppus, 0.66 hours. Liloan fishermen took longer time to reach the fishing area because the fishing area was 2.29 km from the shoreline. Libagon had the shortest distance from shore to fishing area with a distance of 0.31 km. The fishing area in Tomas Oppus was about 1.67 km from the shore.

Padre Burgos fishermen allotted the longest time for fishing (34.61 hours per trip). This was followed by Sogod fishermen with 6.82 hours per trip; Tomas Oppus, 4.15 hours; Liloan, 3.83 hours. Libagon fishermen spent the shortest time per trip with only 2.05 hours per trip. The hours spent for fishing also depend on the type of fishing method used by the fishermen and on the fish stock available. With more stock, more fish can be caught within a shorter period of time. Catching fish using a hook-and-line generally takes more time than using other fishing equipment such as fishnets.

More than half of the fishermen-respondents (73 respondents) used the hook-and-line method (Figure 9). In Liloan, 20 fishermen used the hook-and-line, while 8 fishers in Libagon used the same. This method was also popular among the fishers from the other municipalities surveyed. Fishnet was also used by 34.5% of all the fisherfolk surveyed (44 fishers). In particular, more than 40% of the fisher-respondents in Liloan (10 fishers) were using fishnets; in Libagon, 20% (2 fishers); and Tomas Oppus, almost 50%. Scoop net, jigger spear long line, and others were also used. The kind of fishing gear used also determines the kind of fish caught.

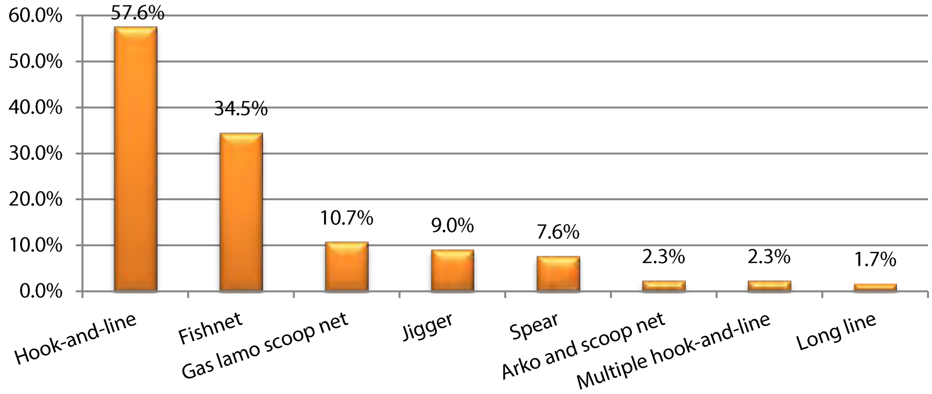


Figure 9. Fishing gear used by fishermen in the five municipalities, Sogod Bay (n = 127)

Fishing equipment. About 76% (96 respondents) of all the fisherfolk interviewed owned non-motorized boats (Table 11). More than 60% of the fisherfolk who had fishing boats in Padre Burgos had non-motorized fishing boats; thus, explaining why it takes them a long time to reach the fishing ground. Since most of them were using non-motorized boats, it follows that they also owned paddles; this explains why the number of non-motorized boat owners are almost equal to the number of paddle owners. None of the fisherfolk interviewed mentioned whether they were renting or borrowing fishing boats.

Only 22% of the 127 fishermen-respondents had lighting equipment; 21.26% had motorized boats. Other equipment owned included fishnets, ice boxes, hook-and-line, and jigger. The results imply that the fisherfolk in the five municipalities do not earn much from fishery. Likewise, capital equipment was minimal, which may be because fish stock has been dwindling in the area; thus, investing too much on large fishing vessels and other equipment may not be economically rewarding considering the low return on investment. All of these imply that the local people in the five municipalities were less dependent on the marine resources for their livelihood.

Fish species caught and average catch per trip. More than 50 species of fish are caught by the fisherfolk in Sogod Bay. These are squid, mangsi, and blackspot emperor, among others. The high-end species—such as groupers, *maya-maya* (snapper), and grouper (*lapu-lapu*)—are seldom caught; only a few of the fishermen respondents reported catching these fishes. Most of the species caught are coral reef species. Mackerel and tuna are caught in deep seas, and only a very few fishermen reported having caught such fishes. Based on the survey results, the average catch per trip in Liloan was 2.50 kg, 7.17 kg in Libagon, 2.61 kg in Sogod, 6.22 kg in Tomas Oppus, and 3.51 kg in Padre Burgos (Figure 10). Almost all of the fisherfolk interviewed have observed a decrease in fish catch; this result was consistent with the reports of the FGD participants.

Aside from fish, the fishers interviewed harvested a variety of about 35 species of sea shells. These are all edible species, and thus were gathered by the residents for food.

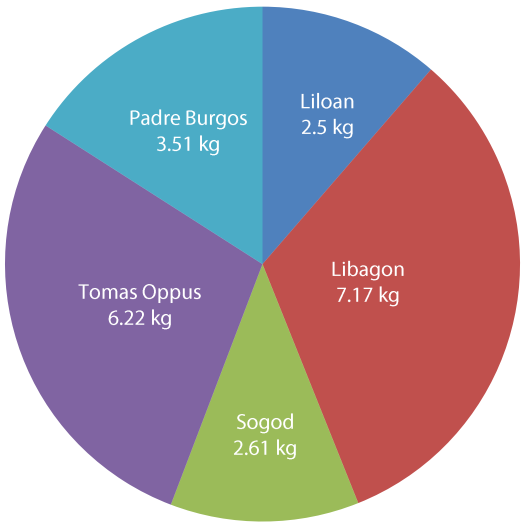


Figure 10. Average fish catch (kg) of fishermen, by municipality

Table 11. Fishing equipment used by fishermen, by municipality

Fishing Assets	Number of Fishermen Respondents per Municipality											
	Liloan n = 25		Libagon n = 10		Sogod n = 29		Tomas Oppus n = 24		Padre Burgos n = 39		Total N = 127	
	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
Non-motorized boat	23	92.00	9	90.00	25	86.21	15	62.50	24	61.54	96	75.59
Paddle	18	72.00	7	70.00	28	96.55	1	4.17	36	92.31	90	70.87
Fishnets	5	20.00	5	50.00	7	24.14	11	45.83	9	23.08	37	29.13
Lighting equipment	1	4.00	5	50.00	0	0.00	11	45.83	11	28.21	28	22.05
Motorized boat	2	8.00	1	10.00	6	20.69	8	33.33	10	25.64	27	21.26
Ice boxes	1	4.00	2	20.00	7	24.14	4	16.67	12	30.77	26	20.47
Others	0	0.00	0	0.00	0	0.00	0	0.00	9	23.07	9	7.09

Notes: (1) Figures reported in this table are multiple responses; (2) The total number of respondents in each municipality is 100; thus the total sample size for all five municipalities is 500. In this table, "n" pertains to the number of fishermen respondents in each municipality, while "N" represents the total number of fishermen respondents in all five municipalities.

Marketing outlets. The fish caught in Sogod Bay are sold unprocessed since the catch is very few; thus, they can be easily marketed as fresh fish. About two-thirds of all fishermen respondents (75 respondents) said that they sell their fish catch within the barangay, while 20.9% said they sell it to their relatives and neighbors (Table 12). About 10% had traders and regular buyers in the area; only a few said that they bring their fish catch to the market. Since the average fish catch was very low, most of the harvest was for home consumption; only a few were sold. This reinforces the respondents' claim that fishing is no longer a major source of income, and that that they no longer depend on marine resources for their livelihood. Since they only market their catch within the barangay, marketing is done by walking.

Despite the claim that fish stock has declined, a variety of fish and other marine species are caught by the fisherfolk, which implies high biodiversity of the fish population in Sogod Bay. However, high-end species are seldom caught; what abounds are the nontarget species. One way to improve fish catch is to help fisherfolk acquire motorized fishing boats so that they will spend shorter time sailing to the fishing area.

Table 12. Marketing outlets of households involved in fishing activities, by municipality

Primary Outlet	Number of Respondents per Municipality											
	Liloan n = 16		Libagon n = 6		Sogod n = 27		Tomas Oppus n = 28		Padre Burgos n = 33		Total N = 110	
	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
Within Barangay	10	62.5	6	100.0	21	77.8	6	21.4	32	97.0	75	68.2
Neighbors/ Relatives	5	31.3	0	0.0	6	22.2	12	42.9	0	0.0	23	20.9
Traders	1	6.3	0	0.0	2	7.4	8	28.6	0	0.0	11	10.0
Regular buyers	1	6.3	0	0.0	0	0.0	2	7.1	1	3.0	4	3.6
Market	1	6.3	0	0.0	2	7.4	0	0.0	0	0.0	3	2.7

Notes: (1) Figures reported in this table are multiple responses; (2) The total number of respondents in each municipality is 100; thus the total sample size for all five municipalities is 500. In this table, "n" pertains to the number of those fishermen respondents who market their fish products per municipality, while "N" represents the total number of fishermen respondents who market their produce.

3.3 Environmental Awareness and Participation in Environmental Activities

3.3.1 Participation in environmental activities

Among the environmental activities present at the study sites, mangrove reforestation was the most popular among the respondents, with 20.8% of the total respondents confirming participation in the activity (Figure 11). The respondents from Padre Burgos had the highest level of participation in environmental activities, with 94% of the respondents participating in such activities. Only 43% of the respondents in Libagon said that they participate in the same. More than half of the respondents in Sogod confirmed participation, while 76% in Tomas Oppus, and 73 % in Liloan.

The local municipal governments of Liloan, Tomas Oppus, and Padre Burgos have been actively promoting environmental conservation initiatives, which may explain the high participation of the respondents from these municipalities. Padre Burgos and Liloan have existing recreational facilities (e.g., diving sites), which highly depend on the quality of the natural resources (e.g., coral reefs and marine sanctuaries) in the area. Padre Burgos has several tourist-attraction destinations (e.g., diving sites and beach resorts) that provide income for the municipality and its residents.

In general, the household heads interviewed participate in the general cleaning activities of the community (83.8% of the total respondents), tree planting (17.6%), and coastal cleanup activities (4.7%). These environmental initiatives were mostly for biodiversity conservation as cited by 67.9% of the total respondents. Another important concern was for maintaining the barangay surroundings. The agencies involved were the barangay and municipal LGUs and the local agencies of the DENR and Department of Social Welfare and Development (through the *Pantawid Pamilyang Pilipino Program* [4P]).

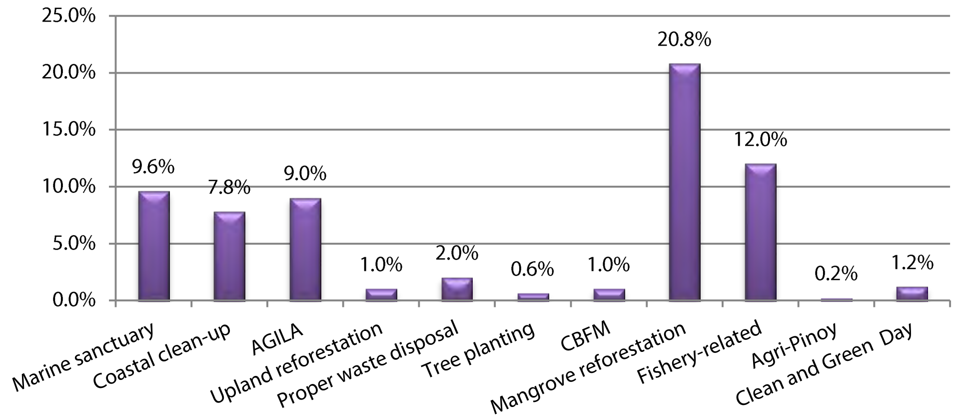


Figure 11. Participation in environmental projects in the five municipalities, Sogod Bay (n = 500)

3.3.2 Participation in community organizations

Majority of the respondents in each municipality revealed memberships in community organizations in the area, except for the respondents from Tomas Oppus in which only 9 respondents acknowledged membership. Across municipalities, 54% (270 respondents) were members of community organizations; most of them were just members, very few were leaders. Fifty-four households (20%) were members of fishery-related organizations, and only 6.6% were participants of community-forest management. Of the 54 respondents who were members of fishery-related organizations, 9 were from Liloan and 37 were from Padre Burgos.

When asked for their reasons for joining organization/s, more than 20% of all members in organization (54 respondents) said they had joined because they were concerned citizens, and thus would like to protect the environment from natural calamities; while 12.2% responded that they were required to participate. About 18.2% (49 respondents) joined because the organization was in line with their occupation; 12.5% cited their desire to serve the public. Another important reason cited for joining an organization was the financial support provided by the organizations, particularly the support given by 4P.

3.3.3 Community projects for natural resource protection and conservation

Only a few projects for resource conservation existed in the area, and these include projects related to marine sanctuaries, peoples' organization, mangrove reforestation, and fisherfolk organization. Mangrove reforestation was mentioned by 88.8% of the total respondents. The agencies implementing these projects were the Bureau of Fishery and Aquatic Resources of the Department of Agriculture (DA-BFAR) and DENR. These projects aimed to conserve biodiversity and to promote coastal cleanup, reforestation and garbage segregation. Likewise, the projects (i.e., mangrove reforestation) aimed to protect marine life and to provide a breeding ground for fish.

Only 31.5% (55 respondents) were actively involved in these initiatives, and these respondents were from the municipalities of Libagon, Padres Burgos, and Liloan. The projects (e.g., the Agila- and BFAR-implemented projects) were concentrated only in these municipalities because the project proponents closely monitor the MPAs located in the three municipalities. Sogod had no existing project. These respondents cited that they had participated in the projects because they wanted to help clean and protect the environment, conserve marine life, help their barangay, and to be able to fish in the area.

About 148 out of the 500 respondents interviewed (29.6%) accessed information through television programs (Figure 12). Friends and relatives and radios were also important sources of information as mentioned by 16.2% and 7.6% of the respondents, respectively. The respondents further said that they get most of their information on current events, weather, and prices of commodities by watching the news on TV. However, 31.4% of the total respondents said that they get fishery- and farm-related information from government and community workers. Very few of them read newspapers because most print materials such as newspapers are circulated in the town proper only.

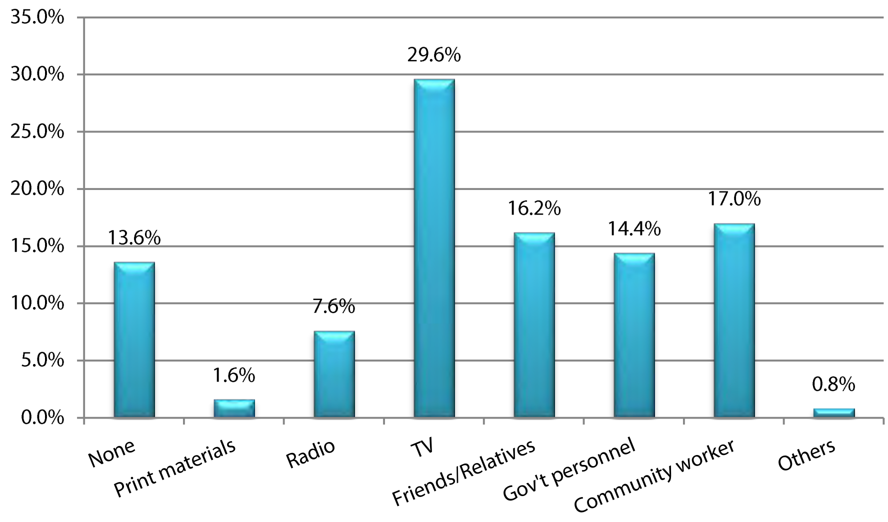


Figure12. Households' sources of information in the five municipalities, Sogod Bay (n = 500)

The above results reveal that not all respondents recognize the importance of the natural resources and that these assets provide services to mankind, as reflected by the number of households participating in environment-related activities. The three municipalities—Liloan, Tomas Oppus, and Padre Burgos—had more household respondents participating in environmental activities because these municipalities are very active in promoting environmental awareness. Planting mangroves was popular because of the presence of an organization that spearheads the activity. These activities should then be adopted by the other municipalities. The local government should also continue their awareness campaigns regarding environmental protection.

3.4 Community Assessment and Valuation of Natural Resources

3.4.1 Community assessment of conditions of natural resources

Sogod Bay is a rich source of coastal and marine resources, and it is one of the fishery areas in the region with high-potential productivity. During the FGDs, the fishermen reported that the population of other fish species (e.g., reef species) and those species with high economic values has already decreased. Crop productivity and agricultural lands have also decreased due to land-use conversions. Among the agricultural crops, coconut was the most stable source of income, although coconut farms have recently been damaged by the incidences of tropical storms in the area. Households have resorted to alternative livelihood in some off-farm activities; some have even worked outside the area either locally or abroad.

Among the five municipalities studied, only in Liloan and Padre Burgos have marine resources remained abundant and have fishery remained active, mainly because of the existing infrastructure in these areas such as fish ports. Likewise, among the marine resources studied, mangroves showed positive increase due to the ongoing mangrove-planting activities initiated by the coastal barangays. The coastal communities started these initiatives after they had become aware of the environmental services provided by mangroves such as shoreline protection and a breeding ground for fish. Also, a number of NGOs have been assisting them to plant mangroves. The assessment also showed that coral reefs are still alive, but only in MPAs. The coral reefs present were diverse and occupied a large area of the MPAs. Accordingly, these areas have become major diving attractions for many tourists.

The forest covers in the surrounding areas of Sogod Bay have also decreased; consequently, wildlife has also decreased. According to the residents, the forest area has gotten farther from the community such that it has become very difficult for them to reach these areas unlike before. Premium tree species could still be observed at the sites; but cutting these kinds of tree species was prohibited. Thus, the local residents did not depend on forest products for their livelihood.

Among the provisioning services generated from the natural assets in the area, coconut farming is the most important as it serves as the local residents' main source of income. Most of the barangays under study are coastal and do not have flatlands for cultivating rice and other agricultural crops. Likewise, the local communities have become less dependent on marine resources as a source of livelihood due to the decline in the fish population in the bay. This decline was also the reason why some fishermen engaged in crop farming and other activities to earn a living. As mentioned previously, selling "frigate tuna" (*mangko*) used to be a good source of income when this fish species was still abundant. However, overfishing has caused their number to decline.

Forest and agricultural lands. In Liloan, 91% of the respondents have visited the forest; in Libagon, however, only 60% responded the same. Two-thirds of the respondents in Sogod have also gone to the forest, and this was echoed by 53% of the respondents in Tomas Oppus and 99% in Padre Burgos. The major factor constraining the respondents from visiting the forest was its inaccessibility due to the considerable distance of the forest to their residences. More than half of the households interviewed were aware of the protective function of the forest and acknowledged that forests do reduce flooding. However, 71.3% also said that the forests are a source of lumber, which is a provisioning function of the forest ecosystem. In Libagon, 95% of those who responded to this question thought of forests as a source of income. Overall, only 24.1% thought of the forests as a livelihood source. In Liloan, 42.9% perceived the forest as a source of fuel; in Padre Burgos, 33% thought of it as a source of fresh air; for all municipalities, 7% thought of this natural asset as a source of food.

Access to the forests was restricted in some areas as mentioned by 30.9% of all the household heads interviewed. However, 68.8% said that the forest is an open-access resource. To cope with the access restriction, local residents secure barangay permits to be able to enter the forested area.

Another important resource found at the study sites were agricultural lands, in which 41% of all household heads interviewed thought of them as sources of income and food and for farm use. Majority of the respondents thought that the agricultural lands in the area are still productive. A little over one-third of the respondents thought that everybody has access to these agricultural lands, while 27.5% said that the use of these lands has been restricted. If the lands were not accessible by all, then the farmers have an agreement with the owner such that the former can cultivate the land provided that they will share the proceeds with the owner.

Fishing grounds. Almost all of the respondents said that they have fishing grounds in the community. However, only 35% of all respondents thought of fishing as an income source. In Sogod and Liloan, 83.7% and 47.9% of the household heads surveyed, respectively, also thought that their fishing ground is a source of income. More than half believed that the fishing ground both serve as a source of income and a breeding ground for fish. About 57.1% thought that this fishing ground is still healthy and productive. Most of them (81.37%) also believed that the fishing ground is accessible to all, while some (18.7%) said otherwise. To cope with the restriction, the respondents said that they tend to follow the rules and regulation with regard to the use of the fishing ground.

Mangroves. Almost all of the respondents from Liloan (98%) said they have mangroves, while about half of the respondents from Libagon (49%), Sogod (52%), and Padre Burgos (51%) answered the same. Of all the municipalities, Padre Burgos had the largest mangrove area. About 70% of the total respondents said mangroves serve as a breeding ground for fish, while 56.7% believed that mangroves protect coastal communities from sea level rise. A few (4%) mentioned that mangroves help reduce flooding. At the time of the study, the mangroves in Sogod Bay were still healthy and productive. The mangrove area could be accessed openly, although some parts were prohibited from people. There has been an observed increase in mangrove areas as a result of the mangrove-planting campaigns initiated by the NGOs in the area. About half of the respondents reported that they have grasslands, which are mostly used for animal grazing. More than a third said it is for aesthetic purposes. Only 31% of the respondents said that these grasslands are healthy and productive.

Rivers, lakes, and streams. About 28% of the respondents considered that the rivers in their area are still alive and clean, while 21% believed otherwise. Everyone at the study sites had free access to rivers. Rivers were used mainly for laundry and for irrigation purposes. Very few believed that the water from the river is potable. Lakes, on the other hand, were used mainly for agriculture and irrigation, while 65.5% cited that the lakes are sources of food. More than half of the households surveyed (57.5%) believed that the lakes in their area are generally healthy and productive, and can be accessed by all of the local residents. Streams could also accessible by all.

Nipa plantation. Nipa plantations were being used as a source of income and as source of roofing material. About 75% of all respondents said the nipa plants are still healthy and productive. Access to them was not open because they were privately owned.

Other resources. All of the respondents agreed that the atmosphere is a source of fresh air, and some also said that it is a source of light. All of them said they have free access to fresh air from the atmosphere. Another important resource recognized by the households interviewed was solar energy, which the respondents viewed as a renewable resource that everyone can access. Almost all of them agreed that they have water resources, and that this is an important source of drinking water. Other uses of the water resources available to them included water for domestic use (e.g., laundry, cooking, etc.) and for agriculture. Almost 75% of the total respondents said their water is potable. In some cases, water was available to them for free; in some areas, the respondents had to pay for the use of water.

The natural resources in Sogod Bay have deteriorated in terms of productivity. Therefore, policy interventions are needed to rejuvenate and improve the current status of these resources that would eventually improve the quality of life of the people in the area. If these resources continue to be degraded, the ecosystem services upon which the community is dependent on will also diminish, which will have a significant impact on the well-being of the people in Sogod Bay. Declining productivity of agricultural lands and marine resources can be mitigated through policies such as technologies to ameliorate nutrient deficiencies and through establishing MPAs that would restore coral reefs and improve fish population.

3.4.2 Valuation of natural resources and ecosystem services

This study assessed the provisioning services given by two important ecosystems in Sogod Bay, namely, marine and terrestrial ecosystems. Terrestrial ecosystems include those in agriculture and soils resources. The authors determined the status of these resources and the kinds of ecosystem services that the local communities derive from them.

The manner by which ecosystems are used and managed affects the services they provide. There are trade-offs when people change the quality and quantity of these resources. MEA (2005) identified a number of management options for these resources and the corresponding predicted trade-offs. For example, agricultural intensification to increase food production may adversely affect water availability, carbon sequestration, and nutrient regulation. Agricultural intensification may also increase the exposure of crops to pests and diseases. Another example is the establishment of a strictly protected area like a marine sanctuary or the development of a marine park. The protected area assures the local communities of a rich fishing ground, while marine parks promote tourism and recreation services. Although such establishments would help preserve wildlife and the environment, the trade-off is the loss of livelihood and food for the local residents. With these possible scenarios, valuation of ecosystem services becomes imperative in order to compare the trade-offs, and thereby help in management decisions.

In a scoping study done by TEEB in Southeast Asia, TEEB reported that forests have been the most extensively studied ecosystem in the region (Brander and Eppink 2012). This was followed by wetlands; coastal ecosystems (combinations of coral reefs, mangroves, and seagrasses); and mangroves. Among the ecosystem services, provisioning services (i.e., provision of food and raw materials) have been the most extensively valued along with cultural services, particularly the recreational and tourism opportunities provided by nature. The same study also determined that regulating services (i.e., flood and storm protection) have received relatively little attention, although these ecosystem services are likely to increase in importance over time in the context of climate change.

The authors of this study estimated only the provisioning values of the ecosystems considered. This ecosystems included the forests (watershed protection), agricultural land (soil nutrient), and marine ecosystems (coral reefs).

Agricultural land. The provisioning function of agricultural lands can be valued by estimating the value of crops produced per hectare. The common crops grown in the area include coconut, rice, abaca, and root crops. To estimate land rent, the authors estimated the gross margin per crop per hectare. The present value was estimated using a 10% discount factor and a period of five years. The discount factor used is lower than the current lending and borrowing rate, which ranges from 18%–22%.

The data used in the analysis (i.e., yield and production cost) was sourced from the survey results of this study and from secondary sources. The authors used two types of scenarios—one with proper cultivation or the *best practice scenario* and the other is without proper cultivation or the *traditional practice scenario*. For the traditional practice, the authors assumed that the farmer is not applying the right amount of fertilizer and not doing the right cultivation practices such as weeding. On the other hand, the best practice scenario included practices such as under brushing and fertilizer application.

The data for the traditional practice scenario came from the survey results of this study, while the data used for analyzing the best practice scenario were sourced from the Bureau of Agricultural Statistics (BAS 2013) and from the study of Ostertag et al. (2004). Table 13 enumerates the assumptions used in estimating the values of agricultural lands in the study area.

Based on the projection, the net present values (NPV) for the traditional practice would be lower than that of the best practice (Table 14). This is because the right amount of nutrients are absent from the former, especially for rice. As per the result of the soil analysis, the area is deficient of phosporous and nitrogen, especially in the rice farms. Since the best practice for all crops considered assumes that the farmer is following the recommended cultural and management practices including fertilizer levels, expected yield would be higher as compared to that of the traditional practice.

Table 13. Assumptions used for the valuation of agricultural lands

Variable	Value
Discount factor	10 % for all crops
Yield per hectare	
Coconut	6,000 nuts per year, with an average of 4 nuts per kg and 150 trees per hectare
Abaca	1,875 kg of fiber per hectare
Rice (palay)	3,263.33 kg/ha
Banana	2,838 pieces
Root crops	50.17 kg/ha
Price	
Coconut	PHP 18/kg and increases by PHP 1 every year
Abaca	PHP 45/kg of fiber
Rice (palay)	PHP 10.80/kg
Banana	PHP 1.43 per piece
Root crops	PHP 18/kg
Yield growth	5% per annum with proper cultivation and inputs; yield for the traditional practice is assumed to be constant
Years covered	five years (2014–2018)
Wage rate	PHP 200 per day
Cost of inputs	
Coconut	PHP 50.55 per tree for coconut for fertilizer
Rice (palay)	PHP 8,685.3/ha for fertilizer; PHP 1,374/ha for pesticides
Abaca	PHP 45,400 labor cost for best practice (227 man-days x PHP 200) PHP 7,600 labor cost for traditional practice (38 man-days x PHP 200)

Table 14. Net present values of benefits from agricultural crops, by farm practice, 2014–2018

Crops Planted	NPV (PHP/ha)		Total Area Planted (ha)	Total Value (PHP/ha)	
	Best Practice	Traditional Practice		Best Practice	Traditional Practice
Rice	92,813.62	63,870.77	55.93	5,191,065.95	3,572,292.34
Coconut	154,735.44	62,367.26	327.00	50,598,489.61	20,394,095.34
Abaca	128,754.07	6,425.20	4.00	515,016.29	25,700.81
Banana	346,877.31	15,464.53	4.00	1,387,509.23	61,858.14
Root crops	178,786.36	3,747.98	5.00	893,931.82	18,739.92

Note: NPV = net present value

The authors estimated the total provisioning values of land of the five study sites by multiplying the NPV (per hectare) to the total area (in hectares) devoted for each crop. The analysis showed that NPV per hectare of rice production in the traditional practice would be PHP 63,871 or (USD 1,458); while that in the best practice would be PHP 92,814 (USD 2,118) with a difference of PHP 28,943 (USD 660) (Table 14). For all the municipalities covered, NPV of rice production in the traditional practice is expected to be PHP 3,572,292 (USD 81,522); while that in the best practice would be PHP 5,191,066 or (USD 118,463).

The main difference between the two practices is the amount of fertilizer applied by the farmers. Accordingly, the difference in value would be a proxy of the value of the nutrients added coming from the fertilizer applied. In the analysis, the NPV of coconut production is predicted to be PHP 62,367/ha (USD 1,423/ha) in the traditional practice scenario, while that in the best practice would be PHP 154,735/ha (USD 3,351/ha). The total value of coconut production in the five municipalities is projected at PHP 20,394,095 (USD 465,406) in the traditional practice and PHP 50,598,490 (USD 1,154,689) in the best practice. This value included the value of copra only; other coconut products were not included in the analysis.

Abaca farms that use the traditional practice would have NPV of PHP 6,425/ha or USD 147/ha, while it would be PHP 128,754/ha or USD 2,938/ha in the other scenario. The total value of abaca production in the five municipalities would be PHP 25,701 (USD 587/ha) in the traditional practice and PHP 515,016 (USD 11,753) in the best practice scenario.

Banana production, on the other hand, would have an NPV of PHP 15,465/ha (USD 353/ha) for farmers in the traditional practice scenario, while it would be PHP 346,877/ha (USD 7,916/ha) in the best practice scenario. For all the municipalities, the NPV of banana production in farms with traditional practice would be PHP 61,858 (USD 1,412/ha), while that in farms with best farm practice would be PHP 1,387,509 (USD 31,664). The analysis also showed that there would be a wide gap in banana yield between the traditional and best farm practices. This is because most of the banana farmers in the study sites were applying less attention to banana production as compared to the production of the first three crops mentioned in Table 14. Root crop production was also expected to have lower yields than the other crops mentioned because root crops were not the main crop produced in the area; they were mostly for home consumption. The estimated NPV of root crop production in farms using traditional practice was PHP 3,748/ha or USD 86/ha, while it was PHP 178,786/ha or USD 4,080 in farms with best practice. The NPV of root crop production in all the municipalities covered is expected to be PHP 893,932 or USD 20,400 in the best practice scenario and PHP 18,740 or USD 428 in the traditional practice.

These findings show that if agricultural lands are well-maintained and if the needed soil nutrients are available for crop production, farm productivity can be sustained and can provide households with sustainable income. Section 3.2.1 has presented that only a small percentage of the respondents' household income came from farming; a greater percentage came from nonfarm activities. This implication is consistent with the data on national income accounts, which cite that the share of agriculture in the national income contributes about 20% only.

Currently, the Philippines is aiming for food self-sufficiency (i.e., rice), as evidenced by the various government programs being implemented that aim to increase rice production. The findings of this study can therefore be used to justify expenditures aimed at improving farm production (e.g., fertilizer and seed subsidy for rice) and budget allocation for research studies to improve farm production. With greater farm productivity, farmers' dependence on agricultural production as an income source will be restored, and this will accordingly increase the contribution of agriculture to the gross domestic product of the country.

Water resources. About 51% of the total respondents had their own water connection in their respective households. Some (10%) sourced their water supply from public faucets, which were communal to all residents in the community. A few (2%) sourced water from public wells (Figure 13). There were also privately owned and group-owned shallow tube wells, which served as sources of water. Water supply from private water connections were used for drinking, cooking, bathing, and washing. Generally, water was used for home consumption only; very few households mentioned using water for irrigation.

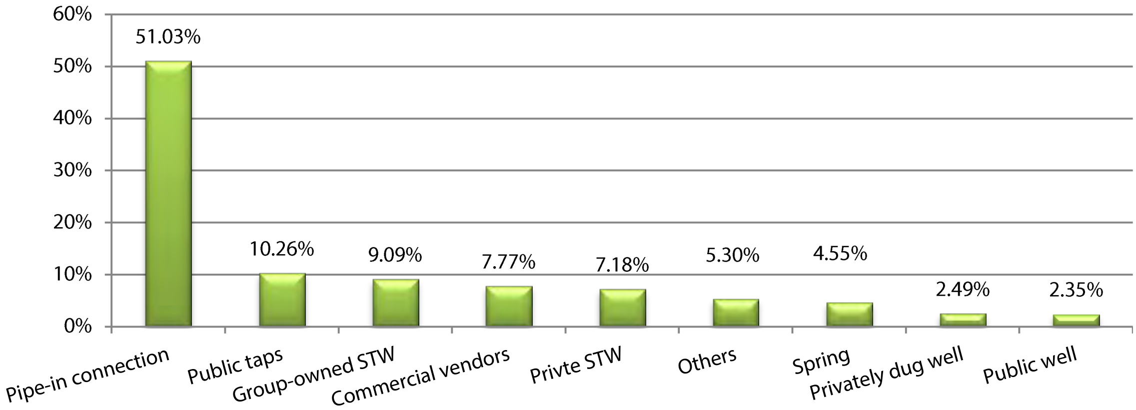


Figure 13. Sources of drinking water of households in the five municipalities

Water provision is one of the ecosystem services that the local communities around Sogod Bay derive from the forest. To estimate the value of this service, the authors estimated the total volume of water generated per municipality and collected data on the amount paid per household for their water supply. Only four municipalities were included in the estimation of water values; at the time of the study, Tomas Oppus have no public institution that supplied water to the local residents. The water districts in Libagon, Liloan, and Padre Burgos were imposing a uniform rate of PHP 15 per cubic meter (m^3) per month, while that in Sogod imposed a higher monthly rate of PHP 18/m^3 per month.

To estimate the total value of water services, the research team also determined the number of household water subscribers per municipality. The total value of water was estimated by multiplying the amount paid per household by the number of household subscribers. The analysis used 2013 data, which was provided by the water districts of the four municipalities.

Table 15 shows the results of the water valuation analysis for the 2013 period. The results showed that Sogod had the highest number of water subscribers in 2013 at 2,424 households. Accordingly, the municipality also had the highest water value (expressed in terms of the amount paid for water use) of PHP 695,688 per month or PHP 287 per month per household. The total value of water generated in 2013 in Sogod was PHP 8,348,256. Meanwhile, the total volume of water consumed by the 1,242 households in Libagon was13,099 m^3, with an average monthly amount paid per household equal to PHP 158. Libagon water users paid a total amount of PHP 196,487 per month for their water use. The value of the total volume generated was PHP 2,357,847. In Liloan, the total amount collected from all water consumers in the municipality was PHP 142,312 per month; while in Padre Burgos, it was PHP 256,440 per month.

Table 15. Valuation of water for domestic use, by municipality, 2013

Water Consumption	Liloan	Libagon	Sogod	Padre Burgos
Price (PHP/m^3)	15.00	15.00	18.00	15.00
Total number of consumers (in households)	759.00	1,242.00	2,424.00	964.00
Average volume consumed per month per household (m^3)	13.00	11.00	16.00	13.00

Table 15 continued

Water Consumption	Liloan	Libagon	Sogod	Padre Burgos
Total volume generated per month of all water subscribers (m^3)	14,605.00	13,099.15	5,8209.00	15,000.00
Average amount paid per month per household (PHP)	187.50	158.20	287.00	266.02
Average amount collected per month from all household subscribers (PHP)	142,312.50	196,487.25	695,688.00	256,440.00
Total amount paid for water (PHP)	**1,707,750.00**	**2,357,847.00**	**8,348,256.00**	**3,077,280.00**

Note: (1) Tomas Oppus was excluded because there was no metered water provided in the area at the time of the study; (2) According to the water districts in each municipality, the volume of water generated is the water consumed by all subscribers; it is the volume that water users pay per month. (3) The amount collected, as used in the table, refers to the total amount collected from all water users per month.

Note that this study estimated the value of water for domestic use only; other uses of water (e.g., water for agriculture and industrial use) were not included. This function of the ecosystem alone is enough reason to preserve or restore the forest resources in the area. If the other functions are included in the valuation (e.g., regulatory and support services) the value would be much higher than what has been shown in this study. Likewise, if these values will be part of the benefits derived from preserving the forest, it would provide a stronger argument for a policy that would promote sustainable management of a forest resource in Sogod Bay communities and for the province of Southern Leyte.

The water resources in the municipalities covered in this study are all managed and maintained by the water districts of each LGU. The concept of water charging for water by government is associated with Pigou (1952, p. 6) who stated that “It is the clear duty of the government which is the trustee for the unborn generations as well as for its present citizens to watch over and if need be, by legislative enactment to defend the exhaustible natural resources from rash and reckless exploitation.” According to Convery (2013), there is a substantial and convincing literature that cites that using price (rather than regulation) to reflect scarcity value of the environmental good yields a given level environmental quality at a lower cost and in creases innovation.

Most of those with household water connections are those residing in the town proper and those barangays nearby. The water sytem was established through a loan. The rate of P15/m^3 is the predetermined water rate to be imposed on water users that would enable concessionaires and the government to recoup their investments and pay for the loan within the prescribed period. The price does not reflect water scarcity because it is not based on the marginal cost of providing an additional unit of water. Those barangays far from the towns have their own water supply, which they themselves maintain by paying an amount ranging from P10 to P20 per month. The problem with this arrangement is that there is no incentive for them to save water because it is not metered and if there are repairs to be done, collection for the maintenance of these facilities become a problem. Tomas Oppus had no water connection at the time of the survey because they have yet to explore possible sources that can be tapped.

The current source of water would not be sufficient to meet the demands of all households if all barangays will be provided with water supply. Only those barangays within the vicinity of the towns have water connections. The LGUs are constrained from providing water supply to all barangays because of the needed infrastructure and funds to support it. Providing potable water to all households is one support that will improve well-being of the people in the area. Thus, both the local government and NGOs should promote policies that would protect the watershed of Sogod Bay. Pricing mechanisms that would reflect the demand for water should also be done through creating a market for water. The market viability of water needs appropriate technology to allow water to be diverted (e.g., measuring system) is crucial.

Coastal and marine fisheries. For the marine ecosystem, the authors calculated the provisioning function of coral reefs by estimating the volume of fish caught with and without MPA. The authors assumed that the coral reefs in the MPAs are healthy and that fish stock has improved when MPAs were established. The average fish catch data in 2014 was taken from the surveys, and this represented the fish catch for the *without MPA* case. Fishing efforts (i.e., labor and inputs) were included in the estimation (Table 16).

Table 16. Assumptions used in the benefit-cost analysis of fish catch, with and without marine protected areas

Attributes	With Marine Protected Area	Without Marine Protected Area
Average fish catch (t/ha)	20,000	1,497
Cost of establishing(PHP)	14,0150	0
Maintenance (PHP)	20,000	0
Warden (PHP)	90,000	0
Total cost of fishing effort (PHP)	250,150	0
Revenue (PHP)	2,000,000	149,742
Net(PHP)	1,749,850	149,742

Table 17. Benefit-cost analysis of fishery, with and without marine protected areas

Year	With Marine Protected Areas			Without Marine Protected Areas		
	Benefit	Cost	Net	Benefit	Cost	Net
1	2,000,000.00	1,749,850.00	250,150.00	1,497.42	0	1,497.42
2	2,000,000.00	1,749,850.00	250,150.00	1,497.42	0	1,497.42
3	2,000,000.00	1,749,850.00	250,150.00	1,497.42	0	1,497.42
4	2,000,000.00	1,749,850.00	250,150.00	1,497.42	0	1,497.42
5	2,000,000.00	1,749,850.00	250,150.00	1,497.42	0	1,497.42
	NPV = PHP 948,265.31/ha			**NPV = PHP 5,676.39/ha**		

The estimated NPV of the profit from fishing in the *with MPA* scenario is expected to PHP 948,265/ha; while in *the without MPA*, NPV would be PHP 5,676. In the *with MPA* scenario, the authors assumed that for every hectare of healthy coral reef, 20 tons of fish would be produced per year,[1] and that only the growth of fish stock would be harvested (Table 17).

The results of the analysis imply that establishing MPAs can restore the health of coral reefs, as evidenced by the significantly greater fish catch in the *with MPA* scenario than in the *without MPA* scenario. Almost all of the survey respondents have observed the declining fish catch in Sogod Bay, which has made them less dependent on fishery as an income source. Although establishing a marine sanctuary requires large financial outlay, the values of the benefits from having one is enormous as shown by the difference in benefits between the *without MPA* and *with MPA* scenarios.

4.0 CONCLUSIONS AND POLICY RECOMMENDATIONS

This study determined the status of the natural assets of Sogod Bay and determined how the provisioning services of these resources contribute to the well-being of the people in the area. The results of this study imply that the quality of these resources have degraded over time due to the local community's unsustainable use of these resources. Consequently, the capability of these ecosystems to provide services has also been affected.

Sogod Bay's fishery grounds have deteriorated through the years as shown by its declining fish catch, especially that of reef species and fishes of high economic values. Agricultural lands have shown declining productivity; but coconut farming has continued to be an important source of household income of the local communities. Abaca production, which used to be an important livelihood of the residents surrounding Sogod Bay, has been affected by the bunchy-top virus, which has adversely affected the residents' household income. Likewise, forest covers have declined, which has affected the wildlife residing in the forests. With this scenario, the range of goods that these ecosystems are providing have also declined, which resulted in the need for alternative livelihood sources to augment household income. Interventions to conserve natural assets in the area should start with identifying and providing livelihood opportunities and

[1] Expert assessment of Dr. Humberto Montes, Jr., research team member and Associate Professor and Director, Institute of Tropical Ecology and Environmental Management, Visayas State University.

installing mechanisms where payments for ecosystem services can be collected from the users. In Sogod Bay, payment for water for household use is currently administered by the water districts of each municipality. Rehabilitation of abaca and coconut farms is recommended, which can be done by replanting the farms with virus-free planting materials (in the case of abaca) and with early- and high-yielding coconut varities.

The results of the marine resources assessment indicate that the resources in those study sites with MPAs have high biodiversity. Brgys. Gud-an and Himay-angan in Liloan were the most diverse in seaweeds and seagrasses. Brgy. Gud-an had an MPA, while Brgy. Himay-angan was in the process of establishing a marine sanctuary at the time of the study. On the other hand, Brgys. Mac and Tampoong in Sogod had the lowest species diversity of seaweeds and seagrasses because most of the substrate in the areas is sandy, which is not favorable for the growth of such species. Meanwhile, Padre Burgos and Liloan (i.e., Brgys. Buenavista and Gud-an, respectively) also had high diversity values. This observation reflects the physical characteristics and the economic activities in these two municipalities. Liloan is on the tip of Sogod Bay, while Padre Burgos is on the other tip. The location of these two municipalities makes them less vulnerable to disturbances caused by human activities. Sogod municipality is in the middle. Sogod is considered a commercial center where most of the establishments are operating, including a quarrying business. The high biodiversity of seaweeds, seagrasses, and corals found in Brgys. Gud-an and Himay-angan may be because of the barangays' population sizes and locations (less prone to anthropogenic activities). Likewise, the residents of Liloan have been very involved in resource-conservation projects sponsored by a number of international agencies; thus, the concept of natural resources conservation was not new to its residents.

The marine ecosystem in Sogod was found to be more disturbed because Sogod is relatively more populated than the others, which consequently puts more pressure on natural resources. For example, the Subangko Daku River, where a quarrying business is ongoing, is widely used in Sogod. Moreover, the findings of the assessment also indicated the presence of sandy substrates near the mouth of the river. Another source of pressure on the natural resource in the area was the infestation of the abaca bunchy-top virus, which have wiped out almost all of the abaca farms around Sogod Bay. As a result, farmers shifted to fishing as a source of income.

Marine resources in Padre Burgos had high biodiversity, especially in the MPAs. They also had the biggest area for mangroves. The town also has diving sites because of the nice coral reef cover. This is also one reason why residents in the area are concerned with preserving their marine resources. Moreover, the town has also received assistance from international agencies in terms of information campaign for resource conservation.

The local communitie' have become less dependent on the natural assets for their livelihood as a result of the declining productivity of the ecosystems, particularly of land and marine resources. The provisioning function of these ecosystems has been significantly affected by anthropogenic activities like production and consumption. The results also reveal that the residents in the area have resorted to various nonfarm income sources to offset the lesser income received from farming and fishing. This indicates resiliency and innovativeness. This may also imply that alternative sources of income would lessen the pressure on marine and agricultural lands. Except for Libagon and Sogod, most of the towns covered do not have flatlands suited for rice cultivation because they are located along the coast; most of the crop productions are in the uplands.

The soil analysis also revealed that nitrogen was deficient in the research sites, especially in the rice fields of Brgy. Mac. Soil-based nutrient requirements were estimated as an output of this study. Accordingly, the municipal agriculturist offices of the municipalities covered in this study should reorient farmers on the importance of soil nutrients to plants. Implementing proper cultural and management practices is also recommended to improve farm productivity and to make farming an important source of livelihood.

The diversity values of the marine resources in those study sites with MPAs were high; this conforms to the expected results of MPAs. This finding is further corroborated by the valuation results, which show that the increase in benefits provided by MPAs outweigh the costs of establishing them. This implication would be useful in justifying those policies that would further improve the existing MPAs or that would promote establishing new MPAs in other localities in the area.

Brgy. Himay-angan in Liloan and Brgy. Higusuan in Tomas Oppus also had high biodiversity indices, although these two have no established MPAs. This can be attributed to the locations of the barangays that have made them less accessible to human activities. Brgy. Himay-angan is near the tip or at the mouth of Sogod Bay; thus, it is quite far from humans. On the other hand, Brgy. Higusuan in Tomas Opus is on the other side of Sogod Bay. These places with high diversity of marine resources are worth preserving through the establishment of marine sanctuaries.

Meanwhile, Sogod had the lowest biodiversity index. Brgy. Mac in Sogod had the lowest biodiversity index among the sampled barangays analyzed, while Brgy. Tampoong (also in Sogod municipality) was excluded in the species diversity analysis because none of the species analyzed were present in the barangay. Sogod is more populated than the rest of the municipalities studied; expectedly, there are lots of anthropogenic activities that have affected the quality of the marine resources in the area. Accordingly, the local government of Sogod needs to implement stricter laws in the use and management of natural resources in the municipality. In the past, there used to be abundant supply of frigate tuna in the area, but now they are lost because of overfishing.

The values derived in this study for the water resource is understated because it covered water for household use only. Other uses were not included such as water for agricultural and commercial uses. There is a need to review water-pricing policies to determine the most efficient water-pricing mechanism in the four municipalities (i.e., Tomas Oppus was excluded because there was no metered water provided in the municipality at the time of the study). Pricing should be market-based and should reflect water scarcity. Likewise, water quality in the four municipalities needs to be improved in order to encourage people to pay if ever there's an increase in water rates. At present, water in the municipalities studied is untreated and water availability is irregular. To improve the water service, additional funds are needed. If these will be generated by increasing water fees, then household users would be willing to pay if assured that water quality is improved.

The results of the marine ecosystem assessments have one common conclusion—the marine ecosystems in those areas with MPAs are healthy, particularly the coral reefs, sea grasses, sea weeds, and mangroves. Non-MPA sites with healthy coral reefs (e.g., Brgy. Higusuan) is a potential MPA site. Hence, there should be policies and support from the LGU and other organizations for the establishment of an MPA in those non-MPA sites in order to improve the marine ecosystem services in the area, and conquently improve the quality of life of the local residents. Likewise, efforts to rehabilitate the mangrove ecosystem should be continued, similar to the mangrove rehabilitation activities being implemented in Liloan and Padre Burgos. Proper care and management of new mangrove areas should be implemented to reduce mortality.

The local governments of the municipalities surrounding Sogod Bay—as well as the provincial government of Southern Leyte—should focus on promoting livelihood options for their fisherfolk and farmer households in order to augment their income. Likewise, rehabilitating those abaca farms infested with the bunchy top virus should be done using bunchy-top-free planting materials. Coconut farms also need to be rehabilitated, which can be done through planting early-maturing coconut varieties. This can address the problem of low-yielding coconut trees.

Lastly, considering the erosion-prone topography of the towns covered in the study, concerned government agencies, such as the municipal office of agriculture and the Philippine Coconut Authority, need to assist farmers on how to choose the right crops and technologies that would help control soil erosion. The results of the study have shown that only a few farmers adopt practices that would reduce soil erosion or that would improve/restore nutrients that are deficient. The only practice mentioned was crop rotation, which was done by a few of the farmers interviewed. As such, the results of the soil fertility assessment would be useful in formulating soil test-based fertilizer recommendations to monitor properly the soil health status in the area.

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APPENDIX

Table 1. Soil-test based fertilizer recommendation, by commodity, by municipality.

Top Commodity	Buenavista			San Juan			San Isidro			Higusoan			Tampoong			Maac			Pangi			Biasong			Himay-angan			Gud-an		
	Soil Test-Based Nutrient Recommendation			Soil Test-Based Nutrient Recommendation			Soil Test-Based Nutrient Recommendation			Soil Test-Based Nutrient Recommendation			Soil Test-Based Nutrient Recommendation			Soil Test-Based Nutrient Recommendation			Soil Test-Based Nutrient Recommendation			Soil Test-Based Nutrient Recommendation			Soil Test-Based Nutrient Recommendation			Soil Test-Based Nutrient Recommendation		
	Kg N	**Kg P_2O_5**	**Kg K_2O**	**Kg N**	**Kg P_2O_5**	**Kg K_2O**	**Kg N**	**Kg P_2O_5**	**Kg K_2O**	**Kg N**	**Kg P_2O_5**	**Kg K_2O**	**Kg N**	**Kg P_2O_5**	**Kg K_2O**	**Kg N**	**Kg P_2O_5**	**Kg K_2O**	**Kg N**	**Kg P_2O_5**	**Kg K_2O**	**Kg N**	**Kg P_2O_5**	**Kg K_2O**	**Kg N**	**Kg P_2O_5**	**Kg K_2O**	**Kg N**	**Kg P_2O_5**	**Kg K_2O**
Rainfed Rice (DS)	80	60	30	40	30	30	40	30	30	40	30	30	40	30	30	80	30	30	40	30	30	40	30	30	40	60	30	40	60	30
Rainfed (WS)	80	60	30	40	30	30	40	30	30	40	30	30	40	30	30	80	30	30	40	30	30	40	30	30	40	60	30	40	60	30
Corn	60	60	15	60	30	15	60	30	15	60	60	15	60	30	15	120	30	15	60	30	15	60	30	15	60	60	15	60	60	15
Sweet-potato	50	40	30	25	20	30	25	20	30	25	40	30	25	20	30	50	20	30	25	20	30	25	20	30	25	40	30	25	40	30
Taro	20	50	37.5	10	25	37.5	10	25	37.5	10	50	37.5	10	25	37.5	20	25	37.5	10	25	37.5	10	25	37.5	10	50	37.5	10	50	37.5
Banana	92	25	162.5	46	12.5	162.5	46	12.5	162.5	46	25	162.5	46	12.5	162.5	92	12.5	162.5	46	12.5	162.5	46	12.5	162.5	46	25	162.5	46	25	162.5
Coconut*	125	-	157.5	62.5	-	157.5	62.5	-	157.5	62.5	-	157.5	62.5	-	157.5	125	-	157.5	62.5	-	157.5	62.5	-	157.5	62.5	-	157.5	62.5	-	157.5
Coconut**	250	-	250	125	-	250	125	-	250	125	-	250	125	-	250	250	-	250	125	-	250	125	-	250	125	-	250	125	-	250

Table 2. List of all species observed during visual census at the 9 study sites in Sogod Bay, Southern Leyte.

TAXA (Family / Species)	COMMON NAME	Sites								
		1	2	3	4	5	6	8	9	10
ACANTHURIDAE										
Zebrasoma scopas	Twotone tang	0	0	0	0	1	2	0	0	0
APOGONIDAE										
Apogon aureus	Ring-tailed cardinalfish	5	0	20	0	0	4	0	0	0
Apogon bandanensis	Bigeye cardinalfish	0	0	0	0	0	0	0	0	1
Apogon compressus	Ochre-striped cardinalfish	30	0	4	0	6	0	3	0	8
Apogon nigrofasciatus	Blackstripe cardinalfish	0	0	0	0	0	1	0	0	0
Cheilodepterus quinquelinatus	five-lined cardinalfish	15	15	1	0	2	3	1	0	0
Cheilodipterus macrodon	Large toothed cardinalfish	0	0	0	0	0	0	0	0	1
Cheilodipterus nigrotaeniatus	Black-striped cardinalfish	0	4	0	0	0	0	0	0	0
AULOSTOMIDAE										
Aulostomus chinensis	Chinese trumpetfish	0	0	0	0	0	1	0	0	0

Table 1 continued

TAXA (Family / Species)	COMMON NAME	Sites								
		1	2	3	4	5	6	8	9	10
BALISTIDAE										
Rhinecanthus verrucosus	Blackbelly triggerfish	0	0	1	0	0	0	0	0	0
BLENNIIDAE										
Blenniidae sp. 1	unidentified	0	0	2	0	0	0	0	0	0
Meiacanthus grammistes	Striped poison-fang blenny	0	0	0	0	0	0	0	1	0
Salarias fasciatus	Jewelled blenny	0	0	0	0	0	0	1	0	1
CAESIONIDAE										
Caesio teres	Yellow and blue-back fusilier	0	0	0	0	0	1	0	0	0
Pterocaesio pisang	Banana fusilier	0	0	0	0	0	0	0	22	0
Pterocaesio tile	Dark-banded fusilier	0	0	0	0	0	0	0	2	0
CENTRISCIDAE										
Aeoliscus strigatus	Razorfish	0	0	0	0	0	13	16	10	0
CHAETODONTIDAE*										
Chaetodon baronessa	Eastern triangular butterflyS	30	0	0	0	9	10	1	0	0
Chaetodon octofasciatus	Eightband butterflyfish	0	0	0	0	3	3	3	0	0
Chaetodon trifasciatus	Melon butterflyfish	20	2	0	0	2	3	0	0	0
Chaetodon ulietensis	Pacific double-saddle butterflyfish	0	0	0	0	2	0	0	0	0
FISTULARIIDAE										
Fistularia commersonii	Bluespotted cornetfish	0	0	0	0	1	0	0	0	0
LABRIDAE										
Bodianus sp.		2	0	0	0	0	1	0	0	0
Cheilinus fasciatus	Redbreast wrasse	0	0	0	0	1	0	0	0	0
Cirrhilabrus cyanopleura	Blueside wrasse	0	0	0	0	0	0	0	1	0
Halichoeres chrysus	Canary wrasse	0	0	0	0	0	1	0	0	0
Hemigymnus melapterus	Blackeye thicklip	0	0	0	0	0	1	0	0	2
Hologymnosus doliatus	Pastel ringwrasse	0	0	0	1	0	0	0	0	0
Labridae sp. 1	unidentified wrasse 1	3	0	0	0	0	8	0	0	0
Labridae sp. 2	unidentified wrasse 2	0	1	0	0	0	0	0	0	0
Labridae sp. 3	unidentified wrasse 3	0	0	0	0	0	0	1	0	0
Labridae sp. 4	unidentified wrasse 4	0	0	0	0	0	0	0	0	1
Labroides dimidiatus	Bluestreak cleaner wrasse	2	9	2	5	2	5	0	5	5
Stethojulis bandanensis	Red shoulder wrasse	0	0	7	0	0	0	0	0	0

Table 1 continued

TAXA (Family / Species)	COMMON NAME	Sites								
		1	2	3	4	5	6	8	9	10
Thalassoma hardwicke	Sixbar wrasse	0	4	0	2	0	0	1	2	1
Thalassoma lunare	Crescent / moon wrasse	26	27	15	6	12	6	2	7	17
Thalassoma lutescens	Yellow-brown wrasse	1	1	0	2	2	0	0	0	9
LUTJANIDAE										
Lutjanus decussatus	Checkered snapper	0	0	0	0	3	3	0	0	0
MULLIDAE										
Parupeneus barberinus	Dash-and-dot goatfish	0	0	0	0	0	0	0	1	0
NEMIPTERIDAE										
Scolopsis bilineatus	Two-lined monocle bream	0	0	1	1	1	1	0	2	0
Scolopsis margaritifera	Pearly monocle bream	0	0	0	0	0	0	1	0	0
PINGUIPEDIDAE										
Parapercis clathrata	Latticed sandperch	1	1	0	0	0	0	1	2	0
PLOTOSIDAE										
Plotosus lineatus	Striped eel catfish	0	0	0	0	0	60	0	0	70
POMACANTHIDAE										
Chaetodontoplus mesoleucus	Vermiculated angelfish	0	0	0	0	2	0	0	0	0
POMACENTRIDAE										
Abudefduf sexfasciatus	Scissortail sergeant	0	0	2	0	25	0	0	0	0
Abudefduf vaigensis	Indo-Pacific sergeant	0	0	0	0	30	0	0	0	0
Amblyglyphidodon curacao	Staghorn damsel	0	0	7	10	16	11	0	1	0
Amblyglyphidodon leucogaster	Yellowbelly damselfish	0	0	0	0	8	0	0	1	0
Amphiprion clarkii	Yellowtail clownfish	8	0	7	3	3	0	1	0	0
Amphiprion frenatus	Tomato clownfish	0	1	5	0	2	3	3	3	0
Amphiprion ocellaris	False clown anemonefish	6	0	0	0	0	0	1	0	0
Amphiprion perideraion	Pink anemonefish	0	0	6	1	2	2	1	0	0
Amphiprion sandaracinos	Yellow clownfish	15	0	0	4	0	0	1	0	0
Chromis retrofasciata	Black-bar chromis	1	0	0	0	3	0	0	0	0
Chromis viridis	Bluegreen damsel	100	2	3	15	5	0	3	4	0
Chrysiptera parasema	Goldtail demoiselle	10	0	100	0	0	7	0	3	0
Chrysiptera rex	King demoiselle	0	0	70	24	0	0	0	94	5
Dascyllus aruanus	Whitetail dascyllus	30	20	73	13	9	2	17	0	0
Dascyllus reticulatus	Reticulate dascyllus	10	0	35	0	1	3	0	0	0

Table 1 continued

TAXA (Family / Species)	COMMON NAME	Sites								
		1	2	3	4	5	6	8	9	10
Dascyllus trimaculatus	Threespot dascyllus	0	0	6	4	0	0	0	0	0
Dischistodus perspicillatus	White damsel	0	0	0	0	0	3	0	0	0
Neoglyphidodon nigroris	Black-and-gold chromis	0	1	0	0	0	0	0	0	1
Neopomacentrus anabatoides	Silver demoiselle	0	0	0	84	18	0	5	10	0
Pomacentridae sp. 1	unidentified damselfish 1	0	0	0	0	0	0	4	0	0
Pomacentridae sp. 2	unidentified damselfish 2	0	0	0	0	0	0	0	4	0
Pomacentrus amboinensis	Ambon damsel	50	6	85	8	17	15	29	0	0
Pomacentrus brachialis	Charcoal damsel	45	21	90	20	0	10	12	72	25
Pomacentrus moluccensis	Lemon damsel	80	80	10	23	38	53	24	21	42
Premnas biaculeatus	Spinecheek anemonefish	6	0	0	0	0	0	1	0	0
SCORPAENIDAE										
Pterois antennata	Broadbarred firefish	0	0	0	0	0	0	0	1	0
Pterois volitans	Red lionfish	3	0	1	0	0	0	0	1	0
SERRANIDAE										
Pseudanthias huchti	Red-cheeked fairy basslet	150	0	0	0	0	8	2	0	0
Pseudanthias squamipinnis	Sea goldie	80	5	69	10	0	0	0	80	3
SPHYRAENIDAE										
Sphyraena flavicauda	Yellowtail barracuda	0	0	0	0	0	0	0	70	0
TETRAODONTIDAE										
Arothron nigropunctatus	Blackspotted puffer	0	1	0	0	0	0	0	0	0
ZANCLIDAE*										
Zanclus cornutus	Moorish idol	0	0	1	0	1	2	0	0	0
Ntotal (Nt)		**729**	**201**	**623**	**236**	**227**	**246**	**135**	**420**	**192**
N0 (Number of species)		**26**	**18**	**26**	**19**	**30**	**31**	**25**	**25**	**16**

Notes: (1) Families in **bold** have members that are commercially important. (2) Species with (*) are indicators.

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