Demonstration of the

Eco-town

Framework Project in San Vicente, Palawan, Philippines

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Foreword

The Philippines is one of the world's most vulnerable countries to climate change. As an archipelago consisting of more than 7,000 islands with a quarter of its population living below poverty level, the negative effects of climate change on the Filipino people are potentially severe and far-reaching. In the past several months, we have all witnessed the magnitude of devastation brought forth by climate change-related events to our people, and as we try to recover and rebuild, we are now more aware of the extent to which climate change could affect each one of us.

To help build the country's climate resilience and promote green growth, the Climate Change Commission (CCC) has partnered with the Global Green Growth Institute (GGGI) to implement the **Demonstration of Eco-town Framework Project** in the Municipality of San Vicente, Palawan. The project aimed to reduce the vulnerability of communities and ecosystems to climate change impacts and promote adaptation measures as drivers of economic growth. While actively involving the municipality and stakeholders, the project adopted a methodical approach in assessing climate change impacts. The project team used analytical tools, such as GIS-informed hazard and risk assessments, environmental and natural resource accounting, and vulnerability assessments to ensure that there was an objective basis for formulating practical interventions to mitigate these negative impacts.

This report, which integrates the project results and recommendations, is a key instrument to advocate climate change awareness and provide guidance to stakeholders and decision-makers in pursuing "ecologically stable" and "economically resilient" local communities. It comes at a very opportune time as we actively support the implementation of the National Climate Change Action Plan (NCCAP) at the local level.

The adoption of the project outputs by the Municipality of San Vicente, through Resolution No. 2014-16, paves the way for their institutionalization in the municipality's local development plans and the eventual translation of priority climate change adaptation measures into concrete local interventions. The experience of this project demonstrates that with partnership and technical assistance, local government units (LGUs), and communities can take leading roles in responding to the impacts of climate change at the local level.

Through similar initiatives, the CCC envisions the replication of project lessons in other localities to mainstream climate change awareness and action in the local development planning process and help empower LGUs and communities as our partners in pursuing climate resilience and green growth.

Secretary Mary Ann Lucille Sering
Climate Change Commission of the Philippines
Office of the President

Acknowledgement

This report is a result of the collaboration between the Climate Change Commission (CCC), the lead policy-making body of the Government of the Philippines (GoP) tasked to coordinate, monitor, and evaluate programs and action plans of the government on climate change, the Municipality of San Vicente in the province of Palawan, and the Global Green Growth Institute (GGGI), an international organization dedicated to developing and diffusing green growth as a new development paradigm.

This report contains the integrated results and analysis of the outputs within the project entitled “Demonstration of the Eco-town Framework in San Vicente, Palawan.” The project aims to build the resiliency of communities and ecosystems to the impacts of climate change while promoting climate change adaptation measures as new sources of economic opportunities. The contents were drafted by the technical teams of CCC and GGGI composed of:

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The local government officials, department heads, and the local residents of the municipality of San Vicente, Palawan – headed by Mayor Carmela “Pie” Alvarez, Vice Mayor Antonio Gonzales, and former Vice Mayor Romulo Molo – deserve much recognition for their cooperation during the entire implementation of the Eco-town Project.

Above all, the Eco-town Project would not have been successfully completed without the shared leadership provided by Secretary Mary Ann Lucille L. Sering (Executive Director) of CCC, and Mattia Romani (Deputy Director General), Imran Habib Ahmad (Regional Director), and Ho Seok Kim (Principal Economist) of GGGI. This endeavor will hopefully pave the way for further collaboration between CCC and GGGI in the years ahead.

Abbreviations and acronyms

AGR	Average Growth Rate
BAU	Business-as-usual
BPO	Business Processing Outsourcing
BUB	Bottom-Up Planning and Budgeting
C	Celsius
CBD	Convention on Biological Diversity
CBMS	Community-Based Monitoring System
CCA	Climate Change Adaptation
CCC	Climate Change Commission
CCCC	Cabinet Cluster on Climate Change
CCM	Climate Change Mitigation
CDP	Comprehensive Development Plan
CFWS	Cooperation Fund for the Water Sector
CI GRASP	Climate Impacts: Global and Regional Support Platform
CLUP	Comprehensive Land Use Plan
CLUWP	Comprehensive Land Use and Water Plan
COT	Crown of thorns
cu.m.	cubic meters
DA	Department of Agriculture
DBM	Department of Budget and Management
DEM	Digital Elevation Model
DENR	Department of Environment and Natural Resources
DMP	Development Market Place
DoE	Department of Energy
DoF	Department of Finance
DOH-NEC	Department of Health- National Epidemiology Center
DPSIR	Driving Force-Pressure-State-Impact- Response
DPWH	Department of Public Works and Highways
DTI	Department of Trade and Industry
EBA	Ecosystem-Based Approach
ECAN	Environmentally Critical Areas Network
EEA	European Environment Agency
ENR	Environment and Natural Resources
E-S-AC	Exposure-Sensitivity-Adaptive Capacity
FGD	Focus Group Discussion
FMB	Forest Management Bureau
FPIC	Free Prior and Informed Consent
GCM	Global Circulation Model
GDP	Gross Domestic Product
GEECHS	Global Environmental Change and Human Security
GFDRR	Global Facility for Disaster Reduction and Recovery
GGGI	Global Green Growth Institute
GIS	Geographic Information System
GoP	Government of the Philippines
GPS	Global Positioning System
IEC	Information, Education and Communication
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRRI	International Rice Research Institute
IVA	Integrated Vulnerability Assessment
KACCC	Korea Adaptation Center for Climate Change
KEI	Korea Environment Institute
km	kilometers
kph	kilometers per hour
LCCAP	Local Climate Change Action Plan
LDF	Local Development Fund
LDRRMF	Local Disaster Risk Reduction and Management Fund
LGU	Local Government Unit
LPG	Liquefied petroleum gas
m	meters
MAO	Municipal Agriculture Office
MDG-F	Millennium Development Goal Achievement Fund
MEEDO	Municipal Economic and Enterprise Development Office
MENRO	Municipal Environment and Natural Resources Office
MGB	Mines and Geosciences Bureau
mm	millimeters
MMTDP	Municipal Medium-Term Development Plan
MT	metric ton
NAMRIA	National Mapping and Resources Information Authority
NCCAP	National Climate Change Action Plan
NCIP	National Commission on Indigenous Peoples
NDRRMC	National Disaster Risk Reduction and Management Council
NEDA	National Economic and Development Authority
NFSCC	National Framework Strategy on Climate Change
NGA	National Government Agency
NGO	Non-Governmental Organizations
NIPAS	National Integrated Protected Areas System
NOAA	National Oceanic and Atmospheric Administration
NRA	Natural Resources Accounting
NSCB	National Statistics Coordination Board
NSO	National Statistics Office
OECD	Organization for Economic Cooperation and Development
OFWs	Overseas Filipino Workers
PAGASA	Philippine Atmospheric, Geophysical, and Astronomical Services Administration
PCA	Principal Component Analysis
PCF	Performance Challenge Fund
PCSD	Palawan Council for Sustainable Development
PDAF	Priority Development Assistance Fund
PHO	Provincial Health Office
PhP	Philippine Peso
PO	People's Organization
PRECIS	Providing Regional Climate for Impact Studies
PROFOR	Program on Forests
PSFB	People's Survival Fund Board
PSR	Presure-State-Response
RBB	Rice Black Bugs
RCM	Regional Climate Model
REECS	Resources, Environmental and Economic Center for Studies
RHU	Rural Health Unit
RIL	Rain-induced landslide
SCCF	Special Climate Change Fund
SCF	Strategic Climate Fund
SEEA	System of Environmental and Economic Accounting
SGP	Small Grants Programme
SIE	Statement of Income and Expenditure
SPI	Stream Power Index
TWI	Topographical Wetness Index
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UPLB	University of the Philippines Los Baños
USGS	United States Geological Survey
VA	Vulnerability Assessment
VBD	Vector-borne disease
WFPF	Water Financing Partnership Facility
WHO	World Health Organization
WRI	World Resources Institute

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Executive Summary

Eco-town Framework

The Philippines' promising economic outlook is being threatened by the adverse impacts of climate change. Being one of the most susceptible countries to changes in climatic conditions and natural disasters due to its geographical characteristics, the country needs a more proactive approach to adapt accordingly. The challenge lies in understanding the dynamics between the changing climate and the economic, environmental, and social dimensions of development.

Through the "Eco-town" framework, climate change response and green growth are synergized based on a systematic analysis of physical and economic resources, sectoral vulnerabilities, and adaptation measures. Eco-town, in the Philippine context, stands for "ecologically stable" and "economically resilient" local communities. It is a local planning unit (e.g., municipality) located within and around boundaries of critical key biodiversity areas, which are at high risk to climate change.

The project – **Demonstration of Eco-town Framework in the Philippines** – aims to build the foundation for establishing the Eco-towns by achieving the following objectives: (1) determine the available natural resources of the local unit and the vulnerability of its most crucial sectors vis-à-vis the impacts of climate change; (2) identify and prioritize the appropriate adaptation measures based on sound science and knowledge of the local community; (3) undertake climate proofing by mainstreaming the prioritized climate change adaptation measures into the local development plans.

The Project Site

The municipality of San Vicente in Palawan – a first-class municipality with a total land area of 165,798 hectares and population of 30,565 (as of 2010) – was prioritized as one of the pilot sites for the demonstration of the Eco-town framework for two reasons: (1) being a coastal municipality, it is perceived to be highly vulnerable to sea-level rise and coastal flooding; and (2) people's livelihood (farming, fishing and tourism) is highly dependent on natural resources, which are already being adversely affected by climate change, thereby exacerbating the poverty situation in the area.

San Vicente can boast for its 22 islands and islets serving as tourist attractions. Its largely untapped beaches, coral reefs, water falls, forest cover, and mangrove areas are home to 23 of the 25 wildlife species found in Palawan. Given its rich natural resource endowments, the municipality aspires to be a top tourist destination that strikes the balance between economic growth and environmental sustainability. In line with this, a Municipal Tourism Master Plan is now being prepared to optimize the economic benefits of a booming tourism, which is expected to bring positive spillover effects to other industries particularly infrastructure, services, and energy.

Climate Change in San Vicente

The baseline climate in San Vicente is characterized by Type III climate (seasons are not very pronounced, relatively dry from November to April, wet during the rest of the year). Climate projections reveal an increase in mean annual temperature by 0.8°C for 2020 and 1.8°C for 2050. Moreover, there will be shorter but drier dry season (about 25% decrease in rainfall) as well as longer and wetter wet season (approximately 60-115% increase in rainfall). The number of months with extreme rainfall during the wet season and in the number of days with rainfall greater than 300 mm is projected to increase.

The increasing rainfall and temperature over the past years has already inflicted serious damage to agriculture and fishery, the main sources of livelihood of the local people. A significant increase in the total annual rainfall in 2011 and 2012 led to flooding in low-lying areas and brought damage to crops. From 2006 to 2010, 8.34% of the total area cultivated for rice was affected every planting season by climate-related impacts such as delayed rainfall, continuous rain during the harvesting season, floods, droughts, and irregular planting season due to extreme events. On the other hand, the El Niño phenomenon in 1998 and 2010 caused coral bleaching that damaged a significant portion of the live coral cover, thereby affecting the quantity and quality of fish stock and other marine organisms.

Natural Resource Assessment

San Vicente is a farming community concentrated on rice (78%), which is mostly consumed by the households. Since a large majority of the rice produce does not make it to the market, San Vicente has a deficit in rice supply and thus imports from neighboring municipalities. Agriculture is not efficient enough to provide additional savings due to the fact that rice has a significantly lower land rent compared to assorted crops. Furthermore, production which largely depends on rainfed land and single cropping practice is expected to worsen the shortage in rice production.

While rice harvest mainly goes to feed the local population, earnings from fish catch serve as a major source of income for many households. Fisherfolks represent around 50% of the total number of households and over 90% of their fish catch made way into the market. However, although the fishery sector provides the bulk of local income, only about half of the fishing households were able to save. In addition, overfishing was found to already threaten the sustainability of the reef and fishery resources.

Despite the lush forest cover of San Vicente, the municipality barely obtains revenue from the forest as it is legally protected from exploitation. Present threats still prevail however, such as illegal cutting for boat making, lumber production, *kaingin*, fuel wood gathering and charcoal-making. Forest stocks are expected to decrease if interventions are not introduced to counter these threats.

It is worth noting that the aforesaid gaps in resource utilization will have considerable implications on future development, particularly on the tourism sector. Accommodating the influx of tourists will be proven challenging for San Vicente if the municipality cannot achieve self-sufficiency in producing its staple food, if coastal resources continue to deteriorate, and the forests remain simply protected as it can also serve as a major tourist attraction if managed sustainably. If San Vicente can manage to supply the sufficient amount of goods and services that a booming tourism industry requires instead of relying on external sources, this will allow the municipality to earn more economic rent.

Hazard and Vulnerability Assessment

Hazard. GIS-based hazard mapping and assessment was conducted to locate the areas within San Vicente that are most exposed to the three different types of climatic hazards – flood, drought, and rain-induced landslides. Overlaying the hazard maps to the land-cover maps (that provide information on environmental resources, economic activities, and population distribution) enabled spatial assessment of the level of impact. While a large majority of agricultural areas were found to be exposed to drought hazard, low lying areas of the river-bed and coasts were the primary areas exposed to flood hazard. For rain-induced landslide, San Isidro, Kemdeng, and New Agutaya were the barangays found to be most exposed both in terms of physical exposure and population exposure.

Agriculture. Based on the participatory approach to vulnerability assessment, San Vicente's more than 1,700 farmers will have to deal with decreased quantity and quality of yield due to climate change impacts as the 2,013 ha of rice farmlands and 992 ha of coconut farmlands are exposed to a range of climate-related effects such as infestation and depletion of soil nutrients, leading to a decrease in available arable land. Due to the prolonged dry season, the rice variety is susceptible to sterility while the coconuts, especially the matured ones, are prone to having reduced nutshells, desiccation of fronds, and shedding for young coconuts. Furthermore, the risk of higher mortality for about 4,000 work animals due to extreme weather events is high. Overall, this will have far-reaching socioeconomic implications such as food insecurity, malnutrition, and poverty especially on more than 200 farming households classified below the poverty threshold.

Coastal and Marine. Climate change impacts namely coastal flooding, coastal erosion, and sedimentation threaten the livelihood of around 8,000 fisherfolks who depend on 140,805.5 ha of municipal fishing ground zone, and more sensitive to these impacts are the estimated 300 fishing households below the poverty level. Moreover, the houses and other establishments located near the 120 km coastline faces the risk of being swept away by storm surge especially the structures made up of weak and light materials. Furthermore, 75% of the live coral cover faces the risk of coral bleaching due to drought as well as the 832 ha of mangrove forests. Since these resources provide a natural habitat for marine life, continuous depletion triggers fish migration, leading to decrease in fish stock and less variety of fish catch.

Health. The population of San Vicente is exposed to water-borne diseases (cholera and typhoid fever) and vector-borne diseases (malaria and dengue), which are both triggered by climate change. Aside from increased morbidity rate related to these health woes, other climate-induced impacts that require attention include health stroke and increased incidence of direct physical injuries and deaths due to extreme events. Most susceptible to these health threats are the 12,168 children aged 0-14 years old (39.5% of the total population) and 3,326 elderly aged 50 and over (10.8% of the total population). Households below the poverty (51.07%) and food (28.81%) threshold are also deemed more vulnerable.

Adaptive Capacity. Vulnerability to climate change impacts, as revealed by exposure and sensitivity, can be countered by adaptive capacity. Overall, San Vicente's adaptive capacity to respond to climate change leaves much to be desired. In the agriculture sector, for instance, San Vicente's capacity is limited to the presence of a very limited number of agriculture specialists and officials, use of alternative crops (root crops), training and seminar for farmers, and the like. The fishery sector has yet to be at par in terms of modernizing its fishing methods and processing facilities to adapt to the evolving pressures on the coastal and marine resources. Likewise, the capacity of the local public health infrastructure and human resources remains inadequate to cater to the increasing population, including tourists.

Prioritization of Adaptation Measures

Based on a comprehensive analysis of San Vicente's development priorities, natural resources, hazards and risks, and climatic vulnerability, a menu of adaptation measures was put forward through the consultation between the local stakeholders and the local and foreign experts. The task of prioritizing adaptation measures is critical to planning due to limitation in resources to finance all identified options. Through multi-criteria analysis, several options were prioritized based on effectiveness, cost, technical feasibility, social and cultural feasibility, required time, and sustainability and overall impact. It is also worth noting that in the course of prioritization, the current adaptive capacity of the municipality was also taken into consideration.

Agriculture. Some of the prioritized options for agriculture are grounded on the modernization of farming practices and technology to increase productivity. These include the construction of additional automatic weather stations and small scale irrigation facilities; training on alternative livelihood (non-timber forest product); establishment of farmers' field schools and programs; introduction of new climate-resilient crop varieties, including hybrids; and alteration of cropping calendar and practices to adjust to changing climate patterns.

Coastal and Marine. Top measures for the coastal and marine sector are targeted to save the depleting coral reefs, promote sustainable utilization of marine resources, and prepare for natural catastrophes in the coastal areas. Specifically, the proposal highlights the establishment of sea walls and dikes in Port Barton; setting up of early warning system; mangrove deforestation; total fish-catch monitoring including illegal fish catch practices; organizing and strengthening fisherfolk organizations; undertaking herbivore seeding and creating the necessary mix of marine habitat types to enhance coral resiliency; training for alternative livelihood; involving private sector in coastal planning and management; conducting trainings and orientation on disaster risk reduction and management, and the like.

Health. The adaptation measures for health seeks to address the primary vulnerabilities specifically the climate-induced diseases and hazards. The prioritized options include the provision of clean and adequate water supply system, insecticide impregnated bed nets, and rapid treatment strips for malaria and water tablets. As preventive mechanisms, promoting regular health weighing and monitoring; training on early detection/treatment of infectious, water/vector-borne diseases; public health and hygiene training for the youth; and increased enrolment in health financing facility (PhilHealth) are paramount.

Climate Proofing

To implement the proposed tailor-made adaptation measures, San Vicente needs to incorporate them into development planning to enable development priorities to be pursued in the context of current and future opportunities presented by climate change. Climate proofing is a critical part of development planning since climate change cuts across a wide array of sectors such as health, agriculture, water, and infrastructure, among others, as shown in the results of the vulnerability assessment for San Vicente. Moreover, mainstreaming climate change into the Comprehensive Development Plan (CDP) and the Comprehensive Land Use Plan (CLUP), and down to the level of more specific local plans such as Annual Investment Plans (AIP), Executive Legislative Agenda (ELA), and the like requires the participation of various stakeholders to achieve a mix of perspectives on development issues and their linkage to climate change.

In line with this, a climate proofing workshop was conducted, where the results of the assessment were presented to the local officials and stakeholders. Moreover, the existing CLUP and CDP were also reviewed through a climate change lens to see how the prioritized adaptation measures could be incorporated. As a preparatory step, the local stakeholders have already expressed their interests in taking into account the results and recommendations of the project in drafting the Municipal Tourism Master Plan. The whole climate proofing exercise enabled the local leaders to gain a deeper understanding of the link between Eco-town and green growth, and heed the urgency of revising their local development plans in response to the pressing development challenges. As such, they have agreed to provide a time frame for revising their local plans and also conveyed their willingness to explore various funding sources from the national government and foreign donors to finance the adaptation measures.

It is worth noting that in the context of climate proofing, strong relationship between adaptation measures and economic activities are apparent. Conventional approaches often set apart climate change adaptation and economic growth as distinct processes. However, the menu of risks and adaptation measures identified by the local stakeholders were directly or indirectly related to economic activities. Thus, there is a need to carefully assess the economic implications of climate change adaptation, specifically delving into how adaptation efforts can serve as a driver of innovation and economic growth.

Way Forward

The Demonstration of Eco-town Framework in the Philippines supports key aspects of green growth by reducing vulnerability to climate change, thereby enhancing resilience, as well as prioritizing adaptation measures that are framed within the local economic development model. This goes to show that although climate change presents daunting challenges, it can serve as a strong catalyst to positive green growth transition. The necessity of identifying and implementing the appropriate adaptation measures, highlighted in the Eco-town framework, therefore holds promising outcomes toward achieving climate-resilient green growth.

Finally, it is also crucial to emphasize that climate proofing is just an initial step toward becoming an Eco-town. San Vicente can rightfully consider itself as an Eco-town if it successfully implements the adaptation measures proposed in its revised local development plans. San Vicente can serve as a role model for other LGUs in demonstrating green growth as a solution to achieve climate-resilient growth and sustainable local development. It can also initiate the shift of green growth momentum from the LGU to the provincial, national and sectoral level, thereby embedding green growth as a core strategy in development planning at all levels.

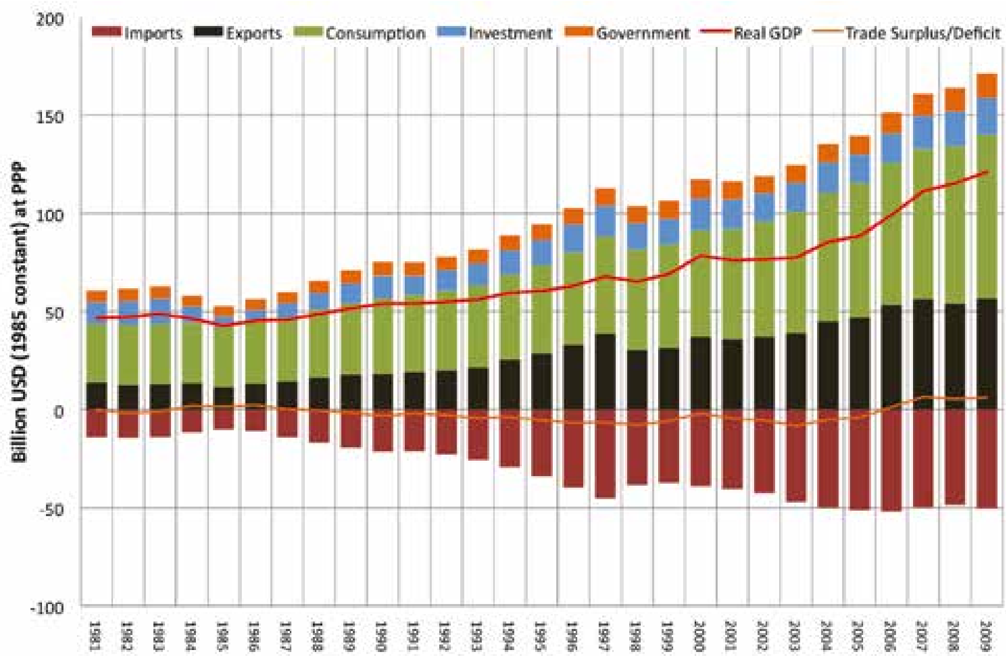
Chapter 1
Introduction

Figures and tables

A. The Philippines: Economically robust but environmentally fragile

The Philippines has been achieving steady economic growth in the past years. As one of the emerging markets in the world, the country reached a gross domestic product (GDP) growth rate of 6.8% in 2012 despite the global economic downturn. By the first quarter of 2013, it posted a robust growth rate of 7.8%, the highest in Asia, followed by China and Indonesia. Against this backdrop, the Philippines has obtained investment rating upgrades from credit rating agencies such as the Fitch Group and Standard & Poor's. Noting that the Philippines has more growth momentum than the rest of the world, the International Monetary Fund (IMF) raised its growth forecast from 6% to 7% for 2013 and from 5.5% to 6% for 2014.

Such notable economic performance is driven by several factors: the booming business process outsourcing (BPO) industry, thriving mining and construction sector, strong domestic consumer and government spending, and increasing remittances from Overseas Filipino Workers (OFWs), among others. The country's favorable economic fundamentals are sustained by its young demographics, where the bulk (62.3%) of the country's population is of working age (15-64).



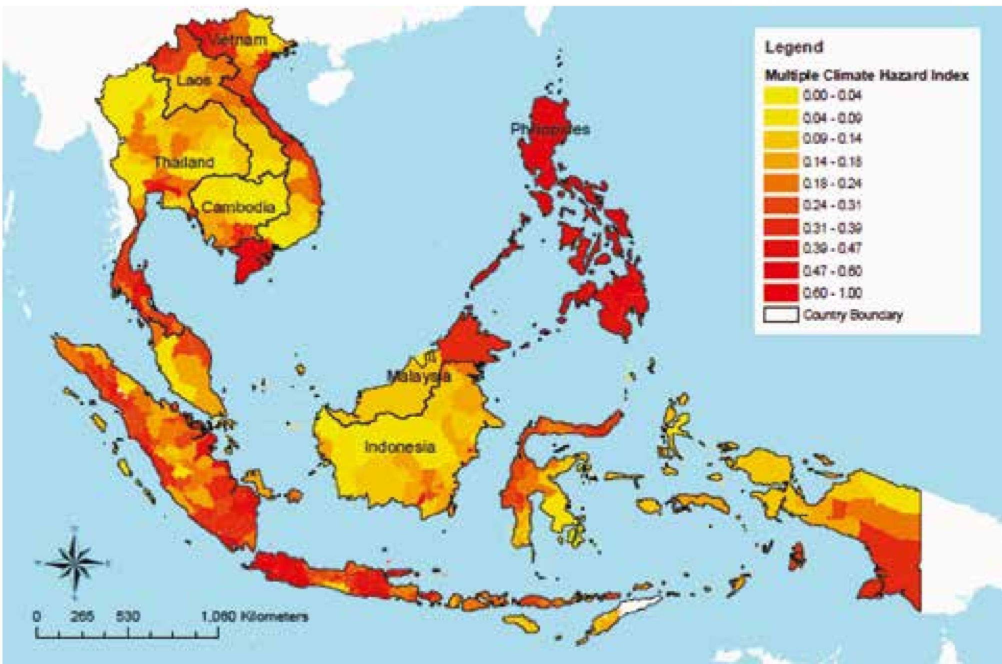
Source: Economist Intelligence Unit

Figure 1.1. The Philippines' real GDP growth and its components (1981-2009)

While the overall economic landscape of the Philippines looks promising, the harmful impacts of climate change pose a serious threat and might eventually offset the development gains achieved in recent years. The United Nations noted that vulnerability to climate change will be greater in developing countries located in warmer latitudes, such as the Philippines. Although it is not a significant emitter of greenhouse gases, the Philippines is among the world's most vulnerable countries to climate change due to its archipelagic characteristics and location. These factors make the country more prone to tropical cyclones, with an average of 19 typhoons annually.

The *2013 Global Climate Risk Index* ranked the Philippines 4th among the 190 countries cited as the worst affected by extreme weather events such as storms and flooding (Eckstein and Harmeling, 2012). Moreover, in the *2012 World Risk Report*, published by the United Nations University's Institute for Environment and Human Security and the German Alliance Development Works, the Philippines ranked 3rd in the list of the most vulnerable countries to natural disasters. Maplecroft's *2013 Climate Change Vulnerability Index* ranked Manila as the 2nd most at risk city from the changing temperatures and weather systems that are projected to take hold in the coming years. *The Climate Change Vulnerability Mapping for Southeast Asia* revealed that the Philippines is more susceptible to climate change risks than other Southeast Asian countries, with 16 of its provinces included in the 50 most vulnerable areas in the region (Yusuf & Francisco, 2009).

Looking at the Philippines' location, climate, and topography, the country is highly exposed to a range of climate-related hazards such as typhoons, floods, landslides, and droughts. Being largely dependent on natural ecosystems and climate conditions for productivity, the Philippines is vulnerable to the brunt of climate variability and extremes, which are expected to intensify as the climate changes.



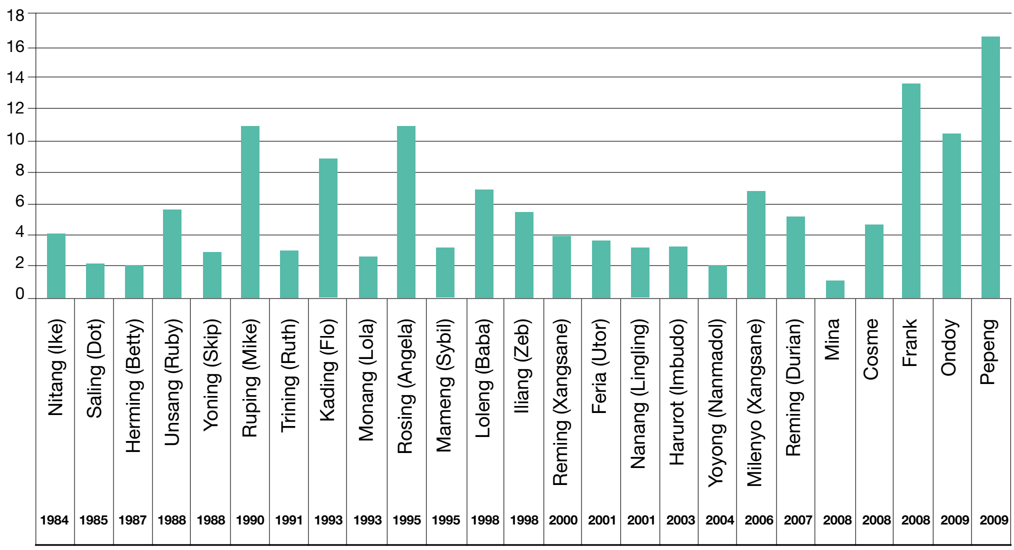
Source: Yusuf & Francisco, 2009

Figure 1.2. Climate change vulnerability map of Southeast Asia

Disaster risk and climate change are considered as threats to development that adversely reinforce each other. Studies have shown that climate variability and extremes increases disaster risk through its effect on the magnitude and frequency of hazards, inflicting numerous deaths and significant economic losses each year. In developing countries, disasters represent a major source of risk for the poor and can potentially destroy development gains, threaten the sustainability of development process and undermine progress towards meeting the Millennium Development Goals (O'Brien, 2008). Natural calamities can strain the national budget and oftentimes, divert funds urgently needed for development activities. Limited resources meant to finance basic services such as farm to-market roads, school buildings, and low-cost housing are instead re-channeled to post-disaster reconstruction and rehabilitation efforts.

Impacts of climate variability and extremes are further complicated by the fact that poor communities, which are most vulnerable to natural disasters, are often the least prepared. Although the Philippines has been achieving steady economic growth recently, the benefits are yet to trickle down to the poor and unemployed to make growth more inclusive. The National Statistics Coordination Board (NSCB) noted that despite impressive economic growth rates, poverty remains rampant and high at 27.9% in the first half of 2012.

Given the widespread poverty in the Philippines, improving the poor's adaptive capacity to climate change remains a big challenge. Failing to empower the poor, which makes up almost one-third (27.9%) of the total population, threatens to inflict immense cost on life and property. Inaction will continue to inflict worse occurrences of typhoons, floods, droughts, deterioration of biodiversity, crop failure, and increased health risks. In this regard, the *Philippines' Initial National Communication on Climate Change in 1999* perceives climate change as an existential threat to the Philippines: "Climate change is a very emotional subject for the Philippines, because the issue is viewed not only as causing additional economic burdens, but as a critical factor that would determine its survival as a nation.."

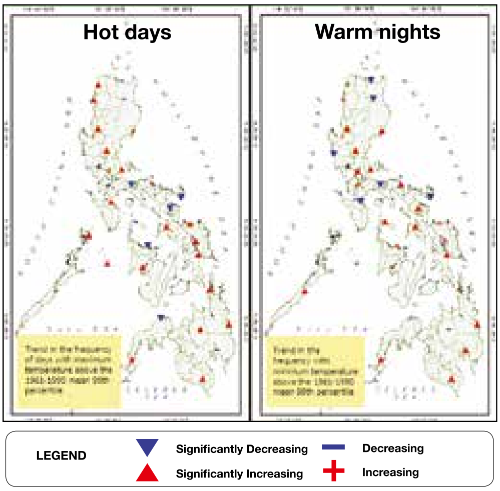


Source: Office of Civil Defense-Natural Disaster Risk Reduction and Management Council

Figure 1.3. Increasing damages from floods in the Philippines in billion pesos (1984-2009)

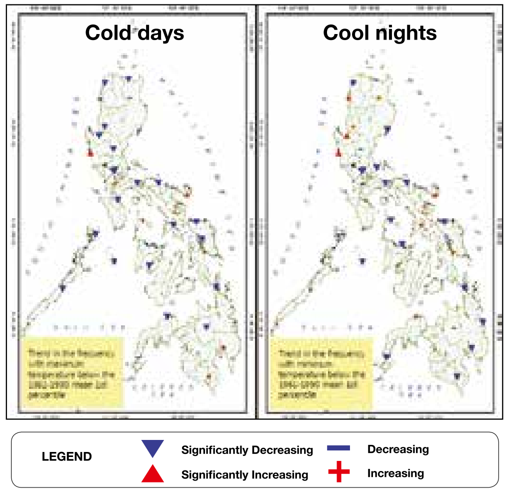
B. National climate change projections

The *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC) concludes that the warming of the climate system is unequivocal. The Philippines, like the rest of the world, has been experiencing an increase in average temperature over the past years. Significant trends of increasing number of hot days and warm nights and decreasing number of cold days and cool nights are evident; signifying that both maximum and minimum temperatures are generally getting warmer (**Figures 1.4 - 1.5**). The Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) recorded a mean temperature increase of 0.57°C or an average of 0.01°C per year increase from 1951 to 2010. Furthermore, there has been a slight increase in the number of cyclones in the Visayas from 1971 to 2000, in comparison with the periods of 1951 to 1980 and 1960 to 1990.



Source: PAGASA

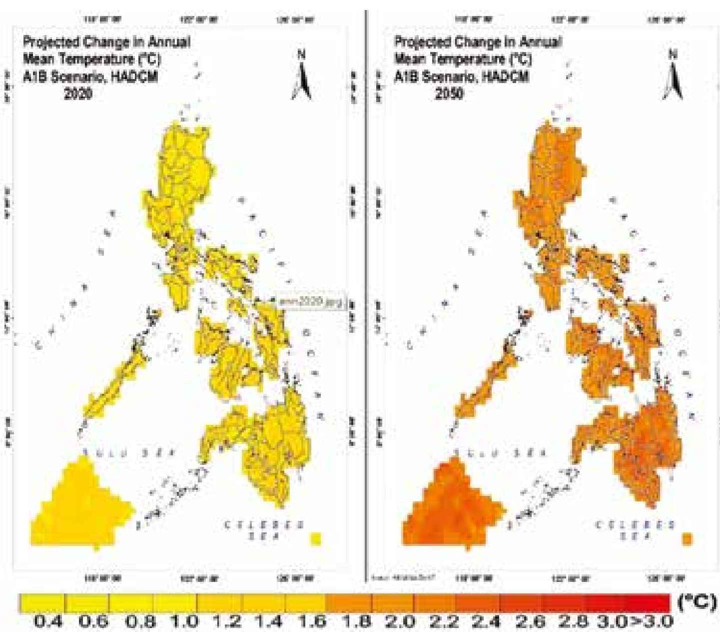
Figure 1.4. Significant increase in the frequency of hot days and warm nights in the Philippines



Source: PAGASA

Figure 1.5 Significant decrease in the frequency of cool days and cold nights in the Philippines

Climate change scenarios[1] provide characteristics of plausible future climates and are constructed using climate models. PAGASA used the Providing Regional Climate for Impact Studies (PRECIS) Regional Climate Model (RCM) in order to generate projections of



Source: PAGASA

Figure 1.6. Projected change in annual mean temperature in 2020 and 2050

1 A scenario is “a plausible description of a possible future state of the world” (Parry and Carter, 1998). In the context of climate change, climate scenario is not a forecast or a prediction but alternative views of what the world could look like in the future because a precise forecast of the climate is not possible. Climate scenarios help structure our knowledge (or ignorance) of the future. It is necessary to provide data for impact and adaptation assessment studies, strategic planning, and policy-making.

temperature increase and rainfall changes in the country in 2020 and 2050. The projections for temperature increase, rainfall changes and projected frequency of extreme temperature and extreme rainfall under the high and the low scenarios, are presented in the two time frames (2020 and 2050).

Under the mid-range scenario (A1B)[2] relative to the baseline (1971-2000) climate, PAGASA projected an increase in mean temperature by 0.9°C to 1.1°C in 2020 and by 1.8°C to 2.2°C in 2050. All areas in the Philippines will get warmer, with largest increase in temperatures during summer months of March, April and May (MAM). season, while an increase is expected in Luzon and Visayas during the southwest monsoon (*Habagat*) and transition seasons of June through November (PAGASA, 2011). Increase in frequency of extreme weather events will be observed, while the intensity of extreme events is expected to heighten with the increasing risks of floods and droughts (Pulhin et al., 2010). Such changes will have adverse impacts on health, agriculture, forestry, and water resources, among others, such as decrease of rice yield and bleaching of coral reefs caused by a warmer sea surface temperature. Typhoon-related damages are already causing a large impact in the economy, amounting to 2.9% of the Philippines' GDP in 2009. In a survey commissioned by the World Bank (2013), eight out of 10 Filipinos said that they are experiencing the impacts of climate change in their daily lives.

Climate change experts anticipate more extreme weather events, but their severity and location are difficult to predict. Preparation for more frequent occurrence of flash floods, landslides (as a result of intense rainfall or flood water), storm surges, man-induced floods such as breaches of embankments, and new cases of floods in areas not previously prone to flooding, such as urban areas, are of paramount importance.

C. The Philippines' strategy on climate change

The country adopted the *Philippine Agenda 21* as its own national agenda toward sustainable development in 1992 as a commitment to the United Nations Conference on Environment and Development (UNCED). To address the growing perils of climate change, the Philippines, being a signatory and thus, a Party to the United Nations Framework Convention on Climate Change (UNFCCC) made a landmark legislation called the *Climate Change Act of 2009* (*Republic Act No. 9729*). Immediately after the enactment of the law, the Climate Change Commission (CCC) was created and two of its most significant outputs are: the **National Framework Strategy on Climate Change 2010-2022 (NFSCC)**, which provides the national framework how to achieve sustainable development goals while enhancing the country's ability to respond to climate change; and the **National Climate Change Action Plan 2011-2028 (NCCAP)**, which outlines the priority programs and activities related to climate change.

The CCC is an independent and autonomous body that has the same status as that of a national government agency. It is directly attached to the Office of the President and is the lead policy-making body of the government tasked to coordinate, monitor, and evaluate the programs and action plans of the government relating to climate change. Its advisory board is composed of secretaries from all national departments, presidents of the leagues of local government units (LGUs), and sectoral representation from the academe, business, and non-governmental organizations. **Figure 1.7** illustrates the CCC organizational structure.

The NFSCC, adopted in April 2010, guides the national as well as the sub-national planning processes over the next 12 years to achieve a "climate risk-resilient Philippines with healthy, safe, prosperous and self-reliant communities and thriving and productive ecosystems."

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2 According to IPCC, A1B scenario implies medium emissions (rapid economic growth with decreasing reliance on fossil fuels). The other scenarios are A2 (high emissions – high population with strong emphasis on economic development) and B1 (a more environmentally sustainable approach with lower consumption and lower population growth).

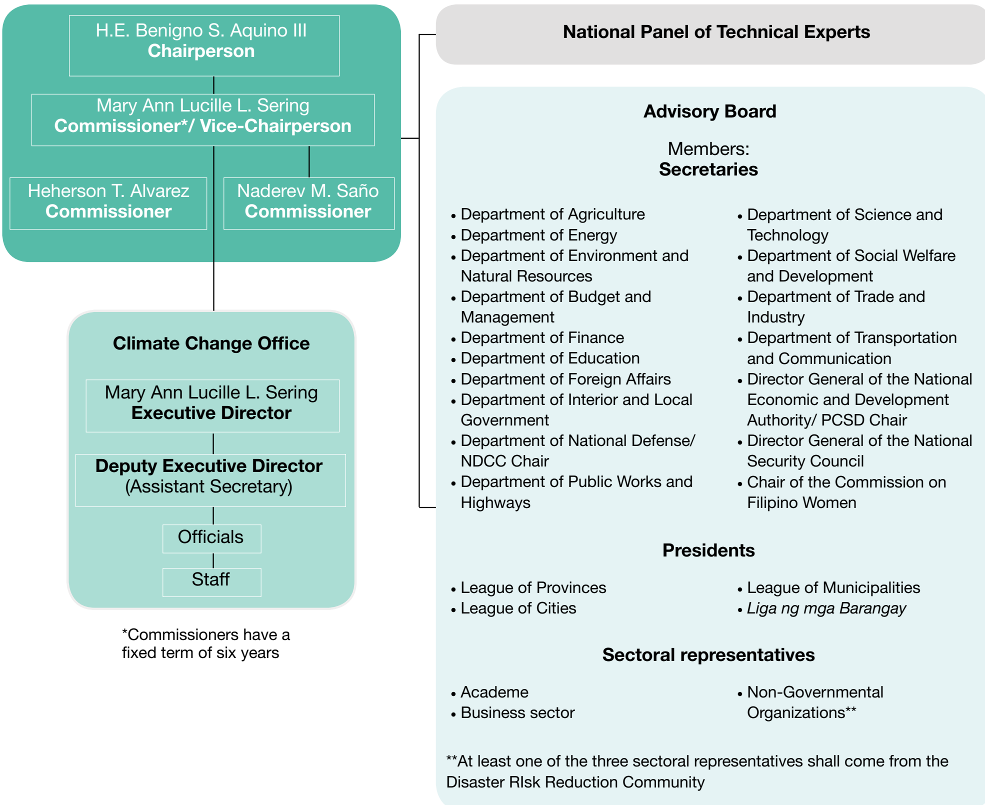


Figure 1.7. Simplified organizational structure of the CCC

It seeks to enhance the resilience and adaptive capacity of communities and natural ecosystems to climate change, anchored on the pillars of adaptation and mitigation.

Although the Philippines' policy on climate change recognizes the importance of both mitigation and adaptation, NFSCC puts emphasis on adaptation as the anchor strategy while mitigation serves as a function of adaptation. This is due to the fact that even if greenhouse gas emissions are reduced significantly in the coming years, climate change impacts such as gradual temporal and spatial shifts in drought, floods, severe weather events, and sea-level rise are still likely to manifest with higher frequency and intensity. Such climate change impacts make adaptation an urgent and enormous challenge in the country considering its limited resources and high level of vulnerability.

The NFSCC has been translated into the NCCAP, which assesses the current risks to climate change and outlines strategic direction for 2011 to 2028. Within the two long-term objectives of adaptation and mitigation, it pursues seven strategic priorities, namely:

- Food security
- Water sufficiency
- Ecosystem and environmental stability
- Human security
- Climate-smart industries and services
- Sustainable energy
- Knowledge and capacity development

Themes	Food Security	Water Sufficiency	Ecosystem and Environmental Stability	Human Security	Industries and Services	Sustainable Energy	Knowledge and Capacity-building
Subject of Assessment	Agriculture, Fisheries	Watersheds, River Basins, Infrastructure	Ecosystems, Environment	Communities	Industries and Services, Infrastructure	Energy Systems, Transport Systems	
Scale of Assessment	Provincial level	Provincial level and Regional level	Provincial level and Municipal level	Provincial level	Nationwide	Nationwide	
Government Institution	DA	DENR, DPWH	DENR, DA	NDRRMC	DTI, DPWH, DENR	DoE, DOTC	

Source: NCCAP

Table 1.1. Where Eco-town stands in the seven priority goals of the NCCAP

The NCCAP is a comprehensive plan. It seeks to build the adaptive capacity and resilience of communities and natural ecosystems to climate change, adopts the total economic valuation of natural resources and recognizes the competitive advantage of putting value on the utilization of natural resources as a short to long-term sustainable development goal. As shown in **Table 1.1**, the Demonstration of the Eco-town Framework is nestled under the NCCAP's themes as it is considered as the implementation of the NCCAP at the local level. It promotes the ecosystem-based approach of environmental management, an integrated strategy to manage land, water and natural resources based on the principles of conservation, equitability, and sustainability to maintain the natural structure and functioning of ecosystems. Further discussion on the ecosystem-based approach will be tackled in the next chapter.

D. Eco-towns: A brief history

Climate change impacts are predicted to worsen the poverty incidence in the Philippines and will in turn, increase the vulnerability of about a third of its population living below the poverty line and who are heavily dependent on natural resources for subsistence. In response, the CCC led the demonstration of a framework determined to increase the resiliency of local communities to climate change impacts while boosting economic growth at the same time – the Eco-town.

Notably, the concept of "Eco-town" did not originate from this Project. It is also worth noting, however, that the concept of Eco-town in this particular context is different from the typical Eco-towns in other countries. More information about how the Eco-town was conceptualized in the Philippines and its difference from the typical Eco-towns will be tackled in the next chapter.

Several Eco-town projects have been pursued in different countries in the past although each case varies in its conceptualization and implementation. For instance, the Ministry of Economy, Trade and Industry of Japan launched in 1997 an Eco-town project in Kitakyushu, a city located in the northern part of the region of Kyushu and is within the Fukuoka Prefecture. Eco-town, in this context, is a special community where strict adherence to international standards on eco-friendly practices was promoted as a way of life. It sought to solve the prevailing waste management problem and to stimulate domestic growth in a sustainable and environment-friendly manner.

Following the success of several Eco-towns in Japan, the International Environmental Technology Center (IETC) of the United Nations Environment Program (UNEP) has also established Eco-towns in Penang (Malaysia), Bandung (Indonesia), and Shenyang (China). According to IETC, Eco-towns refer to “urban planning and environmental management approach where industries located in the designated area pursue synergies in resource utilization, waste management, environmental preservation, and promotion of industrial and economic development.” Eco-towns, in this particular case, strive to enhance productivity, while reducing environmental impact through the effective use of tools, techniques, and technologies.

In the United Kingdom, on the other hand, the Eco-town concept emerged as a way of ecologically addressing the housing shortage in Britain in 2007. It involved the establishment of new towns in England to serve as exemplary standards of environmental sustainability. These communities are designed as models of zero carbon settlements using new design and architecture approaches. Eco-towns have also been established in other parts of Europe such as Adamstown in Ireland, Amersfoort in the Netherlands, Hammar by Sjöstad in Sweden, and Hafen City, Kronsberg and Freiburg in Germany. There are also Eco-towns in Mesa del Sol in New Mexico and Babcock Ranch in Florida, United States.

E. The Demonstration of the Eco-town Framework in the Philippines

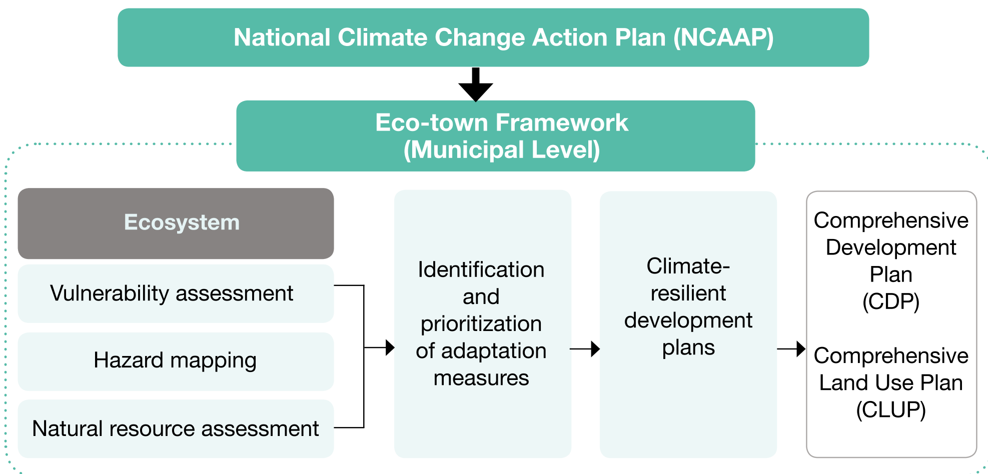
A synergistic development in CCC’s efforts to pursue climate change adaptation and attain resiliency of livelihoods is the execution of a *Memorandum of Understanding* between CCC and the Global Green Growth Institute (GGGI) signed in October 2011, in order to jointly pursue, cooperate and promote green growth programs and activities in the Philippines. This was followed by another milestone in strengthening the ties between GGGI and the Government of the Philippines, when the Philippines signed GGGI’s *Establishment Agreement* on June 21, 2012 and ratified on October 9, 2012, thus becoming one of the founding members of GGGI.

Through this partnership, the implementation of NCCAP at the local level using the Eco-town framework will enable communities to be climate change-resilient, ecologically sustainable, and economically thriving. The CCC has adopted the Eco-town Framework to model Climate Change Adaptation (CCA) and develop Climate Change Mitigation (CCM) projects at the local level. Ten municipalities were prioritized by the CCC for the implementation of the Eco-town Project, five of which are covered under the GGGI-CCC collaboration. Specifically, these are the municipalities of Del Carmen, Pilar, San Benito, and San Isidro in the province of Surigao del Norte and the municipality of San Vicente in Palawan. As a partner research institute, the Korea Adaptation Center for Climate Change (KACCC) provides advisory services to GGGI toward the successful implementation of the project.

The Philippines’ concept of an Eco-town shares the widely accepted idea that Eco-towns are sustainable communities in harmony with the environment, but is set in a rural context. Eco-town stands for “ecologically stable” and “economically resilient" local communities. Moreover, an Eco-town is a planning unit composed of municipalities or a group of municipalities located within and around boundaries of critical key biodiversity areas, which are at high risk to climate change. Eco-towns will be built around protected areas and key biodiversity areas, using ecosystem management-based approach to enable communities to become ecologically and economically stable.

As indicated in the NCCAP, an Eco-town is an area designed with considerations to: (1) environmental impacts and protection of ecosystems, (2) efficient use of land, energy, water and food (i.e., eco-efficient), (3) minimization of waste outputs, and (4) creation of sustainable jobs. The cruxes, therefore, of Eco-towns are the creation of the smallest possible ecological footprint, reduction of its overall contribution to climate change, and building resilient communities and ecosystems.

The vision behind the promotion of the Philippine Eco-towns will be achieved by implementing sound climate change adaptation measures based on hazard analysis, vulnerability assessments, and natural resource assessments. While the Eco-towns from other countries mostly focus on mitigation (e.g., zero carbon footprints, recycling, etc.), the Philippines' version of Eco-town emphasizes adaptation. This initiative is the first of its kind at the municipal level that attempts to integrate and mainstream climate change adaptation measures, together with disaster risk reduction in the local development plans, programs, and activities to promote green growth.



Note: The Comprehensive Development Plan and Comprehensive Land Use Plan are the plans to be submitted by the local government units to the central government as mandated by the Local Government Code of 1991.

Figure 1.8. The Demonstration of the Eco-town Framework is the implementation of the NCCAP at the local level

1. Objectives

Vulnerability and adaptation assessment will be designed to provide baseline information useful in understanding the areas' vulnerability to climate change and the identification and implementation of adaptation measures for integration in the development planning.

Specifically, the Project aims to achieve the following objectives:

1. Determine vulnerability and risks of the ecosystems, communities and infrastructure vis-à-vis the impacts of past, present, and future climate change in the project sites;
2. Identify and characterize adaptation measures;
3. Prioritize the adaptation strategies through an integrated adaptation assessment;
4. Develop menu of adaptation (and mitigation) measures for the different sectors; and

5. Develop capacities of implementing partners (LGUs and communities) in terms of climate-smart planning, implementation, and monitoring and evaluation through capacity-building workshops and actual site visits.

In summary, the Demonstration of the Eco-town Framework Project seeks to recognize and foster the role of the local governments as front liners in addressing climate change risks as mandated in the NFSCC. It also builds the adaptive capacity of communities, seeks ways to increase the resilience of natural ecosystems to climate change, and optimizes opportunities for economic growth towards sustainable development.

2. Project sites

Siargao Island in Surigao del Norte and San Vicente in Palawan are projected to be among the most vulnerable areas to climate change and, thus, have been prioritized as pilot sites for the Demonstration of the Eco-town Framework. It is worth noting that both areas belong to island provinces that are prone to sea-level rise and inundation. The selected project municipalities also have alarming poverty levels, despite the abundance of natural resources in their respective areas.

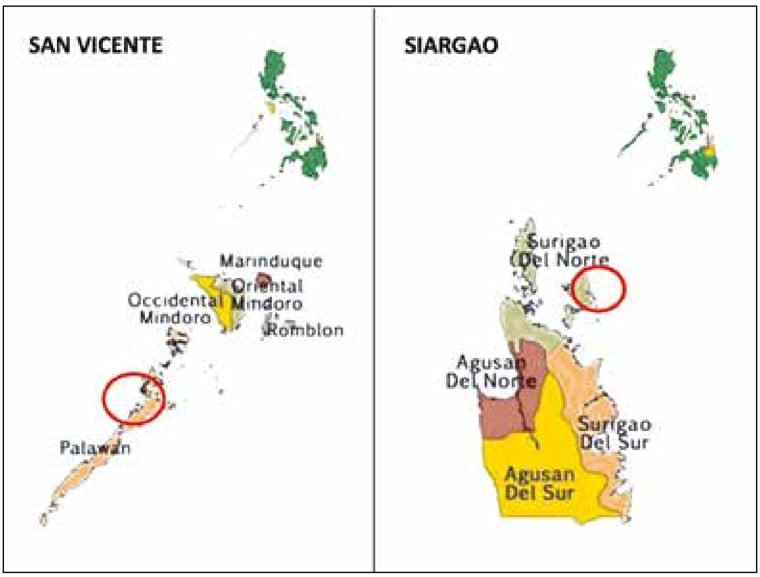


Figure 1.9. Location of the Eco-town project sites

Note that while GGGI supported five Eco-town project sites in Palawan (San Vicente) and Surigao del Norte (Del Carmen, San Isidro, Pilar, and San Benito), this report will solely focus on the case of San Vicente, Palawan since GGGI funded all the components of the Eco-town project in this municipality. In the case of Siargao, GGGI only financed the conduct of the socio-economic profiling, vulnerability assessment, and GIS mapping; the remaining activities of the Eco-town framework were supported by other development agencies.

3. The Eco-town and Green Growth

Green growth is aimed at creating a new development paradigm in which the conflicting goals of economic growth and protection of environment are no longer seen as such (GGGI, 2011). Green growth is the only way forward to achieve sustainable development and alleviate poverty in the long term (OECD, 2013). Pursuing green growth by developing countries is crucial for their future and offers significant socio-economic benefits over time.

The Demonstration of Eco-town Framework supports key aspects of green growth by reducing vulnerability to climate change, thereby enhancing resilience, as well as prioritizing adaptation measures that are framed within the local economic development model.

Climate resilience is an important facet of green growth. The World Bank (2012) puts green growth as the efficient use of natural resources, minimization of environmental impacts, and resilience from natural hazards. Likewise, the OECD (2013) emphasized that “green growth cannot be sustained without resilience to climate change impacts and natural disasters and protecting human well-being and natural and economic assets.” The resilience of communities, which encompasses a wide range of socio-economic and environmental systems, confronts a plethora of development challenges such as rapid population growth, increased levels of economic activity, and worsening natural catastrophes.

The Eco-town Project intends to reduce climate risks through a systematic assessment of vulnerability followed by the prioritization of adaptation measures aimed at reducing sensitivity and increasing adaptive capacity of local communities to respond to climate risks. This will hopefully result in better management of ecosystem resources that promotes strong and sustainable growth simultaneously. In this case, climate change adaptation (CCA), much like climate change mitigation, is perceived in a positive light; it can be a driver for innovation and an engine for economic growth. CCA plans, when integrated with green growth, can serve as a catalyst for positive economic transformation, emphasizing a better balance of growth, resource-use, and equity. Therefore, economic growth and climate change adaptation are not distinct processes that can be set apart – the needs for adaptation is an opportunity as much as it is a challenge across all sectors of the economy to transform the way they operate.

Green growth departs from traditional growth models by integrating environmental considerations and the value of natural capital into economic and development decision-making (OECD 2011). In the process of climate proofing of municipal development plans, a systematic analysis of the natural resource endowments of the localities under study will provide an objective basis for assessing the overall vulnerability of the municipality, followed by the recommendation of appropriate adaptation measures. Climate proofing the Comprehensive Development Plan (CDP) and the Comprehensive Land Use Plan (CLUP) – which contain the long-term vision of the municipality, and identifies development goals, strategies, objectives, and targets that serve as primary inputs to investment programming and subsequent budgeting and program implementation – is envisaged to go beyond assessing the climate risk of existing productive assets and practices, but also frame adaptation measures in a way that could serve as a driver for economic development. This will ensure that green growth is pursued at the heart of development planning and hopefully, in implementation.

In the process of climate proofing the existing productive assets, this explains why a significant portion, if not all, of the risks and adaptation measures identified by the local stakeholders are related, directly or indirectly, to their income-generating activities. This heightens the need to carefully assess economic implications of climate change adaptation efforts. The policy recommendations put forward in the revised development plans are envisaged to facilitate growth of potential employment and other economic opportunities.

In the final analysis, while climate change presents daunting challenges, it can serve as a strong catalyst to positive green growth transition. The necessity of identifying and implementing the appropriate adaptation measures highlighted in the Eco-town framework holds promising outcomes toward achieving climate resilient green growth.

Chapter 2

Methodology

Figures and tables

A. Conceptual framework

As a means to localize the implementation of the NCCAP of the Philippines, the Eco-town was conceptualized and developed by the CCC in order to create climate change-resilient communities. Eco-town touches upon the key aspects of green growth – environmental sustainability and economic stability – by addressing the impacts of climate change especially in the communities and ecosystem.

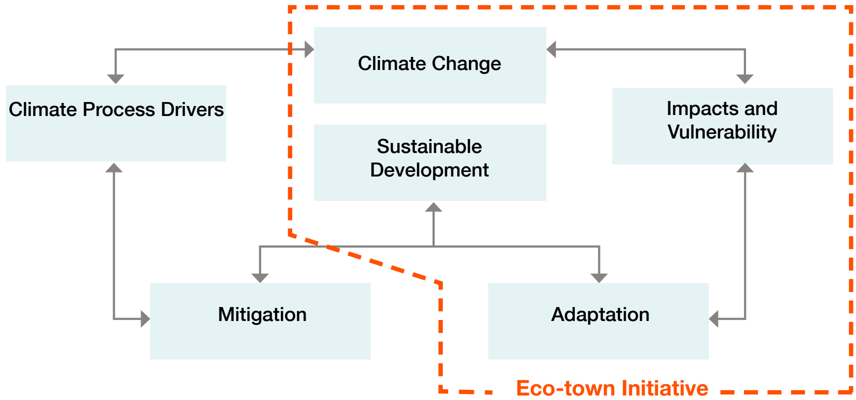


Figure 2.1. The scope of the Eco-town framework in advancing the Philippine climate change policy

The changing climate conditions will have a myriad of impacts and underscore the vulnerabilities in all sectors of society and the economy. Addressing climate change moves beyond the environmental challenges and will have to be closely linked with economic targets and social sustainability. Based on the country experiences, implementation of the *Philippines Agenda 21's (PA 21)* three pillars (economic development, social development, and environmental protection) of sustainable development should be realized both at the local and national levels.

Impacts of climate change are felt across all sectors, hence, adaptation measures should be as comprehensive as possible. One approach to implementing adaptation is through ecosystem-based approach (EBA). According to the *Convention on Biological Diversity* (CBD), "the ecosystem-based approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way". The objective is to maintain the natural structure and functioning of ecosystems from the upland (ridge) to the coastal lowlands and water (reef). Ecosystem-based approaches address the crucial link between climate change, biodiversity, sustainable resource management, and land and water uses, thus providing multiple benefits. The Eco-town framework addresses the drivers and pressures of climate change in an ecosystem-based approach toward sustainable development and green growth.

B. Assessment tools

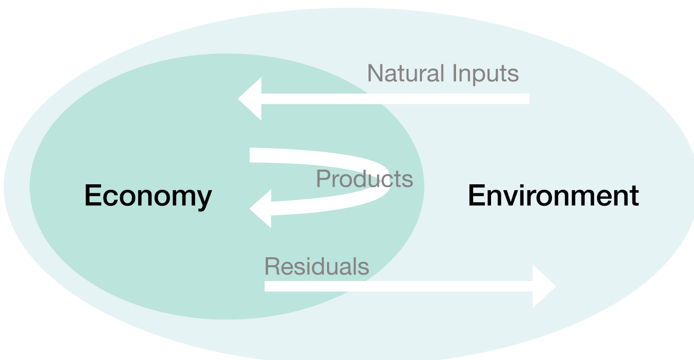
1. Natural resources accounting

The Philippine government espouses that economic valuation of natural resources and recognition of the significance of putting value on the environment and natural resources' uses are among the key actions to help achieve the goals of the NCCAP. It called for the institutionalization of natural resource accounting to determine the cost to the environment and the government when resilience of ecosystems is not built.

Given that the Eco-town aims to increase both the adaptive capacities of the communities and the natural ecosystems and highlight climate-resilient green growth, the natural resource assessment (NRA) can be used to establish the baseline resources and ecosystem services that will provide local policy makers sound data for decision-making. In particular, NRA enables the appropriate pricing for the resources and services to inform policymakers on the appropriate resource or land use allocation that considers climate projections.

The NRA framework

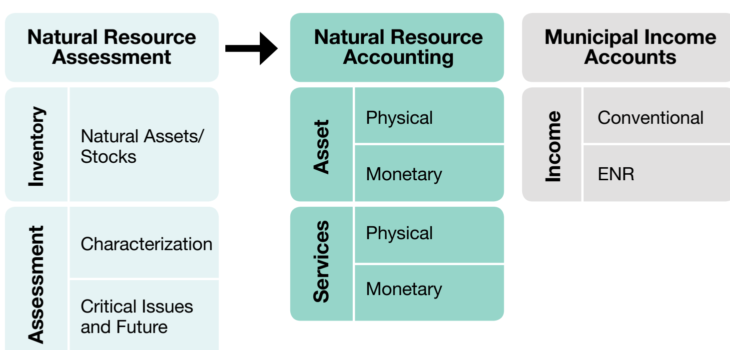
The measurement of the relationship between the economy and the environment focuses on the physical flows of the natural resources. The environment provides natural inputs to the economy, making it possible for the economy to produce goods and services. Goods are produced within the economy, while their production in the economy yields to residuals which flow back to the environment. These residuals may either be recycled for the production of goods or released to the environment, such as solid waste, air emissions, or return flows of water (Committee of Experts on Environmental Economic Accounting, 2012).



Source: Adapted from the UNCEEA, Revisions to the SEEA: Chapter 1, Draft Version, 2011

Figure 2.2. Relationship between the economy and the environment

Figure 2.2 shows how the NRA illustrates the relationship between socio-economic systems and natural resources. This relationship consists of the provision of various environmental services to human population. **Figure 2.3** shows the NRA's study framework, which is a combination of the physical assessment of the natural resources and the ecosystems, the natural resource accounting of sectors and the greening of income accounts. The sectors



Source: Resources, Environment and Economics Center for Studies, Inc., 2003

Figure 2.3. The NRA's study framework

assessed are based on the existing natural resources in the project site as well as the priorities of the local government in terms of natural resources management.

a. Physical assessment

The physical assessment of the natural resources involves the inventory of stocks, characterization of resources, and the critical issues and future opportunities for sustainable resource use. The project had conducted actual inventory as well as household surveys, focused group discussions and key informants interviews. Specifically, the project activities related to NRA include the following:

Agricultural Resource Accounting is based on the data collected from household survey in the municipality, as well as information gathered through key informant interviews and available secondary data.

Forest Resource Assessment entailed sampling inventory on the ground to determine the stand structure and volume of the forests, tree plantation, and non-timber forest products. Key informant interviews were conducted on illegal harvesting of forest products, *kaingin* farming (slash-and-burn) and other types of forest utilization.

Manta Tow Survey is a quick survey method to provide a general illustration of the different coral covers in the project site.

Coral Cover Assessment is aided by the photo transect method that is used to get the percentage benthic cover of the coral community in the area.

Reef Fish Assessment was done by underwater fish visual census technic utilizing the same transect for the coral community assessment.

b. Natural resource accounting

The accounting approach used in the study followed the general structure in the United Nations System of Environmental and Economic Accounts (SEEA) Central Framework. As shown in **Table 2.1**, the measurements are comprised of the physical flows of materials and energy within the economy; as well as between the economy and environment, stocks of assets and changes in the stocks, and the economic activities and transactions related to the environment.

c. Municipal Income Account

Year 1 Physical account: Area and harvest	Year 1 Monetary account: Peso value
Opening stock	**Opening stock**
Plus	**Plus**
Growth: Natural in growth, man-made growth (area and product quantity)	Growth: Natural in growth, man-made growth, reappraisal of economic value
Less	**Less**
Reduction: Mortality, harvest, natural causes, land use conversion	Reduction: Mortality, harvest, natural causes, land use conversion, reappraisal of economic value of reductions
Closing stock	**Closing stock**

Source: United Nations System of Environmental and Economic Accounts (SEEA) Central Framework

Table 2.1. Physical and economic accounting methodology for natural resources

Source: Resources, Environment and Economics Center for Studies, Inc., 2013

Figure 2.4. Steps in incorporating the missing values in the SEEA Framework

Under this project, the municipal government's income and expenses account is initially assessed and analyzed in order to determine its actual and potential links with the environment and natural resources (ENR). Moreover, economic rents in the forestry, fishery and agriculture sectors are estimated to measure the income that particular natural resources have generated, or the resource value that has been extracted out of the natural resource stock. This also determines if there is sufficient savings for the future generation to restore the depleted natural resources stock and degraded ecosystem services.

Prior to the development of the natural resources and asset accounts for the municipality, the local government's income and expense account was initially assessed and analyzed to determine its actual and potential link with the environment and natural resources. The assessment included reviewing the income sources of the local government and how much of this income is contributed by the natural resources and services; the extent of local government spending specifically for management and protection of each natural resource sector; and how much savings the municipality generates and how these savings are used. It utilized the general System of Environmental and Economic Accounting (SEEA) framework in the development of an environmentally adjusted municipal income account. Given the limitation encountered in terms of data availability, the municipal gross domestic product (GDP) was computed through the income-expenditure approach and the savings of households, businesses and government was derived, apart from accounting for the depreciation of the physical capital.

Municipal Investment
Expenditures = Municipal GDP – Consumption Expenditures -
Taxes + (Taxes – Government Expenditures)

→ SSH+SB+SG = D + Additional Capital
Household Savings (SHH) + Business Savings (SB)
+ Government Savings (SG) =
Investment Expenditures (consisting of Physical Capital
Depreciation (D) + Additional Capital

With Municipal GDP – Depreciation =
Municipal Net Domestic Product
and
Depreciation is shouldered by households and businesses

Net Savings of households + SG = Additional Capital (natural and human)

2. Hazard assessment

Hazard assessment involves the study of hazards to determine their potential, origin (e.g., geologic or hydro-meteorological), extent and impact characteristics including their magnitude and frequency, historical behavior, and triggering factors. In general, the process is used to determine the hazard types to be considered. The assessment is based on a comprehensive list that includes any hazard type with a reasonable probability of occurring within the study region in a given one-year period. It is noted, however, that practical limits exist on data availability (especially on considerations on frequencies and probabilities) on certain hazard types. Hazard maps[1] available for use typically define levels of proneness and form the basis for determining risk levels.

The data sources for hazard identification and inventory can include weather officials, seismologists, engineers, science specialists, emergency management personnel, building officials and other experts, as well as the mandated agencies. Subject to information and data availability, the following are the categories of natural hazards that are covered in the assessment:

- Mass movement (rain-induced landslides)
- Flood and coastal hazard
- Drought hazard

Theoretically, the hazard map should provide the spatial extent or distribution of a hazard event given a probability of occurrence. The hazard map is used to determine the specific parts or areas that will be affected by the hazard. To ensure long-term sustainability and respect institutional mandates, maps currently available and sourced from mandated government agencies were the basis of the assessment. Available hazard maps are then refined and/or validated using the following methodology:

- Literature research
- Morphostructural interpretation of available satellite imagery, aerial photographs, 1:50,000 scale NAMRIA topographic maps
- Site visits and field validation
- Review of historical data

a. Determination of exposed elements

The exposed elements is defined as the population, aggregated built-up areas (i.e., residential and non-residential) and agricultural areas. These elements formed the bases of the hazard assessment.

Population: The exposed population was derived by overlaying the hazard map with the population density map. The basic unit of analysis was the *barangay*.

Land use: Procedurally, the exposure in terms of land uses was derived by overlaying the hazard map with the land use map. Note that the method was limited to available land use maps of the municipalities.

b. Analysis of population exposed to hazards

This assessment involved the identification of the population (and certain sectors) exposed to the hazard (i.e., rain-induced landslide). The analysis includes the magnitude or the proportion of the exposed population. Additional assessment included the proportion or

1 Hazard map is defined as the map with predicted or documented extent of a hazard, with an indication of probability of occurrence (Gouldby and Samuels, 2005).

number of *barangays* that may be significantly affected (e.g., *barangays* with more that 50% of its population affected). The analysis also looks into potential implications on the land use and planned activities, including the following:

- Exposure of the population centers to a specific or combination of hazards
- The exposure of the high population growth or urban *barangays* to a specific or combination of hazards
- The identification of less exposed area/s for future development and/or expansion (or growth spatial directions)

c. Analysis of spatial extent to hazards

The importance of undertaking hazard analysis vis-à-vis vulnerability assessment is underscored in the NCCAP, which calls for a more interlinked analysis of climate change adaptation and disaster risk reduction since most disasters are also climate-related. The overlay of the hazard map and the base map (i.e., topographic map with administrative/ municipal boundaries) led to the determination of areas covered or affected by the various levels of hazard susceptibility. The results of the map overlaying step was analyzed using a working table with areas segregated at the level of the *barangays*. The analysis was in the context of its impact on the land use and planned activities, such as:

- Proportion (%) of *barangays* that may be affected
- Proportion (%) of *barangays* that may be significantly affected (e.g., *barangays* with more that 50% of its area affected)
- Proportion (%) of urban or highly populated/developed areas that may be affected
- The identification of less vulnerable area(s) for future development and/or expansion (or growth spatial directions)

3. Vulnerability and adaptation assessments

The study underscores the importance of conducting vulnerability and adaptation assessments toward achieving the objective of building the adaptive capacity of community and increasing the resilience of natural ecosystems to climate change. The study of the vulnerability of human and natural systems to climate change and variability, and of their ability to adapt to changes in climate hazards, is a relatively new field of research that brings together experts from a wide range of fields.

The main goal of vulnerability assessment is to understand the nature of threats and subsequently use such understanding to formulate policies to avoid or mitigate the threats. In the context of climate change, efforts to lessen or prevent the threats from happening are called adaptation (Eriksen and Kelly, 2007; Perez and Gotangco, 2013). This study intends to view adaptation as a potent tool to seize the opportunities associated with climate change. While climate change poses daunting challenges to growth and environmental sustainability, it also presents critical opportunities if the proper adaptation strategies are put in place.

Vulnerability framework

Vulnerability, as used in this project, is defined by the IPCC and adopted in the *Republic Act No. 9729* as the "degree to which a system is susceptible to or unable to cope with, adverse effects of climate change, including variability and extremes". It is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity and adaptive capacity. Vulnerability to impacts is a multi-dimensional concept, encompassing bio-geophysical, economic, institutional, and socio-cultural factors. Vulnerability is usually considered to be a function of a system's ability to cope with stress and shock (Smith, 1992).

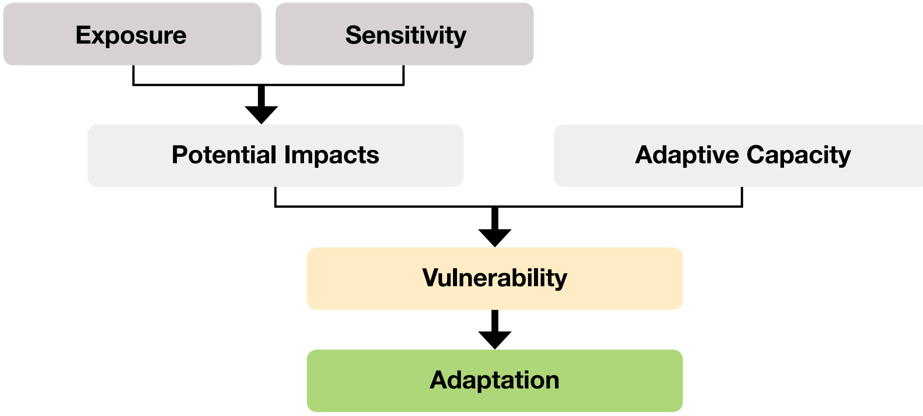


Figure 2.5. Exposure-sensitivity-adaptive capacity continuum

Vulnerability = f (Exposure, Sensitivity, Adaptive Capacity)

Exposure is the nature and degree to which a system is exposed to significant climatic variations. It could include geographical location, especially related to high exposure to risks. Sensitivity and adaptive capacity are context-specific and vary per location, among social groups and individuals and over time in terms of its value (Fussel, 2007; Khajuria et al., 2012). Sensitivity is defined as the degree to which a system is affected, either adversely or beneficially, by climate variability or change. Impacts typically mean the effects of climate change. For biophysical systems, it can be changes in productivity, quality or population. For societal systems, impact can be measured as changes in value (e.g., gain or loss of income) or in morbidity, mortality or other measure of well-being (Parry and Carter, 1998). The effects may be direct (e.g., changes in crop yield in response to a change in the mean, range or variability of temperature) or indirect (damages caused by an increase in the frequency of coastal flooding due to sea-level rise) (Mc Carthy et al., 2001).

Finally, adaptive capacity is the ability of a system to adjust to climate variability and extremity to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Operationalizing the vulnerability assessment (VA) framework (bottom-up approach)

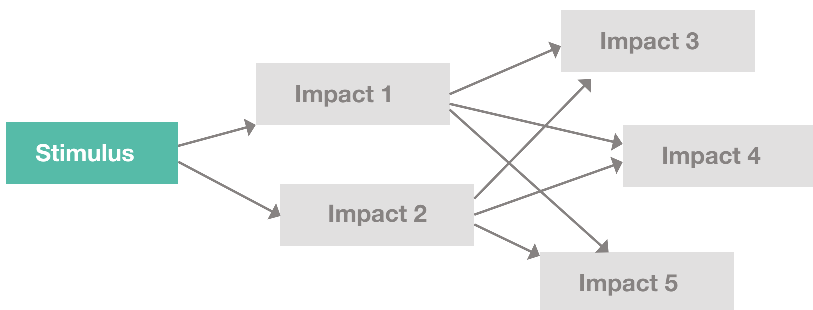
The vulnerability of populations or systems cannot be measured directly, thereby making its assessment challenging. Fussel (2009) posits that vulnerability assessments must describe the four components of vulnerability:

- System being considered
- Attributions of the system
- Hazards involved
- Temporal reference

For this project, both the physical and socio-economic vulnerabilities of San Vicente, Palawan were assessed. The physical vulnerability assessment covered the geophysical and biological factors relating to vulnerability; while the assessment of the social vulnerability covered the results of interplay among many contextual factors, including social, economic, political, and cultural conditions that generate unequal exposure to risk and create differential capacities to respond to both shocks and long-term changes (O'Brien et al., 2008).

Sectors to be assessed are prioritized on the basis of the types of resources present in the municipalities and the identified climate risks that could affect these resources. The sectors selected, agriculture and fishery, constitute as the primary livelihood sources of San Vicente. The necessity to focus on these sectors is justified by the likely possibility that climate change impacts will threaten both environmental and economic sustainability. In addition, socio-economic implications represent a cross-cutting issue across the following three sectors:

A. Agriculture
B. Coastal and marine
C. Health



Source: Climate Impacts: Global and Regional Adaptation Support Platform (CI: GRASP)

Figure 2.6. An impact chain

Cause and effect dynamics related to climate change can be represented by impact chains, which show how a particular sector can be affected by climate-related impacts. By tracing how climate change effects may generate and proliferate through a system of interest, information related to climate change impacts can be clearly presented toward a more objective and systematic analysis.

The impact chain presented in **Figure 2.6** depicts the climate stimulus as the start of the impact chain, which is connected to multiple boxes to the right representing actual impacts. These impacts can be interrelated as shown by the arrows. The relationship reveals how climate stimulus can lead to one or more impacts or how an impact can possibly lead to one or more impacts, according to CI GRASP.

The impact chain shows that climate change impacts do not act in isolation and that these impacts interact with prevailing socio-economic conditions. If adaptation and coping strategies are insufficient, climate impacts may substantially affect the quality of livelihood. In order to understand climate change impacts from a sectoral approach, the following research, consultation, and capacity-building activities were carried out:

- A team of local and foreign experts conducted meetings and consultations with the relevant stakeholders from November 2012 to January 2013. The goal was to understand the exposure, sensitivity, and adaptive capacity of the municipality in the context of climate change. In this approach, the exposure and sensitivities that are pertinent to the community are identified by the community itself. It requires the active involvement of stakeholders, considerable effort on the part of the researchers to ensure legitimacy, information collection on community-relevant climate phenomena and processes, the integration of information from multiple sources such as insights from local and regional decision makers, resource managers and the engagement of decision makers.

- Baseline profiling of historical and current climate, socio-economic conditions and characteristics, resources, and technologies.
- To derive future climate profiles of San Vicente and Siargao, the PAGASA used PRECIS model in two time frames – 2006-2035 and 2036-65 in order to generate projections of temperature increase and rainfall change.
- A validation workshop was conducted. Initial outputs of current baselines for climate profiles and socio-economic characteristics, changes in local climate, climate-related hazards and risk assessments, and impact and vulnerability assessments were presented, reviewed, and validated by the stakeholders. Workshops were also held in order to develop and construct impact chains and incorporate the results of natural resource assessments.
- An extensive review of related literature was conducted specifically on the various approaches to vulnerability and adaptation assessment. The fact that there is no universally accepted standard methodology to operationalize climate vulnerability renders this task challenging. As such, this report hopes to enrich the existing literature and fill in knowledge gaps through the Eco-town experience.

Classifying climate change impacts (top-down approach)

The first step of climate change impact and adaptation assessment in this study is to determine an appropriate categorization method for classifying impact sectors. Among several categorization tools, the IPCC AR5 WG II (Assessment Report 5 Working Group II) model was used as a main classification method in this research. This classification method, divided into three categories, incorporates a wide variety of variables from geographic conditions to socio-economic status: natural and managed resources and systems and their uses; human settlements, industry and infrastructure; and human health, well-being, and security. Each sector is again divided into sub-categories (**Table 2.2**).

Category	Sub-category
Natural and Managed Resources and Systems and their Uses	Freshwater resources
	Terrestrial and inland water systems
	Coastal systems and low-lying areas
	Ocean systems
	Food production systems and food security
Human Settlements, Industry and Infrastructure	Urban areas
	Rural areas
	Key economic sectors and services
Human health, Well-Being and Security	Human health
	Human security
	Livelihoods and poverty

Source: IPCC AR5 WG2

Table 2.2. Impact classification category of IPCC AR5 WG II

The classification of IPCC AR5 Lee et al. (2010) made a modification to the above method, by adjusting the list of sub-categories and re-organizing them into two categories: natural environment and human activities (**Table 2.3**), which the project has adopted.

Category	Sub-category
Natural environment	Water resources
	Natural disasters
	Biodiversity
	Natural resources
Human activities	Energy
	Living condition and poverty
	Infrastructure
	Industries
	Health

Source: IPCC AR5 WG2

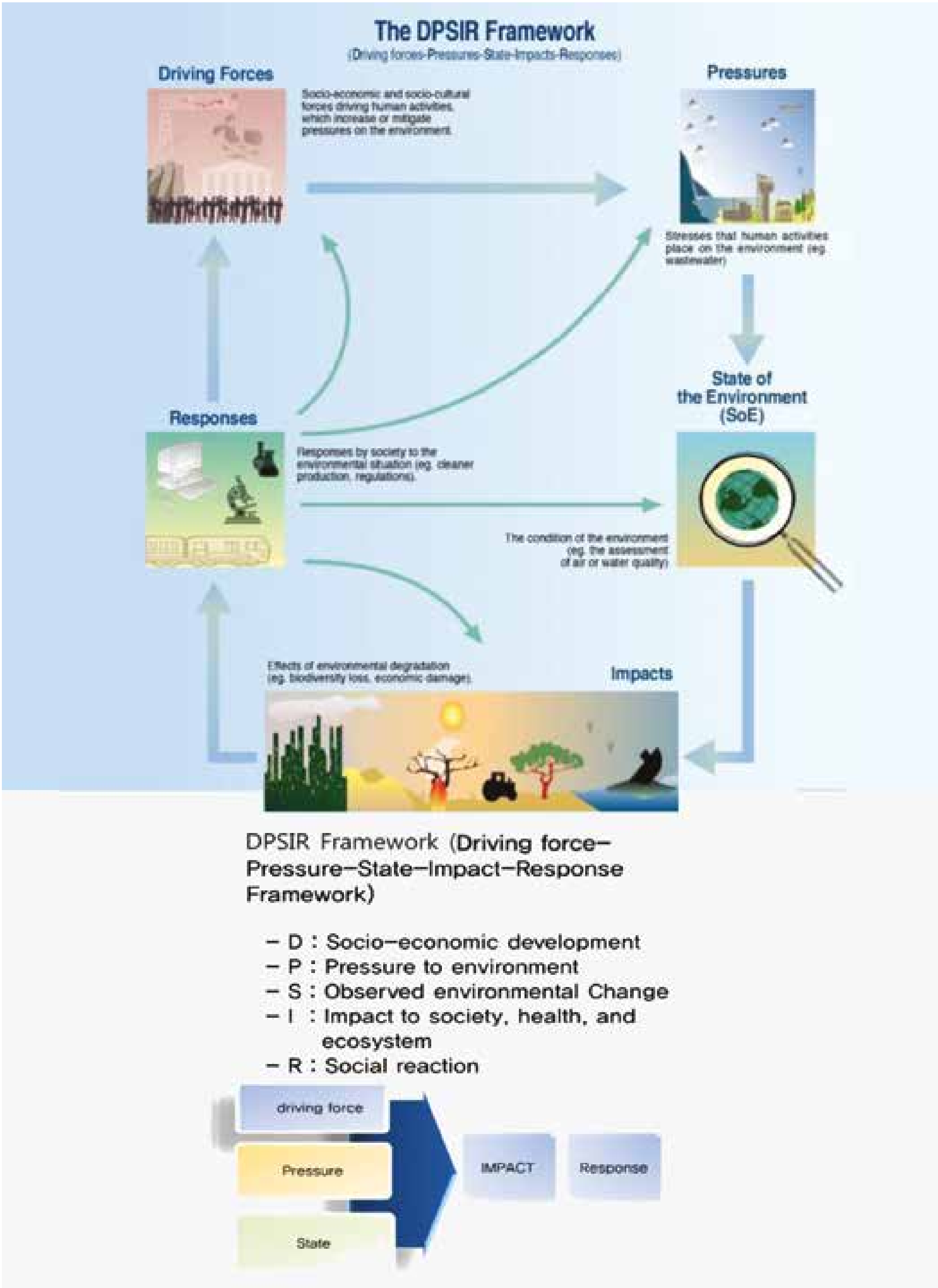
Table 2.3. Impact classification category of Lee et al. (2010)

The classification model was adopted with a slight modification (**Table 2.4**). Since it is assumed that the impacts of climate change on air as a natural resource will be insignificant in the Municipality of San Vicente, the item was deleted in the list, thereby confining the assessment to nine sectors: water resources; natural disasters; biodiversity; natural resources; energy; living condition and poverty; infrastructure; industries; and health.

Category	Sub-category
Natural environment	Water resources
	Natural disasters
	Biodiversity
	Natural resources
Human activities	Energy
	Living condition and poverty
	Infrastructure
	Industries
	Health

Table 2.4. Impact classification category for the Eco-town Project

Based on the classification of the IPCC AR5 WG II, the following framework, which distinguished driving forces, pressures, states, impacts, and adaptive capacities, was used to extract relevant impact and adaptive capacity indicators. The framework, known as the Driving Force-Pressure-State-Impact-Response (DPSIR) Framework, is a slightly extended version of the well-known "PSR" (Pressure–State–Response) model used by the OECD. The DPSIR Framework was first proposed by National Institute of Public Health and Environment of the Netherlands to the European Environment Agency (EEA), who has widely adopted it. The DPSIR framework is useful in describing the relationships between the origins and consequences of environmental problems considering interactions among socio-economic domains (**Figure 2.7**).



Source: Global International Waters Assessment (GIWA), 2001; European Environment Agency (EEA), Copenhagen

Figure 2.7. The DPSIR Framework

A “driving force” is a need that results in all human activities such as the production of goods and services, population growth, and urbanization, among others. Also, it can be examined according to economic sectors (e.g., transport, energy, industry, agriculture, and households). Many of the driving forces are common to all or a number of issues. As a result, production and consumption processes put “pressures” on the environment in three major ways: excessive use of environmental resources, changes in land use, and emissions (i.e., chemicals, waste, radiation, and noise) to air, water, and soil.

In consequence, the “state” of the environment, which is a combination of the physical, chemical, and biological conditions, affects the quality of air, water and soil as well as the ecosystems and human health. The changes in the state of the environment may not only have environmental but also, economic “impacts” on the dynamics of the ecosystems. “Responses”, such as political actions to abate the negative impacts, can be designed to affect any part of the chain between driving forces and impacts.

By using the DPSIR framework (in a recursive way), climate change-induced “damages and impacts” are first carefully identified and rearranged according to each category and afterwards, all possible “states” and interlinked “pressures” are then analyzed. Next, the “driving forces” for each pressure are deduced. This analysis makes it possible to figure out the tailored options (“responses”), by considering which part of the chain will be affected by a particular option. An example of generic DPSIR framework for groundwater is shown in **Figure 2.8**.

Driving Forces	Pressures	State	Impact and Damage
• Land use • Industry • Agriculture • Population growth • Climate	• Over-abstraction of available water • Increase in impermeable layers • Changes in recharge rate • Changes in precipitation	• Decrease in groundwater level	• Freshwater discharge • Impacts on wetland ecosystem • Intrusion of saltwater into coastal aquifers

Response		
• Stregthen groundwater management	• Regulation on over-abstraction of ground water	• Water re-use

Figure 2.8. A generic DPSIR framework for water

The Impact classification category for the Eco-town Project can be extended by applying the DPSIR framework for assessing each impact, as shown in **Table 2.5**.

Category	Sub-category	Impact	State	Pressure	Driving force	Response
Natural environment	Water resources					
	Natural disaster					
	Biodiversity					
	Natural resources					
Human activities	Energy					
	Living condition and poverty					
	Infrastructure					
	Industries					
	Health					

Table 2.5. An extended table of impact classification

Completing **Table 2.5** will enable a better understanding of the mechanism of climate change impacts, which helps toward deducing the most appropriate adaptation measure for each impact.

Vulnerability indicators

Indicators indirectly measure different levels of vulnerability, examining the factors that measure the consequences of vulnerability. Since establishing a set of concrete set of standards of assessing vulnerability is still evolving, the foremost challenge, therefore, lies in choosing indicators that accurately represent a vulnerable condition.

Lee et al. (2010) succeeded in constructing the tailored index for the climate change vulnerability assessment for the local government in South Korea, specifically in 16 metropolitan councils of the country. Their impact indicators measure physical impacts of climate change as economic damages converted into monetary value, while response indicators are detailed recovery or preclusive actions to minimize the impacts, that is, adaptive capacity.

The expert team identified the indicators through a careful review of the science and the literature of vulnerability assessment, as well as experts' consultations and project site visit. For example, impact indicators of water shortage can be groundwater level, water level of the river, or reserve rate of the dam; while the response indicator can be a checklist of whether water sources are secure, water reuse system is established, or regulation on water consumption is implemented.

Category	Sub-category
Natural environment	Water resources
	Natural disasters
	Biodiversity
	Natural resources
Human activities	Energy
	Living condition and poverty
	Infrastructure
	Industries
	Health

Table 2.6. Impact and response indicators for each category

The VA was done for each sector separately and the most vulnerable units (*barangay*) were identified per sector. The impact and adaptation indicators are listed in **Tables 2.8** and **2.9**, respectively. However, due to the nature of the format of some response indicators – entered data is either 0 or 1- some indicators could not have any influence to the PCA results.

Sectoral components	Data categories	Source
Demography	• Population • Poverty	• Comprehensive Land and Water Use Plan of San Vicente, Palawan 2009-2020 • CBMS Census 2011-2012 • Annual Report 2012 of the Municipality of San Vicente • Health Annual Report 2011 and 2012
Social sector	• Water supply • Electricity • Infrastructure • Industry • Health	
Economic sector	• Crop production • Livestock production • Forestry resources	
Biodiversity	• Watershed area • Flora and fauna	• Flora survey and biodiversity assessment for core zoning for San Vicente Municipality, 2006 • Fauna survey report for San Vicente Municipality, 2006

Table 2.7. Data sources for the VA of the Municipality of San Vicente

Water resources	
Impact	**Indicator**
Red tides	• Number of red tides days
Coastal inundation	• Sea-level rise (mm)
Water quality deterioration	• Water temperature • Water quantity
Water scarcity	• Ratio of land area to Scale of watershed • Amount of groundwater use

Natural disaster	
Impact	**Indicator**
Flood impacts	• Cost of damages from floods
Storm impacts	• Cost of damages from storms
Landslide impacts	• Landslide frequency (% of high landslide possibility)
Forest fire impacts	• Forest fire frequency • Forest fires impact area
Drought	-

Biodiversity	
Impact	**Indicator**
Decrease in flora species	• Rate of flora diversity (Shannon-Weiner Index) • Rate of flora evenness (Pielou Index)
Decrease in fauna species	• Number of individuals of fauna
Increased influx of foreign species	• Number of foreign species
Increase in endangered species	• Number of endangered species

Energy	
Impact	**Indicator**
Increase in energy consumption	• Energy consumption per capita
Increase in electricity use	• Increasing rate of electricity use (# of access to electricity in 2008 and in 2005)

Key economic sectors	
Impact	**Indicator**
Industry facilities impacts	• Insurance payout
Reduction of production	-
Loss of tourism resources	• Revenue of climate-sensitive tourism

Living condition and poverty	
Impact	**Indicator**
Temperature rise	• Rate of temperature increase • Number of days above 25°C
Disaster	• Flooded area • Number of flooded households
Deterioration of living conditions	• Poverty rate

Natural resources	
Impact	**Indicator**
Crop yield reduction	• Rice yields (MT per ha)
Loss of forest resources	• Quantity of forestry and stock-farming
Reduction in livestock production	• Mortality rate in summertime
Reduction in fisheries and aquaculture	• Reduction in cold current fish

Infrastructure	
Impact	**Indicator**
Lack of water supply system	• Water supply capacity per capita
Lack of sewage treatment capacity	• Amount of sewage/treatment capacity
Damages of transport infrastructure	• Rate of road pavement • Number of means of transportation • Number of cars
Damages of communication infrastructure	• Status of wired or wireless communication
Damages of ports	• Number of port non-operation days • Number of port inundation days

Health	
Impact	**Indicator**
Increase in incidence of infectious diseases	• Incidence/mortality rate of vector- and water-borne diseases • Rate of non-flushed facility
Increase in allergic diseases	• Incidence rate of environmental diseases (e.g., asthma, atopy skin, conjunctivitis, rhinitis)
Increase in cardiovascular diseases	• Incident/mortality rate of cardiovascular disease
Heat-related mortality	-

Table 2.8. Impact indicators

Water resources	
Impact	**Adaptation Indicator**
Red tides	• Coastal environment management plans • Red tides early-warning system, • Red tides control measures, facilities and plans • Regional compensation payment system
Coastal inundation	• Regulation on coastal area development, • Enforcing installation criteria of facilities in coastal area • Evacuation of risk-prone region settlements and facilities

Water resources	
Impact	**Adaptation Indicator**
Water quality deterioration	• Wastewater treatment facilities • Diameters of sewerage pipes (considering the flooding levels during last several years) • Enlarge capacities of wastewater treatment facilities • Total pollution regulation system (BOD quarters per local community) • Aqua-ecosystem monitoring system • Water quality warning system
Water scarcity	• Establishing local groundwater management plan • Prevent over-exploitation of groundwater • Dam, dyke, réservoir, irrigation canal • Rainwater reuse • Sewage, waste water recycling facilities • Integrated river management capacity • Alternative water resources

Natural disasters	
Impact	**Adaptation Indicator**
Flood impacts	• Small stream management plan • Eco-streams • Flood early-warning system • Area of wetland • Flood map preparation (% of total area) • Pavement area of permeable layers • Evacuation procedure guideline and its distribution
Storm impacts	-
Landslide impacts	-
Forest fire impacts	• Number of forest fire extinguishers (number of helicopters)
Drought	• Crop insurance subscription rate

Biodiversity	
Impact	**Adaptation Indicator**
Decrease in flora species	• Ecosystem monitoring system • Area of wetland (ha of preserved watershed)/total area
Decrease in fauna species	• Number of orangutan
Increased influx of foreign species	• Land environment preserve area • Area of natural ecology preservation area (ha)
Increase in endangered species	

Energy	
Impact	**Adaptation Indicator**
Increase in energy consumption	• Existence of energy management scheme • Budget for energy saving campaigns • Number of renewable energy facility development plan
Increase in electricity use	• Electricity use per household • Public transport infrastructure per capita

Living condition and poverty	
Impact	**Adaptation Indicator**
Temperature rise	• Number of buildings with roof gardens • Forest area per capita • Green area per capita (communal and social forestry) • Other green area per capita (camping site, ecotourism village, mountain resort, wildlife ecopark, farm, trekking, canopy walk, etc.)
Disaster	• Natural disaster vulnerability assessment • Budget for awareness campaign and public education of natural disaster • Existence of emergency restoration plans • Implementation of evacuation plans
Deterioration of living conditions	• Re-organization plan of deteriorated infrastructure and its budget execution

Natural resources	
Impact	**Adaptation Indicator**
Crop yield reduction	• Average farm income • Current status of organic product production • Budget for climate change-adaptive crops research • Proportion of organic products • Preventive measures of crop diseases and pests • Number of emergency irrigation facilities
Loss of forest resources	• Anti-forest disease and pest measures • Area of development limited area (ha)
Reduction in livestock production	• Average income

Industry	
Impact	**Adaptation Indicator**
Industry facilities impacts	• Reinforcement of coastal area development regulation • Integration ratio of industrial facilities (industrial complex, small-scale industry facilities) • Early warning system • Subscription rate of natural disaster insurance • Existence of infrastructure for disaster prevention (fire protection, flood protection)
Reduction of production	• Distribution of adaptive crops and budget for their development
Loss of tourism resources	• Ecotourism development • Induce local community participation

Infrastructure	
Impact	**Adaptation Indicator**
Lack of water supply system	• Computerization of water supply and sewerage system management • Budget for repair and maintenance of water supply and sewerage system • Per capita water saving policy

Infrastructure	
Impact	**Adaptation Indicator**
Lack of sewage treatment system	• Penetration rate of sewerage • Ratio of installed separated sewage operator • Sewage treatment facility number per area
Damages of transport infrastructure	• Road linearization ratio
Damages of ports	• Port protection system

Health	
Impact	**Adaptation Indicator**
Increase in incidence of infectious diseases	• number of healthcare institutions per capita • Public health center per capita • Secured vaccine quantity • Healthcare expenditure per capita • Local autonomous entities' budget for preventive measures of epidemics • Vulnerable group management
Increase in allergic diseases	• Allergenic fauna and flora monitoring system • Pollen monitoring system
Increase in cardiovascular diseases	• Present status of ambulance operation
Heat-related mortality	• Shelters for heatwaves • Number of staffs of vulnerable group care programs

Table 2.9. Adaptive capacity indicators

C. Top-down and bottom-up approaches

The main obstacle of adaptation planning is uncertainty. There is high uncertainty not only in the decision-making process of adaptation planning, but also in the assessment process of climate risks. As described in the previous section, this explains why both top-down and bottom-up approaches were used in this study. Integrating the results drawn from the two approaches enables a more comprehensive understanding of the impacts and response measures appropriate for the municipality.

The various international literatures define the prediction-oriented methods as the top-down approach. The **top-down approach** stresses foreseeing the future with sophisticated modelling tools and techniques, and uses global data to predict the future impacts of climate change. The **bottom-up approach**, on the other hand, is resilience-oriented. It embraces uncertainty as an unavoidable factor, and draws lessons from past and present events. It puts emphasis on local stakeholders' participation and local knowledge in the assessment and planning process.

In order to minimize such uncertainty, this report adopted both top-down and bottom-up approaches in its assessment process. The main top-down approach used in this report is the **Integrated Vulnerability Assessment (IVA)** – the impact and response capacity of nine sectors was assessed to understand the municipality's vulnerability.

The top-down approach is quantitative, and shows a clear picture of the target area's vulnerability, as it focuses on direct relationship of the indicators. However, it tends to neglect the complexity inherent within human-environment systems that a bottom-up approach attempts to include (Adger & Kelly, 2004). The bottom-up approach, on the other hand, is generally qualitative and often gives a vague description of the vulnerability. However, it shows more local-specific outcomes based on the target area's social context, as its process begins at the local scale, assessing current and emerging risks, the social, economic, and environmental factors that underpin risk and the capacity for risk management (Dessai & Hulme, 2004).

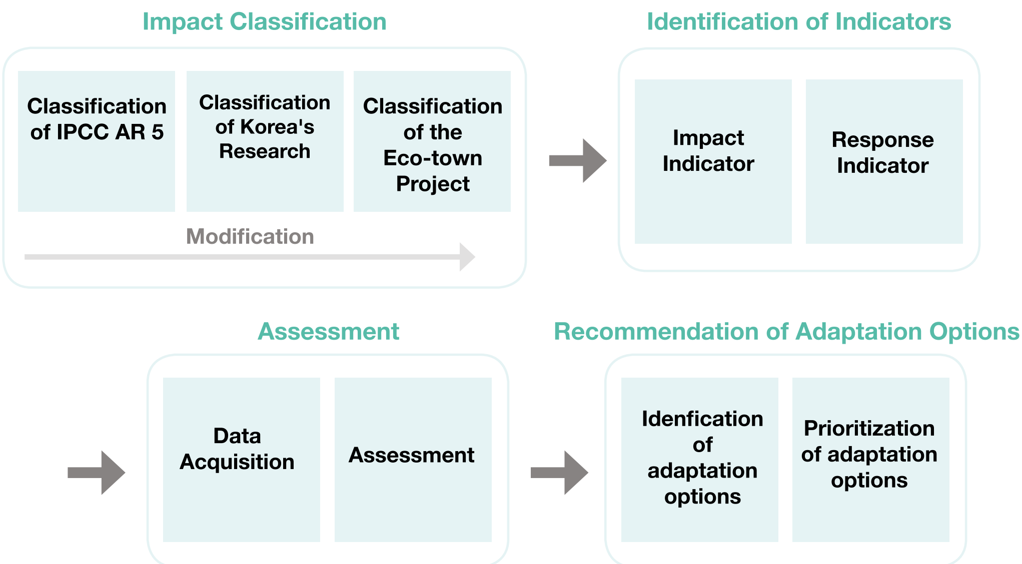


Figure 2.9. The process of top-down vulnerability assessment

Bottom-up approach followed a participatory method where meetings and consultations with relevant stakeholders provided information to determining the current and future impacts, exposures, sensitivities, and adaptive capacities. Therefore, outcome is able to show a more local-specific impacts and practical response capacity of the community from various perspectives. Such participatory process enables the community to provide a strong support towards implementing the adaptation measures identified from the assessment.

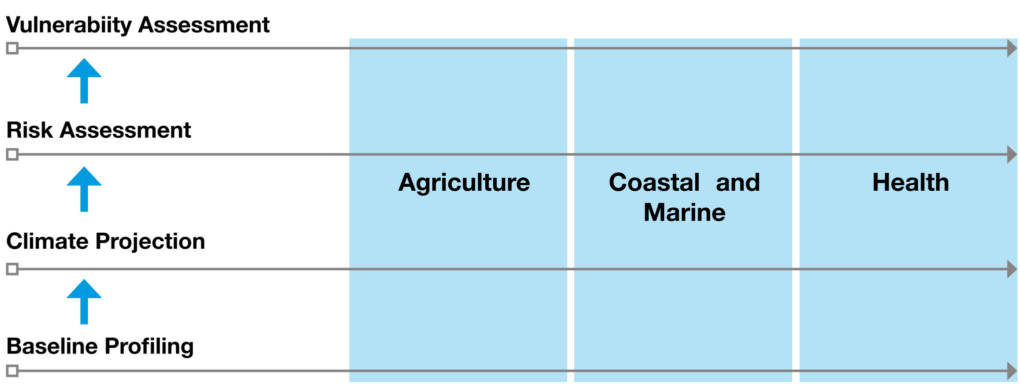


Figure 2.10. The process of bottom-up vulnerability assessment

Figure 2.11 indicates how those top-down and bottom-up approaches work together in this report. In principle, both top-down and bottom-up approaches provide the overall impacts and response capacity of the community, based on an international assessment model, as well as the local-specific outcomes that are grounded on past and present events.

However, as mentioned previously, it is important to note that although the participatory approach is able to bring results from the perspective of the vulnerable, assessment of their own condition often fails to uphold the objectivity needed in coming-up with the appropriate response measures. Such subjective nature of the participatory approach may also lead to results that implicitly reflect the political power relations within the community, especially because the sample size is small to be fully representative. In addition, it is inevitable that the bottom-up approach must also rely (partially, if not fully) on a team of experts to interpret the response of the community members in creating a logical set of reasoning for the proposed adaptation options.

Once again, this study emphasizes that there is no dispute in understanding the importance of allowing the views of the vulnerable in shaping the municipality's climate response measures. The top-down approach was initiated in the course of conducting the bottom-up participatory assessments to help the study in coming up with well-informed and balanced climate change adaptation plans for decision-makers.

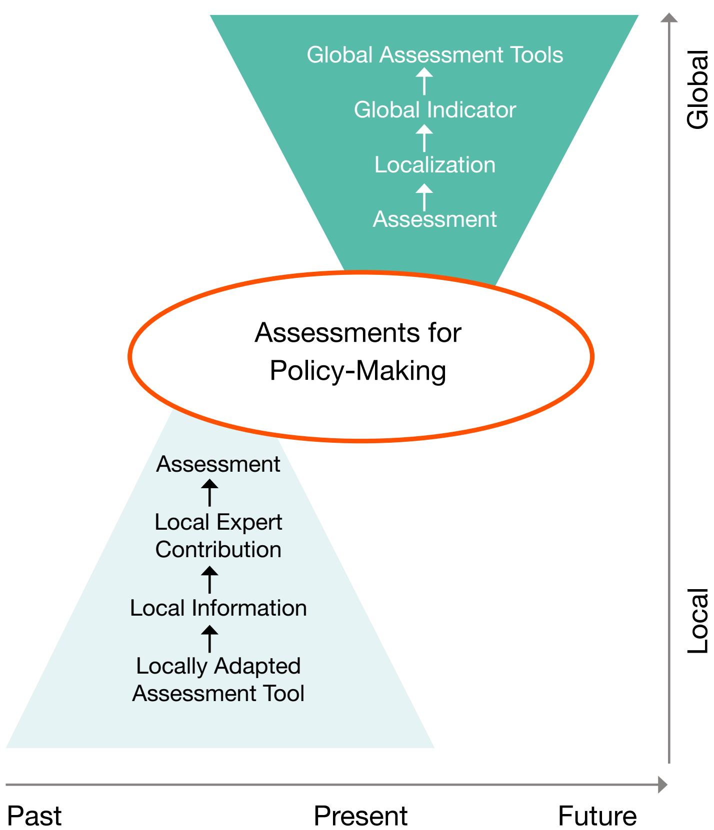


Figure 2.11. Top-down and bottom-up approaches based on the Dessai and Hulme's model

Chapter 3

Analysis

Figures and tables

A. General profile

1. Biophysical and socio-economic profile

San Vicente is located in the northwestern side of Palawan and 186 km from Puerto Princesa City. It occupies a total land area of 165,797 ha and has jurisdiction over 10 *barangays*, namely: Alimanguan, Binga, Caruray, Kemdeng, New Agutaya, New Canipo, Poblacion, Port Barton, San Isidro and Sto. Niño.

The 2010 census conducted by the National Statistics Office (NSO) recorded a total population of 30,565 in San Vicente, with a growth rate of 6%. Based on the Community-Based Monitoring System (CBMS) survey, the municipality's population increased by 3,500 from 27,065 in 2008. The total number of households is 6,460 with an average size of five members.

San Vicente has 22 islands and islets within its municipal boundaries serving as tourist attractions. Its largely untapped beaches, coral reefs, water falls, forest cover and mangrove areas are home to 23 of the 25 wildlife species found in Palawan. It has a forest area of 82,080 ha and 22 identified islands and islets within its municipal boundaries. San Vicente also hosts 24 ethno-linguistic resident groups, each with their own distinct dialects and cultural heritage.

The main livelihoods in San Vicente are fishing (46.98%) and farming (37.43%). Rice and coconut are the major agricultural crops. As a first-class municipality, San Vicente aspires to tap the potential of tourism particularly the 14 km long beach from Poblacion to Alimanguan, waterfalls, dense forest cover, and rich fishing ground to generate more income and attract investments.

Given its natural resource endowments and sceneries, San Vicente is driven to transform itself as a world-class tourism destination. Specifically, the vision articulated in its Comprehensive Land Use Plan (CLUP) is "a municipality of empowered and peaceful citizens…enjoying the benefits of a balanced agro-industrialized tourism economy within an ecologically stable environment…" Working on its development priorities, San Vicente continues to strengthen the tourism industry. Currently, the municipality is in the process of creating the Tourism Development and Management Plan to optimize the economic benefits of a booming tourism.

2. Climate profile

Baseline climate

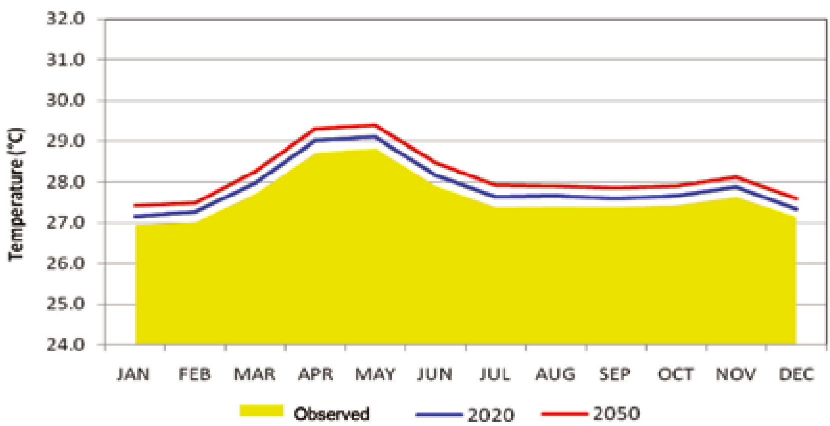
The baseline climate of the municipality (based on 1971-2000 records of rainfall patterns) is under Type 3 of the Modified Coronas' climate classification, which is characterized by a short dry period during the months of January to April, with monthly rainfall averaging from 10.6 mm in February (driest) to 35.7 mm in April. Rainfall is most pronounced during the months of June to October, with mean monthly values ranging from 242.0 mm to 290.8 mm. Annual mean temperature is 27.6°C, with the highest monthly mean value of 28.8°C in May and the lowest of 26.9°C in January.

One main climate phenomenon that affects the municipality and the whole province of Palawan is the passage of tropical cyclones. A total of 105 tropical cyclones had crossed the province of Palawan from 1948 to 2011, while a total of 124 had crossed within 100 km of the province. This is a significant climate factor to consider because most of the tropical cyclones have rain band diameters exceeding 100 km and maximum wind speeds that sometimes exceed 180 kph.

There is no weather station in the municipality that could have provided long historical weather records. Instead, model outputs from re-analyzed data (as inputs to the PRECIS model) were used to derive the baseline climate in terms of monthly normal values of mean temperatures and rainfall for San Vicente.

Climate scenarios for San Vicente in 2020 and 2050[1]

In order to assess future vulnerabilities of agriculture and other key sectors based on climate scenarios, projections of future changes in temperature and rainfall in 2020 and 2050, prepared by the PAGASA using the PRECIS model, were used. In this assessment, the model outputs under the medium-range scenario were within a planning horizon of up to 2050. Outputs of the model runs under the high-, medium- and low-range scenarios will only diverge after 2050 due to the long lifetimes of the greenhouse gases. The outputs of the model runs for the observed monthly, and changes in the monthly mean temperatures both in 2020 and 2050 (based on the medium-range emission scenario) were used in the vulnerability assessments in all the sectors, and are shown in **Figure 3.1.**



Source: PAGASA

Figure 3.1. Projected changes in monthly mean temperatures in °C in 2020 and 2050

The numerical values of the estimated observed (1971-2000) change, and projected values of monthly mean temperatures in °C in 2020 (2006-2035) and 2050 (2036-2065) under the medium range emission scenario are presented in **Table 3.1**.

Month	Observed (1971-2000)	Change (°C) (2006-2035) (2020)	(2036-2065) (2050)	Projected (°C) (2006-2035) (2020)	(2036-2065) (2050)
Jan.	26.9	0.8	1.7	27.2	27.4
Feb.	27.0	0.9	1.8	27.3	27.5
Mar.	27.7	1.0	2.0	28.0	28.3
Apr.	28.7	1.1	2.0	29.0	29.3
May	28.8	1.0	2.0	29.1	29.4
Jun.	27.9	1.0	2.1	28.2	28.5
Jul.	27.4	1.0	2.0	27.6	27.9
Aug.	27.4	1.0	1.9	27.6	27.9
Sept.	27.4	0.8	1.8	27.6	27.9
Oct.	27.4	0.9	1.7	27.7	27.9
Nov.	27.6	0.9	1.8	27.9	28.1
Dec.	27.1	0.7	1.7	27.3	27.6

Source: PAGASA

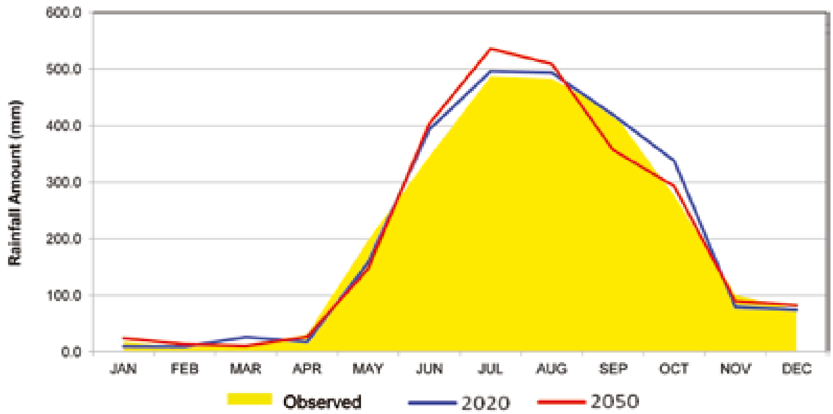
Table 3.1. Estimated changes in average monthly temperatures by 2020 and 2050

1 The PRECIS model is used to generate climate scenarios specifically to be used in vulnerability and adaptation assessments in countries which do not have the capacity to run global circulation models (GCMs). This model is run using high, medium and low emission scenarios in order to give practitioners a range of climate projections in preferred time frames.

On the other hand, **Figure 3.2** presents the projected change in monthly average rainfall (in mm) under the medium-range emission scenario (A1B) in 2020 and 2050.

Table 3.2 shows the estimated mean monthly rainfall in mm (1971-2000), and the corresponding projected changes in 2020 and 2050 under the medium-range emission scenario (A1B) in San Vicente.

The PRECIS model outputs for the projected frequency of extreme events (e.g., defined as the number of days with maximum temperatures exceeding 35°C, the number of dry days or days with less than 2 mm of rain, and the number of days with rainfall exceeding 300 mm) in 2020 and 2050 under the medium-range emission scenario in the province of Palawan are shown in **Table 3.3.**



Source: PAGASA

Figure 3.2. Projected changes in average monthly rainfall in mm by 2020 and 2050

Month	Observed	Change (°C)		Projected (°C)	
	(1971-2000)	(2020)	(2020)	(2050)	(2050)
Jan.	14.5	-4.7	23.7	13.9	18.0
Feb.	10.6	11.9	17.1	11.9	12.5
Mar.	19.3	114.9	-12.5	41.6	16.9
Apr.	35.7	-26.2	4.8	26.3	37.4
May	163.8	-24.3	-13.4	124.1	141.8
Jun.	248.7	16.4	3.3	289.4	257.0
Jul.	290.8	-18.5	-24.6	236.9	219.4
Aug.	290.1	-0.8	34.6	287.8	390.4
Sept.	278.2	-4.4	-7.6	265.9	257.0
Oct.	242.0	60.9	17.9	389.2	285.3
Nov.	161.1	42.8	28.4	230.1	206.8
Dec.	102.9	7.5	-20.2	110.6	82.1

Source: PAGASA

Table 3.2. Estimated changes in average monthly rainfall by 2020 and 2050

Province	Station	No. of days with Tmax >35°C			No. of dry days			No. of days with rainfall >300mm		
		OBS	2020	2050	OBS	2020	2050	OBS	2020	2050
Palawan	Puerto Princesa	29	23	297	8,348	6,457	6,455	0	5	3
	Coron	242	739	1,988	7,726	5,542	5,561	0	1	1
	Cuyo	59	195	791	7,447	5,382	5,406	0	2	2

Source: PAGASA

Table 3.3. Projected frequency of extreme events in 2020 and 2050 in Palawan

B. Hazard assessment

1. Determination of hazard and exposed elements

A GIS-based mapping and assessment was conducted to determine the area's vulnerability to the climate hazards. Of the many different types of hazards related to climate change, flood, drought, and landslides were the three hazards selected to be assessed in this study. The selection is founded on the understanding that the projected climatic changes in the area involve significant variations in the amount, frequency, and seasonal pattern of rainfall. With shorter/ drier dry seasons and longer/ wetter wet seasons expected to become more prevalent, more frequent flood and drought events are expected to affect the local community's activities. Landslide is a major hazard in mountainous terrain – which characterizes much of the land cover of the municipality. It is highly dependent on the amount and frequency of rainfall for irrigation, which induces a rise in groundwater level and increase in pore-water pressure that results in slope failures. Mapping areas of high vulnerability to rain-induced rainfall helps guide the local government units (LGUs) in the process of land-use planning and disaster risk management.

Hazard mapping and assessment was conducted using seven different steps. The first six steps pertain to the determination of exposed elements and analysis of population exposed to hazards, whereas the last step covers the analysis of spatial extent to hazards::

1. **Gathering of secondary data and primary GIS-mapping:** Gathering of existing information from all possible sources, including LGUs, Department of Environment and Natural Resources (DENR) offices, other government agencies and NGOs. Pertinent maps were generated using GIS based on available image files and satellite data. Digital Elevation Map (DEM) was generated based on the satellite image.
2. **Site reconnaissance:** Ocular surveys undertaken to familiarize the GIS team with prevailing conditions in the area.
3. **Coordination with stakeholders:** Planning field activities with relevant stakeholders of the LGU and related agencies, including identifying key informants, respondents, and field guides.
4. **Gathering of primary and secondary data and GIS mapping:** Gathering of existing information from all possible sources, including LGUs, DENR offices, other government agencies and NGOs. Pertinent maps were generated using GIS based on available image files and satellite data. DEM was generated based on the satellite image.
5. **Collection and validation of spatial information:** Field data gathering and ground truthing surveys, conducted in coordination with LGUs, especially the Municipal Environment Office (MENRO) and concerned local communities.
6. **Community mapping:** Validation by a selected number of local community members of the collected spatial information, through focused group discussions, site inspection, and workshops.
7. **Preparation of GIS-based hazard maps:** Based on the DEM, collected field data and information on climate projections, different hazards were assessed and interpolated into the GIS maps to create GIS-based hazard maps.
8. **Spatial assessment of vulnerability to hazards:** Assessment of spatial vulnerability to hazards by overlaying the GIS-based hazard maps with land-cover maps.

As described in Step 7, land-cover maps provided crucial information needed in assessing the level of exposure to the different hazards. The land-cover maps were prepared following the procedure similar to the preparation of the GIS-based hazard maps (Steps 1-5). The process of validating geographic information shown on land-cover maps were facilitated using GPS and smartphone-based Google mapping application.

2. Land-cover maps

The GIS team was assisted by local residents familiar with the project site to draw a comprehensive land-cover map of the municipality. They paid courtesy calls to and interviewed *barangay* officials regarding the field activity. The officials and local residents provided valuable information as to the location of various map features on the ground in their respective *barangays*. They also shared information on land use changes and practices that occurred in their area (Figure 3.3.).

Figure 3.3. Coordination with stakeholders and gathering of field data

The team used grid maps and GPS to validate on the ground the land features shown on the municipality's land use and land-cover maps. This is done by comparing the features shown on the map with what are found on the ground. The location is fixed using ground features such as streams, mountain peaks, roads, and bridges. The ground validation points and coordinates per *barangay* are shown in **Table 3.4**. Land was categorized into one of the following:

- Closed/Open forest
- Mangrove forest
- Closed/Open canopy
- Other wooded land (shrubs, wooded grassland, etc.)
- Other natural land (barren land, grassland, etc.)
- Cultivated land (annual, perennial, etc.)
- Unclassified land

As a means of final validation, the *barangay* representatives were asked to comment on their corresponding *barangay* land use and land cover maps that were shown to them. Their comments were integrated into the final land cover and land use. The maps of **Annex 1** illustrate the results of the gathered data for the 10 *barangays* of San Vicente. These maps provided a sound basis to determining the extent of human exposure to the climatic risks identified.

Barangay	Point	Coordinates (deg-min-sec)		Remarks/ changes	
		North	East	Land cover	Land use
Alimanguan	A	10°36'0"	119°21'15"	Open forest broadleaved	Open canopy
	B	10°35'48"	119°21'31"	No changes	
	C	10°35'17"	119°21'36"	No changes	
	D	10°35'17"	119°21'49"	Open forest broadleaved	Open canopy
	E	10°34'57"	119°21'46"	No changes	
	F	10°36'13"	119°19'34"	No changes	
	G	10°34'56"	119°19'16"	No changes	
	H	10°36'53.4"	119°19'26"	Mangrove forest	Mangrove vegetation
	I	10°37'01.3"	119°19'22.8"	Mangrove forest	Mangrove vegetation
	J	10°37'8.5"	119°19'24.5"	Mangrove forest	Mangrove vegetation
	K	10°36'51.6"	119°19'15.2"	Other wooded land, wooded grassland	Crop land mixed with coconut plantation
Binga	A	10°44'20.2"	119°21'28"	No changes	
	B	10°46'21.7"	119°20'54.5"	Other land, cultivated annual crop	Cultivated area mixed with brushland/ grassland
	C	10°46'27"	119°18'26.8"	No changes	
	D	10°46'30.7"	119°19'43.9"	No changes	
	E	10°46'18.5"	119°19'05.2"	Mangrove forest	Mangrove vegetation
	F	10°46'01.2"	119°19'30.8"	No changes	
	G	10°45'44.7"	119°19'26.9"	No changes	
	H	10°44'22.5"	119°20'37.2"	Mangrove forest	Mangrove vegetation
Caruray	A	10°19'26"	119°08'04.1"	Cultivated, mixed crop land	Crop land mixed with coconut plantation
	B	10°18'58.9"	119°06'14.6"	Other land, natural grassland	Cultivated area mixed with brushland/ grassland
	C	10°18'12"	119°04'16"	No changes	
	D	10°17'44"	119°03'37"	Other land, natural grassland	Cultivated area mixed with brushland/ grassland
	E	10°17'23"	119°03'01"	No changes	Cultivated area mixed with brushland/ grassland
	F	10°17'58"	119°01'32"	Other land, cultivated annual crop	Cultivated area mixed with brushland/ grassland
	G	10°18'55"	119°00'15"	Mangrove forest	Mangrove vegetation
	H	10°18'48"	119°20'12"	Mangrove forest	Mangrove vegetation
Kemdeng	A	10°29'55.6"	119°16'30.1"	No changes	
	B	10°30'08.2"	119°16'30.8"	No changes	
New Agutaya	A	10°30'56"	119°18'44"	No changes	
	B	10°31'01"	119°18'19"	No changes	
	C	10°30'26"	119°18'31"	No changes	
	D	10°30'41"	119°18'23"	No changes	
	E	10°32'33"	119°16'45"	Mangrove forest	Mangrove vegetation
New Canipo	A	10°44'20.2"	119°21'28"	No changes	
	B	10°44'07.4"	119°20'52.4"	No changes	
	C	10°42'25.3"	119°20'41.2"	No changes	
	D	10°43'03.3"	119°21'18.9"	No changes	
	E	10°42'58.7"	119°20'52.2"	No changes	
Poblacion	A	10°30'50.7"	119°16'08.6"	No changes	
	B	10°30'11"	119°16'28.1"	Other land, cultivated annual crop	Cultivated area mixed with brushland/ grassland
	C	10°33'17"	119°08'18"	Mangrove forest	Mangrove vegetation
	D	10°33'27"	119°08'27"	Mangrove forest	Mangrove vegetation
	E	10°33'47"	119°09'01"	Mangrove forest	Mangrove vegetation
	F	10°33'57.8"	119°09'04.5"	Mangrove forest	Mangrove vegetation
	G	10°34'07.4"	119°09'11.3"	Mangrove forest	Mangrove vegetation
	H	10°34'07.9"	119°09'15.2"	Mangrove forest	Mangrove vegetation
	I	10°34'13"	119°10'28"	Other land, cultivated annual crop	Crop land mixed with coconut plantation
Port Barton	A	10°21'36"	119°12'02"	No changes	
	B	10°23'13"	119°10'50"	No changes	
	C	10°24'30"	119°10'40"	No changes	
San Isidro	A	10°33'59"	119°21'42"	No changes	Open Canopy
Sto. Niño	A	10°38'37.2"	119°19'45.1"	No changes	
	B	10°39'05.9"	119°20'0.3"	No changes	

Table 3.4. Ground validation points and coordinates per *barangay*

3. GIS-based hazard maps and assessment of exposure to hazard

Drought hazard

Drought is defined as the unavailability of water due to extreme weather conditions such as a long period of abnormally low rainfall. It is also a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and man over a sizeable area (USGS). A drought-related hazard is an event in which a significant reduction of water brings about severe economic, social and environmental hardships to the population. Vulnerability to drought is defined as economic, social and environmental characteristics and practices of the country's population that make it susceptible to the effects of a drought (Jackson, 2011).

In this project, the drought hazard maps were generated using the existing drought hazard maps developed by MGB-DENR and projected rainfall change for year 2020 and 2050. The maps of mean frequency of days with mean temperature of >35˚C, adopted in this project as the maximum temperature threshold for drought to occur, were overlaid with the validated existing drought hazard maps to assess drought hazard.

The approach was based on a study done by Murad (2011), which used GIS to assess drought in selected areas in the north-west region of Bangladesh. Meteorological and agricultural drought risk maps were prepared by integrating the various classes of drought. A resultant risk map was obtained by integrating agriculture and meteorological drought risk maps, which indicate the areas facing a combined drought.

The climate-related drought risk maps for the project were generated by overlaying the existing drought hazard maps with current land use and identifying the agricultural lands (rice, corn, coconut) to be affected and label them as high (red), populated areas medium (yellow), and others low (green). The attribute table was then generated to determine the population exposed to drought risk per *barangay*. **Annex 2** shows the maps summarizing the hazard assessments.

As illustrated in **Tables 3.5** and **3.6**, spatial assessment indicates that a total of 10,000 ha of ricelands and 1,395 ha of coconut plantations are vulnerable to drought. Of these, a total of 3,964.6 ha of areas planted with rice and 1,115.7 of areas planted with coconut are highly vulnerable to drought. *Barangay* Caruray is projected to have the most areas affected by drought, while Binga has the smallest. Accordingly, *Barangay* Caruray has the most areas planted with rice and coconut which are highly vulnerable to drought.

Barangay	Drought hazard (ha)		Grand total
	Low	High	
Alimanguan	751.2	1,977.1	**2,728.3**
Binga	730.5	860.4	**1,590.9**
Caruray	3,076.4	24,209.7	**27,286.2**
Kemdeng	557.9	4,816.8	**5,374.7**
New Agutaya	1,607.6	2,884.3	**4,491.9**
New Canipo	714.0	2,063.2	**2,777.2**
Poblacion	2,071.4	2,676.6	**4,748.0**
Port Barton	2,217.5	14,067.3	**16,284.8**
San Isidro	664.6	3,510.2	**4,174.8**
Sto. Niño	879.8	2,005.2	**2,885.1**
Grand total	13,271.0	59,070.9	72,341.9

Table 3.5. Drought vulnerability of *barangays* in San Vicente, Palawan

Barangay	Coconut	Rice	Coconut	Rice
Alimanguan		254.6	57.9	168.1
Binga	24.6	1.0	39.7	
Caruray	172.9	3,314.9	95.6	2,120.5
Kemdeng	25.8	524.5	1.6	106.1
New Agutaya		260.9	261.2	615.5
New Canipo		77.6	209.1	121.9
Poblacion	8.6	133.3	26.4	124.1
Port Barton	45.6	1,292.1	98.1	513.9
San Isidro		670.8	210.1	67.7
Sto. Niño	2.0	109.7	115.	126.7
Grand total	279.4	6,639.7	1,115.7	3,964.6

Table 3.6. Drought vulnerability of agricultural crops in San Vicente, Palawan

Flood hazard

Flood is defined as an overflow of water onto normally dry land. It is also described as the inundation of a normally dry area caused by rising water in an existing waterway, such as a river, stream, or drainage ditch (National Oceanic and Atmospheric Administration). In this study, flood hazard categories were made and assigned for each cluster, based from geomorphologic analysis in the field and historical data from the interviews. **Table 3.7** gives

Category	Frequency	Depth	Morphology
High	Frequent to less frequent (Several times a year or at least once a year)	Variable; may reach over 7ft.	Beach, estuary, marsh, swamps, swales, wetlands, mudflats, tidal flats, main channels, channel tributaries, lower terraces, paleochannels, oxbows, lakes, sinkholes, backswamps, gullies, rills
Moderate	Less frequent to seldom (At least once in 5 years)	Variable; may reach over 3ft.	Beach ridges, middle terraces, sandbars/pointbars, levees
Low	Seldom (At least once in 10 years)	Variable; may reach over 2ft.	Footslopes, hills, ridges, upper terraces
Less-likely	Unobserved (Cannot measure)	Unobserved	Mountain tops, hill grounds, hills, -plateaus, high slopes
Flashflood	Cannot measure	Variable	Rivers, streams, with V-shaped valleys, steep slopes, constricted channels, prone to landslides and blockage

Note: The data on frequency and depth are ranges deduced from records from the office of the LGU and actual field validation from affected residents for each representative samples.

Table 3.7. Flood hazard susceptibility category for group of landform units with assumed frequency and depth based on field verifications

a description of the three indicators (frequency, depth, morphology) for the different flood hazard categories.

As shown in the table above, the grouping of landform units is called morphology, which provides the important information in categorizing the risks to floods. For example, there are landform units that are permanent flood hazard such that these areas are almost always affected by floods. Some are occasionally affected and others are not affected at all. The high flood hazard category was assigned to group of landform units that are consistently flooded, the moderate flood hazard category to group of landform units that occasionally suffer from flood, the low flood hazard category on group of landform units that has a low probability of floods and lastly no category was assigned to areas that are less likely to suffer floods.

Future flood hazard maps were developed by overlaying existing flood risk map with the projected rainfall change for 2020 and 2050 by PAGASA. The projected increase in rainfall would likely enhance the flood related risk in the future. With the analysis being geomorphological, it can be considered a “worst-case scenario approach.” This means that the analysis covers susceptibilities of the areas to all flooding events of various frequency and magnitude that have already happened and can still happen in the target areas. In short, the maps include spatial information, not only of historical flood susceptibilities, but also future projections of worst flood scenarios at any time in the future.

As shown in **Figure 3.4**, the assigned colors represent specific categories and translated into susceptibilities. In short, it is the possibility or probability of floods in the area covered by each colored representation. However, susceptibility cannot be equated with floodwaters. This is not what the map represents. The red color, for example, suggests that the areas covered are highly susceptible to flooding at any given event. Although they are grouped in one single category, this does not mean that the entire area will be under flooding all at the same time at any given event but rather depending on the magnitude and concentration of the different factors that will dictate which areas will be affected. Thus, at any given storm

Barangay	Total area (sq. km.)	Affected area (sq. km.)				
		LSA	MSA	HSA	Flashflood	Total
Alimanguan	92.32	4.24	3.20	2.47	0.34	**10.25**
Binga	29.57	11.92	0.69	1.59	-	**14.20**
Caruray	302.85	14.21	11.88	8.21	4.08	**38.37**
Kemdeng	51.98	2.00	1.05	1.02	0.61	**4.68**
New Agutaya	112.67	8.93	6.90	4.03	1.44	**21.30**
New Canipo	23.99	2.39	0.81	1.08	0.34	**4.62**
Port Barton	101.40	0.62	0.34	0.57	0.24	**1.77**
Poblacion	59.01	3.95	2.97	2.53	1.73	**11.18**
San Isidro	49.18	0.33	0.31	0.32	0.12	**1.08**
Sto. Niño	47.49	0.43	0.12	0.09	0.34	**0.98**
Total	870.46	49.03	28.28	21.90	9.22	108.43

Table 3.8. Spatial extent for flooding

Barangay	Total pop.	Population density	Total area* (sq. km.)	Affected population				
				LSA	MSA	HSA	Flashflood	Total
Alimanguan	4,010	43.44	92.32	184.17	138.99	107.29	14.77	**445.22**
Binga	1,735	58.67	29.57	699.40	40.49	93.29		**833.18**
Caruray	3,866	12.77	302.85	181.40	151.65	104.80	52.08	**489.81**
Kemdeng	847	16.29	51.98	32.59	17.11	16.62	9.94	**76.26**
New Agutaya	2,891	25.66	112.67	229.13	177.05	103.41	36.95	**546.54**
New Canipo	1,416	59.02	23.99	141.07	47.81	63.75	20.07	**272.69**
Port Barton	5,655	55.77	101.4	34.58	18.96	31.79	13.38	**98.71**
Poblacion	4,686	79.41	59.01	313.67	235.85	200.91	137.38	**887.81**
San Isidro	813	16.53	49.18	5.46	5.12	5.29	1.98	**17.85**
Sto. Niño	1,133	23.86	47.49	10.26	2.86	2.15	8.11	**23.38**
Total	27,052	31.08	870.46	1,523.75	878.88	680.60	286.54	3,369.77

Table 3.9. Population exposure for flooding

event, some parts will be severely affected, others moderately affected, some less affected and some not at all. The reason for this variation within the clustered units is simply due to the fact that within these colored areas are different individual watersheds independent from each other. Nevertheless, they all fall within the same category because of their morphology.

Table 3.8 gives information on the extent of area vulnerable to floods for different *barangays*. Areas affected by flood risk were found to be ranked in the order of Binga, New Canipo and New Agutaya. With more than 40% of the area in *barangay*, Binga was being susceptible to flooding, it also ranked first in the number of people affected by floods, despite its low total population. Spatial risk assessment proved that New Canipo and Poblacion were also ranked among the top three in terms of the population exposed to flooding.

Landslide hazard

Landslide is defined as the downward sliding of a relatively dry mass of earth and rock. It is usually triggered by excessive rainfall or the occurrence of an earthquake strong enough to cause instability in the underlying rock layers (USGS). The rain-induced landslide hazard maps for 10 *barangays* of San Vicente were generated by overlaying elevation and slope maps that were extracted from the digital elevation model (DEM) of area. This is similar to the study done by Lee (2012) who used GIS as a tool to map storm-induced landslides from

SPOT5 images. In the study, he used a GIS-based DEM of 10 m x 10 m resolution to extract geomorphic landslide causative factors such as slope gradient, slope roughness, tangential curvature, relative slope height, total slope height, and wetness index, etc.

A related study was conducted by Li et al. (2012) in a selected area of Qingchuan County in China. It considered four factors in assessing the susceptibility to rain-induced landslide, which were slope gradient, elevation, slope height, and distance to the stream. Results show that slope gradient has the highest weight for landslide susceptibility mapping.

Liangjie et al. (2012) also used GIS to generate landslides susceptibility maps based on factors such as topographical elevation, slope angle, slope aspect, profile curvature, plan curvature, flow direction, flow accumulation, flow length, distance to rivers, distance to highways, distance to faults, stream power index (SPI), and topographical wetness index (TWI).

To generate areas to be affected by landslide, the political boundary map was then overlayed with landslide hazard. The landslide hazard attribute tables were then generated per *barangay* and per municipality to determine the population exposed to rain-induced landslide (risk) per *barangay* and per municipality.

As shown in the landslide hazard map (**Figure 3.5**), the susceptibility was described in three categories of low, medium, and high. The basis for classification is morphological, with no consideration made on the geological or geotechnical characteristics of the site morphology.

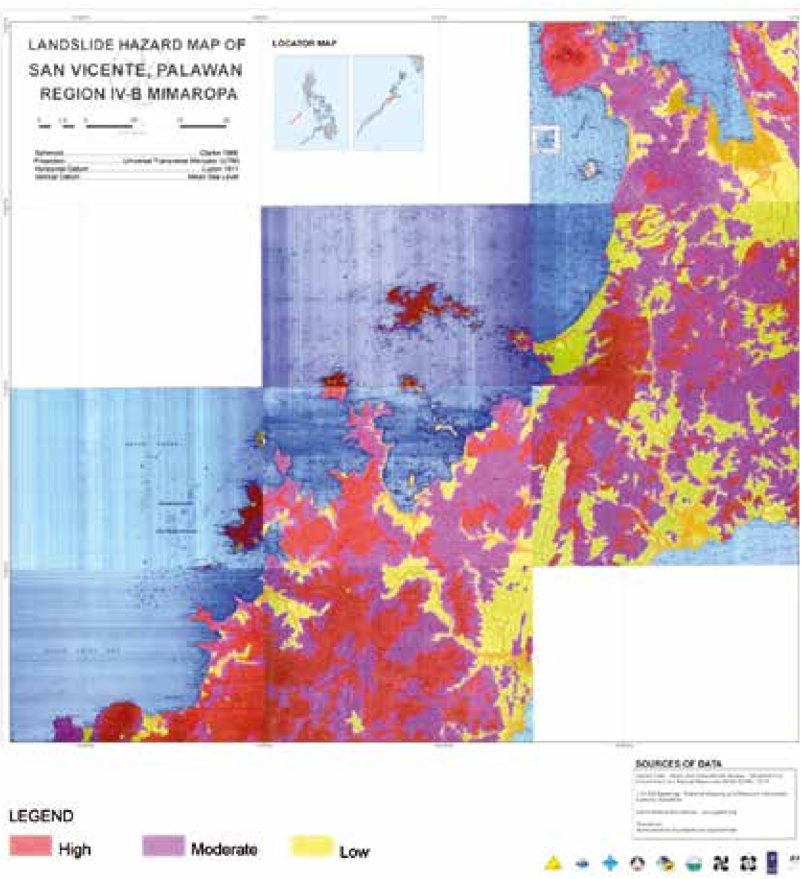


Figure 3.4. Flood hazard map of San Vicente, Palawan

It is important to understand that landslide is an event where the uncertainties of prediction are very high. Precise predictions require a complete understanding of spatial variability of geological and geotechnical conditions, as well as the spatial variability of rainfall. Based on the satellite images, the municipality was found to be highly vegetated with no scars of active or inactive landslides. There were no obvious morphological manifestations of landslides such as escarpments, scarplets, ponded water, ampitheaters, and hummocky debris. Thus, the landslide hazard map derived in this study is largely dependent on the slope morphology extracted from DEM mapping of the area. Critical slopes should be subjected to geotechnical investigations and slope stability analysis.

Spatial vulnerability to landslides was determined by overlaying the hazard maps to the base maps, which gives information on the administrative units affected. In terms of hazard exposure, the physical vulnerability of the top three *barangays* was ranked in the order of San Isidro, Kemdeng and New Agutaya. These *barangays* were also the top three *barangays* in terms of population exposure to rainfall-induced landslides.

Barangay	Total area (sq. km.)	Affected area (sq. km.)			
		LSA	MSA	HSA	Total
Alimanguan	92.32	8.78	49.28	33.43	**91.49**
Binga	29.57	1.00	23.74	4.58	**29.32**
Caruray	302.85	133.79	115.18	48.20	**297.18**
Kemdeng	51.98	21.26	18.44	11.98	**51.68**
New Agutaya	112.67	52.02	30.13	29.77	**111.92**
New Canipo	23.99	0.05	17.82	5.90	**23.78**
Port Barton	101.40	16.56	67.51	15.55	**99.62**
Poblacion	59.01	26.94	22.92	7.05	**56.92**
San Isidro	49.18	9.91	30.60	8.41	**48.92**
Sto. Niño	47.49	4.74	39.12	-	**43.86**
Total	870.46	275.06	414.75	164.87	854.68

Table 3.10. Spatial extent for rainfall-induced landslides

Barangay	Total population	Population density	Total area (sq. km.)	Affected population			
				LSA	MSA	HAS	Total
Alimanguan	4,010	43.44	92.32	381.37	2,140.52	1,452.06	3,973.95
Binga	1735	58.67	29.57	58.67	1,392.93	268.73	1,720.33
Caruray	3,866	12.77	302.85	1,707.88	1,470.32	615.29	3793.62
Kemdeng	847	16.29	51.98	346.43	300.47	195.21	842.11
New Agutaya	2,891	25.66	112.67	1,334.78	7,73.11	763.87	2,871.76
New Canipo	1,416	59.02	23.99	2.95	1,051.82	348.25	1,403.60
Port Barton	5,655	55.77	101.4	923.54	3,764.98	867.21	5,555.73
Poblacion	4,686	79.41	59.01	2,139.31	1,820.08	559.84	4,520.03
San Isidro	813	16.53	49.18	163.82	505.85	139.03	808.70
Sto. Niño	1,133	23.86	47.49	113.09	933.31		1,046.40
Total	27,052	31.08	870.46	85,48.27	12,889.53	5,123.80	26,561.59

Table 3.11. Population exposure for rainfall-induced landslides

C. Environment and natural resources accounting

1. Municipal income account

The conventional municipal income account usually includes the production and expenditure of the local government for final consumable commodities and the physical capital by households, businesses, and the local government, as well as the net exports, within a given period. It does not incorporate the contribution of the environment and natural resources in the municipal accounts, which is among the significant drivers of local economies, given that benefits from these resources are used to produce goods and services. This component of the project aims to measure the contribution of the environment and natural resources to the income accounts of San Vicente, which can provide leaders at the local level sound information for sustainable environmental decision-making.

Results

The Statement of Income and Expenditure (SIE) identifies the sources of local government income and the uses of its revenue. It is also useful in monitoring the growth of the income sources and expenditures, as well as the actual and potential net income.

The income from external sources accounts for the largest contribution of the operating income with the bulk coming from the government's Internal Revenue Allotment (IRA) at 87.8% in 2012. This figure indicates San Vicente's large dependence on external funds. Selected natural resources, on the other hand, also serve as revenue source in some non-tax revenue sources such as the municipality's business income and payment of permit and registration fees. It only accounts for 6.5% of the total operating income.

Sources	Income (in million PhP)		
	2010	2011	2012
External source	142.58	156.87	152.4
Non-tax revenue	12.75	13.99	13.16
Tax revenue	3.34	4.48	4.44
Total	158.67	175.34	170
Revenue from ENR			
Income from waterworks system	4.67	4.67	4.88
Rent income (Pearl Farm operations)	1.87	2.56	2.92
Landing and parking fees	0.16	0.18	0.05
Fishery rental fees	0.04	0.95	0.02
Registration fees	0.49	0.53	0.38
Business tax	1.58	2.82	2.8
Sub-total	**8.81**	**11.71**	**11.05**
% of Operating income	5.6%	6.7%	6.5%

Table 3.12. Summary of municipal revenue of San Vicente

Further assessment of the SIE, specifically on LGU's expenses, shows that the local government unit has focused its spending on personal services (salaries, wages, compensation) and other operating expenses (traveling expenses, gasoline, supplies, electricity, etc.) without building additional physical capital. There is no reported expenditure for productive facilities or services such as reforestation, watershed protection, irrigation as well as water reservoir, artesian wells, roads and bridges, and environment and sanitary services.

Subsidies have been provided to national government agencies, other entities, other funds, NGOs/POs and donations, estimated at 6% of the operating income. These subsidies, however, equate to foregone savings that could have financed productive investment options. Even the calamity fund is identified under the subsidy. This is assumed to provide the financial assistance for recovery due to natural disasters.

With the net savings of the government from 2010 to 2012 amounting to 13% to 30% of the operating income, the above mentioned subsidies can add up to additional savings that can be used for investments on natural capital protection, rehabilitation and human capital development on climate change adaptation measures or mitigation actions.

Item	Income (in million PhP)		
	2010	2011	2012
Personal services	66.17	78.63	79.7
Other operating expenses	23.59	22.78	21.32
Repair and maintenance	3.72	15.85	2.27
Confidence, intelligence, extraordinary and miscellaneous expenses	2.49	1.24	7.32
Non-cash expenses (Depreciation)	3.46	3.25	2.48
Other maintenance and operating expenses	39.29	28.07	6.31
Financial payments	1.96	2.51	2.21
Total subsidies, donations and extraordinary items	**7.46**	**8.68**	**14.51**
Total non-operating expenses			**11.69**
Total expenses	148.14	161.01	147.81

Table 3.13. Summary of municipal government expenses

Particulars	Total amount (PhP)			Percentage of total amount		
	2010	2011	2012	2010	2011	2012
Total current operating income	158,667,980.78	175,334,307.63	170,045,072.61	100	100	100
Total operating expenses	138,727,401.05	149,834,615.38	119,416,024.16	87	85	70
Net operating savings	19,940,579.73	25,499,692.25	50,629,048.45	13	15	30
Non-operating expenses	9,415,550.77	11,190,411.43	16,726,353.90	6	6	10
Net savings	10,525,028.96	14,309,280.82	33,902,694.55	7	8	20

Table 3.14. Financial standing of San Vicente

Apart from government savings, household savings, and economic rents in the agriculture, fishery, and forest sectors may also be available for natural capital restoration and improvement of ecosystem services. Among the rich natural resources in San Vicente, the directly marketed natural goods and services contribute to household savings and accrue to the additional natural capital that were not included in the SIE. As such, their economic rents have been estimated to determine the value of such natural assets.[2]

2 Economic rent, as a residual value of the market value of the resource minus all costs of production and margin for profit and risk, represents the value contribution of the natural resource based on its market price. It becomes a value of natural resource depletion when extraction of natural resource is unsustainable.

Table 3.15 shows the total amount of economic rent that has been generated for 2012, as well the rent per unit product, proportion relative to resource price, and the particular group who has acquired the income from the natural resource. It implies that the total value of the natural capital in the study accrue to PhP650.49 million to PhP671.9million among the natural resources in San Vicente that the communities commonly use. As can be gleaned from results, the fishery sector is the highest economic rent generator due to its open access condition and the availability of high valued marine products. Forestry-based activities, on the other hand, are small-scale and limited to a certain number of households. A look into the extraction activities vis-a-vis the economic rents generated, it may not be possible to provide enough savings to fund the reforestation of the cleared areas.

Comparing the computed economic rents and the result of the household survey shows that economic rents of the fishery sector accounted for a substantial portion of the total income. Although not all households in the fishery sector were able to save, more than half has generated positive net savings. The same circumstance cannot be observed in the agriculture sector since its total net dissavings means excess expenditures that must be funded by borrowing or by income sources that are unaccounted. This comparison further shows that rent distribution and savings would indicate how much can be tapped for investments in regenerating the depleted natural resource or in producing a perpetual stream of renewable substitutes.

Fishery	Economic rent (in million PhP)	Forestry	Economic rent (in million PhP)	Agriculture	Economic rent (PhP)	Water	Economic rent (in million PhP)
Registered grouper traders and exporters	132M 2.06M/MT Or 2,065/kg 69% of the price	Fuelwood gatherers	3.71M 53.1/m^3	10 out of 80 farmers	0.51/kg 4.03% of the price	Domestic water supply	1.08M
Registered commercial boat owner	43.7M 0.15M/MT Or 151/kg	Charcoal producers	0.208M 59.9/m^3	70 farmers	(6.35)/kg	Volume: 398,933 m^3	Unit rent:2.72/m^3 20.9% of the price
Registered municipal fisher	317.4M 0.052M/MT or 51.9/kg	Boat maker	1.52M 426.9/m^3	Price/kg P12.66/kg		Price of water: 13/m^3	
Unregistered fishers and traders	-	Lumber for home construction	0.795M 774.3/m^3	-	-	-	-
External illegal commercial vessel	149.4M – 170.8M	Shifting cultivator (*kainginero*)	0.678M 52.5 ha. Cleared	-	-	-	-
Total (in million PhP)			642.5 – 663.9		6.912		1.08

Table 3.15. Economic rents of the fishery, forestry and agriculture sectors, 2012

Conclusion

Determining the contribution of the ENR to the local economy and developing a green municipal account proved to be a challenge in consideration of the limited dataset and unreported NR-related activities of households and businesses. The minimal contribution of the ENR in the municipal income accounts (6.5%) illustrated that even marketable natural goods and services are not accounted even though a majority of its population are dependent on either agriculture, fishery or forestry sectors. Looking into the estimated value of the natural resources as well as the ENR contribution to San Vicente's municipal income account, it has to be considered that the utilization or harvesting of such resources are in business-as-usual (BAU) resource management scenario. This has not yet considered climate projections that will increase the vulnerabilities of the sectors in study, thereby affecting not just the physical stocks but also the asset values of the resources and eventually, the income of the households, businesses and municipality.

Can household and government savings in agriculture, fishery and forestry sectors be enough to fund investment in natural capital formation, restoration of ecosystem services and build-up of productive assets?[3] For government savings, the LGU should determine its priority actions and strategic measures to secure a steady stream of income in the future or climate change adaptation (CCA) measures to increase the resilience of communities and ecosystems.

Results of the survey, however, show that for the households, the agriculture sector will have limited savings due to dissavings and poverty. In the fishery sector, savings are only generated from a small proportion of the household income. These imply meager savings that can be tapped from the households, in the assumption that these savings will be used for natural resources-related investments.

In greening the municipal income accounts, it is imperative for the local government to implement the following activities to be able to achieve natural resource sustainability at the municipal level:

1. Identification of natural resources deterioration – the need to establish physical accounts in order to determine the state of the depletion and deterioration.
2. Estimation of ENR-based economic rent and household and business savings from ENR-based production activities.
3. Imposition to close open access areas (coastal waters, fishery, forestry) to registered and regulated uses whose activities would be limited to predetermined allowable harvest levels and shipment volume and cease illegal utilization of natural resources and shipment.
4. Increase of government savings as well as exercise the imposition of environmental charges (forestry and fishery), increase in taxes and royalties for the product sales.

2. Agriculture

Agriculture is a major economic sector of the Municipality of San Vicente. It provides the source of food and livelihood for its people. As shown in **Figure 3.6**, the green colored areas indicate the relative locations of its agricultural lands. The proximities of agricultural areas to the rivers, creeks and streams must be viewed in two ways. Although rivers, creeks, and streams provide a source of irrigation water that is vital for agricultural activities, these areas also pose potential risks of flooding during times of extreme rainfall events to agricultural lands.

According to the records of the Municipal Agriculture Office (MAO) in 2010, the total number of farmers in San Vicente was 1,704 farmers. This information is important for planning the agricultural development in case it is pursued in response to the future development of San Vicente. The distribution of the total number of farmers by *barangay* showed that there are more farmers in Port Barton, Alimanguan, New Agutaya and Caruray than the other *barangays*.

3 Productive assets may include investments in human and social capital formation such as expenditures on education, health, improvement and institution building and strengthening.

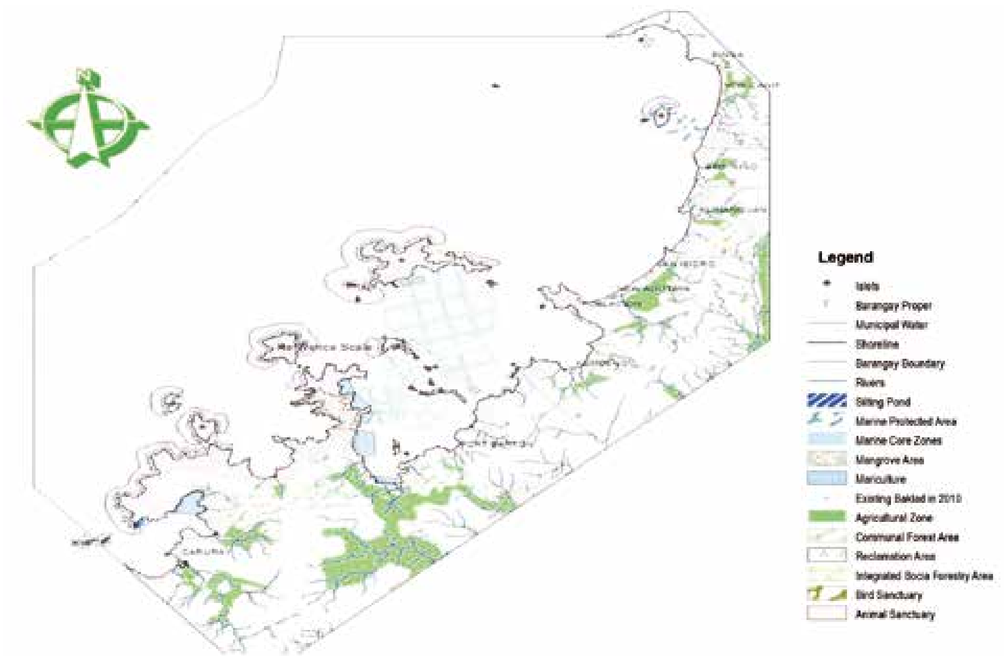


Figure 3.6. Geographical locations of agricultural lands in San Vicente, Palawan (2013)

The agricultural land areas of San Vicente have experienced significant changes in the past two decades. From 1988 to 2004, agricultural land use in San Vicente increased from 3,942.16 ha to 6,138.99 ha. Such increase was driven by arable land with cereals and sugar as main crops, which increased significantly from 538.63 ha in 1988 to 5,311.19 ha in 2004. On the other hand, crop lands that are mixed with coconut plantation reduced from 3,403.52 ha in 1988 to 827.80 ha in 2004. The grassland and brushland category presents potential expansion of agricultural area, although they may not be arable or productive. **Table 3.17** represents the agricultural area for different crops harvested from 2010 to 2012.

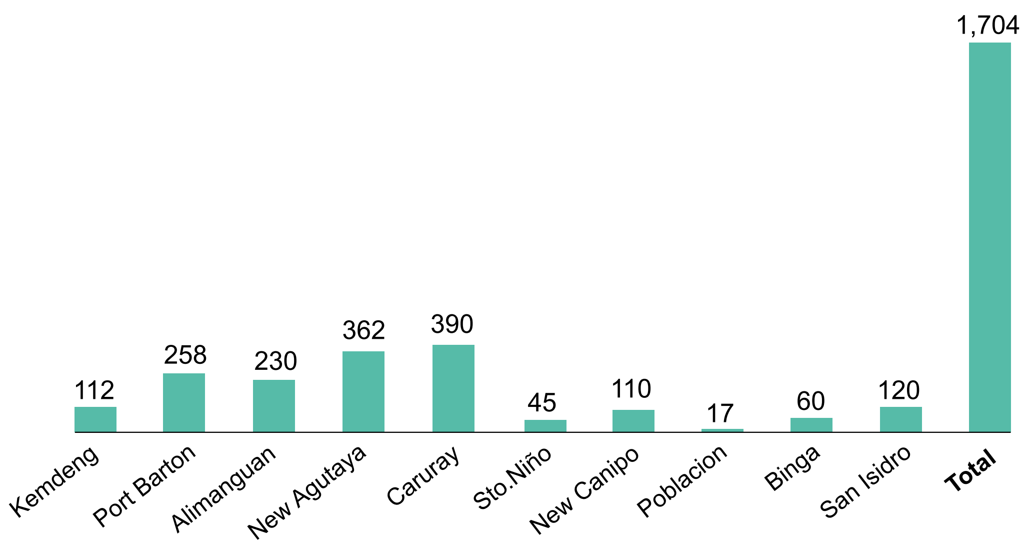


Figure 3.7. Number of farmers per *barangay*

2004 NAMRIA		1988 DENR-FMB				
Land use	Area (ha)	Land use	Area (ha)	Change	Annual change	% Change
Grassland and brushland						
Grassland and Brushland	10,475.05	Grassland and brushland	10,335.88	139.17	8.70	1.35
Other wooded land, shrubs	3,340.21	Cultivated area mixed with brushland/grassland	10,335.88	139.17	8.70	1.35
Other land, natural, grassland	621.38	-		-	-	-
Other land, natural, barren land	68.38	-		-	-	-
Other wooded land, wooded grassland	6,445.08	-		-	-	-
Sub-total	10,475.05					
Agriculture						
Agriculture	6,138.99	Agriculture	3,942.16			
Other land, cultivated, annual crop	5,311.19	Arable land, crops mainly cereals and sugar	538.63	4,772.56	298.28	886.05
Other land, cultivated, perennial crop	827.80	Crop land mixed with coconut plantation	3,403.52	(2,575.72)	(160.98)	(75.68)
Sub-total	6,138.99	Sub-total	3,942.16	2,196.83	(160.98)	(75.68)
Fishery						
Other land, fishpond	42.48	-		-	-	-

Table 3.16. Land use change in agriculture in San Vicente (1988-2004)

Crops	Area cultivated by year			
	2010	2011	2012	Average
Rice	2,013	2,015	2,018	**2,015**
Corn	21.20	-	27.25	**24**
Mango	15	15	15	**15**
Vegetables	6	6	6	**6**
Coconut	1,141	992	992	**1,042**
Cashew	196	170	170	**179**
Cassava	57	55	248	**120**
Assorted fruits	20	22	35	**26**
Total	5,479	5,286	5,523	5,429

Source: Municipal Agriculture Office, San Vicente, Palawan

Table 3.17. Area planted with agricultural crops

Scoping of activities and data gathering

At the scoping stages of the activity, the project team assessed the availability of data that can be used in constructing the agricultural accounts. The focus of analysis was on rice and several assorted agricultural crops that made up the greater majority of the total agricultural produce in the municipality. Most of the available data were secondary data, related to the amount of production and prices given at various stages of the supply chain. In order to compensate for the lack of data in creating physical and economic accounts, key informant interviews, and questionnaires were used to collect data from key stakeholders.

Key Informant Interviews

The objective of the key informant interview is to assess the agricultural practices of farmers, their income, expenditures and savings, crops and area cultivated as well as the sales and consumption of food products. There were six *barangays* that were interviewed.

Unfortunately, the other four *barangays* were not covered due to unforeseen issues[4]. There were 80 farmer-respondents in total, which make up approximately 33.9% of the total number of households sampled in the study, and 11.13% of the total farm household in the six *barangays*. The distribution of respondents is summarized in **Table 3.18**.

Barangay	Total farm household sample*	% to the total household sample	% to the total farm households in six *barangays*
Kemdeng	4	30.77	**12.90**
New Agutaya	13	30.95	**8.97**
New Canipo	11	31.43	**10.00**
Poblacion	13	17.11	**10.83**
San Isidro	23	60.53	**14.20**
Sto. Niño	16	50.00	**10.60**
Total	80	33.90	11.13

* *CBMS survey, 2010-2011*

Table 3.18. Distribution of respondents in the key informant interview

The basic data necessary for the construction of agricultural accounts are: a) area of cultivation, b) yield per hectare, c) savings or land rent per hectare, d) farm gate prices per kilogram, e) damages due to insect and rat infestation, climate-related events, farm management deficiencies, wastages and f) demands for agricultural crops.

Structure of agriculture accounts

Savings that can be considered to be equivalent to land rent is an important factor considered in resource accounting. The following formula was used to calculate the savings or land rent for production in agricultural sector:

Land rent = Market price of agricultural crop – Total costs involved in production

The total cost related to production can be divided into the milling cost, cost of trader's profit, seed purchase cost, fertilizer purchase cost, labor cost, fuel cost, farmer's management cost, and farmer's margin for profit. In cases where there were no complete data on these variables, the farm gate price was used.

The agricultural account is divided into physical account and economic account. The physical account is a form of stocks and flows in physical terms in the form of the following entries:

- **Opening stock:** Cultivated areas for rice and assorted agricultural crops based on the average area planted in 2010, 2011, and 2012
- **In-growth or addition:** Total of natural in-growth and man-made growth in terms of cultivated areas and production. However, this entry was limited due to the lack of data
- **Reduction factors:** Factors related to the reduction of production, which includes the loss from the following incidents:
    - o Insect infestation (as percentage of area affected)
    - o Climate-related impact (as percentage of area affected)
    - o Deficiencies in farm management (as percentage of area affected)
    - o Food demand (rice and assorted agricultural crops)

4 The project was put on hold for six months during implementation, due to instruction by the local government to halt all activities until a formal clearance is issued based on social and environmental safeguard policy.

o Loss of harvest during the stages of harvesting, drying, transporting, processing, and consumption (as percentage of food demand)

- **Net addition/reduction:** Difference in in-growth or addition and reduction factors
- **Closing stock:** Calculated by adding the net addition or reduction to the opening stock of area and yield accounts

The physical accounts describe above cannot be compared directly with the standard measures of economic performance to assess the sustainability of growth or development. Therefore, the economic account was created, which is a monetary conversion of physical accounts by economic valuation. Although the entries of physical and economic accounts correspond to each other, economic accounts may contain additional entry to account for the change in asset value from changes in prices between the start and end period of investigation. The economic account for the study was created in the form of the following entries using nominal value:

- **Opening stock value**
- **Savings or land rent:** Total multiple savings or land rent per project quantity and yield account of the opening stock
- **In-growth or addition:** Total multiple savings or land rent per product quantity and yield account of in-growth or addition
- **Reduction value:** The value of total reduction in harvest resulting from the reduction factors entry of the physical account, which is a multiple of savings or land rent per product quantity and yield account reduction factors
- **Net addition or reduction:** Value of in-growth or addition subtracted by reduction value
- **Closing stock value:** A sum of net addition or reduction and opening stock value

Table 3.19 gives a summary of the resource accounting system used in this study.

Year 1 (Physical account): Area and yield accounts	Year 1 (Economic accounts): Land rent (PhP)
Opening stock	Opening stock
Plus	Plus
Growth: Natural in-growth, man-made growth (area and product quantity)	Growth: Natural in-growth, man-made growth, re-appraisal of economic value
Less	Less
Reduction: Mortality, harvests, natural causes, land use conversion	Reduction: Mortality, harvest, natural causes, land use conversion, re-appraisal of economic value of reductions
Closing stock	Closing stock

Table 3.19. Structure of physical and economic accounts for agriculture

Results of the baseline survey

a. Households engaged in agriculture

The number of households engaged in agricultural activities was found to be greater in San Isidro (25% of total number for *barangay*), followed by Sto. Niño (21%), and New Agutaya (19%); while the least number of farmers are situated in Poblacion (15%), New Canipo (12%), and Kemdeng (8%). Of the total number of farming households, 11.13% were sampled to base the agricultural accounts in this study.

Barangay	Total number of households	Farm households sample	% Sample
Kemdeng	31	4	**12.90**
New Agutaya	145	13	**8.97**
New Canipo	110	11	**10.00**
Poblacion	120	13	**10.83**
San Isidro	162	23	**14.20**
Sto. Niño	151	16	**10.60**
Total	719	80	11.13

Table 3.20. Farm households sampling

A large majority of farmers (78%) interviewed are engaged in rice production. Across the six *barangays*, coconut and banana cropping, although very minimal, came second and third at 10% and 9%, respectively. Both vegetable and corn farming are uncommon in all the aforementioned *barangays*, representing only 2% and 1%, respectively. In the case of New Canipo and San Isidro, all individual households interviewed exclusively produce rice. San Vicente, although categorized as a fishing community, prioritizes rice production primarily for household consumption.

Statistics for San Vicente demonstrate the importance of rice production, which also applies across the nation. Rice is the staple food in the Philippines and is an important part of the local economy, especially to those at lower income levels.

Barangay	Rice	Coconut	Banana	Corn	Vegetables	Total
Kemdeng	4.40	0	3.30	0	0	**7.69**
New Agutaya	12.09	2.20	2.20	1.10	1.10	**18.68**
New Canipo	12.09	0	0	0	0	**12.09**
Poblacion	14.29	1.10	0	0	0	**15.38**
San Isidro	25.27	0	0	0	0	**25.27**
Sto. Niño	9.89	6.59	3.30	0	1.10	**20.88**
Grand total	78.02	9.89	8.79	1.10	2.20	100.00

Table 3.21. Crop distribution among households

Anecdotal accounts revealed that coconut production came second because it needs the least maintenance and monetary investment. Seven percent (7%) of the households interviewed in Sto. Niño claimed that they are only second-generation land owners; they either bought or inherited lands, wherein a number of coconut palms were already planted. Thus, they are only harvesting produce from palms planted by their previous owners. These lands in Poblacion and New Agutaya can be seen along the road. Meanwhile, banana production, of which most of the harvest is consumed by the households, is produced by only 8% of the farmers interviewed in Kemdeng, Sto. Niño, and New Agutaya. Vegetables are produced both in Sto. Niño and New Agutaya, but only the latter brings the harvest to the market, the former consumes 100% of their produce. Corn, which is least popular among the farmers, is produced only in New Agutaya (1%).

b. Farming practices and costs of production

Agricultural areas in the municipality can be divided into rain-fed and irrigated land. While irrigated farming enables higher water use efficiency, especially in water scarce regions, it is also used in regions with sufficient rainfall to boost the growth of crops. **Tables 3.22** to **3.24** presents the periods of farming and the planted areas and yields in the irrigated lands and rain-fed areas in two cropping seasons. The planted areas in 2011 are used as the area planted for the 2013 rice accounting. The average yield of the irrigated and rain-fed areas is adopted in the 2013 rice accounting. Both the irrigated and rain-fed areas by cropping season showed insignificant difference in terms of yields per hectare. Thus, only one set of rice account is prepared. The area considered in the accounting is the sum of the irrigated lands and rain-fed lands. The yield per hectare used is the average of the two rice lands in two cropping seasons.

Crop year	Irrigated				
	First cropping season				
	Period		Area (ha.)		Yield
	Planting	Harvesting	Planted	Harvested	(t/ha)
2006-2007	May – Aug.	Sept. – Jan.	1,457.25	1,457.25	3.70
2007-2008	May – Sept.	Oct. – Jan.	1,544.25	1,544.25	3.88
2008-2009	June – Oct.	Oct. – Feb.	1,569.25	1,569.25	3.88
2009-2010	June – Oct.	Oct. – Feb.	1,586.25	1,586.25	3.89
2010-2011	May – Sept.	Sept. – Jan.	1,586.25	1,584.25	3.51
2011-2012	May – Sept.	Sept. – Jan.	1,586.25	1,584.25	3.77
2012-2013	May – Sept.	Sept. – Jan.	1,586.25	1,584.25	3.77

Table 3.22. Irrigated land's first cropping season

Crop year	Rain-fed				
	First cropping season				
	Period		Area (ha)		Yield
	Planting	Harvesting	Planted	Harvested	(t/ha)
2006-2007	June – Oct.	Oct. – Feb.	471.00	471.00	3.66
2007-2008	June – Oct.	Oct. – Feb.	457.75	457.75	3.79
2008-2009	July – Nov.	Oct. – Mar.	452.75	452.75	3.76
2009-2010	July – Nov.	Oct. – Feb.	428.75	426.75	3.32
2010-2011	June – Oct.	Oct. – Feb.	428.75	428.75	3.66
2011-2012	June – Oct.	Oct. – Feb	428.75	428.75	3.64
2012-2013	June – Oct.	Oct. – Feb	428.75	428.75	3.64

Table 3.23. Rain-fed land's first cropping season

Crop Year	Rain-fed				
	Second cropping season				
	Period		Area (ha)		Yield
	Planting	Harvesting	Planted	Harvested	(t/ha)
2006-2007	Oct. – Dec.	Feb. – Apr.	455.00	455.00	3.61
2007-2008	Oct. – Dec.	Feb. – Apr.	474.00	474.00	3.78
2008-2009	Oct. – Nov.	Jan. – Mar.	449.00	445.00	3.70
2009-2010	Oct. – Dec.	Jan. – Feb.	424.75	391.75	3.32
2010-2011	Sept. – May	Dec. – May	422.50	422.50	3.56
2011-2012	Sept. – May	Dec. – May	445.05	437.65	3.59
2012-2013	Sept. – May	Dec. – May	445.05	437.65	3.59

Table 3.24. Rain-fed land's second cropping season

Whether a farmer adopts mono-cropping or multiple-cropping practices is also a factor affecting productivity. While 90% of the farm households were found to be engaged in at least one crop, which is rice, only 9% and 1% were found to be involved in two or more crops, respectively. Farmers who produce two crops live in *Barangay* Kemdeng, while those who produce five crops in the entire year reside in New Agutaya, as shown in **Figure 3.8** and further in **Table 3.25**. In terms of the equipment and machineries used in agricultural activities, a large portion of the farmers were found to own hand tractors and mechanical threshers. However, a significant percentage of the machineries owned were non-operational, which implies the lack of maintenance services in the region.

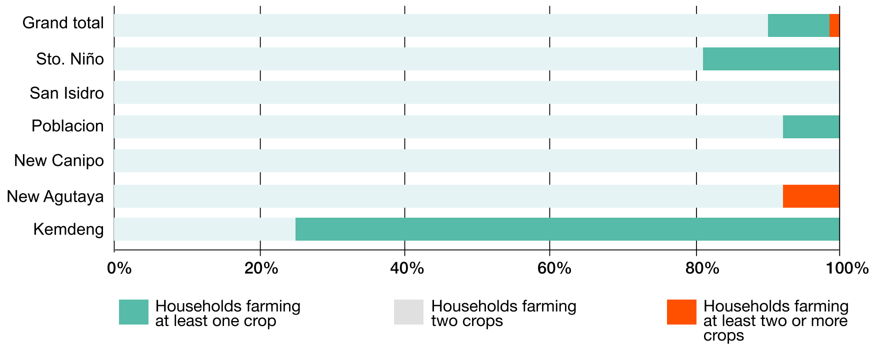


Figure 3.8. Percentage of households engaged in mono-cropping and multiple-cropping

Barangay	Number of households farming at least one crop	Number of households farming two crops	Number of households farming two or more crops
Kemdeng	1	3	0
New Agutaya	12	0	1
New Canipo	11	0	0
Poblacion	12	1	0
San Isidro	23	0	0
Sto. Niño	13	3	0
Grand total	72	7	1
% to the total surveyed	90%	9%	1%

Table 3.25. Cases of mono and multiple-cropping practices among households

Facility/ Machinery	No. of units		% Operational
	Total	Operational	
Mechanical thresher	90	84	23.46
Multi-purpose pavement/ solar dryer	27	27	7.54
Flatbed dryer	8	2	0.56
Palay warehouse	45	43	12.01
Hand tractor	150	144	40.22
Four-wheel tractor	4	2	0.56
Water pump	9	3	0.84
Reaper rice stripper	1	0	-
Harvester	0	-	
Combine harvester	0	-	
Baby *cono*	57	53	14.80

Source: MAO, San Vicente

Table 3.26. Post-harvest facility and machinery of farmers

The difference in percentage of farmers practicing either upland or lowland farming is minimal. That is, only a little more than half (52.5%) of them plant various crops in upland areas, while slightly less than (47.5%) grow crops in the lowland areas (**Table 3.27**). San Isidro ranked first on both the percentage of farmers who are dependent in upland (17.5 %) and lowland farming (11.25 %). They are followed closely by farmers from Sto. Niño (12.5%) for the former, and Poblacion (11.25%), and New Agutaya (10%) for the latter.

Barangay	Upland farming	Lowland farming
Kemdeng	-	5.00
New Agutaya	6.25	10.00
New Canipo	6.25	7.50
Poblacion	5.00	11.25
San Isidro	17.50	11.25
Sto. Niño	12.50	7.50
Grand total	47.50	52.50

Table 3.27. Percentage of farmers engaged in lowland and upland farming

The land holdings of the farmer households surveyed in six *barangays* showed that only 31.65% own their farmland. Those who own their farmland has an average yield of 2.37 ha, which implies that they are mainly land owners who use external labor to conduct agricultural activities. Interviewees' responses on the expenses spent in agriculture are also in line with these implications. The highest expenses (63%) were for payment of hired labor (e.g., land preparation, planting, harvesting), suggesting that family or personal labor is very common in San Vicente despite anecdotal evidence and household survey results. This is followed by the cost for seeds and fertilizer with 17% and 15%, respectively. On the other hand, purchase of pesticides is the least costly, representing only 6% of the total farming expenditure. A little less than 1% is paid for fuel used in rice production. The total annual expenses from the production of all crops amounted to more PhP1.6 million. The two *barangays* with the highest agricultural costs incurred for an entire year were San Isidro and New Canipo with 35% and 21% or equivalent to PhP565,000 and PhP337,000; while the *barangays* with the least costs were Kemdeng and Poblacion with 4% and 10% or PhP69,500 and PhP168,000, accordingly.

Barangay	Total farm land (ha)**	Household surveyed*	% to the total surveyed	Average farm owned by respondents (ha/farmer)
Kemdeng	13.08	4	30.77%	**3.27**
New Agutaya	15.77	13	30.95%	**1.21**
New Canipo	11.91	10	28.57%	**1.19**
Poblacion	25.4	10	12.99%	**2.54**
San Isidro	55	23	60.53%	**2.39**
Sto. Niño	56.25	15	46.88%	**3.75**
Grand total	177.41	75	31.65%	2.37

**Number of farm-based households surveyed*

***Total land areas used in farming*

Source: REECS Survey Team, 2013

Table 3.28. Farmer's land property used in farming

Barangay	Seed	Fertilizer	Pesticide	Labor	Fuel	Total cost
Kemdeng	9,600.00	8,600.00	5,600.00	45,798.21		**69,598.21**
New Agutaya	34,650.00	41,400.00	15,300.00	125,910.00	330.00	**217,590.00**
New Canipo	45,400.00	51,370.00	15,260.00	225,182.86		**337,212.86**
Poblacion	43,716.00	29,000.00	15,360.00	80,131.67		**168,207.67**
San Isidro	95,500.00	74,620.00	32,360.00	362,720.00		**565,200.00**
Sto. Niño	37,880.00	28,700.00	15,220.00,	169,828.57	1,088.00	**252,716.57**
Grand total	266,746.00	233,690.00	99,100.00	1,009,571.31	1,418.00	1,610,525.31

Source: REECS Survey Team

Table 3.29. Distribution of production cost based on farm inputs (in PhP)

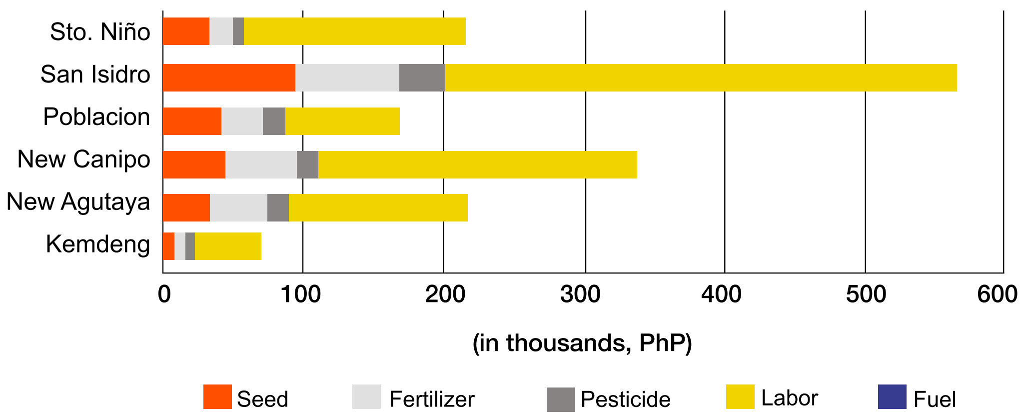


Figure 3.9. Distribution of farm inputs per *barangay*

c. Amount of harvest and household consumption

Across the six *barangays*, a majority of the household farmers (69%) were able to harvest within 1 to 4,000 kg, including all crop varieties. About 22% was able to produce between 5,001- 8,000 kg, and a smaller percentage (10%) was able to harvest more than 8,001 kg **(Table 3.30**). The average harvest of all farmers interviewed according to crop variety is given in **Table 3.31**. The average for rice is 3,751.2 kg, 959.44 kg for coconut, 1,212.81 kg for banana, 1,500 kg for corn and 1,360 kg for vegetables. Kemdeng was found to have the highest annual average, while San Isidro was found to have the least annual average

Value range (in kg.)	# of farmers	% distribution
10,0001 and above	1	1.25
9,001 – 10,000	2	2.5
8,001 – 9,000	3	3.75
7,001 – 8,000	1	1.25
6,001 – 7,000	1	1.25
5,001 – 6,000	9	11.25
4,001 – 5,000	8	10
3,001 – 4,000	15	18.75
2,001 – 3,000	10	12.5
1,001 – 2,000	15	18.75
1 – 1,000	15	18.75

Table 3.30. Harvest range of farmers

Barangay	Rice	Coconut	Cashew	Banana	Corn	Vegetables	All Crops
Kemdeng	3,575.00	-	-	3,060.83	-	-	**5,870.63**
New Agutaya	3,815.00	225.00	-	150.00	1,500.00	800.00	**3,462.69**
New Canipo	3,323.00	-	-	-	-	-	**3,323.00**
Poblacion	3,065.19	3,360.00	-	-	-	-	**3,323.65**
San Isidro	3,066.52	-	-	-	-	-	**3,066.52**
Sto. Niño	7,015.56	804.17	-	73.33	-	1,920.00	**4,381.56**
Grand total	23,860.27	4,389.17	-	3,284.16	1,500.00	2,720.00	23,428.05

Table 3.31. Annual average harvest of all crops

harvest. **Figure 3.10** reflects the average yield of rice in kilograms per year, was highest both in New Canipo and Poblacion with 4,093 kg and 3,096.30 kg of rice, respectively. According to the respondents, the reason for the relatively high yield in New Canipo and Poblacion may be attributed to the use of fertilizer and insecticides. Household surveyed in San Isidro represents the lowest average yield with only 1,991 kg.

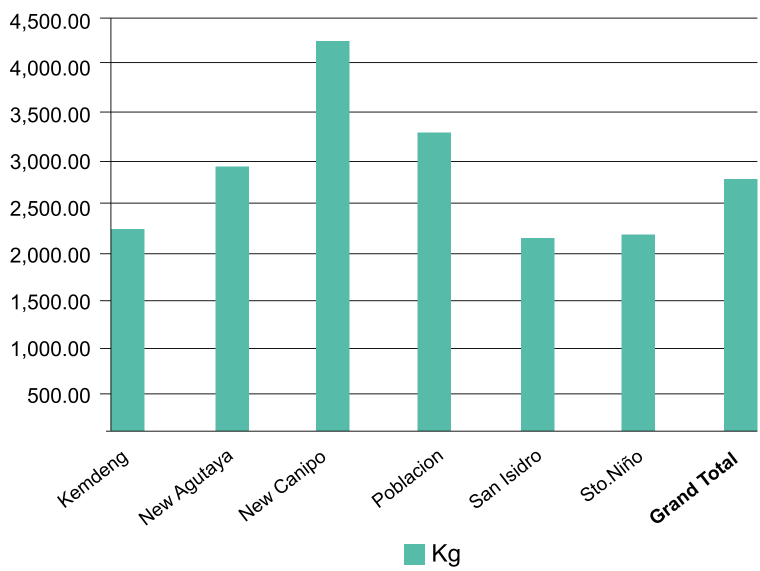


Figure 3.10. Average annual rice yield (kg/ha)

As mentioned previously, the agricultural sector is an important part of San Vicente's local economy, especially for those at lower income levels because a significant amount of what is produced is consumed by the respective farming household. Surveys conducted revealed the total annual yield (**Table 3.32**), consumed (**Table 3.33**) and sold (**Table 3.34**) by crop and per *barangay*. For all crops, an average of 64.8% is consumed by the farmers and 35.2% is sold to the market. In terms of crop variety, rice is the crop that is highly consumed, with only 33.5% making its way to the market. The situation is more significant for bananas, with only 3.33% being sold to the market. However, a large percentage of coconut, corn, and vegetables reach the market, with percentages of 94.85%, 100%, and 90.71%, respectively.

Barangay	Rice	Coconut	Cashew	Banana	Corn	Vegetables	All crops
Kemdeng	14,300.00	-	-	9,182.50	-	-	**23,482.50**
New Agutaya	41,965.00	450.00	-	300.00	1,500.00	800.00	**45,015.00**
New Canipo	36,553.00	-	-	-	-	-	**36,553.00**
Poblacion	39,847.50	3,360.00	-	-	-	-	**43,207.50**
San Isidro	70,530.00	-	-	-	-	-	**70,530.00**
Sto. Niño	63,140.00	4,825.00	-	220.00	-	1,920.00	**70,105.00**
Grand total	266,335.50	8,635.00	-	9,702.50	1,500.00	2,720.00	288,893.00

Table 3.32. Annual yield by crop in kilograms

Barangay	Rice	Coconut	Cashew	Banana	Corn	Vegetables	All crops
Kemdeng	12,925.00	-	-	9,182.50	-	-	**22,107.50**
New Agutaya	29,095.00	-	-	12.00	-	80.00	**29,187.00**
New Canipo	34,124.70	-	-	-	-	-	**34,124.70**
Poblacion	23,237.50	-	-	-	-	-	**23,237.50**
San Isidro	44,960.00	-	-	-	-	-	**44,960.00**
Sto. Niño	32,780.00	445.00	-	185.00	-	172.80	**33,582.80**
Grand total	177,122.20	445.00	-	9,379.50	-	252.80	187,199.50

Table 3.33. Total annual volume consumption of crops in kilograms

Barangay	Rice	Coconut	Cashew	Banana	Corn	Vegetables	All crops
Kemdeng	1,375.00	-	-	-	-	-	**1,375.00**
New Agutaya	12,870.00	450.00	-	288.00	1,500.00	720.00	**15,828.00**
New Canipo	2,428.30	-	-	-	-	-	**2,428.30**
Poblacion	16,610.00	3,360.00	-	-	-	-	**19,970.00**
San Isidro	25,570.00	-	-	-	-	-	**25,570.00**
Sto. Niño	30,360.00	4,380.00	-	35.00	-	1,747.20	**36,522.20**
Grand rotal	89,213.30	8,190.00	-	323.00	1,500.00	2,467.20	101,693.50

Table 3.34. Total annual volume sale of crops in kilograms

Considering the importance of rice harvest and consumption in the region, it is worthwhile to examine how the situation is different for the six *barangays*. In terms of the overall percentage of rice harvest, San Isidro and Sto. Niño ranked highest. Consistent with previous discussion, these two communities likewise have the highest proportion of produce allotted

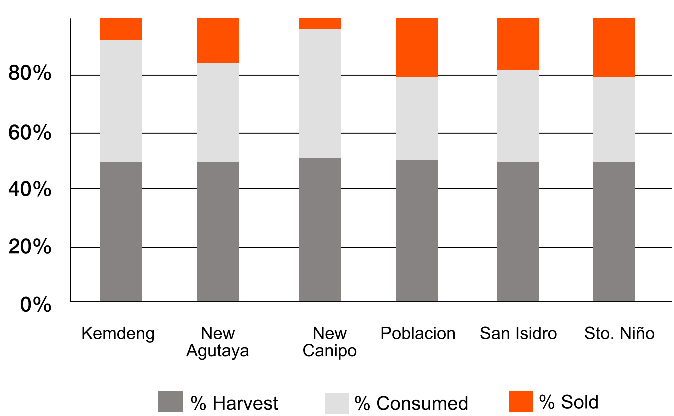


Figure 3.11. Percent distribution of total annual harvest, consumption and sale (in kg) of rice

Barangay	% Harvest	% Consumed	% Sold
Kemdeng	5.37	4.85	0.52
New Agutaya	15.76	10.92	4.83
New Canipo	13.72	12.50	1.01
Poblacion	14.96	8.72	6.24
San Isidro	26.48	16.88	9.60
Sto. Niño	23.71	13.86	9.85
Total	100	67.73	32.04

Table 3.35. Percentage of rice crops harvested, consumed, and sold

Barangay	% Consumed	% Sold
Kemdeng	90.38	9.62
New Agutaya	69.33	30.67
New Canipo	91.05	7.34
Poblacion	58.32	41.68
San Isidro	63.75	36.25
Sto. Niño	58.45	41.55

Table 3.36. Percentage consumption and sold

both for household consumption (17% and 14%) and sale (9.60% and 9.85%). Thus, these *barangays* are the main local contributors of rice produce in the market, while Kemdeng and New Canipo contribute the least with 0.52% and 1.00%, respectively. In the case of New Canipo, its geographical location inhibits local farmers from distributing their produce either to the *Barangay* Poblacion or to neighboring towns. Therefore, these crops are oftentimes sold within a *barangay*. The same is observed in Kemdeng, although in a lesser degree, since it is comparably closer to the town proper than New Canipo. It is also notable that farmers in Kemdeng and New Canipo consumed most of their produce rather than selling them to the market, unlike Poblacion and Sto. Niño.

The performance of the farmers in assorted crops production is shown in the **Table 3.37**. Average production came from the three years production from 2010 to 2012, wherein farm gate prices were adopted from the MAO, while the market prices of the products were based on estimates of the market prices of semi-processed products in the market based on key

Crops	2010	2011	2012	Average	Market price/ Product unit	% Product	Farm gate price	Area cultivated	Yield per hectare
Rice									
Corn	57,240.00		46,994.00	52,117.00	50.00	6.17	11.33	24.223	2,151.37
Mango	5,760.00	5,760.00	5,760.00	5,760.00	50.00	6.17	35	15	384
Vegetable	2,700.00	2,910.00	2,700.00	2,770.00	40.00	4.93	40	6	461.67
Coconut	99,200.00	99,200.00	101,700.00	100,033.33	85.00	10.48	23.33	1,041.67	96.03
Cashew	55,272.00	47,940.00	44,360.00	49,190.67	500.00	61.65	20	178.67	275.32
Cassava	1,425,000.00	1,362,500.00	6,200,000.00	2,995,833.33	36.00	4.44	8.33	119.83	25,000.00
Assorted fruits	48,000.00	52,800.00	55,500.00	52,100.00	50.00	6.17	20	25.67	2,029.87
			Average	465,400.62	115.86		158	1,411.06	4,342.61

Source: MAO, San Vicente, Palawan

Table 3.37. Assorted crops production: area planted, yield, and market price

informant interview. The market prices of the products are based on the following:

- Coconut on virgin coconut oil
- Cashew on roasted and honey-coated cashew nuts
- Corn on steamed corn
- Packed ripe no-stain mango
- Assorted vegetables on packed vegetables
- Cassava on cassava flour

d. Sales and income from agricultural production

More than half of the farm households across the six *barangays* did not have any income from their agricultural produce. This is important information characterizing the farmers of San Vicente; a large majority of them do not practice agriculture for household income or fail to do so. Even a large portion of those who have income from agriculture belong to the sales range of PhP1 to PhP40,000. Only the remaining 8% fall within the range PhP40,001 and above. The total annual sales of agricultural produce in all six *barangays* amount to approximately PhP1 million. *Barangay* Sto. Niño records the highest crop sale with PhP348,442, followed by Poblacion, New Agutaya, and San Isidro with PhP195,870, PhP191,640 and PhP186,268.95, respectively. New Canipo and Kemdeng remained at the bottom with only PhP24,980 and PhP46,875, a miniscule value considering the number of households or farmers engaged.

Value range (PhP)	# of farmers	% distribution
100,0001 and above	1	1.25
90,001 – 100,000	1	1.25
80,001 – 90,000	0	0
70,001 – 80,000	0	0
60,001 – 70,000	0	0
50,001 – 60,000	2	2.5
40,001 – 50,000	2	2.5
30,001 – 40,000	3	3.75
20,001 – 30,000	7	8.75
10,001 – 20,000	8	10
1 – 10,000	12	15
0	44	55

Table 3.38. Sale of crop production

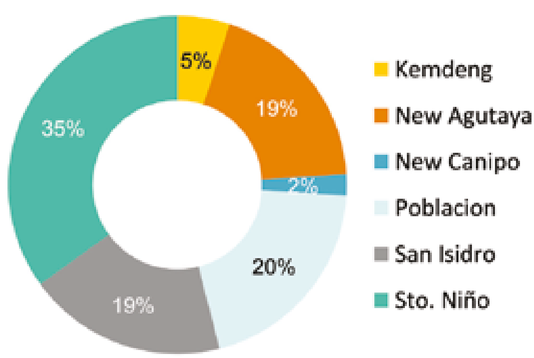


Figure 3.12. Percentage sale of crops by *barangay*

Being the most harvested crop, sales from rice production is the highest (PhP85,234). It is important to note that rice farmers sell their produce either milled or unmilled (*palay*). Between the two options, more farmers choose to sell their harvest as *palay*, probably due to the additional expense that milling entails. Some of them prefer to have it milled in order to increase its market value. New Agutaya, Poblacion, San Isidro, and Sto. Niño farmers sell their rice produce both as *palay* and milled. Some farmers in Kemdeng, however, mill their rice before selling it. Conversely, all farm households in New Canipo opt to sell rice solely as *palay*.

Barangay	Rice (milled)	Rice (*palay*)	Coconut	Banana	Corn	Vegetables	Total
Kemdeng	46,875	-	-	-	-	-	**46,875**
New Agutaya	92,400	72,380	4,000	4,860	18,000	-	**191,640**
New Canipo	-	24,981	-	-	-	-	**24,980**
Poblacion	57,750	91,080	47,040	-	-	-	**195,870**
San Isidro	5,795	180,474	-	-	-	-	**186,268**
Sto. Niño	26,400	254,100	50,300	170	-	17,472	**348,442**
Grand total	229,220	623,014	101,340	5,030	18,000	17,472	994,076

Table 3.39. Total annual sales by crop (PhP)

In terms of local market prices of various crops, each varies depending on the *barangay* where the transaction is made. Milled rice per kilogram is sold for as low as PhP23 and as high as PhP40. But the average price of milled rice across the six *barangays* is PhP30. Sale of *palay* is commonly lower than milled, or in this case four times lower. Palay per kilogram is sold from PhP6 up to PhP10. In addition, coconut, banana, corn and a variety of vegetables are sold, on the average, per kilogram at: PhP10, PhP5, PhP12 and PhP10. The prices are underestimated because these are dictated by the buying price of the traders, which significantly represent the real value of the crops. In effect, the farmers are not getting the right value of their crops.

What is notable is that the produce of local farmers of San Vicente is already limited within San Vicente and therefore cannot expand its market to the neighboring towns. The following tables show that all farmers from the sample *barangays* can only supply crops for San Vicente, if not strictly within their own respective *barangays*. The same result is observed for the consumption of rice which is about 68% of the total harvest, as previously mentioned. In fact, the municipality "imports" rice from the nearby towns such as Narra, which is known to supply high-quality processed rice.

Barangay	Rice (milled)	Rice (*palay*)	Coconut	Banana	Corn	Vegetables
Kemdeng	34					
New Agutaya	40	7	6	7	12	
New Canipo		7				
Poblacion	30	6	14			
San Isidro	23	7				
Sto. Niño	27	10	11	3		10
Average price across the	30	7	10	5	12	10

Table 3.40. Average price of agricultural crops

Barangay	Within San Vicente	% distribution
Kemdeng	4	100%
New Agutaya	13	
New Canipo	11	
Poblacion	13	
San Isidro	23	
Sto. Niño	16	
Grand total	80	

Source: REECS Survey Team, 2013

Table 3.41. Markets of agricultural crops

Savings is an important indicator to examine the economic situation of farming households. Of the six *barangays*, New Canipo and Sto. Niño farmers are better off in terms of income, followed closely by San Isidro, New Agutaya, and Poblacion. Only New Canipo farmers were able to save, while all the other farmers in five *barangays* incurred debts when their household expenditures are taken into account. The reason for the savings of households in New Canipo is that there are 20 household members that are earning from other sources, that when added together with farm-based income, resulted in positive savings. Although the low savings figures may imply the lack of income in most farming communities, the lack of saving habit which prevails in the Philippines, is also another factor to look into.

Barangay	Net income from farming	% of farming income to total household income	Annual household income*	Annual household expenditure	Annual household savings
Kemdeng	363,570.50	79.59	456,822.29	525,095.00	-68,272.71
New Agutaya	755,246.60	84.16	897,357.40	1,167,871.00	-270,513.60
New Canipo	635,562.44	33.50	1,897,303.98	850,676.50	1,046,627.48
Poblacion	593,793.64	71.88	826,058.56	1,178,276.50	-352,217.94
San Isidro	638,071.63	66.22	963,495.63	2,011,037.00	-1,047,541.37
Sto. Niño	883,097.09	72.83	1,212,623.08	1,299,402.00	-86,778.92
Grand total	3,869,341.90	61.87	6,253,660.94	7,032,358.00	-778,697.06

**Annual income from all sources*

Source: REECS Survey Team, 2013

Table 3.42. Farmer's annual income*, expenditures and savings (in PhP)

Results: Agricultural account

The crops covered in this accounting study are rice and assorted crops such as corn, coconut, cashew, cassava, mango and assorted fruits and vegetables. These were grouped together into a cluster in the assorted crops account. Thus, the accounts are for rice and assorted crops cluster only. The agricultural account is primarily based on the following data:

a) Cultivated area in both irrigated and rain-fed rice production areas

b) Yield data on rice and assorted crops

c) Data on the demands for rice and assorted crops

d) Impact data on the threats or reduction factors to agriculture

e) Land rents of rice and assorted crop production

a. Agricultural account for rice

Land rent

Land rent is the residual value of land cultivated for the production of rice after deducting all costs in producing and processing it into milled rice including the margin for profit that goes to the farmer. As shown in **Table 3.43**, the land rent per kilogram of milled rice was found to be approximately PhP5.89. The margin of profit in harvesting milled rice was approximately 15%. However, this does not take into consideration the potential reduction in the margin of profit that may come from the threats that exist in agricultural productivity. These threats, considered as reduction factors in this study, are climate-related impacts, insect infestation, deficiencies in farm management, and the loss of harvest during the stages of all related activities (harvesting, drying, transporting, processing and consumption). These threats were selected based on the MAO records of San Vicente.

Unit	Particular	Rate	Rate/ha	Cost/Revenue per ha
Kilo	*Palay* yield		3,400.00	
PhP	Average price of milled rice		31.50	
Kilo	Rice yield/ha		2.04	
Hectare	Area planted		2.02	
PhP/hectare	Revenue/hectare			64,260.00
PhP/hectare	Production cost per hectare			
PhP	Milling cost/kilo	3.57	7,285.71	
PhP	Transport cost/kilo	2.00	4,080.00	
PhP	Traders/kilo	3.00	6,120.00	
%	Seed	15.26	2,278.38	
%	Fertilizer	13.37	1,995.86	
%	Pesticide	13.52	2,017.47	
%	Labor	57.77	8,623.13	
%	Fuel	0.08	12.11	
PhP	Family farm management/kilo	5.00	10,200.00	
PhP	Total cost		42,612.67	42,612.67
PhP	**Revenue-Cost**			**21,647.33**
	% profit margin	**15**		**9,639.00**
PhP	Land rent after profit per hectare			12,008.33
PhP	**Land rent per kilo of milled rice**			**5.89**

Table 3.43. Estimation of land rent

Reduction factors

Climate-related impacts lead to a number of problems, which reduce the agricultural productivity in the area, as shown in **Table 3.44**. Delayed rainfall, continuous rain during the harvesting season, floods, and droughts lead to delayed planting season and poor grain quality. There are some"salvageable" harvests from damaged areas by severe climatic events, however, there was no indicator and measurement provided as to the quantity. The areas affected by climate-related events were transformed into percentages so that this will be applied in the accounting of rice. The average percentage of climate-related impacts to agriculture from 2006-2010 is 8.34%, that is every planting season, 8.34% of the total area cultivated for rice will be affected. However, the area affected differs significantly each year. For a BAU scenario, 95% was assumed to be recoverable area out of the 8.34% affected. In the worst-case scenario, all 100% of the affected area was considered to be not recoverable. BAU and worst-case scenarios are described in detail in the latter parts of this study.

Year	First cropping season				Second cropping season				Average percent per year
	Problem	Area affected	Total agricultural area (ha)	Percent area affected	Problem	Area affected	Total agricultural area (ha)	Percent area affected	
Irrigated									
2006-07	Rice at different stages wash out	160	2,015	7.94	Inadequate irrigaton water (drought)	140	2,015	6.95	7.44
2007-08	Delayed rainfall Drying grains (poor)	800 200	2,015 2,015	39.70 9.93	Drought	280	2,015	13.90	21.17
2008-09					Inadequate irrigation water (drought)	155	2,015	7.69	7.69
2009-10	Delayed planting/ Late rainy season Continuous rain at harvesting	90 120	2,015 2,015	4.47 5.96	Inadequate irrigation water	350	2,015	17.37	9.26
2010-11	None				None				
Rain-fed									
2006-07	Flooded areas Poor drying of grains due to continuous rain	40 100	2,015 2,015	1.99 4.96	Inadequate rainfall				3.47
2007-08	Delay rainfall/ planting Poor Grain drying due to continuous rain	75 70	2,015 2,015	3.72 3.47	Drought	150	2,015	7.44	3.56
2008-09	Drought	90	2015	4.47	Inadequate rainfall	150	2015	7.44	5.96
2009-10	Delayed planting due to rainfall	155	2015	7.69	Severe drought	90	2,015	4.47	3.08
					Inadequate	210	2015	10.42	

Source: Municipal Agriculture Office, San Vicente, Palawan

Table 3.44. Climate-related impacts to agriculture in San Vicente, Palawan, 2013

Insect and rat infestation is an offshoot of changes in the climatic conditions when such conditions favor the rapid multiplication of insects and rats that feed on agricultural crops. According to the Chartered Institute of Environmental Health (2008), rodent population increased with temperature. Warmer temperature increases the reproductive potentials of rodents. The World Resources Institute (WRI), states: "Climate change will affect plant pests and diseases. The range of many insects will expand or change, and new combinations of pests and diseases may emerge as natural ecosystems respond to altered temperature and precipitation profiles. Any increase in the frequency or severity of extreme weather events could also disrupt the predator-prey relationships that normally keep pest populations in check."

In the case of bacteria blight, the International Rice Research Institute (IRRI) reported that at 25-30°C temperature with rainfall that produce deep water and high humidity, the development and infestation of bacterial blight is favored. "Since the 1997 El Niño, the village of Sepaka experienced one of the worst drought period in 2006 which lasted for six months. Subsequently, another climate linked problem appeared in 2007. This is the rice black bugs (RBB). Many of the rice fields in the village turned black and dried up because of RBB. The RBB or *Scotinophara coarctata*, attack rice stems, infesting the bases of rice stems and draining their saps causing the plants to weaken. This process eventually causes the stalks to wither (bug burn) and die."

In the case of coconuts, the leaf beetle (*Brontispa longgissima*) increases during: (a) the dry periods, and (b) monsoon because the strong wind repels its natural predator. The factors that contribute to the abundance of the leaf beetle are mainly: a) large-scale availability of 2-3 year old coconut palms attracts the pest; b) dry periods favor the development of *Brontispa* populations; c) the palms grown in poor soil, infested by aleurodids and other pests or inadequately maintained were more susceptible to attack of *Brontispa*; d) poorly-grown palms with a less compact heart are more susceptible to *Brontispa* attacks; and e) strong monsoon winds are considered to reduce the influence of parasitoids and predators, which triggers the pest attack.

Table 3.45 summarizes the different problems observed by the MAO in San Vicente. The average percentage of insect and rat infestations in rice production areas from 2006 to 2010 is 7.18% of the total area planted with rice. Just like in the climate-related impact, it is assumed that after insect and rat infestations, there would still be some harvests that can be recovered (95% recovery for BAU scenario and 0% recovery for worst-case scenario).

Farming system and management is another significant factor of agricultural productivity. In San Vicente, there are gaps in farming practices characterized by inappropriate use of fertilizers, lack of soil quality assessment before cultivation and planting, lack of quality seeds, poor soil quality, and inadequate drying period. The others are attributed to high cost of farm inputs such as fertilizers, insecticide, and others to make the soil alkaline and improve its productivity. Of the three threats to agricultural productivity, farming system and management deficiency has the highest impact, affecting 11.65% of the areas planted. Details of the farming system and management deficiency are presented in **Table 3.46**.

For high cost of farm inputs, the LGU may provide loan assistance to farmers, and provision of farmers training on proper farm management under a climate change scenario. During the scoping conducted, it was found that irrigation water is too excessive in irrigated lands and causes soil nutrients, which are needed by plants to grow, to be washed out by the continuous flow of irrigation water.

Figure 3.13 demonstrates how the three reduction factors described (climate-related impacts, insect infestation, deficiencies in farm management) are applied to the accounting of all crops. First, climate-related impacts are applied in all agricultural crops. Second, insect and rat infestation impacts do not apply on cashew and cassava. Third, farming system and management deficiency factors do not cover coconut, cashew, and cassava. The other threat to maximum rice production is wastage of rice from harvesting, transporting, drying, packaging, and milling. Wastage according to MAO is 6.5% of actual rice production and this was multiplied to rice production to account for the reduction.

Year	First cropping season: Problem	Area affected	Total agricultural area (ha)	Percent area affected	Second cropping season: Problem	Area affected	Total agricultural area (ha)	Percent area affected	Average percent area by year
Irrigated									
2006-07	Black bug infestation	300	2,015	14.89	Black bug infestation	140	2,015	6.95	6.95
	Blight infestation	50	2,015	2.48	Rodents infestation	70	2,015	3.47	
2007-08					Rice bug infestation	300	2,015	14.89	1.99
					BLB infestation	40	2,015	1.99	
2008-09	Rat infestation	200	2,015	9.93	Rice black bug & rice bug infestation	400	2,015	19.85	12.28
	Rice bug infestation	300	2,015	14.89	Rat infestation	90	2,015	4.47	
2009-10	Neck rot	40	2,015	1.99	Rat infestation	130	2,015	6.45	4.30
					Neck rot	90	2,015	4.47	
2010-11	Rice bug infestation	300	2,015	14.89	Rice bug infestation (Resistant to control)	700	2,015	34.74	17.87
Rain-fed									**Percent area by year**
2006-07	Black bugs infestation	70	2,015	3.47	Black bug infestation Rodent infestation	-			3.47
2007-08	Rice bug infestation	70	2,015	3.47	Rice bug infestation	150	2,015	7.444	4.47
					BLB infestation	50	2,015	2.481	
2008-09	Rat infestation	40	2,015	1.99	Rice bug infestation	200	2,015	9.926	5.96
2009-10	Rice bug infestation	300	2,015	14.89	Rice blast & neck rot infestation	40	2,015	1.985	6.29
	Rat infestation	40	2,015	1.99					
2010-11	Rice bug infestation	250	2,015	12.41	Rat infestation	75	2,015	3.722	8.27
					Rice infestation	175	2,015	8.685	
								Average percentage	7.18%

Source: Municipal Agriculture Office, San Vicente, Palawan

Table 3.45. Insect and rat infestation affecting agriculture in San Vicente, Palawan, 2013

Year	First cropping season: Problem	Area affected	Total agricultural area (ha)	Percent area affected	Second cropping season: Problem	Area affected	Total agricultural area (ha)	Percent area affected	Average percent area by year
Irrigated									
2007-08	Excessive fertilizer	300	2,015	14.888					12.41
	Drying of grains (poor)	200	2,015	9.926					
2008-09	High cost of inorganic fertilizer	500	2,015	24.814					24.81
2010-11	High cost of inorganic fertilizer	500	2,015	24.814	Poor soil quality	300	2,015	14.89	15.72
	Unavailability of high quality seeds	150	2,015	7.444					
Rain-fed	First season cropping				Second season cropping				**Percent area by year**
2008-09	Poor soil and high cost of fertilizer	150	2,015	7.444	Poor soil quality	150	2,015	7.44	7.44
2009-10					Unplanted or temporarily abandoned	12	2,015	0.60	0.60
2010-11	Very low soil fertility	180	2,015	8.933					8.93
	High cost of inorganic fertilizer	180	2,015	8.933					
								Average percentage	11.65%

Source: Municipal Agriculture Office, San Vicente, Palawan

Table 3.46. Impacts of farm management deficiency affecting agriculture in San Vicente, Palawan

Reduction factor	% Area affected *	% Crop area totally damaged**	Rice	Corn	Coconut
Insect and rat infestation	7.18	5			
Climate-related	8.34	5			
Deficiency in farm management	1.65	5			
Rice consumption*3	120				
Wastage*4	6.5				

** Based on the MAO- San Vicente, Palawan*
*** Based on the consultant's estimate where 95% of the affected area is recovered at final harvest*
**3 Based on 120 kg per capita. This is also the basis of rice demand*
**4 Based on the MAO-San Vicente, Palawan data at 6.5% of production. While this was observed in rice only, it is assumed that the same % applies to the other crops. It would be advisable to observe the wastage of the other crops.*

Figure 3.13. Threats or reduction factors applied in agriculture accounting

Rice production accounts

One of the primary inputs needed to craft the rice account is the quantity of rice produced by farmers. This is similar to rice demand of the population. Usually, the rice demand of the population is based on the actual rice consumption as recorded or estimated using the rice consumption of each person given the population. According to the MAO record of San Vicente, the per capita rice consumption is 120 kg. Given the estimated population by *barangay*, the rice demand is computed by multiplying the rice consumption per capita by the *barangay* population. As shown in the following table, the total rice demand is 5.7 million kg. Poblacion has the highest rice demand, followed by Port Barton and Alimanguan.

Barangay	Household population	Family size	Total population	Rice consumption (kg)	% Consumption by *barangay*
Alimanguan	878	6	5,268	885,024	15.54
Binga	334	6	2,004	336,672	5.91
Caruray	789	6	4,734	795,312	13.96
Kemdeng	192	6	1,152	193,536	3.40
New Agutaya	689	6	4,134	694,512	12.19
New Canipo	280	6	1,680	282,240	1.96
Poblacion	993	6	5,958	1,000,944	17.58
Port Barton	1,057	6	6,342	1,065,456	18.71
San Isidro	189	6	1,134	190,512	3.35
Sto. Niño	249	6	1,494	250,992	4.41
Total	5,650		33,900	5,695,200	

Source: MAO- 120 kg per capita per year rice consumption

Table 3.47. Projected rice demand for 2013, San Vicente, Palawan

The result of rice accounting is presented in **Table 3.48** for single-cropping in a BAU condition. Single-cropping BAU condition is characterized by the following assumptions:

- Rice farming is single-cropping a year
- Inadequate skills in farming
- Minimal farm protection and management
- No integrated pest management
- Actual farming and management deficiencies identified on the ground apply

- Wastage level at 6.5% based on the MAO records
- The percentages of threats or reduction factors with 95% of the affected areas are recoverable in terms of yield or harvest

The total rice production area is 2,015 ha. This is the total area of irrigated lands and rain-fed areas cultivated for rice production. This area is estimated to produce 4.46 million kg of milled rice valued at PhP26.28 million. The total area required to produce the rice demand, plus the threats or reduction, is 2,433.92 ha with expected yield of 5.39 million kg of milled rice supposedly valued at PhP31.74 million. The difference in area is 418.92 ha with expected production of 0.93 million kg of milled rice valued at PhP5.46 million. If BAU condition applies on the ground, the deficit in area for rice production in San Vicente means deficiency in rice produced to satisfy municipal demand. Such deficiency in demand will need to be covered by import from adjacent municipalities or Puerto Princesa.

Account title	Area (ha)	Milled rice yield per ha	Total yield (million kg)	Milled rice land rent (PhP per kg)	Total land rent (PhP million)
Opening stock	2,015.00	2,214	4.46	5.89	26.28
Reduction	2,433.92	2,214	5.39	5.89	31.74
a. Insect infestation	5.69	2,214	0.01	5.89	0.07
b. Climate change	6.61	2,214	0.01	5.89	0.09
c. Farming management factor	9.24	2,214	0.02	5.89	0.12
d. Rice demand	2,265.14	2,214	5.02	5.89	29.54
e. Wastage	147.23	2,214	0.33	5.89	1.92
Addition-Reduction	(2,433.92)	2,214	(5.39)	5.89	(31.74)
Closing stock	(418.92)	2,214	(0.93)	5.89	(5.46)

Table 3.48. Rice area, yield and economic account, single-cropping

The result of rice accounting is presented in **Table 3.49** for double-cropping in BAU conditions. Double-cropping BAU condition is identical to that of single-cropping BAU conditions, but the total area cultivated is assumed to be twice the single-cropping conditions. This will yield 8.92 million kg of milled rice valued at PhP52.55 million land rent or savings. Total reduction in area is 2,433.92 ha with 5.39 million kg of milled rice valued at PhP31.74 million. The account resulted to a net reduction of 2,433.92 ha which when applied to the opening stock reduces the closing stock to 1596.08 ha. The total yield (opening stock) exhibited a 60.3% depletion as well as depreciation in value. Its difference with the single-cropping BAU is that, the single-cropping BAU ended with a negative closing stock in terms of area, rice production and value. The double-cropping ended with reduced positive closing stock, which may be treated as savings. Such savings may be added to the next year's account. The result of rice accounting is presented in **Table 3.50** for worst-case scenario conditions. The following assumption applies for worst-case scenario conditions. All other assumptions follow that of the double-cropping BAU conditions.

Account title	Area (ha)	Milled rice yield per ha	Total yield (million kg)	Milled rice land rent (PhP per kg)	Total land rent (PhP million)
Opening stock	4,030.00	2,214	8.92	5.89	52.55
Reduction	2,433.92	2,214	5.39	5.89	31.74
a. Insect infestation	5.69	2,214	0.01	5.89	0.07
b. Climate change	6.61	2,214	0.01	5.89	0.09
c. Farm management factor	9.24	2,214	0.02	5.89	0.12
d. Rice demand	2,265.14	2,214	5.02	5.89	29.54
e. Wastage	147.23	2,214	0.33	5.89	1.92
Addition-Reduction	(2,433.92)	2,214	(5.39)	5.89	(31.74)
Closing stock	1,596.08	2,214	3.53	5.89	20.81

Table 3.49. Rice area, yield, and land rent account for double-cropping

Scenario: Zero recoverable harvests in the areas affected by threats or reduction factors
The account under this scenario shows area and yield depletion and value depreciation by 87% of the opening stock in area, yield, and value. The total area under threat or reduction is 3,507.39 ha. This has a corresponding expected production of 7.77 million kg of milled rice valued at PhP45.74 million. Except for rice demand, which technically is not a threat, the other reduction factors have increased in areas, yields, and values. Based on **Table 3.50**, the total value of a to c is PhP14.27 million. The value of wastage is still PhP1.92 million because this is attached to the rice demand.

Account title	Area (ha)	Milled rice yield per ha	Total Yield (million kg)	Milled rice land rent (PhP per kg)	Total land rent (PhP million)
Openings	4,030.00	2,214	8.92	5.89	52.55
Reduction	3,507.39	2,214	7.77	5.89	45.74
a. Insect and rat infestation	289.35	2,214	0.64	5.89	3.77
b. Climate-related impacts	336.11	2,214	0.74	5.89	4.38
c. Farming management factor	469.56	2,214	1.04	5.89	6.12
d. Rice demand	2,265.14	2,214	5.02	5.89	29.54
e. Wastage	147.23	2,214	0.33	5.89	1.92
Addition-Reduction	(3,507.39)	2,214	(7.77)	5.89	(45.74)
Closing stock	522.61	2214	1.16	5.89	6.82

Table 3.50. Rice area, yield, and land rent account, for double-cropping under worst-case scenario

b. Agricultural account for assorted crops

The assorted crops area account includes the following crops planted throughout the agricultural areas of the municipality: corn, mango, vegetables, coconut, cashew, cassava, and assorted fruits. The percentage area by crop indicates that the least planted are vegetables, mango, corn and assorted fruits. These are planted randomly within the premises of each of the farmers' households. Topping the list is coconut, followed by cassava, and cashew. With the exception of vegetables which are planted in backyards, mango, cashew, and cassava are inter-planted under coconut trees.

Land rent

Just like the rice account, land rent for the production of assorted crops is the basis of the accounting. For the assorted crops, the land rent is estimated in clusters depending on the farming scheme used, which can be multiple-use scheme or intercropping and that some crops are planted in small areas with low production levels such as corn, mango, vegetables, cashew, and assorted fruits. (**Table 3.51**)

Crops with higher area allocations are coconut, cashew and cassava. Assuming that farming will be done by a family (owning one hectare of agricultural land) without any additional hired labor from outside sources, the total amount that would be earned for the services of the family labor is PhP67,514.60 plus the family farm management fee of PhP79,860.67 and the margin for profit of PhP75,468.33 or a total of PhP222,843.6 per year. This is only PhP18,570.3 per month income of the family. Comparing it with the poverty income threshold of PhP12,712 per capita of the province (based on CBMS Survey 2010-2011), a farming household will require harvesting multiple crops to have an income over the poverty threshold. The breakdown of the costs and revenues of the assorted crops is shown in **Table 3.52.** Due to the high market price of cashew, it yielded the highest net return in the amount of PhP61,900/ha. The lowest returns are corn and cassava. Based on the costs and revenues, land rent of specific crops was calculated as shown in **Table 3.53**. Cashew has the highest land rent, while corn, mango, vegetables, and cassava have the lowest land rent.

Unit	Particular	Rate/ha	Cost and revenue per ha
PhP	Average price of assorted crops cluster/ kg	115.85	
Kilo	Average yield of assorted crops cluster in kg/ha	4,342.61	
PhP/ha	**Revenue/ha**		**503,122.11**
PhP/ha	**Production cost/ha**		
PhP	Average processing cost into semi-finished products	57,043.30	
PhP	Transport cost (from farms to processing site to market)	31,944.27	
PhP	Traders	47,916.40	
PhP	Seeds and planting materials (cost of variety of seed procurement, handling and storage, and propagation, protection and maintenance)	17,838.52	
PhP	Fertilizers	15,626.54	
PhP	Pesticide	15,795.74	
PhP	Labor (all farming activities from seed/planting materials preparation planting to packaging of semi-finished or finished products)	67,514.60	
PhP	Fuel	94.81	
PhP	Family farm management (farm management activities including protection and maintenance)	79,860.67	
PhP	Total cost	333,634.86	
PhP	Margin for profit of the farmer	75,468.33	
PhP	**Grand total**	**409,103.19**	**409,103.19**
PhP	**Land rent /ha (savings in PhP/ ha)**		**94,019.03**
PhP	**Land rent/kg (savings in PhP/ ha)**		**21.65**

Table 3.51. Land rent of assorted crops cluster

Assorted crop cluster	Total revenue/ha	Total cost/ha	Net profit/ha
Corn	9,374.95	7,623.04	1,751.91
Mango	31,249.83	25,410.14	5,839.69
Vegetable	24,999.83	20,328.11	4,671.75
Coconut	53,124.71	43,197.23	9,927.48
Cashew	331,248.17	269,347.44	61,900.73
Cassava	9,374.95	7,623.04	1,751.91
Assorted fruits	43,749.95	35,574.19	8,175.57

Table 3.52. Cost and revenue of assorted crops

Unit	Particular	Rate/ha	Cost and revenue per ha
PhP	Average price of assorted crops cluster/ kg	115.85	
Kilo	Average yield of assorted crops cluster in kg/ha	4,342.61	
PhP/ha	**Revenue/ha**		**503,122.11**
PhP/ha	**Production cost/ha**		
PhP	Average processing cost into semi-finished products	57,043.30	
PhP	Transport cost (from farms to processing site to market)	31,944.27	
PhP	Traders	47,916.40	
PhP	Seeds and planting materials (cost of variety of seed procurement, handling and storage, and propagation, protection and maintenance)	17,838.52	
PhP	Fertilizers	15,626.54	
PhP	Pesticide	15,795.74	
PhP	Labor (all farming activities from seed/planting materials preparation planting to packaging of semi-finished or finished products)	67,514.60	
PhP	Fuel	94.81	
PhP	Family farm management (farm management activities including protection and maintenance)	79,860.67	
PhP	Total cost	333,634.86	
PhP	Margin for profit of the farmer	75,468.33	
PhP	Grand total	409,103.19	409,103.19
PhP	**Land rent /ha (savings in PhP/ ha)**		**94,019.03**
PhP	Land rent/kg (savings in PhP/ ha)		21.65

Table 3.53. Land rent of assorted crops

Assorted crop accounts

The same assumptions made in reduction factors and BAU conditions for rice apply in the accounting of assorted crops. The total area for assorted crops is 1,411 ha with 6.13 million kg of assorted agricultural crops and with a total land rent of PhP132.35 million. At the end of the year, the area declined in capacity equal to 1,177. 15 ha with a total productivity reduction of 5.11 million kg with a total land rent of PhP110.32 million. The production area showed resource depletion (area and yield) and depreciation in total land rent. While it depreciated in yield and value, there is still a balance or savings that may be utilized for any product processing in the municipality or marketed as raw products shortly after harvest. Because assorted crops are not a staple food, thus the demand is much lower. The perishable products such as fruits and vegetables should be marketed within days after harvesting. The products that can be carried on to the next accounting period are coconut and cashew because these products can be preserved. This may also be a margin for external markets or for expected tourists and other transient visitors during the year.

Account title	Area (ha)	Yield/ha (Kg/Ha)	Total yield (million kg)	Land rent (PhP/kg)	Total land rent (PhP million)
Opening stock	1,411.00	4,342.61	6.13	21.6	132.35
Reduction	233.85	4,342.61	1.02	21.6	21.94
a. Insect and rat infestation	5.07	4,342.61	0.02	21.6	0.48
b. Climate-related impacts	5.88	4,342.61	0.03	21.6	0.56
c. Deficiency in farming system and management	8.22	4,342.61	0.04	21.6	0.77
d. Demand for assorted crops	201.58	4,342.61	0.88	21.6	18.91
e. Wastage	13.10	4,342.61	0.06	21.6	1.23
Addition-Reduction	(233.85)	4,342.61	(1.02)	21.6	(21.94)
Closing stock	1,177.15	4,342.61	5.11	21.6	110.42

Table 3.54. Area, yield, and land rent accounts of assorted crops under BAU

In the worst-case scenario (identical to that of rice accounting), depletion of yield is from 6.13 million kg (opening stock) to 3.53 million kg (closing stock) and depreciation is from PhP132.25 million to PhP76.25 million. Excluding the area for assorted crops intended to satisfy the demand, the three threats, including wastage, will reduce the capacity of the area equivalent to 396.49 ha with a corresponding yield of 1.72 million kg with PhP37.19 million foregone land rent. The worst-case scenario further reduces the net land rent by PhP34.17 million or 31% from the closing stock of the BAU. While both situations resulted in depletion (area and yield) and depreciation (land rent), savings at the end of the accounting period are positive as reflected in the balance of the closing stock. The accounting results for different crops are presented in **Table 3.56**. In terms of the closing stock, corn, mango, vegetables, and assorted fruits are the lowest. The crops with the high closing stocks are coconut, cashew, and cassava.

Account title	Area (ha)	Yield/ha (kg/ha)	Total yield (million kg)	Land rent (PhP/kg)	Total land rent (PhP million)
Opening stock	1,411.00	4,342.61	6.13	21.6	132.35
Reduction	598.08	4,342.61	2.60	21.6	56.10
a. Insect infestation	101.31	4,342.61	0.44	21.6	9.50
b. Climate-related impact	117.68	4,342.61	0.51	21.6	11.04
c. Deficiency in farming systems and management	164.40	4,342.61	0.71	21.6	15.42
d. Demand for assorted crops	201.56	4,342.61	0.88	21.6	18.91
e. Wastage	13.10	4,342.61	0.06	21.6	1.23
Addition-Reduction	(598.08)	4,342.61	(2.60)	21.6	(56.10)
Closing stock	812.92	4,342.61	3.53	21.6	76.25

Table 3.55. Area, yield, and land rent accounts of assorted crops cluster under worse-case scenario

Crops	Area planted (ha)	Opening stock (PhP million)		Reduction (PhP million)		Closing stock (PhP million)	
		BAU	WCS	BAU	WCS	BAU	WCS
Corn	24.23	2.27	2.27	0.38	1.27	1.90	1.31
Mango	15.00	1.41	1.41	0.23	0.79	1.17	0.81
Vegetable	6.00	0.56	0.56	0.09	0.32	0.47	0.32
Coconut	1,041.67	97.70	97.70	16.20	54.81	81.51	56.29
Cashew	178.67	16.76	16.76	2.78	9.40	13.98	9.65
Cassava	119.83	11.24	11.24	1.86	6.31	9.38	6.48
Assorted fruits	25.67	2.41	2.41	0.40	1.35	2.01	1.39
Total	1,411.06	132.35	132.35	21.94	74.25	110.42	76.25

Table 3.56. Area cultivated, opening stock, reduction, and closing stock of assorted crops

Discussion and conclusion

Table 3.57 is an overview of the accounts created for rice and various crops selected in this study. Several conclusions can be drawn based on these results.

Crops		BAU	Worst-case scenario	Change
Rice	Single-cropping	-5.46		
Rice	Double-cropping	20.81	6.82	13.99
Assorted crops				
Crops	Area (ha)	BAU (PhP million)	Worst-case scenario (PhP million)	Change (PhP million)
Corn	24.23	1.90	1.31	0.59
Mango	15	1.17	0.81	0.36
Vegetables	6	0.47	0.32	0.15
Coconut	1,041.67	81.51	56.29	25.22
Cashew	178.67	13.98	9.65	4.33
Cassava	119.83	9.38	6.48	2.90
Assorted fruits	25.67	2.01	1.39	0.62
Total	1,411.06	110.42	76.25	34.17

Table 3.57. Consolidated agriculture land rent

- A large majority of farmers in San Vicente are engaged in rice production (78%). In the case of New Canipo and San Isidro, all individual households interviewed responded that they exclusively produce rice. However, rice was found to have a significantly lower land rent compared to the assorted crops.
- The land holdings of the farm households surveyed showed that only 31.65% of the farmers in six *barangays* own property in the land they farm. Those who owned their farmland had an average of 2.37 ha.
- Rice produced in San Vicente is primarily for household consumption. A large majority of this produce is not marketed. This is understandable considering how rice production in the region is actually in deficit of the total demand. San Vicente imports rice from other parts of Palawan.
- Based on the MAO records, the impacts of climate change were assumed to approximately reduce 33.6% of production under BAU conditions. Under the worst-case scenario, depletion in yield (and thus the depreciation of the land rent) was assumed to be more significant. If the impacts of climate change were to escalate in the future as expected, the reduction in yield will be much more severe.
- Assuming single-cropping conditions, rice production in the municipality will not be sufficient to satisfy the total demand. However, if all farmers were to practice double-cropping, what is produced will be sufficient to fulfill the total demand even under the worst-case scenario.
- Despite the reduction in yield, the closing stock of the non-rice crops studied has a positive value. This is attributed to the low demand for consumption– non-rice crops are not staple food and the current production well exceeds local consumption.
- Land rent is not collected, handled nor managed by the individual farmers. Records do not show that LGUs have taken advantage of this by imposing any form of additional taxation.
- Despite the land rent, only a small percentage of farmers were found to have any financial savings based on income from agricultural activities.

Based on the conclusions drawn above, the following suggestions should be considered in developing the agriculture sector of San Vicente.

- **Additional rice fields will need to be developed to fulfill the increasing demand in the municipality,** as not all farmers are practicing double-cropping and have access to irrigated land. Considering the recent developments in the municipality based on the potentials for tourist attraction, the demand is expected to increase continuously in the future.
- **Methods should be sought to increase the land rent of the crops, especially rice.** Some schemes on how to realize the land rent are: a) sourcing of additional agricultural support fund from the national government, and b) seeking ways to pass the burden to the lucrative tourism and services sector by increasing the local market value of rice. Fund may be collected to be used for sustaining improved agriculture through strengthening of farmers' capabilities, crop insurance, and protection and maintenance of the watersheds and forest ecosystems that provide ecological services to agriculture.
- **Multi-cropping and concentration to high value crops is highly recommended.** In addition, acclimatized rice varieties, including organic upland rice varieties that are climate-resilient, may be cultivated by the farmers with support from the LGU. Cashew and cassava are crops worth expanding since they have good market potentials. Cashew supports the nut, chocolate and ice cream industries while cassava is a raw material for alcohol and flour production. In anticipation of the future influx of tourists, coconut juice is expected to have an increased demand. Thus, old coconut plants that are no longer bearing the optimum yield should be replaced by inter-planting open spaces in coconut plantations.

- **Future development in the agricultural sector must be inclusive.** Land owners are only a small majority of total farming population, who use external labor to conduct agricultural activities. If land rent is a form of assistance given toward agricultural activities by the natural environment and government, such assistance can focus primarily on the land owners.
- **According to the MAO records, climate-related events were identified as one of the three major risks to agricultural productivity.** Changes in seasonal rainfall, floods, and droughts were the main climate-related events that reduced agricultural yield in the municipality. Infect and rat infestation, which is also one of the three major risks is also (indirectly) related to climate. Not only does rodent population increase with temperature, but new combinations of pests and diseases may emerge, as natural ecosystems respond to altered temperature and precipitation profiles. To reverse the depletion and depreciation trends of agricultural lands in terms of land rent value, the LGU must continue to draw an agricultural development plan for the farming system that considers climate change adaptation.

3. Fishery

San Vicente is a coastal municipality where fishing is a major source of income. Fisherfolk households comprise 48% of the total number of households (5,652). The fishing grounds of San Vicente, spanning 1,344.78 km^2, consist of Imuruan Bay, Caruray Bay, Pagdanan Bay, and Jibbon Bay, are blessed with rich coral reefs. According to the 2000 report of the Palawan Council for Sustainable Development (PCSD)[5], San Vicente's coral reefs covering a limited area of 4.244 km^2 are said to be in fair or good conditions but have relatively low fish density for target fishes. However, the density (number per ha) of groupers[6] in particular is generally higher in San Vicente relative to other municipalities.

Commercial fishing vessel owners and municipal fisherfolks, using motorized boats and non-motorized boats, have easy and direct access to its fishing grounds. According to the 2010-2011 CBMS Survey, there were about 2,727 fishery-based households in San Vicente that have direct access to the municipality's fishery resources with their boats. There other groups of people who benefit from fish catch include those engaged in fishery industries and market traders. Beneficiaries also include the local consumers and travelers outside the municipality.

This report aims to create a fishery account to determine the amount of economic rent extracted from San Vicente's marine environment and estimate how much of such savings are retained by the coastal community. The results also provide strong reasoning in determining whether the benefits taken by the municipality in the fishery sector is sustainable. The fish biomass, which is the basis of determining the sustainability of the fishery sector, is affected by many different factors such as the level of fishing effort, degradation of coral reefs, and climate change impacts.

Marine resources in San Vicente

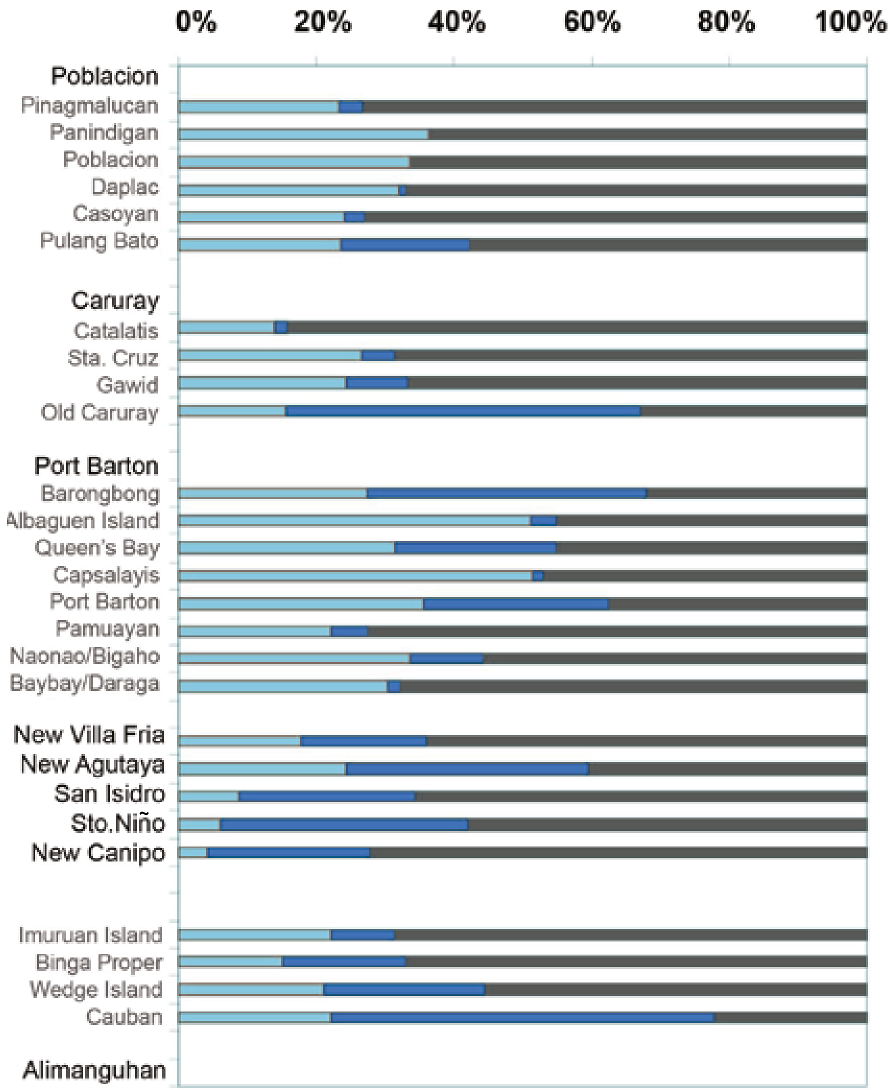
a. Coral reefs

A coral reef assessment in 1997 identified eight sites, namely: Old Caruray, Barongbong, Albaguen Island, Queen's Bay, Capsalay Island, Port Barton, New Agutaya, and Cauban. These sites had more than 50% of live coral cover with hard and soft coral, while two sites (Albaguen Island and Capsalay Island) had about 50% hard coral cover, as shown in

5 The corals in San Vicente cover only a limited area, 4.244 km^2, but they are said to provide natural and economic services (Carpenter and Springer 2005, Allen 2008, Carpenter et al 2011, Sanciangco et al. 2013).

6 Grouper refers to any of numerous fishes (Family *Serranaide* and especially *Epinephelus* and *Mycteroporca*) that are typically large solitary bottom-dwelling fishes of warm seas and include important food fishes.

Figure 3.14. Majority of the sites, however, had 60% abiotic (i.e., a benthic life form condition characterized by the dominance of rock, silt, sand, and rubble). Moreover, 17 out of 27 sites were highly abiotic (about 60% or more) which include all sites in Poblacion, three of the four sites in Caruray, two out of the eight sites in Port Barton, and Sto. Niño, New Canipo, Villafria, San Isidro, Imuruan, and Binga Proper.



Source: Philippine Coral Reef Assessment, 1997

Figure 3.14. Coral reef assessment of San Vicente, Palawan

Various stressors and threats have historically impinged on the coral reefs and fishery resources of San Vicente, and their exposure to each successive stressor has made it more vulnerable to further degradation. First, Nañola's observations during the May 2013 survey confirm the impact of sedimentation on some of the reefs, especially in the embayments of Caruray, Port Barton, and Poblacion. Some sites have less abiotic level compared to the 1997 assessment, possibly because land clearing and the resulting sedimentation are taking place in deeper inland and upstream and much farther from the coastal areas.

Apart from the adverse impact of siltation on some reefs from river run-offs and sedimentation from coastal development and proximate upstream land clearing, another event that had a damaging effect on the coral reefs was the 1998 El Niño event, which hit both the northern and western coast of Palawan, including San Vicente. The event caused the coral bleaching of an undetermined area on the western coast. There is no visual record on how hard the western area was hit, but the bleaching event for the adjacent northern Palawan shelf was estimated to have damaged more than 10% of its live coral cover (Arceo et al. (2001). The more recent El Niño episode in 2010 is said to have had an almost comparable impact as that of the earlier one (Nañola, 2012).

One of the most significant biological disturbances on a tropical coral reef is a population outbreak of the fecund, crown of thorns (COT) sea star. It has been observed or deduced that the onset of El Niño and the consequent bleaching of the corals, have also made the affected corals vulnerable to infestation in particular by the COTs. As observed, the location of bleached corals generally coincides with the areas infested by the COTs. **Figure 3.15** shows the distribution of COTs observed in San Vicente based on a marine survey conducted in September 2004. Apart from coral bleaching, other more recurring factors may have facilitated the entry of the COTs and the ensuing degradation of the coral reef, such as over harvesting and the damage wrought by illegal fishing techniques. These high fishing pressures on reef fish communities in the area, together with the destruction of the coral reefs, including bleaching, may have made it more conducive for COTs to colonize large portions of the municipality's reef and deplete its remaining nutrients. Unless the COTs are physically extricated, excess fishing moderated and rehabilitation measures immediately undertaken, it may be difficult for the infested corals to recover.

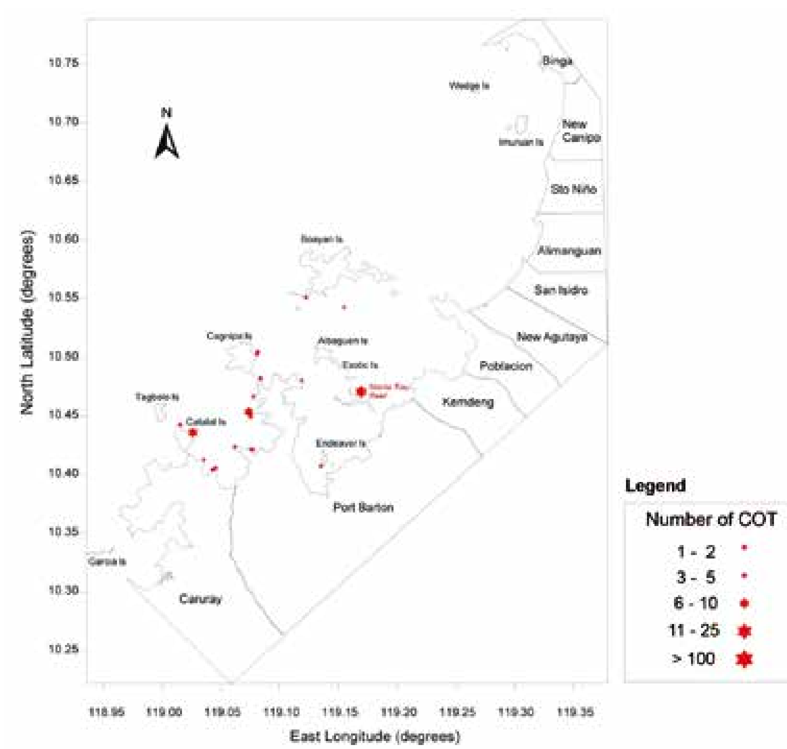


Figure 3.15. COT occurrence in the coral reefs of San Vicente

b. Fish biomass

Nañola's survey of 21 coastal marine sites suggests that the status and location of a site, as well as the level of fishing effort account for the reefs' vulnerability to coral bleaching and infestation. Site status indicates either a zone is protected, less protected or exposed; while location indicates whether a zone is situated either in the inner-sheltered sections of the bay or its outer fringes. **Figure 3.16** shows the various survey sites categorized in this study: 1) the "inner Port Barton Bay" or sheltered area consisting of Aquarium, Black Coral, Capsalay, Exotic, Manta Ray, and Oyster Point; 2) the exposed "outer A" consisting of Albaguen, Boayan Is, Imuran, North Albaguen, Pensawan, Poblacion A and B, and Wilson Head; and 3) the exposed "outer B" consisting of Cagnipa, Lampinigan, Caruray A, Long Beach, and San Isidro.

The first inner, sheltered group comprises the protected fish sanctuaries established earlier in 1997, and it would be compared with the two outer less protected groups. Note, however, that "outer A" has one marine protected area (MPA), Imuruan, and "outer B" two MPAs, namely Lampinigan and Caruray A, and these are farther away from the mainland and hence, more difficult to protect.

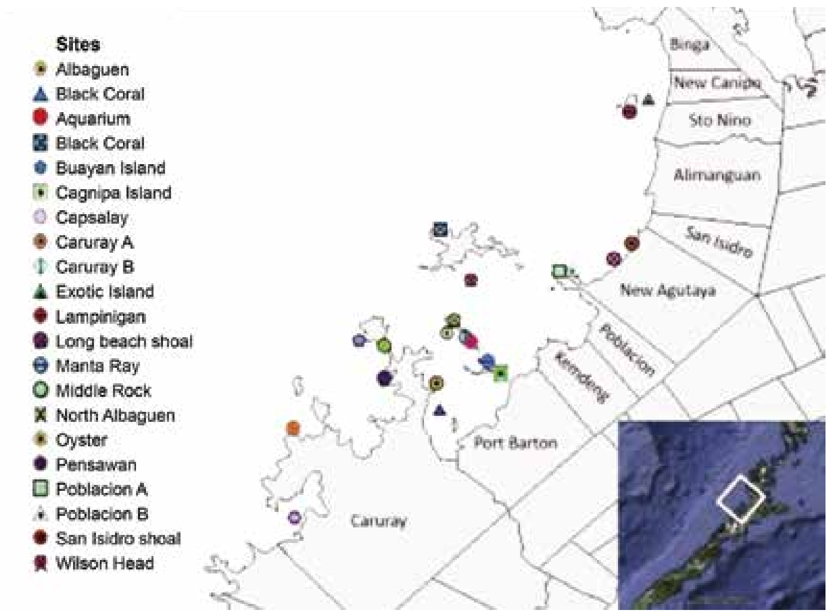


Figure 3.16. Map showing the distribution of the study sites in Palawan

The inner sheltered group consisting mainly of the core protection and buffer zones, as noted by Nañola, was not greatly affected by coral bleaching, and hence by inference, has not been seriously affected by the COT infestation. It is possible to include the Pearl Farm as a de facto member of the inner group sites, given the protection its operator has provided over the area. **Figure 3.19** provides comparison across groups on fish biomass. As a whole, the inner group (including Pearl farm) has a larger fish biomass than Outer A, while Outer site B has the lowest biomass. These differences in average biomass volume across the three groups also exist for the target, commercially important species and the herbivore species.[7] The lower average biomass for target species in the offshore sites, compared to the inner group, suggests that the outer, offshore areas may not have received the level of protection

7 Herbivore fish include the batfish (*Ephippidae*) parrotfish (*Labridae: Scarnae*), rabbitfish (*Siganidae*), and surgeonfish (*Acanthuridae*).

required for their location and also that the inner areas closer to the mainland experienced less fishing intrusion or effort.

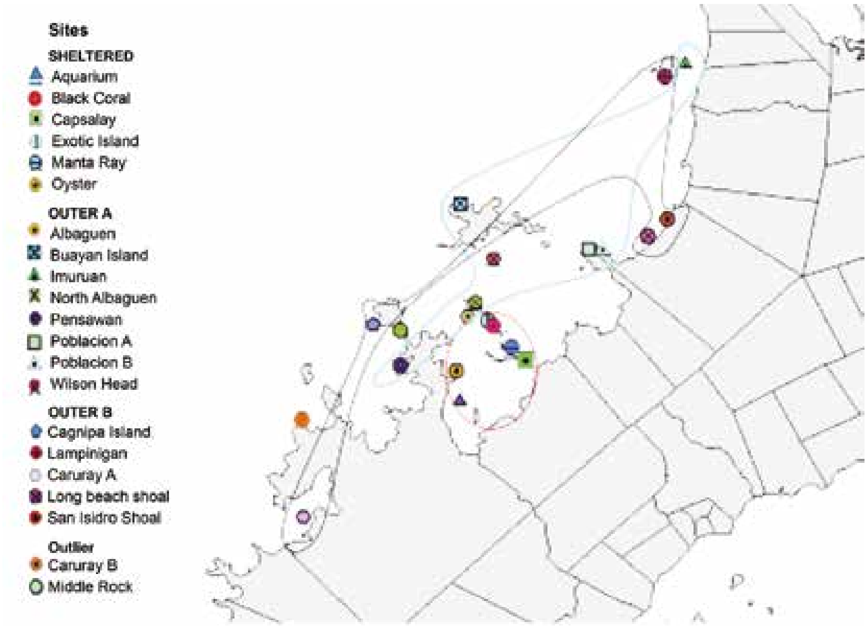


Figure 3.17. Relative location of the three different zones identified

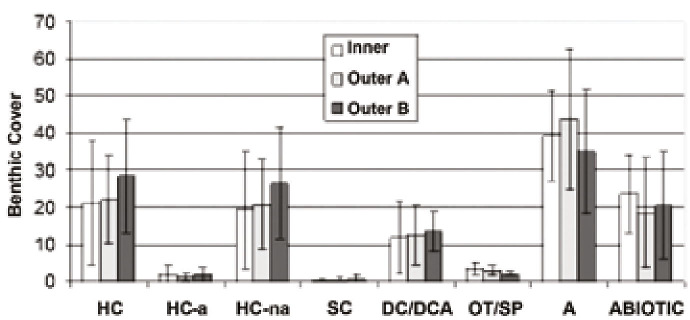


Figure 3.18. Benthic cover of the classified "inner", "outer A" and "outer B" sites

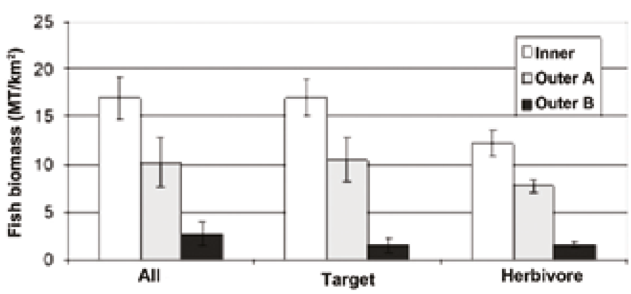


Figure 3.19. Fish biomass composition of the classified "inner", "outer A" and "outer B" sites

Comparing Nañola's 2013 biomass inventory in San Vicente with his earlier inventory in 2003 it is evident that the stock has indeed declined, particularly outside (of the MPA) Port Barton. In the sites within Port Barton, the fish stock has remained almost the same, and almost all the sites have not been overfished as it has been a fish sanctuary and has been benefitting from the protection of the Pearl Farm owner. Also, as part of the outer zone of the Port Barton Marine Park, the Middle Rock has the highest fish biomass at around 141 MT/km². It is an outlier not only because of its large biomass, but also because due to the school of planktivorous fusiliers and damselfishes that visit and feed in the area with its bountiful zooplankton (**Figure 3.20**). While the inner group has a higher biomass on the average than Outer A, the biomass levels within the two groups vary. For instance, among the inner group sites, Exotic Island, Nologan Island, Capsalay, Black Coral and Oyster Farm all have less than 10 MT/km² of the target (commercial) species while Wilson Head in Outer A and Imuran, a MPA, have biomass greater than 10 MT/km².

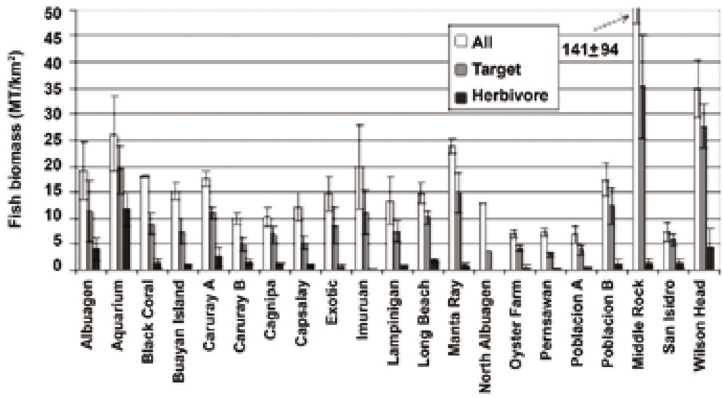


Figure 3.20. Fish biomass data (MT/km²) for both target and herbivores

Protected Area	Protection status	Location	Target fish biomass (mt/km²)*	Herbivore fish biomass (mt/km²)	Algal (%)
Albaguen Fish Sanctuary	Core Zone	Outer A	11 ± 6	4 ± 2	50.46
Exotic Island	Core Zone	Inner/ Sheltered	9 ± 4	1 ± .5	51.68
Haines Island	Core Zone				
Shark Point					
Capsalay	Buffer Zone	Inner/Sheltered	5 ± 1	1 ± .5	23.66
Manta Ray	Core Zone	Inner/ Sheltered	15 ± 4	1 ± .5	46.99
Aquarium	Buffer Zone	Inner/ Sheltered	19.5 ± 4.5	12 ± 3	39.16
Black Coral	Core Zone	Inner/ Sheltered	9 ± 2	1.5 ± 1	31.33
Oyster Point	Buffer Zone	Inner/ Sheltered	4 ± 1	.5 ± .5	42.74
Buayan Island		Outer A	7.5 ± 2.5	1 ± .5	31.52
North Albaguen	Outside Core Zone	Outer A	4		60.86
Pensawan		Outer A	3 ± .5	0.5	75.21
Poblacion A2		Outer A	4. ± .5	.5 ± .5	50.68
Poblacion B2		Outer A	12.5 ± 3.5	1 ± 1	47.26
Imuran Island (New Canipo)		Outer A	11 ± 6	0.5	18.75
Wilson Head	Outside Core Zone	Outer A	22.5 ± 5.5	4.5 ± 3.5	23.98
Cagnipa Island		Outer B	7 ± 2	1 ± .5	51.04
Lampinigan Island (New Canipo)		Outer B	7.5 ± 2	.5 ± .5	22.45
Caruray A	Core Zone	Outer B	11 ± 1	3 ± 2	15.57
Long Beach Shoal		Outer B	9 ± 1	2 ± .5	29.42
San Isidro Shoal		Outer B	6 ± 1	1.5 ± .5	31.26
Caruray B	Core Zone		5 ± 1	1.5 ± .5	59.77
Middle Rock	Outside Core Zone		35.5 ± 10.5	1.5 ± 1	48.41

Table 3.58. Summary of protected areas and corresponding fish biomass

Information on the biomass rate of target species in particular sites is critical because it is a baseline measure of sustainability and the outcome of past fishing pressure. As a baseline measure, biomass translates into allowable fishing pressure. Given the estimated 18,938 MT commercial (target) fish stock in San Vicente over its 1,344.78 km^2 of fishing grounds, 14.08 MT/km^2 would indicate a moderate level or average fishing pressure. Based on current estimated biomasses for the entire country, fishing grounds with biomass below 10 MT/km are considered to have been overfished.[8]

Past fishing efforts in such locations have thus been excessive and unsustainable. **Figure 3.21** shows that 12 out of 21 study sites in San Vicente are overfished, namely, Exotic Island, Caruray B, Capsalay, Black Coral, Oyster Pt., Boayan Island, North Albaguen, Pensawan, Poblacion A, Cagnipa Island, Lampinigan, and San Isidro. In North Albaguen, Oyster Pt, Pensawan, Poblacion A, and San Isidro, the target fish biomass is less than 5 MT/km^2. As a result of overfishing in San Vicente, target species are no longer as common as in many sites, and across sites the most common density is at least 15 individuals/500m^2 with biomass less than 10 MT/km^2. Among the above sites, Capsalay, Oyster Pt. and Pensawan have the poorest target densities (<15 individuals/500m^2). Note that the above sites include some of the inner sites and a MPA, like Lampinigan. There are sites that have been protected from overfishing, including Albaguen Island, Caruray A, Manta Ray, Aquarium, Imuruan, Wilson Head, and Long Beach.

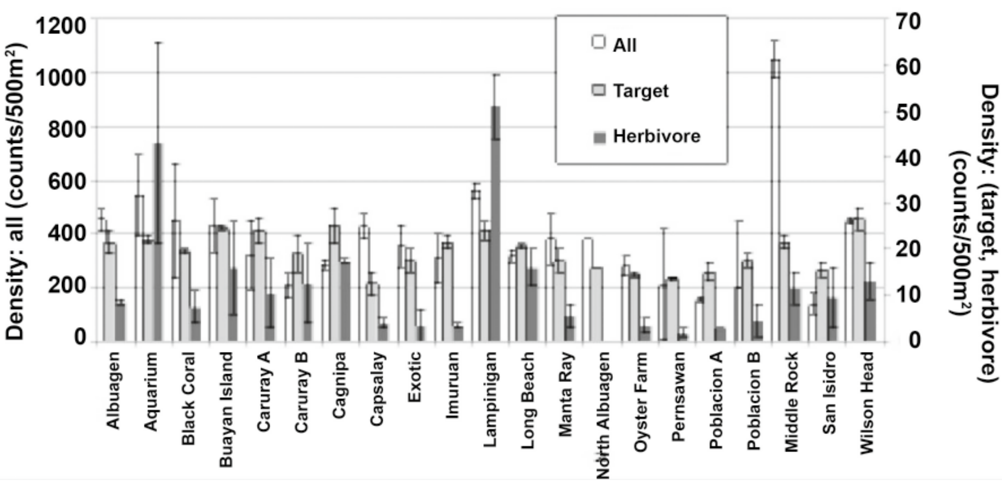


Figure 3.21. Fish density data (counts/500m^2) of all, target and herbivores utilizing all of the sites

c. Fish diversity

Overfishing has caused other profound consequences on the reef and fishery resources of San Vicente. It does not only result in smaller-sized fishes and fewer target species but also affects species composition. Catching more commercially viable target species, which are bigger in size than non-target species, has also changed species composition. Non-target species with low commercial value, like the herbivore *Scaridae* or parrot fish, have thus become more dominant. Thus, the densities of smaller fishes observed in the overfished sites may actually be attributed to non-target species. The effect of overfishing on species composition may also be seen between Outer A and Outer B sites. The significant difference

8 Fish biomass ranging from 0 to 10 MT/km^2 (very low to low) are considered as overfished, from 11 to 20 MT/km^2 (medium) as slightly moderately fished, 21 to 40 MT/km^2 (high) and greater than 40 MT/km^2 (very high) as with very minimal fishing and/or protected.

in species composition between the two groups lies in the abundance of *Plectroglyphidodon lacrymatus*, farming herbivore in Outer B, which indicates that the reefs are in poor condition.

The biomass of non-target species, like herbivores, does not increase with overfishing. Instead, the overfished sites with less than 10 MT/km^2 also have herbivore biomass rates lower than 5 MT/km^2. Across all the 21 sites, herbivore biomass falls below 5 MT/km^2 except for Aquarium (12 MT/km^2). Relative to the target species whose density and biomass respectively accounted for 19±4.6 individuals/500m^2 and 10.7±8.8 MT/km^2, the herbivores only have 12±14.3 individuals/500m^2 and 1.8±2.85 MT/km^2.

It must be noted that while the low biomass of target species associated with overfishing is directly related in general to critically low herbivore biomass, the protected sites with more than 10 MT/km^2 of target species may have either higher or lower herbivore biomass. Aquarium for instance, has higher herbivore biomass. In Aquarium, the herbivore biomass comes mainly from parrotfishes, particularly several large individuals of *Chlorurus bleekeri*. While Imuruan and Caruray A have lower herbivore biomass, despite the fact that these are protected sites. In terms of density, Aquarium and Lampinigan have a considerable number of <40 individuals/500 m^2. But in the other sites, namely Albaguen, Black Coral, Capsalay, Exotic, Imuruan, Manta Ray, North Albaguen, Oyster Farm, Pensawan, Poblacion A and B, and San Isidro, density has declined to >10 individuals/500 m^2.

A comparative analysis of the fish biomass conveys that no significant biomass change has occurred over the past 10 years for the target and herbivorous fishes. It is important to understand whether the overfishing condition and state of the target and herbivore species is a recent development. Nañola et al.'s (2004) reef monitoring conducted 10 years ago in the Port Barton Marine Park, makes it possible to compare the past inventory results with the recent survey. Except for Wilson Head, where target fish biomass greatly increased in the 2013 survey, the absence of any significant difference indicates that the overfished condition in most sites has persisted and that the process of coral reef deterioration must have proceeded unabated over the decade. This suggests that if the unsustainable process is not reversed, the state of the coral reef and fishery resource will only worsen.

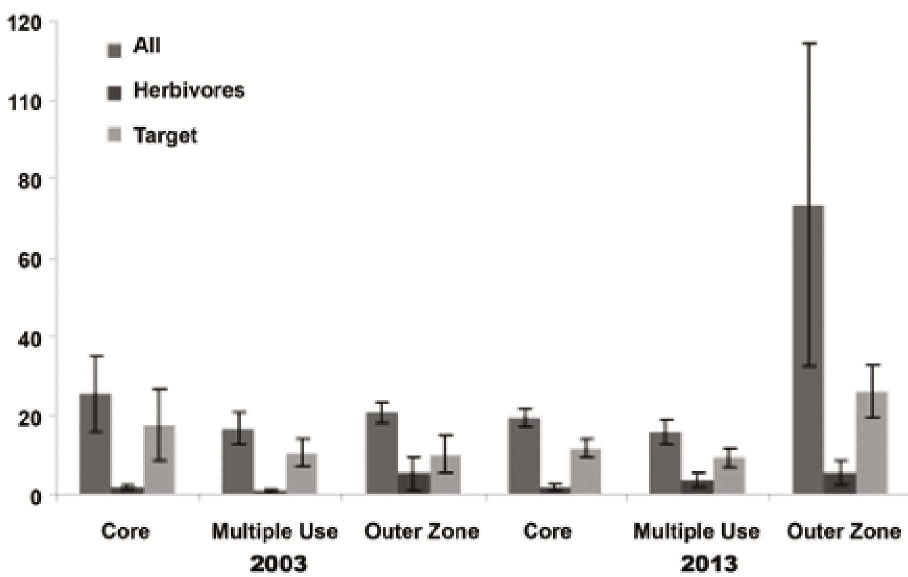


Figure 3.22. Fish biomass composition of Port Barton Marine Park (2003 and 2013)

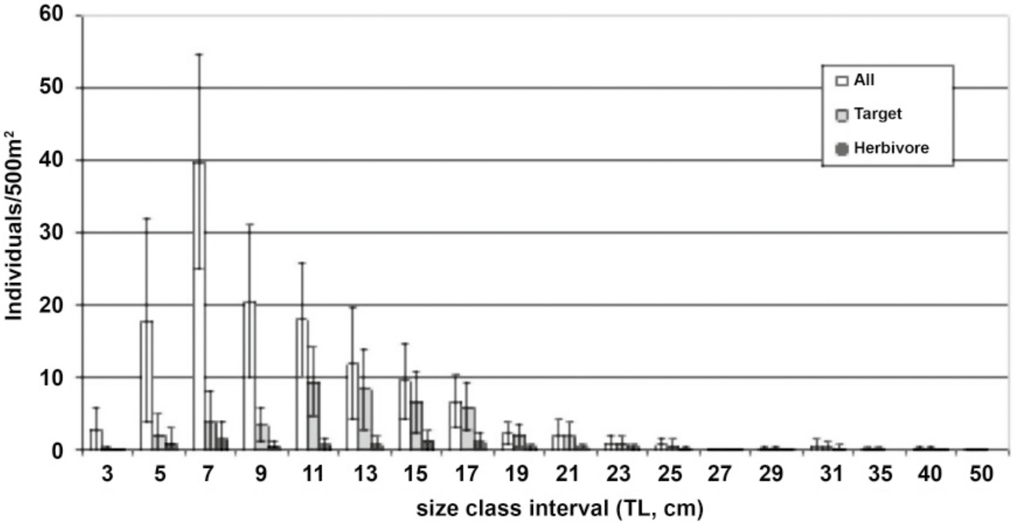


Figure 3.23. Size frequency distribution of all, target and herbivorous reef fishes

Comprehensive understanding of the marine conditions in San Vicente

There are two reasons why a majority of the reefs are dying and undergoing phase shift, according to Nañola (2012). First, San Vicente's reef system is losing its functional diversity or integrity because there is not enough herbivore biomass to trim down algae and allow recruitment of corals, according to Edmunds and Carpenter (2001), Bellwood et al. (2006) and Mumby et al. (2007).

With its low herbivore biomass only at less than 3 MT/km^2, the reefs do not have the required herbivore biomass for fringing reefs to remain resilient in case of perturbation, like coral bleaching and COTs. According to Adam et al. (2011), around 15 MT/km^2 herbivore biomass is needed for reefs to be resilient. Nañola (2012) notes, however, that for an atoll type reef, in particular, like the Tubbataha Reefs, resilience is possible with <10 MT/km^2 of herbivore biomass. He further notes that the chances for recovery will be high if fish biomass would be greater than 5 MT/km^2 and the reefs are fully protected. Recovery is also further guaranteed with the presence of other habitats that play a major role in the life cycle of key important species according to Mumby et al. (2004).

Thus, with critically low herbivore biomass, coral reefs that have naturally been dominated by corals are now being engulfed by algae. It was found that the extent of algal infestation in is 11 out of the 21 sites. The proportion of corals covered with macro algae ranges from about 50% in Oyster Pt. to 75% in Pensawan. There are only very few sites, such as Capsalay, Caruray A, Boayan, Imuruan, and Wilson Head with an algal cover of around 20%, the lowest algal cover in the study. Among these sites, only Caruray A and Imuruan are within the core zones of the MPAs of the municipality. The other two sites, Capsalay and Wilson Head, fall under the multiple use and outer zones of Port Barton Marine Park (PBMP) according to Nañola et al. (2004). The low algal cover in these sites suggests that areas inside and adjacent to the core zones have some chance in preventing the onset of a phase shift. Thus, the continued protection of these sites and the establishment of similar sites are deemed imperative.

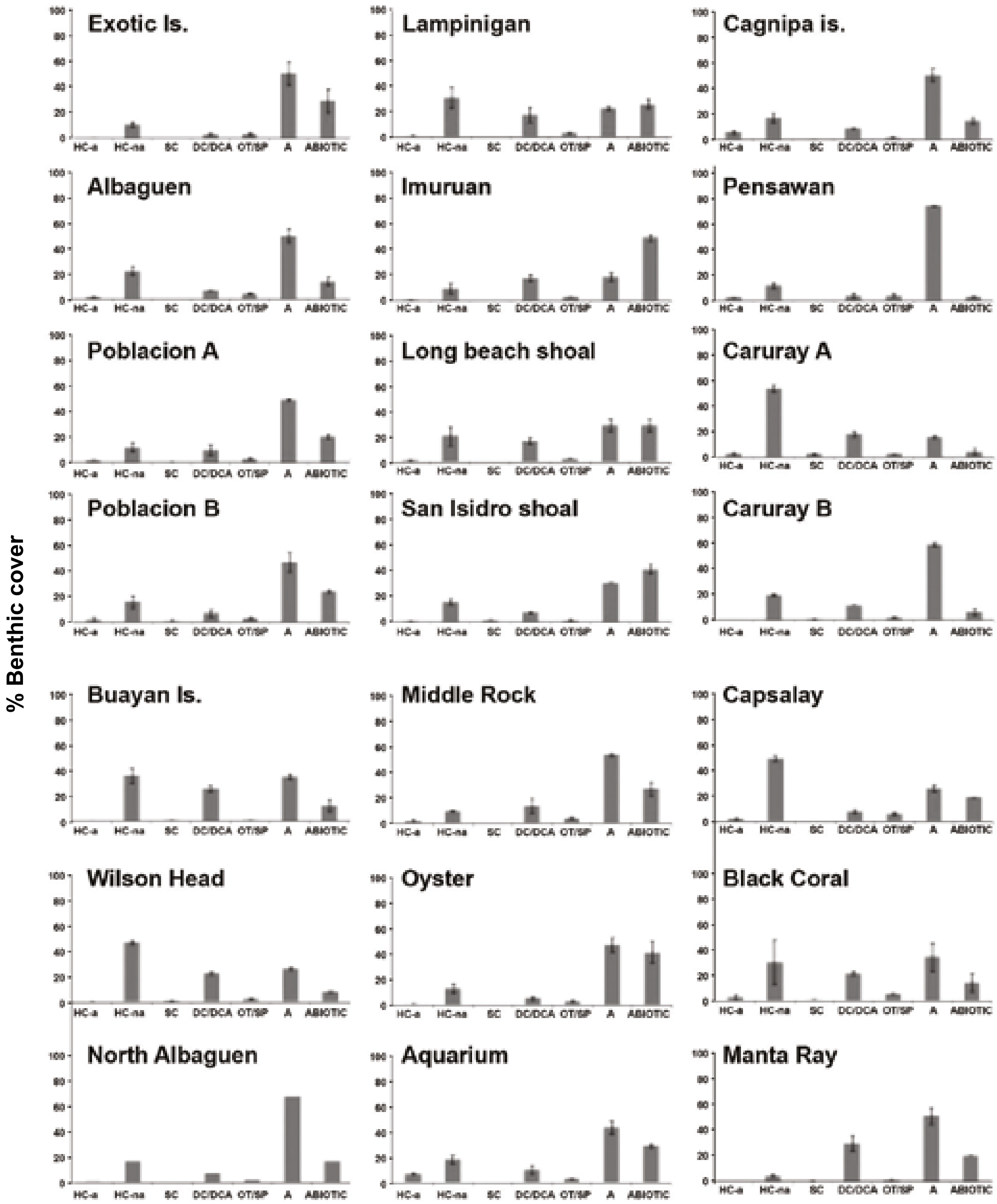


Figure 3.24. Percentage of benthic cover of the sites surveyed

Aquarium, however, poses an intriguing case. As an inner-sheltered site that is not overfished (its biomass of target species is 19.5 MT/km^2) and at the same time has an abundance of herbivores, its level of algal cove remains high at 39.2%. Apparently, the presence of herbivores has either not been sufficient to diminish and weed out the algal growth, or the algal infestation has been quite extensive and has overwhelmed the existing herbivore population. A possible explanation is that the existing herbivores are only mainly eating the turf algae, but not the macro algae such as *Padina* and *Sargassum* (Vermeij et al. 2010). Thus, majority of the sites algae infestation has proceeded unabated, while algae coverage is expected to spread in the remaining less resilient sites.

Furthermore, another possible condition that detrimentally affects the coral reefs of San Vicente is the growing presence of farming herbivores, *Plectroglyphidodon lacrymatus*, especially in Outer B. Like the damsel fish, the farming herbivore, is not a commercially important target species, but it is a dangerous one and an indicator of a bad reef. True to its name, the farming herbivores maintain algal beds in Outer B which prevent the settlement of coral recruits, thereby reinforcing the bad state of the reefs (Potts, 1977; Hata and Kato 2004; Stromberg and Kvarnemo 2005). Also, it is expected that climate change will further worsen the already poor condition of the reefs colonized by farming herbivores (Blanchon and Shaw, 1995; Grigg, 2008; DiCaprio et al. 2010). It seems then, that with the colonization of reefs by farming herbivores, Outer B sites will continue to be threatened. Moreover, if Outer A is said to be a transition between the inner group sites to Outer B, then Outer A is at risk. It is hoped that some inner group sites, like Albaguen and Exotic Island and Manta Ray, which have high algal cover and low herbivore biomass, will not be compromised to this fate.

Results – Baseline study on municipal fishery production

In assessing municipal fishery production, it is important to know the real extent of fishing pressure on the fishery stock, (i.e., whether fish harvests are sustainable at the given stock and yield level). If the existing stock already reflects an overfished state as in the case of most sites in San Vicente, investigation is needed in determining whether catching level has gone down relative to the yield (growth in stock). The following procedures are necessary in order to estimate the stock and yield.

First, the mean value (±SE) derived from the 21 sites was used to estimate the current biomass of the standing stock. As an outlier with its unusually high value, Middle Rock was excluded in the computation. With the estimated standing fish biomass at 15.42±1.60 MT/km^2 and the fishing ground area of 1,344.78 km^2, the available fish stock for the entire San Vicente is approximately 20,749± 2151 MT. But since this stock must be converted into MT/yr, it must be multiplied by the production biomass ratio (P/B) of 1.5 for reef fishes (Polovina, 2004) in order to get the current overall available stock, which is 31,124±3,226 MT/yr. Because this stock volume includes both commercially important or target species and the non-target species, what are expectedly caught will be the target species. To determine the current available stock of target species, the biomass of target species (excluding Middle Rock), which is 9.39±1.34 MT/km^2, must be multiplied by the ratio 1.5 and the area of 1,344.78 km^2, to obtain the current stock of target species (18,941±2696 MT/yr).

Given the available stock of target species, a rule of the thumb is applied to establish the allowable yield. It is construed that in order to implicitly ensure sustainability, the catch must not exceed 50% of the available stock (18,941±2696 MT/yr). Hence, the yield or allowable catch must be 9,469±1,348 MT/yr, and this represents the additions to stock (**Table 3.59**). As an indicator or proxy for yield or growth in stock, the estimated yield, however, only applies

		Demersal (MT/yr)	Pelagic (MT/yr)
Opening stock of aquatic resources		**18,938 + 2,696**	
Additions to stock	Growth in stock	9,469 + 1,348	
	Upwards reappraisal		
	Reclassifications		
	Total additions to stock	**9,469 + 1,348**	
Reductions in stock	Gross catch/ harvest		13,167.32
	Normal losses		
	Catastrophic losses		
	Uncompensated seizure		
	Downwards reappraisals		
	Reclassifications		
	Total reductions in stock		**13,167.32**
Closing stock of aquatic resources		**15,240 + 2,696**	

Table 3.59. Opening and closing stock of aquatic resources of San Vicente

to the target species caught in the reef (i.e., the demersal species) and to pelagic species. A separate inventory of pelagic species must be undertaken to estimate its own stock and yield to determine whether pelagic catching is sustainable or depletive. Unfortunately, an inventory of the standing stock of pelagic will require at least a year's time for gathering the length weight data of the dominant pelagic species in the area, like the groupers.

The fish production data from the MAO show that the municipality produced 1,557.75 MT in 2010, 1,608.26 MT in 2011, and 826.43 MT in 2012. Similarly, the Municipal Economic and Enterprise Development Office (MEEDO) reported the number of live fish (grouper or *suno*) pieces that were air freighted out of the municipality. Further, the MEEDO reported that the shipment of live fish pieces by one major trader declined from 37,247 in 2010, to 20,507 in 2011, and 12,395 in 2012. Similarly, the value of live fish shipments from seven traders decreased from PhP49.8 million in 2010 to PhP34.8 million in 2012. The reliability of the reported MAO fish catch data, however, is doubtful, given its data gathering methodology. With regard to data gathering, a MAO staff would go down to the *barangays* on a monthly basis and interview key regular informants on how much fish catch they have personally caught, as well as the catch of their fellow fisherfolks. The accuracy of information would then depend on the transparency of the informant, knowledge of their fellow villagers' performance, and their desire to reveal what they may know. In practice, based on observation, key informants have tended to oblige, if not, avoid the MAO interviewer. And when interviewed, they would tend to give vague general statements or qualitative responses, and simply leave the matter to the interviewer's interpretation. In other words, MAO data is understandably underreported.[9]

In order to correctly account for the actual volume of fish production or the biomass leakages in San Vicente, it is imperative initially to rectify the under-reporting of MAO fishery household production and the unreported *suno* purchases from local fisherfolks by commercial traders at the very least[10] before the question of sustainability can be addressed. First, with regard to the underreporting of fishery household production, the total household municipality catch must be estimated and projected from the study's sample findings. Initially, in order to make this projection, the distribution of MAO fishery household data in three *barangays*, which differentiates households in terms of their ownership of motorized or non-motorized boat, was used and applied to the available CBMS census data for the remaining six *barangays* in order to obtain a municipal-wide distribution of fishery households by type of boat. **Table 3.60** shows that the total number of fishery households (2,727) in San Vicente consists largely of municipal fishers with motorized boats (2,533) which they own or operate as a tenant, and commercial fishers (36), and fisherfolks with non-motorized boats (157).

Barangay	Motorized fishers (boat owner & tenant)	Non-motorized fishers	Commercial fishers (boat owner & tenant)	Total fishing household in San Vicente
Alimanguan	389	4	8	**401**
Binga	176	22		**198**
Caruray	153	20		**173**
Kemdeng	82	5		**87**
New Agutaya	265	9		**274**
New Canipo	192	20		**212**
Poblacion	495	4	16	**515**
Port Barton	505	31	4	**540**
San Isidro	146	16	8	**170**
Sto. Niño	131	26		**157**
Total	2,533	157	36	2,727

Table 3.60. Fishing household population

9 The tendency of the MAO underreport may also be present in the reported number of motorized boats. The MAO listed 463 registered motorized boats in 2012. Projecting its own data on motorized boat ownership in three *barangays* to the other villages would result in an estimated number of 2,533 motroized boat owners plus 36 commercial boat operators.

10 Apart from the undocumented shipment of fish traders, there are other unreported marine products that are not included like squids, lobsters, and other target species.

Given the projected municipal fishery household distribution, the fish catch data of the different fisherfolk categories in the sample was then applied to the 10 *barangay* fishery household population to project the municipal fish production. **Table 3.61** presents the total estimated catch (13,167.3 MT) of the different fisher folk categories in the 10 *barangays*. This supply came mainly from the fisherfolks of Poblacion, Port Barton, Alimanguan, Binga, and Caruray. Given this estimate and the total number of fisher households in the municipality, the average household catch would be 4.8 MT for the year (**Table 3.62**). With harvests ranging from 1.3 MT to 5.5 MT, most municipal fisher folk with one or more boats in the sample, together with the tenant operators have fish catch volumes less than the municipal average. Only the year's catch of the commercial owner operators deviated significantly from the municipal average, catching an average of 48 MT/yr.

Barangay	Motorized fishers (boat owner & tenant)	Non-motorized fishers	Commercial fishers (boat owner & tenant)	Total fishing household in San Vicente
Alimanguan	1,325.33	5.20	319.66	**1,936.23**
Binga	599.14	29.40		**956.04**
Caruray	520.84	26.73		**835.33**
Kemdeng	94.44	6.53		**101.14**
New Agutaya	583.54	5.57		**588.16**
New Canipo	388.91	8.24		**386.94**
Poblacion	3,213.00	7.46	667.66	**4,958.07**
Port Barton	1,719.52	41.03	171.85	**2,607.39**
San Isidro	110.78	15.06	332.34	**213.33**
Sto. Niño	173.60	24.61		**197.02**
Total	11,624.02	210.27	1,491.50	13,167.32

Table 3.61. Fish harvest estimates (in MT)

Fish output levels or effort are directly related to the number of trips (or days in a week) fishing operators would make and the type of fisher operator. Like typical enterprise proprietors, the commercial boat owners would finance fishing operations almost five days a week, while possibly because of need, the commercial vessel tenant and the non-motorized boat owner would labor at least six to seven days a week. The municipal fishers with one or more boats, on the other hand, would venture out at least three days a week.

Fisherfolk category	Number fishing households	Total number of trips per year	Annual total harvest (in MT)	Annual average harvest (in MT)	Annual total fishing cost (PhP)	Profit margin (12% of all fishing cost)	Annual total net income from fishing (PhP)	Ratio of net income to the annual total harvest
Commercial fishers (Owner)	6	1302	285.11	47.52	9,557,359	1,146,883	43,138,258	0.80
Commercial fishers (Tenant)	1	306	2.27	2.27	86,130	10,336	(5,746)	-0.06
Municipal fishers (Motorized owner with 1 boat)	101	16,577	293.26	2.90	6,553,043	786,365	16,758,702	0.70
Municipal fishers (Motorized owner with 2 boats)	1	132	1.98	1.98	28,177	3,381	47,642	0.60
Municipal fishers (Motorized owner with 4 boats)	1	168	1.68	1.68	33,306	3,997	29,897	0.44
Municipal fishers (Non-motor owner with 1 boat)	19	2,543	23.85	1.26	550,445	66,053	1,664,821	0.73
Municipal fishers (Non-Motor owner with 2 boats)	1	360	2.88	2.88	38,640	4,637	100,723	0.70
Municipal fishers (Tenant)	26	4,035	142.23	5.47	2,285,740	274,289	5,567,272	0.69
Grand total	156	25,423	753.25	4.83	19,132,840	2,295,941	67,301,569	0.76

Table 3.62. Annual total harvest, cost and net income

With their catch, most of the municipal fisherfolks would share a portion (2% to 19%) of their catch with extended family, neighbors, and fellow villagers. Commercial owners, on the other hand, take hold of their catch completely, while the tenant operators do not have the surplus to share with non-family members. All operators retain a portion of the catch (3% to 10%) for home consumption, while a greater portion of the catch (85% to 97%) is sold to buyers and traders (**Table 3.63**). Commercial boat owners sell the greatest portion of their catch; they also bring home the largest average volume of fish for home consumption. This information indicates the gap in food security and welfare among fisher households. While commercial boat owners can bring home an average of 1.4 MT per family, the tenant, non-motorized owners, and a couple of municipal boat owners can only feed their families an average of 0.08 to 0.14 MT of their catch. This only amounts to 0.24 to 0.41 piece of a fish per day for a family of five; while the commercial boat owners can feed their families 4.13 pieces a day (assuming that there are only 1,078 pieces of good sized fish in one metric ton).

Fisherfolk category	Annual total harvest, consumed, shared, and sold (in MT)					Percentage of harvest, consumed, shared, and sold (%)			
	Harvest	Consumed	Labor cost	Shared	Sold	Consumed	Labor cost	Shared	Sold
Commercial fishers (Owner)	285.11	8.26	45.90	-	230.95	2.90	16.10	0.00	81.01
Commercial fishers (Tenant)	2.27	0.11	-	-	2.15	5.00	0.00	0.00	95.00
Municipal fishers (Motorized owner with 1 boat)	293.26	23.08	3.83	6.27	260.08	7.87	1.31	2.14	88.69
Municipal fishers (Motorized owner with 2 boats)	1.98	0.14	0.04	-	1.80	7.00	2.00	0.00	91.00
Municipal fishers (Motorized owner with 4 boats)	1.68	0.08	-	0.17	1.43	5.00	0.00	10.00	85.00
Municipal fishers (Non-motor owner with 1 boat)	23.85	1.96	0.18	0.76	20.94	8.23	0.77	3.20	87.80
Municipal fishers (Non-motor owner with 2 boats)	2.88	0.29	-	-	2.59	10.00	0.00	0.00	90.00
Municipal fishers (Tenant)	142.23	13.15	5.56	-	123.51	9.25	3.91	0.00	86.84
Grand total	753.25	47.07	55.52	7.20	643.46	6.25	7.37	0.96	85.42

Table 3.63. Annual total fish harvest, consumed, shared and sold (in MT and %)

The sale of a greater portion of harvests across municipal fishery households suggests that external market demand poses greater pressure on the resources than local family consumption. From the sales and price of fishery household supply, it is possible to infer the type and proportion of fish species caught by the community. The tenant seems to catch mainly the lowest-valued fishes, while the commercial fishing vessel owners can haul in the higher-valued fishes (**Table 3.64**). The weighted price does not reach even half of the higher price species, like grouper and squid because a greater portion of the catch of fishery households consists of the lower value fishes (**Table 3.65**). In the sample catch, the *suno* volume amounted to only 0.64% of the sample catch. The small fraction of pelagic species catch may thus reflect the low-value composition of the municipality's fishery resources. Moreover, it implies that much of the minority higher-valued species is supplied mainly by commercial operators, while some by the municipal and non-motorized boat owners, and these end up in the hands of the traders-exporters.

The earlier estimated yield or additions to stock of 9,469±1,348 MT/yr provides a measure of allowable catch. This applies only to the target species caught in the reef, the demersal

Fisherfolk category	Total harvest (kg/yr)	Value of harvest (PhP/yr)	Weighted price (PhP)
Commercial fishers (Owner)	285,105	53,842,500	188.85
Commercial fishers (Tenant)	2,268	90,720	40.00
Municipal fishers (Motorized owner with 1 boat)	293,257	24,098,110	82.17
Municipal fishers (Motorized owner with 2 boats)	1,980	79,200	40.00
Municipal fishers (Motorized owner with 4 boats)	1,680	67,200	40.00
Municipal fishers (Non-motor owner with 1 boat)	23,851	2,281,320	95.65
Municipal fishers (Non-motor owner with 2 boats)	2,880	144,000	50.00
Municipal fishers (Tenant)	142,226	8,127,300	57.14
Grand total	753,246	88,730,350	117.80

Table 3.64. Weighted price of various fish species

Fish species	Average unit price (PhP)	Number of occurrence
Suno (Grouper)	3,000	7
Pusit (Squid)	401– 450	13
Live Squid	251– 300	6
Pusit (Barako), *Lapu-Lapu*, *Pusit Babae*	201–250	22
Pusit Laot, *Tauban/Kalambutan*, *Pitik*	151–200	5
Pusit Bahura, *Tanguegue*, *Pampano*, *Hasa-Hasa* (Indo-Pacific Mackerel), *Sapsap* (Slipmouth), *Dilis* (Anchovies)	101–150	21
Crab, *Bisugo* (Threadfin), *Tulingan* (Frigate tuna), *Tamban* (Indian sardines), *Alumahan* (Indian Mackerel), *Mamsa*, *Maya-Maya*, *Salay-Ginto*, *Buraw*, *Mangagat*, *Baritos*, *Amadas*, *Kalapato*, *Taksay*, *Torsilyo*, *Salmonito*, *Darag-darag*, *Dugso*, *Liglig*, *Kulpot*, *Kaupig*	51–100	87
Tungsoy (Frimbriated sardines), *Dalagang Bukid* (Caesio), *Matambaka* (Big-eyed scard), Flying Fish, *Basa*, *Samaral*, *Banak*, *Pulito*, *Liwit*, *Agahin*, *Salay*, *Balila*, *Baritos*, *Lipot*, *Sagisi*, *Salingga*, *Danggit*, *Salay-salay*, *Molmol*, *Baloe*	50 and below	37

Source: San Vicente Household Survey

Table 3.65. Average unit price of fish harvest

species and cannot be applied to pelagic. Unless there is an estimate of the pelagic stock and yield, it may not be possible to determine whether pelagic catching has been sustainable or depletive (i.e., whether the estimated municipal catch of 13,167 MT has depreciated the target demersal species stock). In the first place, the estimated catch does not only consist only of demersal species. If the catch of pelagic species is only a small fraction (0.64%) of the sample's total catch, then the *suno* catch in total municipal catch (13,167 MT) would amount to 84.27 MT of pelagic which would hardly reduce the estimated catch to the allowable level for demersals. This catch of pelagic species must then be added to the undocumented land shipments and port deliveries and the supply of other unidentified traders, and then compared to the pelagic stock yield once an inventory has been made.

The estimated municipal catch less the *suno* volume may still be an underestimation of the total demersal catch. It does not yet consider the demersal catch volume of commercial vessels illegally encroaching on San Vicente's fishing grounds. The *Bantay Dagat* has reported sightings of *muro-ami* fishing and unregistered commercial Danish seine (*hulbot-hulbot*) vessels, but there has been no apprehension which would provide a determination of the volume of illegal catch. The *hulbot-hulbot* vessel's net capacity of 151 MT and its practice of avoiding apprehension by operating during the *Habagat* period (from June to August) provides a sense of its illegal catch potential or overfishing capacity. If one *hulbot-hulbot* were to operate once a week during the turbulent *Habagat* months, with its net capacity, it can easily stash away 1,812 MT. Moreover, should these commercial vessels become more daring, for example operate five days a week, and take advantage of the fact that the small pump boat of the municipal fishing enforcers cannot immediately apprehend them before it can transfer its catch to auxiliary get-away vessels, then as much as 9,060 MT can be hauled away. Within three months, this hoard would almost equal the allowable yield estimate. In other words, the municipality's failure to stop this illegal encroachment robs the community and its future generation of an opportunity to operate within the allowable yield. It also pushes the local fisherfolks to overfish and resort to inflict the tragedy of the commons.

Results: Fisheries account

Given the dire state of the marine environment, the infested reefs and depleting fishery stock, the concept of economic rent is strategic for sustainable resource management. It defines and measures a residual income or surplus from the use of the ENR that can be tapped and directed for the recovery of marine environmental wellness, the rehabilitation of the reefs, and the restoration and growth of fishery biomass. In order to realize the object of resource sustainability and environmental resilience through economic rent, it must first be generated and realized, and then directed for investments in natural capital formation and restoration of environmental services.

There are many cases in the municipal fishery study that illustrate the magnitude and relative presence of economic rent. Knowledge of these conditions would be the initial step in preparing and organizing the means to tap and direct the rents or savings for the desired investment. For instance, the fishing of *suno* by small fisherfolks rather than lower-valued species (e.g., *danggit*, *dalagang bukid*, etc.) can provide as much as 88% to 96% net income or rent out of the catch value. While ordinary municipal fishers working three days a week and catching 1 to 5 MT a year may earn 60% to 73% of catch value as rent, the commercial boat owners by operating five days a week and catching an average of 47 MT a year can earn rents amounting to 80% of the catch value. The operator of the *hulbot-hulbot* with greater capacity (151 MT) may possibly earn as much rent, if not more. Similarly, by buying and selling live fish at PhP1,815, the *suno* trader can realize rent that is 40% of the price. Likewise, an economic rent of 64% can be gained at PhP3,000, or more if exported to Hong Kong and China.

The relative presence of rent in the case of the municipal fisher with four boats and the commercial tenant is also instructive. Compared to his fellow fishers with one or two boats, the municipal fisher earns only 44.5% of catch value as rent because the greater portion of costs goes to maintenance and depreciation of boats and fishing gears (**Table 3.66**).

Fisherfolk Category	Annual average fishing cost									Annual average fishing cost	Average total fishing cost
	Dep'n cost of fishing boats	Maintenance cost of all boats	Dep'n cost of fishing gears*	Maintenance cost of all gears	Dep'n cost of fixed cost**	Other maintenance cost (PhP)	Variable cost ***	Labor cost of boat owners	Rental cost of tenants		
Commercial fishers (Owner)	38,300	-	71,137	95,000	600	400	81,656	4,014,000	-	1,592,893	9,557,359
Commercial fishers (Tenant)	-	-	1,980	-	-	-	84,150	-	-	86,130	86,130
Municipal fishers (Motorized owner with 1 boat)	3,271	1,327	6,373	4,447	2,029	400	49,407	13,060	-	64,882	6,553,043
Municipal fishers (Motorized owner with 2 boats)	1,600	1,200	9,300	1,200	93	-	13,200	1,584	-	28,177	28,177
Municipal fishers (Motorized owner with 4 boats)	14,000	-	4,950	1,000	396	1,200	11,760	-	-	33,306	33,306
Municipal fishers (Non-motorized owner with 1 boat)	1,093	2,247	6,377	1,615	647	1,200	17,758	7,470	-	28,971	550,445
Municipal fishers (Non-motorized owner with 2 boats)	840	-	21,000	-	-	-	16,800	-	-	38,640	38,640
Municipal fishers (Tenant)	-	-	6,801	5,850	427	-	69,132	-	10,514	87,913	2,285,740
Grand Total	4,096	1,141	9,011	10,061	1,580	600	49,621	433,019		122,646	19,132,840

* Fishing gears: net, hook and line, bow, jigger/pasay/harison **Fixed cost: registration fee, ice box, paddle, goggles/snorkels, rechargeable/battery and flashlight/gas lamp ***Variable cost: ice, salt, food, drinks, gasoline, kerosene, crude oil

Table 3.66. Annual total and average fishing cost

In the case of commercial tenants, because boat rental payments are deducted from their catch, they obtain a positive net value of catch minus production cost (i.e., PhP4,590), which is almost equal to a household consumption expenditures (PhP4,536). In other words, a tenant operates like a subsistent peasant with no net income or rent (-6.3% of catch value). The profit margin imputed to the tenant may actually be shared partly, if not wholly, with the owner and the fisherfolk's extended family workers.

These cases illustrate the various levels of economic rent for a municipal fisherfolk household and how, as a form of income, it may be spent or saved. When spent for household or business expenses, the potential savings sourced from the economic rent is lost, and nothing can be invested for natural capital formation and restoration of environmental services. Among the 156 fisherfolk households, 36 households do not earn any rents. Among those who do receive rent, 76 do not have enough household income to cover household expenditures, even if other income sources from the head and members are included. Among the sample households, only 80 households were able to save or keep a portion of their rents intact. Out of the PhP67.3 million of economic rents generated, PhP66 million was saved. Among these are many small savers, around 50% accounting only for PhP2.29 million, while 10 households accounted for 12% of total savings which amounted to PhP52.5 million (79.5% of the total savings in the sample). In other words, the necessary investments for the ENR from the fishery households would have to be obtained from these savers. Most importantly, the greater the rents or savings generated from the business trading sector, the more should be tapped from them.

While 80 household and commercial fishers in the municipality can save PhP66 million from their economic rents, the seven large *suno* traders can substantially generate more economic rents and savings. With their estimated 64 MT of live fish shipments, on the assumption that they capture 64% of the local producer price of PhP3,000/piece as rent (**Table 3.68**), they can generate as much as PhPP32.2 million of economic rents (255% more than their 76 fisherfolk suppliers). Also, the traders-exporters actually gain more economic rents when their live fish shipments are exported abroad to Hong Kong, China, and Taiwan at higher prices.

Household sample	Annual household income (PhP)	Annual household expenditure (PhP)	Annual household savings (PhP)
Commercial fishers (Owner)	44,445,641	418,420	44,027,221
Commercial fishers (Tenant)	4,590	29,890	(25,300)
Municipal fishers (Motorized owner with 1 boat)	18,965,535	8,814,880	10,150,654
Municipal fishers (Motorized owner with 2 boats)	51,023	101,420	(50,397)
Municipal fishers (Motorized owner with 4 boats)	33,894	130,800	(96,906)
Municipal fishers (Non-Motor owner with 1 boat)	2,030,574	1,459,963	570,611
Municipal fishers (Non-motor owner with 2 boats)	105,360	32,832	72,528
Municipal fishers (Tenant)	6,206,060	2,527,596	3,678,464
Grand total	71,842,678	13,515,801	58,326,876

Table 3.67. Annual total household income, expenditure, and savings

Input and activity	Cost/month (PhP)
Labor (two admin, four operations)	37,500
Food (four trips/month)	24,000
Gasoline	8,000
Boat repair	3,000
Aquarium electricity, water	7,000
Aquarium depreciation	1,667
Water pump depreciation	116.67
Handling and packaging	266,664
Transport (from *sitio* to airport)	1,200,000
Profit margin (12%)	**185,753.72**
Total cost	**1,733,701.39**

Volume of shipment	400-1200 boxes/month; Average of 800 boxes or 1,600 pieces of live fish	
Weighted average peso price per piece	PhP1,386	PhP1,815 PhP3,000
Revenue (1,600 pieces) in PhP	PhP2,217,600	PhP2,904,000 PhP4,800,000
Economic rent/piece	PhP307.35 22.2%	PhP731.44 40.3%
Economic rent/ local supply price		PhP1,916.43 63.88%
Economic rent Estimate of seven traders	PhP132.2 million 255% more than their 76 fisherfolk suppliers (PhP3,000/ piece or 64% of the local producer price)	

Table 3.68. Cost and economic rent of live *suno* (grouper) production

Discussion and conclusion

Based on a comprehensive understanding of the state of marine resources, fish biomass, and fishing practice in San Vicente, this study highlights the following findings and conclusions:

- **Various stressors and threats have impinged on the coral reef resources of San Vicente, and their exposure to each successive stressor has made it more vulnerable to further degradation, which eventually leads to reduction in fish biomass and production.** The main climate-related stressors identified were the El Niño and infestation by crown-of-thorns. Many recent studies show that El Niño patterns are intensified by climate change and the consequent bleaching of the corals make them more vulnerable to infestation, in particular by the crown-of-thorns.

- **The Inner area was found to have a larger fish biomass compared to Outer A and Outer B areas.** Such result implies that the outer offshore areas have not received the appropriate level of protection, while inner areas closer to the mainland, experienced less fishing intrusion or effort.
- **Overfishing has caused other profound consequences for the reef and fishery resources of San Vicente.** Target fish biomass confirmed that more than half of the sites studied were being overfished significantly, and such condition has persisted in the process of coral reef deterioration over the past decade.
- **Only a maximum of 10% of the catch by the local fisherfolks were being used for household consumption.** Most of the fish catch is sold in the market and remains an important source of income to the fishing community. However, only about half of the fishing households were able to save or keep a portion of their rents. While commercial fishing vessel owners were found to haul in the higher-valued fishes, a greater portion of the catch of municipal fishery households consists of lower value fishes. The sale of a greater portion of harvests across municipal fishery households suggests that external market demand poses greater pressure on the resource, than local family consumption.
- **The calculated amount of economic rents extracted from marine environment and fishery resources does not account for the illegal fishing activities.** *Bantay Dagat*, a nationwide network of local fisher-stakeholder volunteer groups, has reported sightings of unregistered commercial vessels in the area, such as *hulbot-hulbot* fishing which operates illegally in the area, which easily takes away a significant portion of the allowable yield estimate.

- **Municipality and beneficiaries of San Vicente have continued to draw upon the given marine environment and natural resource stock at an alarming rate.** Despite its depleted state and vulnerability to infestation and climate change, all the economic agents seem unaware of the grave condition, the ongoing ENR degradation and phase shift, and they continue to operate on a business-as-usual (BAU) scenario.

Based on the conclusions drawn above, the following suggestions should be considered in developing the fisheries sector of San Vicente.

- **Pursue expansion of protection zones and different conservation management arrangements.** Overfishing in most sites has persisted and that the process of coral reef deterioration has continued unabated over the decade. Since the reef of San Vicente is alarmingly shifting from a coral dominated to an algal dominated reef, more core protection zones should be established to cover half of the total area in maximum. But if this is not feasible, different conservation management arrangements may be established. The most immediate target is to establish the required 85.37 km^2 protection area which is around 15% of the total fishing ground. The suggested core zones areas for coral reefs are as follows: a) the two big shoals under New Agutaya; b) the Imuruan and Lampinigan Islands; c) Pensawan area under *Barangay* Caruray; d) the multiple use (i.e., Aquarium, Black Coral, Capsalay, Oyster Rock) and outer zones (north Albaguen, Middle Rock, and Wilson Head) in Port Barton must be converted as core zones. There must also be a core zones for pelagic species.
- **Strengthen efforts toward herbivore seeding (particularly parrotfish) and the establishment of close season of catching fish for all herbivores (parrotfish, rabbitfish and surgeonfish).** Past fishing efforts in a large majority of sites studied have been excessive and unsustainable. Resilience should also be strengthened through the establishment of a balanced and proper mix of marine habitats, like lagoons and sea grass beds in order to improve species diversity and fish biomass.
- **Mechanisms for the protection of marine resources must be supported by both local and commercial fisherfolks.** Economic rents from marine resources are seized mainly by the small number of commercial fisherfollks who haul in the higher-valued fishes, while local fisherfolks, especially those using non-motor boats rely their household income from lower value fishes. Economic rents from commercial fishing and trading activities must partly be redirected towards sustainable fishing practices. Mechanisms must be put in place to mobilize and invest the savings in ENR protection, rehabilitation, and natural and human capital formation and development.

4. Forestry

Protection forest is one of the four general land uses in San Vicente. It is composed of mangrove, protected areas belonging to the National Integrated Protected Areas System (NIPAS), wilderness, watershed and park reservation, and bird sanctuary as shown **Figure 3.25**. Forest area occupies a total of 71,977 ha out of the 165,797 ha of San Vicente total land area. It is not a major source of economic activities in the municipality, but it is an important source of fuel and housing materials. Old growth forest[11] is present in New Agutaya, Alimanguan, Binga, Caruray, and Kemdeng while residual forest[12] is located in New Agutaya, New Canipo, Poblacion, Port Barton, San Isidro, and Sto. Niño. Mangrove forest can only be found in Port Barton and Caruray with a total area of 832 ha.

11 Old growth forest is defined as a primary natural forest, sometimes referred to as virgin forest, of which the composition, structure and function has not been altered. It refers to the areas that are identified as initial components of the Natural Integrated Protected Areas System of 1992. (Forest Management Bureau-DENR, 2006)

12 Residual forest is the status or condition of a forest subsequent to commercial logging in which there is more or less sufficient or adequate volume of residuals or the desired species of trees of future harvest. (Forest Management Bureau-DENR, 2006)

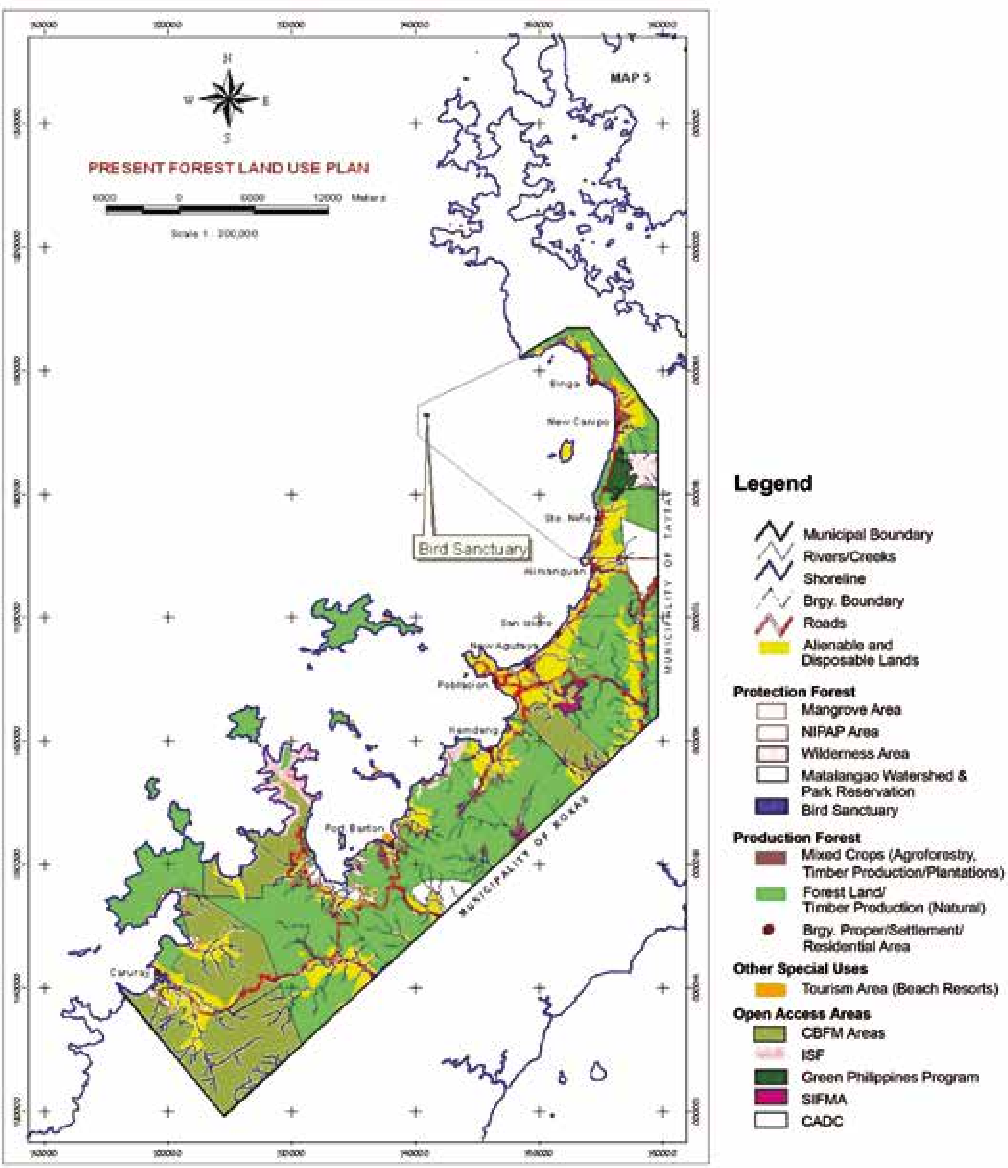


Figure 3.25. Present forest land use plan of San Vicente

The forest, in general, provides not just goods such as timber and non-timber forest products (e.g., rattan, palm species, honey, etc.) but also ecosystem services such as water regulation, maintenance of soil quality, protection of soil from rainfall, limiting soil erosion, climate change moderation, among others (Sousson, Shrestha and Uprety, 1995).

One of the ecosystem services that the forest of San Vicente provides is water recharge. In recognition, the local government has implemented local legislations proclaiming watersheds in the different *barangays* as sources of water supply. The mix of forest types in the municipality, moreover, provides other services such as natural soil nutrients, carbon sequestration, wildlife habitat, and ecotourism.

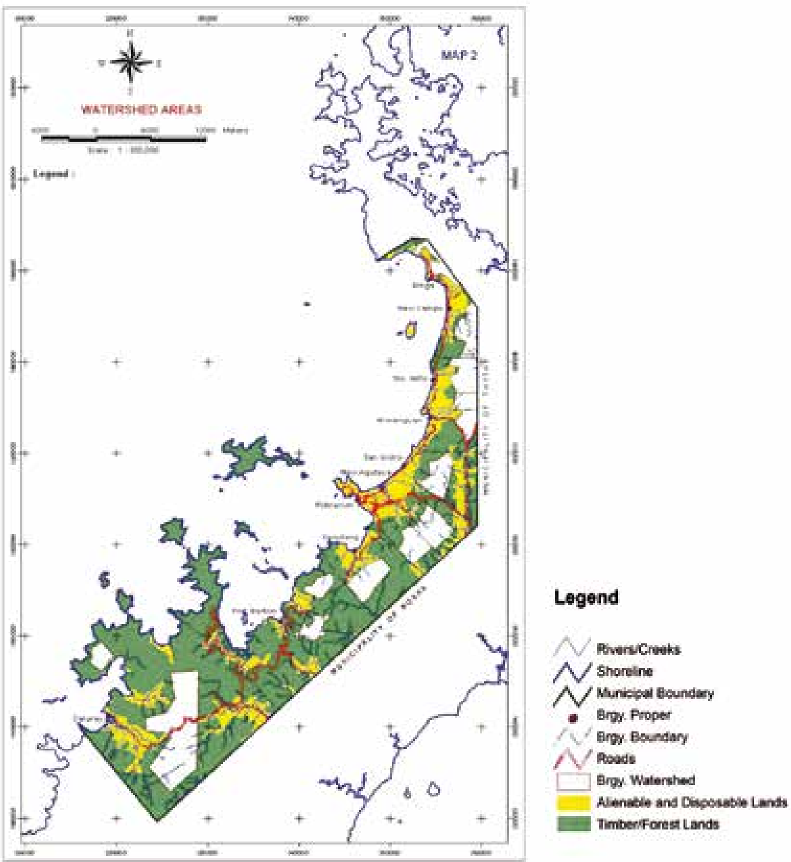


Figure 3.26. Watershed areas of San Vicente

The forest is dominated by dipterocarp species and is also rich in premium species that are both hardwoods and softwoods. These include ipil (*Instia bijuga*), kamagong (*Diospyrus blanco*) and molave (*Vitex parviflora*). With these types of species, carbon sequestration potential is high for San Vicente. The highest growing stocks are provided by the old growth forests in New Agutaya (17%) and Alimanguan (10%) as well as the residual forest from New Agutaya (9%). The total growing stock is 32.9 million cubic meters (cu.m.).

Forest type	Barangay	Average growing stock (cu.m./ha)	Percent growing stock	Total area (ha)	Percent area	Total growing stock (cu.m.)	Percent growing stock
Old growth rainforest	New Agutaya	986.38	17.48	7,144	9.81	7,046,698.72	21.41
	Alimanguan	613.79	10.88	7,511	10.32	4,610,176.69	14.01
	Binga	554.55	9.83	2,050	2.82	1,136,827.50	3.45
	Caruray	368.54	6.53	23,217	31.88	8,556,393.18	26.00
	Kemdeng	467.44	8.28	4,536	6.23	2,120,307.84	6.44
Residual rainforest	New Agutaya	552.41	9.79	592	0.81	327,026.72	0.99
	New Canipo	435.49	7.72	1,488	2.04	648,009.12	1.97
	Poblacion	390.28	6.92	3,818	5.24	1,490,089.04	4.53
	Port Barton	311.56	5.52	8,675	11.91	2,702,783.00	8.21
	San Isidro	360.85	6.40	8,675	11.91	3,130,373.75	9.51
	Sto. Niño	244.10	4.33	3,439	4.72	839,459.90	2.55
Forest plantations		300.50	5.33	839	1.15	252,122.74	0.77
Mangrove forest	Port Barton and Caruray	56.50	1.00	832	1.14	47,010.76	0.14
Total		5,642.40	100.00	72,816	100.00	32,907,278.95	100

Table 3.69. Growing stock of the rainforest, mangrove, and forest plantation

With the potential of the forest products in San Vicente, the present threats include illegal harvesting of trees for boat and lumber production, shifting cultivation (*kaingin*-farming), fuelwood gathering, and charcoal-making, which are all banned in the province. These illegal activities threaten the current condition of their relatively young forest and expected to have a downstream impact on other sectors such as agriculture and fishery, the main sources of livelihood in San Vicente.

Preliminary data collection and assumptions

a. Scoping and secondary data collection

A scoping activity was conducted in San Vicente to assess the availability of secondary data and information that can be used in building the forestry accounts. The data available were mostly the reported information that has been compiled by the local government such as forest types and areas. Key informants interviews and focus group discussions were also used especially on anecdotal accounts on the illegal use of forest and the utilization of timber and non-timber products.

b. Forest sampling

Sampling was done in every *barangay* wherein three sampling plots with 10 m x 20 m dimensions were established. The sampling plots were located in three different elevations and data on the forest species name, base diameter and top diameter were gathered. Non-timber forest products such as rattan and palm within the plots were also measured and recorded. The volume of the trees was computed using the formula:

$$\text{Volume by diameter class} = 0.7854 \times D^2 \times Ht$$

Where D is the average of the base diameter and top diameter and
Ht is the height of the tree from the base (dbh) to the first branch

c. Growth projections and stumpage value calculations

Existing models were used in calculating the annual growth projections. It was assumed that three cu.m. per hectare per year is the average growth rate for the whole rainforest in the country. This growth and yield average was used in projecting the annual growth of residual forest, while it was assumed that there is no increment for the old growth forest. Mangrove forest has an average growth rate of one cu.m./ha/yr while forest plantations' yield grows at 10 cu.m./ha/yr.

The residual forests' annual growth rate, on the other hand, is estimated using the growth and yield model through the average growth rate of an average forest' site quality. The Average Growth Rate (AGR) formula provided by the Resources, Environment and Economics Center for Studies (REECS) to determine the residual forest's annual growth rate for the 10 *barangays* is as follows:

$$AGR = p(1+i/n)^{tn}$$

Where n is the number of times of growth rate is compounded a year (capital volume plus the added volume will grow together in a year)
t is the number of years of residual forest growing
P is the forest wood volume (cu.m/ha) at a given year
A is p equals growth

The forest's growth for the next accounting period is computed using the same formula subtracting the use of wood for the same year. Stumpage value[13] was calculated for the

13 It is defined as the economic value of a standing tree, equivalent to the amount concessionaires earn when a log is sold to the sawmill or the exported, less the cost of logging. (Forest Management Bureau-DENR, 2006)

valuation and construction of the economic account for the forestry sector. They stumpage values of the following were estimated:

- Trees for boat production (actual use value)
- Trees for lumber for house construction (actual use value)
- Trees and other tree parts for fuelwood production (actual use value)
- Trees and other tree parts for charcoal production (actual use value)
- Trees for sawtime (option value[14])
- Trees for pulp/chip wood (option value)

d. Construction of forest physical and economic accounts

The structure of both the physical and economic accounts is similar, taking into consideration the opening stock, growth, reduction, and closing stock. The physical (wood volume account) involved the following activities:

1. Average wood volume for the opening stock classified into trees <50 cm and trees >50 cm in diameter
2. In-growth of the residual forest based on the above mentioned classifications
3. Reductions that include wood volume used for boat production, lumber for house construction, shifting cultivation, fuelwood, charcoal, damaged by rain-induced landslide (RIL), LGU plan for production and damages from harvesting of trees for boat production and lumber production
4. Net addition or reduction (difference between wood addition and wood reduction)
5. Calculation of the closing stock or sum of the net wood volume addition to the opening stock

The economic account primarily considers the economic rent (forest land rent) as equal to the stumpage value of trees used for certain products. Using the components of the accounting structure for forestry, the values were derived by multiplying the wood volume in the physical account and the corresponding stumpage value of the forest product.

1. The opening stock value is the total value of trees of <50 cm and >50 cm diameters
2. Growth value is the sum of the value of the additions
3. Reduction is the sum of the value of the wood used in boat production, house construction, shifting cultivation, fuelwood, charcoal-making and damage to trees[15] brought about by RIL
4. Net addition or reduction or the addition value minus the reduction value
5. Closing stock value or the net value of addition (or reduction) plus opening stock value.

e. Physical assessment

Based on records of the Department of Environment and Natural Resources (DENR), the forest area decreased by 1.94% in 2004 compared to 1988. This area might have been converted to wooded lands with grasslands and brushlands (1.53%) and agricultural lands (55.73%). The large proportion added to agricultural lands implies that forest land use

14 Option value according to the Millennium Environmental Assessment is the "value for preserving the option to use such services in the future..." (United Nations Environment Program, 2006)

15 Average stumpage value of boat production, house construction, fuelwood and charcoal is used to estimate the damaged trees.

conversion has been taking place since 1988. This can be attributed to the existence of *kaingin* in San Vicente that converts the forest to farm lands. Mangroves, however, increased in area by 54.24%.

Binga and New Canipo have the most number of species, totaling 23, the majority of which is hardwood such as Kamagong, Kamagong and Apitong. This is followed by Sto. Niño and San Isidro with 20 and 18 species, respectively. Much of the species present in the 10 *barangays* are hardwoods that grow in higher elevation.

Physical accounts

The growth of the forest in year one for an initial volume stock of 25.56 million cu.m. is estimated at 766,843.4 cu.m. At the end of the first year, the total wood production amounted to 26.32 million cu.m., assuming no reductions.

Year	1
p (Growing stock in cubic meters)	25,561,446.74
Average growth rate (Cubic meters/ year)	3
n (# of times/year)	1
t (Number of years of growing the forest)	1
Volume (Cubic meters)	26,328,290.14
Growth (Cubic meters/year)	766,843.40

Table 3.70. Forest growth, San Vicente

The household survey shows that household fuelwood consumption per year is estimated at 13.76 cu.m. with net fuelwood volume[16] of 12.38 cu.m. per household. With the high prices of the next best source of fuel, the liquefied petroleum gas (LPG), households depend on residual forests for fuelwood. The total fuelwood consumption of the municipality is 69,947 cu.m. per year. The top four *barangays* with high fuel consumption are Port Barton, Alimanguan, Caruray, and New Agutaya. Carbon sequestration is equivalent to 40% to 50% of the *barangay* fuelwood requirement, thus the forest will be emitting that much carbon to the atmosphere.

In relation to fuelwood, there is also a high demand for charcoal, the source of which is the forest (**Table 3.71**). Due to the increasing price of LPG, more households are shifting to fuelwood and charcoal. The estimated wood volume of charcoal from the municipality is 3.53 million cu.m. with New Agutaya as the highest producer of charcoal. Mangrove trees,

Barangay	Sack per year	Equivalent volume	Total charcoal volume	Equivalent wood volume	Equivalent biomass	% Brgy	Trees/ ha	% Trees <50cm	Number of trees for debranching	Wood volume of branches	Total operable area
Alimanguan	240	0.312	74.88	149.76	224.64	6	500	77	385	5.44	27.52
Binga	240	0.312	74.88	149.76	224.64	6	483	77	372	5.26	28.48
Caruray	420	0.312	131.04	262.08	393.12	11	567	77	437	6.17	42.40
Kemdeng	420	0.312	131.04	262.08	393.12	11	322	77	248	3.51	74.77
New Agutaya	720	0.312	224.64	449.28	673.92	19	433	77	333	4.71	65.32
New Canipo	240	0.312	74.88	149.76	224.64	6	450	77	347	4.90	30.57
Poblacion	240	0.312	74.88	149.76	224.64	6	366	77	282	3.98	37.59
Port Barton	720	0.312	224.64	449.28	673.92	19	367	77	283	4.00	112.46
San Isidro	240	0.312	74.88	149.76	224.64	6	550	77	424	5.99	25.01
Sto. Niño	240	0.312	74.88	149.76	224.64	6	500	77	385	5.44	27.52
Total	3,720	3.12	1160.64	2321.28	3481.92	100					

*Volume=(0.7854*D^2*H)*2 Sack diameter=66.04 cm Sack height=101.6 Wood volume=2*charcoal volume*
*Carbon Volume=(0.784*66.04/100^101.6/100) less 10% for air volume inside sack*

Table 3.71. Charcoal requirement by *barangay*, San Vicente

16 Fuelwood consumption minus 10% to account for air spaces in the bundle.

on the other hand, which are harvested in Port Barton, are also used for charcoal-making. In estimating its carbon emission, 50% of the total wood volume for charcoal is added to the original wood volume of 3,528.64 cu.m., producing a 5,292.96 cu.m. of total biomass.

Shifting cultivation or *kaingin* is a common practice in the country, which is one of the major causes of forest destruction. Most of the time, it is undertaken right after logging, which was prevalent in San Vicente in the 1980s. As such, it is estimated that the affected forest area for clearing is 52 ha annually translating to a loss of wood volume totaling 7,546.78 cu.m and biomass of 11,320.16 cu.m. Among the 10 *barangays*, Caruray, Sto. Niño, and Alimanguan posted the highest number of cleared forest for *kaingin* although Alimanguan, Caruray , and Binga have the most number of *barangays* undertaking such activity.

In the assumption that the cleared forests are used for farming, the observation that the *barangays* with the highest number of farm households, based on the Agriculture Sector report of the NRA, does not directly imply that these are also the *barangays* with the large cleared areas. It is possible that there are only a few households responsible for the clearing of large tract of areas in the forest. There are also instances that several patches of farm lands in the cleared forests are “owned” by a few households or “land owners”.

As an implication, practicing *kaingin* farming wastes materials and products that can be derived from the forest and affects the provision of ecosystem services of the watersheds, particularly irrigation, water regulation, and prevention of soil erosion. Without these ecosystem services, *kaingin* will impact major livelihoods of downstream communities.

Another use of the forest products, particularly trees, is for boat production. Being a coastal community, boat production supports the fishing sector in San Vicente. There are a number of households that are this economic activity which also serves as alternative income sources from fishing. Based on the computed gross wood volume, it is estimated that 5,836.20 cu.m. is used annually for boat production. **This is translated to 13.05 ha of forest land being utilized per year.** In addition, it is worth noting that cutting large trees for the boat hull will reduce the number of mother trees that will regenerate the forest, thereby, lengthening the growth period of the forests.

Lastly, forest products are used for construction, fuelwood, and charcoal. Looking into the wood requirements for construction, lumber is the most popular construction material due to its availability, cost, and familiarity of local carpenters in handling such raw material. The total lumber requirement in terms of use is high for house construction (1,539.30 cu.m.) followed by public sector in its construction business (1,318.80 cu.m) and private sector (879.90 cu.m). It is observed that the major sources for lumber are Port Barton, Poblacion, and Alimanguan given the concentration of population and businesses in the three *barangays*.

Barangay	Household population	% Population	New wood volume (cu.m.)	Gross wood volume (cu.m.)	Biomass volume (cu.m.)
Alimanguan	878	15.54	113.91	159.47	239.20
Binga	334	5.91	43.33	60.66	91.00
Caruray	789	13.96	102.36	143.30	214.96
Kemdeng	192	3.40	24.91	34.87	52.31
New Agutaya	689	12.19	89.39	125.14	187.71
New Canipo	280	4.96	36.33	50.86	76.28
Poblacion	993	17.58	128.83	180.36	270.54
Port Barton	1057	18.71	137.13	191.98	287.97
San Isidro	189	3.35	24.52	34.33	51.49
Sto. Niño	249	4.41	32.30	45.23	67.84
Total	5,650		733.00	1,026.20	1,539.30

Net wood volume = bdft/424bdft/cu.m
*Gross wood volume = Net wood volume*40% = Net wood volume*
*Biomass volume = Gross wood volume*50% + *Gross wood volume (to account for tops and branches, buttress and roots)*

Source: MENRO plan for housing lumber requirement at 261 cubic meter

Table 3.72. Lumber requirements of households by *barangay*, 2013

Barangay	Household population	% Population	New wood volume (cu.m.)	Gross wood volume (cu.m.)	Biomass volume (cu.m.)
Alimanguan	878	15.54	39.00	54.61	81.91
Binga	334	5.91	14.84	20.77	31.16
Caruray	789	13.96	35.05	49.07	73.61
Kemdeng	192	3.40	8.53	11.94	17.91
New Agutaya	689	12.19	30.61	42.85	64.28
New Canipo	280	4.96	12.44	17.41	26.12
Poblacion	993	17.58	44.11	61.76	92.64
Port Barton	1,057	18.71	46.96	65.74	98.61
San Isidro	189	3.35	8.40	11.75	17.63
Sto. Niño	249	4.41	11.06	15.49	23.23
Total	5,650		251.00	351.40	527.10

Net wood volume = *bdft/424bdft/cu.m*
Gross wood volume = *Net wood volume*40% = Net wood volume*
Biomass volume = *Gross wood volume*50% + *Gross wood volume (to account for tops and branches, buttress and roots)*

Source: MENRO plan for housing lumber requirement at 435 cubic meter

Table 3.73. Lumber requirements of private construction of housing units

Barangay	Household population	% Population	New wood volume (cu.m.)	Gross wood volume (cu.m.)	Biomass volume (cu.m.)
Alimanguan	878	15.54	97.59	136.63	204.94
Binga	334	5.91	37.12	51.97	77.96
Caruray	789	13.96	87.70	122.78	184.17
Kemdeng	192	3.40	21.34	29.88	44.82
New Agutaya	689	12.19	76.58	107.22	160.82
New Canipo	280	4.96	31.12	43.57	65.36
Poblacion	993	17.58	110.37	154.52	231.78
Port Barton	1,057	18.71	117.49	164.48	246.72
San Isidro	189	3.35	21.01	29.41	44.12
Sto. Niño	249	4.41	27.68	38.75	58.12
Total	5,650		628.00	879.20	1,318.80

Net wood volume = *bdft/424bdft/cu.m*
Gross wood volume = *Net wood volume*40% = Net wood volume*
Biomass volume = *Gross wood volume*50% + *Gross wood volume (to account for tops and branches, buttress and roots)*

Source: MENRO plan for housing lumber requirement at 435 cubic meter

Table 3.74. Lumber requirements of public construction

Barangay	Household population	% Population	New wood volume (cu.m.)	Gross wood volume (cu.m.)	Biomass volume (cu.m.)
Alimanguan	878	15.54	65.11	91.16	136.76
Binga	334	5.91	24.77	34.68	52.02
Caruray	789	13.96	58.51	81.92	122.87
Kemdeng	192	3.40	14.24	19.93	29.90
New Agutaya	689	12.19	51.10	71.53	107.30
New Canipo	280	4.96	20.76	29.07	43.61
Poblacion	993	17.58	73.64	103.10	154.64
Port Barton	1,057	18.71	78.39	109.74	164.61
San Isidro	189	3.35	14.02	19.62	29.43
Sto. Niño	249	4.41	18.47	25.85	38.78
Total	5,650		419.00	586.60	879.90

Net wood volume = *bdft/424bdft/cu.m*
Gross wood volume = *Net wood volume*40% = Net wood volume*
Biomass volume = *Gross wood volume*50% + *Gross wood volume (to account for tops and branches, buttress and roots)*

Source: MENRO plan for housing lumber requirement at 435 cubic meter

Table 3.75. Lumber requirements of private construction

Barangay	Household population	% Population	New wood volume (cu.m.)	Gross wood volume (cu.m.)	Biomass volume (cu.m.)
Alimanguan	878	15.54	9.76	13.67	20.50
Binga	334	5.91	3.71	5.20	7.80
Caruray	789	13.96	8.77	12.28	18.43
Kemdeng	192	3.40	2.14	2.99	4.48
New Agutaya	689	12.19	7.66	10.73	16.09
New Canipo	280	4.96	3.11	4.36	6.54
Poblacion	993	17.58	11.04	15.46	23.19
Port Barton	1,057	18.71	11.75	16.46	24.68
San Isidro	189	3.35	2.10	2.94	4.41
Sto. Niño	249	4.41	2.77	3.88	5.81
Total	5,650		62.83	87.96	131.94

Net wood volume = bdft/424bdft/cu.m
*Gross wood volume = Net wood volume*40% = Net wood volume*
*Biomass volume = Gross wood volume*50% + *Gross wood volume (to account for tops and branches, buttress and roots)*

Source: MENRO plan for housing lumber requirement at 435 cubic meter

Table 3.76. Lumber requirements of industries, restaurants, and bakeries

Local businesses also tap forest products as source of fuelwood and charcoal. The LGU has included in its plan the production of fuelwood to sustain the operations of the food business sector in the municipality. Combining the requirement for both fuelwood and charcoal, the biomass volume is at 3,039.58 cu.m., which is expected to release carbon amounting to 40% to 50% of the total biomass volume.

Barangay	Household population	% Population	New wood volume (cu.m.)	Gross wood volume (cu.m.)	Biomass volume (cu.m.)
Alimanguan	878	15.54	146.45	205.02	307.54
Binga	334	5.91	55.71	77.99	116.99
Caruray	789	13.96	131.60	184.24	276.36
Kemdeng	192	3.40	32.02	44.83	67.25
New Agutaya	689	12.19	114.92	160.89	241.34
New Canipo	280	4.96	46.70	65.38	98.08
Poblacion	993	17.58	165.63	231.88	347.82
Port Barton	1,057	18.71	176.30	246.82	370.23
San Isidro	189	3.35	31.52	44.13	66.20
Sto. Niño	249	4.41	41.53	58.14	87.22
Total	5,650		942.39	1,319.35	1,979.02

Net wood volume = bdft/424bdft/cu.m
*Gross wood volume = Net wood volume*40% + Net wood volume*
*Biomass volume = Gross wood volume*50% + Gross wood volume (to account for tops and branches, buttress and roots)*

Source: MENRO Plan (2009-2013), San Vicente Palawan

Table 3.77. Fuelwood requirements of restaurants and bakeries

Barangay	Household population	% Population	New wood volume (cu.m.)	Gross wood volume (cu.m.)	Biomass volume (cu.m.)
Alimanguan	878	15.54	73.25	109.87	164.81
Binga	334	5.91	27.86	41.80	62.70
Caruray	789	13.96	65.82	98.74	148.10
Kemdeng	192	3.40	16.02	24.03	36.04
New Agutaya	689	12.19	57.48	86.22	129.33
New Canipo	280	4.96	23.36	35.04	52.56
Poblacion	993	17.58	82.84	124.26	186.40
Port Barton	1,057	18.71	88.18	132.27	198.41
San Isidro	189	3.35	15.77	23.65	35.48
Sto. Niño	249	4.41	20.77	31.16	46.74
Total	5,650		471.38	707.04	1,060.56

Table 3.78. Charcoal requirements of restaurants and bakeries

Economic accounts

a. Resource valuation

The forest stocks that were valued in this study are the forest trees that were used for boat production, house construction, fuelwood and charcoal. In determining the value, the stumpage value was computed wherein the value of the tree is equal to the difference of the actual market value of the products and the costs incurred in producing the product.

For boat production, the tree with a diameter of more than 70 cm and a height of 7 m is the common timber size used. With margin for profit and risk at 12%, the stumpage value is PhP426.97 per cu.m. The same process was used in considering the stumpage value for lumber in house construction, taking into account the basic dimensions of a typical rural house (6 m x 6 m). The stumpage value of trees for this is PhP774.34 per cu.m of wood volume used.[17]

The value of fuelwood varies, depending on the harvesting area of the forest products. For areas within 250 m from the community, the stumpage value is PhP53 per cu.m. while beyond 250 m, it will be PhP12.84 per cu.m. since the cost of production have increased due to its distance from the market for fuelwood.

Particulars					
Collection distance (m and km)	250 m	500 m	1 km	1.5 km	Average
Cutting, sectioning, bundling (# bundles)	60	50	40	30	45
Hauling (# of bundles)	60	50	40	30	45
Production in bundles (# of bundles)	60	50	40	30	45
Number of days					
Cutting, sectioning and bundling	1	1.5	2.5	3.5	2
Hauling	0.5	1	1.5	2	1
Labor cost (PhP250/day)					
Cutting, sectioning, and bundling	250	375	625	875	531
Hauling	125	250	375	500	313
Equivalent volume per bundle (cu.m.)	8.48	7.06	5.65	4.24	6
Production cost					
Labor	375	625	1000	1375	844
Bolo	20	20	20	20	20
Carabao and sledge rental	300	400	500	1000	550
Profit margin (10% of gross value)	**127.23**	**106.02**	**84.82**	**63.61**	**95**
Total	822.23	1,151.02	1,604.82	2,458.61	1509
Selling price of fuelwood (P150/ cu m)	**1272.34**	**1060.29**	**848.23**	**636.17**	**954**
Stumpage value all bundles	450.11	-90.73	-756.59	-1822.44	-555
Stumpage value per cubic meter	**53.06**	**-12.83**	**-133.79**	**-429.70**	**-131**

Table 3.79. Stumpage value of fuelwood

17 The house of this dimension requires 10.15 cu.m of lumber of 16.75 cu.m of wood biomass.

When forest product is used as charcoal, the estimated stumpage value is PhP59.9 per cu.m of wood when it applies to the gathering of fallen branches without cutting the trees. The calculation of the stumpage value for charcoal is shown in **Table 3.80**.

	Quantity (Cu m)	Days	Wages (Pesos)	Cost of materials	# of Sack	Total Cost	Revenue
Open stuck/ surface preparation		2	250			500	
Cutting, gathering, bundling	20	7	250			1,750	
Charcoaling	20	4	250			1,000	
Packing (# of sacks)	250	5	250			1,250	
Hauling (labor and animal rental)	250	5	400			2,000	
Cost of sack				25		6,250	
Cost of bolo (5 years depreciation)				2.08		2.08	
# of sack of charcoal					250		
Supervision and management cost		23	350			8,050	
12% Margin for profit						3,000	
Price of 1 sack of charcoal					100		
Revenue							25,000.00
Stumpage value of wood for charcoal, all sacks							**1,197.92**
Stumpage value per cubic meter of wood							59.89

Note: Basis of computation : 1 cu.m. = 500 kg
10,000 kg
5,000 kg of charcoal
20 kgs per sack
250 sacks

Table 3.80. Stumpage value of wood for charcoal

Comparing the stumpage values of the forest products show that lumber posted the highest value followed by boat production, fuelwood and charcoal. It has to be noted that products with higher value entailing lower cost of production (cost is spread across larger volume of wood) have higher stumpage value than forest products with a lower price.

Forest product	Stumpage value of wood used for certain forest product (PhP/product)	Stumpage value of wood based on unit volume (PhP/cu.m.)
Boat	7,600.00	426.97
Lumber	7,861.54	774.34
Fuelwood	450.00	53.06
Charcoal, all sacks	302.92	59.90

Table 3.81. Comparison of stumpage value of different forest products

The value of some existing environmental services of the forest was also estimated to provide a bigger picture of the contribution of the sector to the overall value of the forest ecosystem in San Vicente. Among the indigenous practices that the Tagbanuas undertake in the municipality is the honey collection. It is a growing livelihood among the Indigenous Peoples (IPs) in the area that can provide alternative source of income to the IPs. With pick up price of PhP450 per gallon, the total earning is estimated to be PhP45,000 for every 100 gallon of honey produced per year.

Rattan, on the other hand, is present in the old growth and second growth forests with a total volume of 105,207.44 linear m. The highest stock can be found in New Agutaya at 42.19% of the total volume and the lowest in Poblacion at less than 1%. Rattan fetched a per unit price of PhP6 for an 8-12 meter piece. The total volume converted to pieces equals 13,150.93 or amounts to PhP78,905.58.

b. Wood volume and stumpage accounts

The diameter classes included in the estimation of the economic accounts of the forestry sector are trees >50 cm diameter and <50 cm diameter given the difference in the concentration of the trees in the two diameter classes in the two types of forest in San Vicente. As espoused in the physical assessment, the residual forest has 78% of trees of <50 cm diameter implying that the forest was logged before and that it is a relative young forest. Young forests are more fragile and sensitive to changes in climate and are easily affected by rain-induced landslides. The forest product included in the study is limited to trees under its different uses, including as lumber for boat production, construction; as household fuelwood and charcoal, and for shifting cultivation (*kaingin*). Assumptions considered in the accounting study are:

- Landslide will damage trees on areas 30% and above slope, which will be reflected in the worst-case scenario.
- Extraction damages are considered and estimated at 30% reflecting 15% for the felling of trees and the conveyance and another 15% for the wildlings that may be eroded during the rainy season.
- Opening stock is further classified into trees with diameter at breast height (dbh) of < 50 cm and >50 cm given that there are two types of forests in San Vicente. The bigger trees are valued as sawn timber while young trees as pulpwood, which have stumpage values of PhP1,320 per cu.m and PhP660 per cu.m., respectively.
- Reduction comes in the form of utilizing the trees for boat production, construction, shifting cultivation, fuelwood, and charcoal-making, as well the LGU's plan on the production of forest products and the expected impacts of climate change.

Table 3.82 shows both the volume and the stumpage value account under the BAU scenario. The opening stock of the forest is 25.56 million cu.m or PhP 20.61 billion. It increased to 26.23

Particular	Year 1 (cu.m.)	Stumpage value (cu.m.)	Total stumpage value (PhP)
Opening stock	**25,560,168.67**		**20,619,529,550.40**
Less than 50 cm dia.	19,878,625.90	660	13,119,893,094.00
More than 50 cm dia.	5,681,542.77	1,320	7,499,636,456.40
Addition or In-growth	766,805.06		618,585,884.40
Less than 50 cm dia.	596,358.78	660	393,596,794.80
More than 50 cm dia.	170,446.28	1,320	224,989,089.60
Reduction	88,936.56		6,912,774.86
Less than 50 cm dia.	85,478.61		5,079,862.85
• Extraction damages of boat production	729.53	660	481,489.80
• *Kaingin*-making	11,320.16	59.9	678,077.58
• Fuelwood for households	69,947.00	53.06	3,711,728.46
• Charcoal for households	3,481.92	59.9	208,567.01
More than 50 cm dia.	3,457.95		1,832,912.01
• Boat production	2,431.75	426.97	1,038,284.30
• Household lumber	1,026.20	774.34	794,627.71
Addition-Reduction	677,868.50		557,605,507.80
Less than 50 cm dia.	510,880.17	660	337,180,912.20
More than 50 cm dia.	166,988.33	1320	220,424,595.60
Closing stock	**26,238,037.17**		**21,177,135,058.20**
Less than 50 cm dia.	20,389,506.07	660	13,457,074,006.20
More than 50 cm dia.	5,848,531.10	1,320	7,720,061,052.00

Table 3.82. Wood volume and stumpage value account under BAU scenario

million cu.m. even with forest losses under the BAU scenario. There is an accretion in wood volume and appreciation in value due to in-growth or additions to the current stock. If the LGU decides to create forest products, the result is a closing stock totaling to 26.23 million cu.m. valued at PhP 21.36 billion. This does not mean, however, that the LGU encourages the additional utilization of forest products, but instead, the accounting exercise explores how this would affect the volume stock of the forest for them to make a sound decision.

Account title	Year 1 (cu.m.)	Stumpage value (cu.m.)	Total stumpage value (PhP)
Opening stock (Total)	**25,561,446.74**		**20,750,782,463.40**
Less than 50 cm diameter trees	19,682,313.99	660	12,990,327,233.40
More than 50 cm diameter trees	5,879,132.75	1,320.00	7,760,455,230.00
Addition/In-growth (Total)	766,843.40		622,523,470.80
Less than 50 cm diameter trees.	590,469.42	660	389,709,817.20
More than 50 cm diameter trees.	176,373.98	1,320.00	232,813,653.60
Reduction (Total)	96,500.30		10,050,760.93
Less than 50 cm diameter trees	89,678.34		6,119,791.61
• Charcoal for restaurants, bakeries	707.4	59.9	42,373.26
• Fuelwood for industries, restaurants, bakeries	1,319.35	53.06	70,011.14
• Fuelwood for households	69,947.00	53.06	3,711,728.46
• Charcoal for households	3,481.92	59.9	208,567.01
• Extraction damages (LGU MENRO Plan)	1,735.27	660	1,145,278.20
• Extraction damages of boat production	1,167.24	660	770,387.40
• *Kaingin*-making	11,320.16	59.9	171,455.14
More than 50 cm diameter trees	6,821.96	774.34	3,930,969.32
• Boat production	3,890.80	426.97	1,661,254.88
• Households lumber	1,026.00	774.34	794,472.84
• Lumber housing projects: private sector	351.4	774.34	272,103.08
• Lumber for public construction	879.2	774.34	680,799.73
• Lumber for private construction	586.6	774.34	454,227.84
• Lumber for industries, restaurants, bakeries	87.96	774.34	68,110.95
Addition-Reduction	670,343.10		612,472,709.87
Less than 50 cm diameter trees.	500,791.08	660	383,590,025.59
More than 50 cm diameter trees.	169,552.02	1,320.00	228,882,684.28
Closing stock (Total)	**26,231,789.84**		**21,363,255,173.27**

Table 3.83. Volume and economic rent account of the residual rainforest

The volume and stumpage value account was also developed under a worst-case climate change scenario in consideration that San Vicente lies in the path of tropical cyclones. The results of the hazard assessment also showed that all *barangays* have spatial exposure to rain-induced landslide (RIL), with all the *barangays* having more than 90% of their total area exposed to such hazard. With these assessments, the worst-case scenario is the additional of RIL affecting 4,992.05 ha that are located in areas with 30% and above slopes. While this might not happen in the near future, its probability is simulated to estimate the loss in volume of trees and its corresponding monetary value. Results show that from the opening stock of 25.56 million cu.m. (PhP20.75 billion total stumpage value), it will be reduced to 20.08 million cu.m. with a value of PhP19.62 billion. The impact of climate change is a loss of 2.14 million cu.m. with a value of PhP1.74 billion. The decrease in volume in one year span results to reduction totaling 1.47 million cu.m. or a loss of PhP1.12 billion. Other sources of reduction for trees <50 cm are charcoal, fuelwood, extraction damages from the LGU plan and boat production and *kaingin*. The sources for trees with >50 cm, however, are lumbering for boat production, housing, construction and other industries.

Account title		Total volume (cu.m.)	Stumpage value (cu.m.)	Total stumpage value (PhP)
Opening stock		**25,561,446.74**		**20,750,782,463.40**
Less than 50 cm dia.		19,682,313.99	660	12,990,327,233.27
More than 50 cm dia.		5,879,132.75	1,320.00	7,760,455,230.26
Addition		766,843.40	1,980.00	622,523,472.12
Less than 50 cm dia.		590,469.42	660	389,709,815.88
More than 50 cm dia.		176,373.98	1,320.00	232,813,656.24
Reduction		2,242,587.59		1,752,750,980.95
Climate Change: Trees damage due to landslides		2,146,087.29	811.80	1,742,193,659.63
Less than 50 cm dia. (fuelwood, charcoal)		89,678.34		6,626,352.01
•	Charcoal for restaurants, bakeries	707.40	59.90	42,370.43
•	Fuelwood for industries, restaurants, bakeries	1,319.35	53.06	70,011.14
•	Fuelwood for households	69,947.00	53.06	3,711,728.46
•	Charcoal: households	3,481.92	59.90	208,553.08
•	Extraction damages (LGU MENRO Plan)	1,735.27	660.00	1,145,278.20
•	Extraction damages of boat production	1,167.24	660.00	770,378.40
•	*Kaingin*-making	11,320.16	59.90	687,032.30
More than 50 cm dia. (boat, lumber)		6,821.96		3,930,969.31
•	Boat production	3,890.80	426.97	1,661,254.88
•	Households lumber	1,026.00	774.34	794,472.84
•	Lumber housing projects: private sector	351.40	774.34	272,103.08
•	Lumber for public construction	879.20	774.34	680,799.73
•	Lumber for private construction	586.60	774.34	454,227.84
•	Lumber for industries, restaurants, bakeries	87.96	774.34	68,110.95
Addition-Reduction		(1,475,744.19)		(1,130,227,508.83)
Closing stock		24,085,702.55		19,620,554,954.70

Table 3.84. Volume and economic rent of the residual rainforest under worst-case scenario

The additions in old growth forest are minimal since all trees die and are replaced by new ones. This means that there is no added stumpage per unit area. With this condition, the average wood volume per hectare is 986.38 cu.m. The results of the volume and economic accounts are shown in **Table 3.85**.

Year	Area	Volume (cu.m./ha)	Total volume (cu.m.)	<50 cm dia. (cu.m.)	>50 cm dia. (cu.m.)	Option value (Nominal value, PhP million)		
						<50 cm diameter	>50 cm diameter	Total
				39.81	60.18	660	1,320	
1	7,144	986.38	7,046,699	2,805,291	4,240,703	1,851.49	5,597.72	7,449.22

Table 3.85. Old growth forest wood volume and economic account

Aside from the natural forest in San Vicente, forest plantation is another source of raw materials for wood to meet demand. There are 893 ha of mangium and falcataria plantations before the logging operations. This is estimated to have 300 cu.m. and growing at 10 cu.m. and will eventually diminish by 0.4. cu.m. when it reaches its peak. The stumpage value is PhP2,740 with the following reduction items: cutting of plantation trees, hauling, sawmilling, management contractor's fee and margin for profit and risk. Forest plantation showed a 9% increase of wood volume brought about by in-growth or additions. Wood harvest is valued at PhP8.38 million with only 3,060 cu.m. of wood volume.

Mangrove is also another source of forest product. Charcoal has an estimated demand of 711.36 billion cu.m. per year from the 836 ha in the existing mangrove forest in Port Barton and Caruray. It is estimated to grow at 1.77% yearly translating to a growth of PhP2.82 million. Mangroves are not only good for harvesting but also act as natural defense against storm surges, strong wind, and tsunami. It also provides habitat and breeding grounds for fishes and marine species.

Under BAU scenario, the consolidated forest accounts show that there is accretion of the wood volume at 2.9% and consequently, an appreciation amounting to PhP21.93 billion. The increase can be attributed to the in-growth of the forests while the reduction is estimated at 12% of the total wood volume plus 2% in the value of addition. Both are positive that resulted to the improvement of wood volume and value of closing stock.

Under the climate change scenario, the opening stock is posted at 32.9 million cu.m. of wood volume or PhP21.44 billion of stumpage value. With the effect of rain-induced landslide, specifically affecting the 4,229 ha of steep slope areas, the forest will be depleted, in terms of volume by 4.42% and depreciated by 4.98% in total stumpage value. The wood volume reduction due to rain-induced landslide is greater than its addition. Zooming in to the specific type of forests, the rate of depletion of the forest stocks for the residual forest is estimated at 5.77% or 1.47 million cu.m., while forest plantations and mangroves both posted positive increments in terms of wood volume and stumpage value (8.79% and 0.26%, respectively).

	Wood volume (cu.m.)	Total stumpage value (PhP)	Accretion	% Accretion	Appreciation	% Appreciation
Opening stock	**32,905,995.17**	**21,315,269,854.00**				
• Residual rainforest	25,560,168.67	20,619,529,550.40				
• Old growth rainforest	7,046,699.00	4,240,703.00				
• Forest plantation	252,119.50	690,807,430.00				
• Mangrove forest	47,008.00	712,171.20				
Addition	792,849.01	687,679,232.20				
• Residual rainforest	766,805.06	618,585,884.40				
• Old growth rainforest	-	-				
• Forest plantation	25,211.95	69,080,743.00				
• Mangrove forest	832.00	12,604.80				
Reduction	91,117.20	14,636,550.27				
• Residual rainforest	88,936.56	6,250,322.57				
• Old growth rainforest	-	-				
• Forest plantation	3,060.00	8,384,400.00				
• Mangrove forest	120.64	1,827.70				
Addition-Reduction	700,141.09	618,303,687.50				
• Residual rainforest	677,868.50	557,605,507.80				
• Old growth rainforest	-	-				
• Forest plantation	22,151.95	60,696,343.00				
• Mangrove forest	120.64	1,827.70				
Closing stock	**33,606,136.26**	**21,933,593,533.10**	**700,141.09**	**2.13**	**618,303,678.50**	**2.90**
• Residual rainforest	26,238,037.17	21,177,135,058.20	677,868.50	2.65	557,605,507.80	2.70
• Old growth rainforest	7,046,699.00	4,240,703.00	-	-		
• Forest plantation	274,271.45	751,503,773.00	22,151.95	8.79	60,696,343.00	8.79
• Mangrove forest	47,128.64	713,998.90	120.64	0.26	1,827.70	0.26

Table 3.86. Consolidated forest account under BAU scenario

	Wood volume (cu.m.)	Total stumpage value (PhP)	Depletion	% Depletion	Depreciation	% Depreciation
Opening stock	32,907,273.24	21,446,542,767.73				
• Residual rainforest	25,561,446.74	20,750,782,463.53				
• Old growth rainforest	7,046,699.00	4,240,703.00				
• Forest plantation	252,119.50	690,807,430.00				
• Mangrove forest	47,008.00	712,171.20				
Addition	792,887.35	691,616,819.92				
• Residual rainforest	766,843.40	622,523,472.12				
• Old growth rainforest	-	-				
• Forest plantation	25,211.95	69,080,743.00				
• Mangrove forest	832.00	12,604.80				
Reduction	2,245,768.23	1,760,443,159.42				
• Residual rainforest	2,242,587.59	1,752,056,931.72				
• Old growth rainforest	-	-				
• Forest plantation	3,060.00	8,384,400.00				
• Mangrove forest	120.64	1,827.70				
Addition-Reduction	(1,453,471.60)	(1,068,835,288.90)				
• Residual rainforest	(1,475,744.19)	(1,129,533,459.60)				
• Old growth rainforest	-	-				
• Forest plantation	22,151.95	60,696,343.00				
• Mangrove forest	120.64	1,827.70				
Closing stock	31,453,801.64	20,377,707,478.83	(1,453,471.60)	(4.42)	(1,068,835,288.90)	(4.98)
• Residual rainforest	24,085,702.55	19,621,249,003.93	(1,475,744.19)	(5.77)	(1,129,533,459.60)	(5.44)
• Old growth rainforest	7,046,699.00	4,240,703.00	-	-		
• Forest plantation	274,271.45	751,503,773.00	22,151.95	8.79	60,696,343.00	8.79
• Mangrove forest	47,128.64	713,998.90	120.64	0.26	1,827.70	0.26

Table 3.87. Consolidated forest account : Worst-case scenario

The three scenarios (BAU, BAU + LGU plan, BAU + RIL + LGU Plan) explored in the accounting study exhibited that there are certain levels of forest losses in terms of volume. Forest losses for BAU and BAU + LGU plan being within the confines of in-growth or addition component, imply that the losses incurred are not economically beneficial because the local government is not earning revenue from the illegal activities. The worst-case scenario (BAU + RIL + LGU Plan), that may occur in steep slopes will have negative effects on the existing forest stock of San Vicente.

Conclusion

- **San Vicente has a relatively young forests, composed mainly of hardwood species. Its young tree composition means it is both fragile and still considered unstable**. With present threats to the forest such as lumbering, shifting cultivation, fuelwood gathering, and charcoal-making coupled with utilization plan of the LGU as well as rain-induced landslide, the forest stocks and value are expected to decrease if interventions are not introduced.

- **The total stumpage value of the forests amounted to PhP21.93 billion at BAU and PhP20.37 billion under the worst-case scenario.** This might show a rosy picture, especially under the BAU scenario since the leakage is attributed to net growth or additions. However, the rate of reduction is much faster than the addition that it will eventually catch up and can surpass the growth of forest stocks. This can be attributed to the dependence of households to wood-based energy (e.g., fuelwood and charcoal-making) and the physical development of the municipality (e.g., construction of infrastructure).
- **For the worst-case scenario, the extreme rainfall event that will result to rain-induced landslide will affect the forest areas that are located in steep slopes.** The estimated volume of trees that will be affected is 2.146 million cu.m. with a value of PhP1.742 billion.
- **There are other forest products that can be derived in San Vicente such as non-timber products that include rattan, honey as well as ecosystem services that include water recharge and ecotourism. However, these have not been factored in the total value of the forests.**

Based on the results of the three scenarios in this accounting study, it is recommended to:

1. **Expand the existing forest plantation and manage it on a sustainable basis.** From the existing 839 ha, it can tap brushland areas and grasslands that can eventually produce the wood requirements of San Vicente.
2. **Establish and manage plantations for fuelwood and charcoal production that include idle lands or existing household backyards.** These can be the source of wood-based energy of households and small businesses in the municipality.
3. **Do enrichment planting of hardwoods in the forest gaps** in San Vicente for their high potential to store carbon.
4. **To anticipate rain-induced landslide, de-clog and clean waterways in steep slopes to prevent run-off** concentration and provide free flows of surface run-off in gullies and waterways
5. **Implement payment for ecosystem services (PES) options without harvesting trees and damaging the environment** such as charging watershed or environmental fee for business establishments that utilize water. The payment collected can be used to manage or sustain the current condition of the watershed to be able to provide adequate supply of water.

5. Integration

The basic premise of the natural resource assessment is that the physical stocks of natural resources and their corresponding monetary values will provide information to local planner and leaders on decisions related to sustainable natural resource management that will maintain or improve the productive assets in the area, given the current management and expected impacts of climate change.

Based on the results of natural resource accounting in the sectors of agriculture, fishery, and forestry, only a small portion of this information is visible in the local municipal income account, which makes it difficult for decision makers to create a long-term strategy in managing the portfolio of natural assets. Integration of the different sectoral accounts tackled in this study aim to provide a meaningful set of suggestions in resolving the question of "how and how much" the different natural assets must be exploited to promote growth in San Vicente. This study also tried to explore the various sources of funds that can be tapped to improve the natural resource base.

The physical assessments in agriculture, fishery and forestry sectors show that the fishery sector poses the biggest challenge– the fishing practices have clearly led to depletion of fish biomass and the deterioration of marine conditions required in maintaining a sustainable fish biomass. A report from Municipal Economic and Enterprise Office (MEEDO) states that the shipment of live fish pieces by one of the major traders in the local market declined by 44.5% in the year 2011 and 66.7% in the year 2012 compared to the year 2010. There is other evidence describing how the reduced fish stock is already impacting the income generated. Unlike the fisheries sector, the forestry and agriculture accounts suggest that the current economic activities are sustainable. Although relatively young forests make up a large portion of the forestry account, the total forestry asset is not expected to experience a substantial decrease from any potential threats (including climate change) with respect to the land use or forest stocks, due to continuous regulation of economic activities in the forest of San Vicente. While climate-related impacts may become risks to the productivity of agricultural activities in the municipality, agriculture is primarily conducted at a small-scale and does not involve unsustainable use of soil and water resources.

Considering the unsustainable use of its marine resources, it is comprehensible to see how the fisheries sector makes up the highest portion of the total economic rent calculated for the municipality. At the household level, a higher percentage of fisherfolks were able to save their income compared to farmers. Farmers in the municipality practice agriculture primarily for meeting household consumption, and a large majority of harvest fail to make it into the market. In contrast, the fisheries sector has a high external market demand that drives the total supply. Provided that agricultural practices continue to make sustainable use of natural asset, the LGU should support development directed towards increasing the agricultural output.

Looking into the economic rents of the three sectors, the overall economic value is estimated at PhP22.18 billion with forestry valuing more than the two other sectors combined. Between fishery and agriculture, fishing posted a higher economic rent at PhP132.2 million and farming with assorted crops at PhP110.42 million as brought about by the high value products of the fishery sector and the marketed crops of the agricultural produce, respectively. Forestry sector may have the highest economic rent, but this is not extensively linked to economic activities that generate household income since utilization of forest resources is either unreported or limited to household consumption.

In terms of the efficiency in use of the given natural asset, both the agriculture and fisheries sectors pose serious challenges that need addressing. To the agricultural sector, climate-related events and management deficiency were identified as major risks to productivity. In addition, a large majority of farmers are engaged in rice cultivation which has a low return. Lack of milling facilities has led a greater number of farmers to sell their products (i.e., *palay*), which is one of the reasons for the low market value of rice harvest. In the fisheries sector, various stressors and threats impinged on the marine resources of San Vicente have reduced the productivity of the fishing communities. While overfishing practices have already reduced their available fish stock, municipal fisherfolks are also losing their fish catch and income from the commercial fishers hauling the higher-valued fishes.

The forestry sector may significantly contribute to the income of households through the sustainable use of forest products as a form of ecosystem service to support agricultural and fishery activities. In addition, environmental services of the forest resource such as community-based watershed protection, biodiversity conservation and carbon storage should not be overlooked. Local development plans must determine a level and method of forest use which maximizes the present value of the forest, recognizing how forest has the potential to produce a wide range of services including agriculture and recreation. The unsustainable harvesting of trees for fuelwood, which accounts to 78% of the total reduction, has an implication to the quality of forest stocks, since this practice is most likely to continue with the large dependence of households on wood-based energy. This problem can be addressed by introducing community-based forest management, where local community actively participates in sustaining the forests through various activities such as livestock-raising, agroforestry, and the like.

Natural resource accounts and municipal income accounts created in the study clearly suggest that development plans in San Vicente must have a more sustainable portfolio of natural assets. Considering the fact that a large part of the current investment in the area is directed toward promoting tourism, increased local demand on selected agricultural crops and fisheries as well as the path towards ecotourism must be taken into account in the course of development planning.

Looking ahead, investments in sustaining or improving the current condition of the natural resource sectors in this study must also be considered in the planning process. As the review of the municipal income accounts show, the savings of the local government plus its subsidies can support expenditures for natural resource-based productive facilities or services that would enhance the productivity of the three sectors. Households dependent on natural resource-based economic activities can also be tapped in terms of apportioning its household savings, especially those from the fishery sector, to help improve the natural resource base.

Based from the results of the study, the following are the recommendations:

1. **Regulate natural resource-based economic activities, especially for the fishery sector**, to secure an adequate natural resource base. This includes imposing a close-open access to the coastal waters, charging of environmental fees, and increasing tax or royalties of product sales.
2. **Introduce alternative livelihood if "close-open seasons" is instituted in San Vicente.** This holds true especially for fisherfolks that will be displaced during the close season.
3. **Utilize the economic rent gained by commercial fishers**, such that savings will plow back towards restoration of corals and improvement of fish stock, etc.
4. **Increase the productivity of the agriculture sector** in response to the increasing population demand (within and outside San Vicente) and future impacts of climate change.
5. **Maximize the utility of open spaces in the forests**, especially the abandoned areas used such that these will be used as agricultural lands, subject to existing laws and regulations on forests in the province[18] and the welfare of the Indigenous Peoples (IPs). This can be done with the support of the local government in providing the proper mix of incentives such as improving access to new markets and enhancing local infrastructure.

18 The whole Province of Palawan is governed by *Republic Act No. 7611* or the *Strategic Environmental Plan of Palawan* which established the Environmentally Critical Areas Network (ECAN) that has a graded system of protection and development control in the province. (PCSD, 2004)

D. Sectoral vulnerability assessment: Bottom-up approach

1. Agricultural sector analysis

Agricultural profile of San Vicente

Being a farming community where more than a quarter of the working population is engaged in agriculture, San Vicente aspires to boost economic growth through a "well-developed agricultural production system," along with industries and tourism. However, the amount of economic rent and savings derived from farming revealed by the natural resource assessment shows that the performance of the agricultural sector leaves much to be desired to contribute substantially to the local income. The challenge of taking full advantage of agriculture as an engine of local growth becomes even more daunting as climate change impacts take its toll on crop productivity. This part of the report exposes the foremost vulnerabilities, as well as the adaptive capacities of the agricultural sector of San Vicente in relation to the adverse impacts of climate change. As with the succeeding sectors, the analysis will serve as the basis for formulating the menu of climate change adaptation measures.

As revealed earlier, San Vicente's principal crops are rice and coconut, while corn, cashew, cassava, vegetables, and bananas are also produced in small quantity. The main system of farming is the traditional scatter-planting or the so-called "*sabog-tanim*" system. Nutrient management system is chemical-based, with very few farmers using organic and mixed system (combination of organic and the balanced fertilization scheme). Some farmers are able to have two rice crops during the year, others have alternative crops such as corn and bananas, rice interspersed with vegetables, and root crops and sweet potatoes in the upland.

The total agricultural production area for rice is 2,013 ha. From 2006 to 2011, data on rice production on irrigated farm lands show that more than 1,500 ha was utilized for rice plantation under two cropping seasons, May to August and September to December, with a crop yield estimated at 3.4 to 3.9 MT/ha. For rain-fed farmlands, on the other hand, approximately 448 ha was planted with rice under two planting seasons as well, from June to October and October to December, with a crop yield of 3.3 to 3.8 MT/ha. There are 1,704 farmers dependent on rice production, assisted by 3,752 work animals.

General risks

Two consultations were completed in the municipality in relation to vulnerability assessment for agriculture: first in November 2012 and second in February 2013. The former had 16 farmers (with six women farmers) from *Barangays* Poblacion, New Agutaya, Canipo, and San Isidro and the staff of the Municipal Agriculture Office (MAO) and Municipal Environment and Natural Resources Office (MENRO) while the latter involved six more *barangays* (*Barangays* Alimanguan, Binga, Fort Barton, Sto Nino, Caruray and Kemdeng), represented by 22 farmers (with four women farmers).

Focus group discussions were done to gauge the local perception of the farmers and households on climate change in their municipality. Locals of San Vicente have observed the changes in the climate patterns that affect the local agricultural sector, verified by the experts based on historical records, on-site evidences, and anecdotal accounts. Results of the community-based consultation indicate coherence with the observed adverse impacts in response to the changes in the local climate.

Change in climate	Impacts on agricultural production	Impacts on incomes	Impacts on well-being /livelihood
Drought events/ El Niño	Retarded growth or sterility in rice spikelets, Less yields	Losses in production inputs, Insufficient food supply	Poverty trap, Forced to look for other jobs elsewhere
Intense heat (warmer temperatures)	More pest incidences, Declining quality of yield	Losses in production inputs, insufficient incomes/food supply	Increased incidences of illnesses, increased risk of malnutrition, low school participation
Intense cold events	Insect infestation leading to less yields	Insufficient incomes, inability to provide for family	More susceptible to illnesses, feud among family members due to inability to provide for basic needs
Intermittent rains	Increasing yields due to good weather during the different stages of the crop	Increasing incomes	Opportunities to save
Heavy rains/ La Niña events	Increased pest incidences, premature damage to crops before harvest time, declining yields	Insufficient incomes, inability to provide for family	Low school participation for children due to loss of incomes
Unexpected tropical cyclone occurrences (e.g., strong winds and heavy rains)	Damages to crops	Losses of production inputs (e.g., seeds, fertilizers, etc.), less incomes	Less food, forced migration in search for other jobs, increased risks to health

Table 3.88. Summary of perceived and validated impacts of changes in local climate in San Vicente

The observed erratic rain patterns, whether because of climate variability such as El Niño and La Niña events or changing rainfall amounts as a result of climate change, have resulted to adverse consequences. During periods of unexpected intense rainfall as well as La Niña events, crops end up being submerged in water for long periods of time, thus resulting to serious damages. The farm lands in Binga, New Canipo, and New Agutaya are particularly prone to flooding, especially Binga, where more than 40% of its total land area is deemed very susceptible since majority of the resident live in low lying areas.

Based on the farmers' observation, extreme events such as heavy rain during monsoon season (*Habagat*) resulted to crop damage. Based on the records of San Vicente, the total annual rainfall in 2012 and 2011 showed that there was a significant increase (13.39%) in rainfall over the year. While this may provide an ample supply of water for San Vicente's irrigated and rain-fed agriculture as well as for other uses, excessive rain will cause flooding in low-lying areas, crops and soil nutrient washout, and landslides in sloping areas. Furthermore, the risk of higher mortality for about 4,000 work animals due to extreme weather events is high.

In recent years, farmers experience the impacts of tropical cyclone occurrences during period of the year when these are not expected to cross the island of Palawan. There have been changes in severity of winds and heavy rains associated with the passage of tropical cyclones. **Figure 3.27** shows the tropical cyclone path passing through Palawan from 1948 to 2011. The frequency and the strength of tropical cyclones, including the volume of rainfall and wind speed accompanying them, poses great challenges to agricultural development in San Vicente.

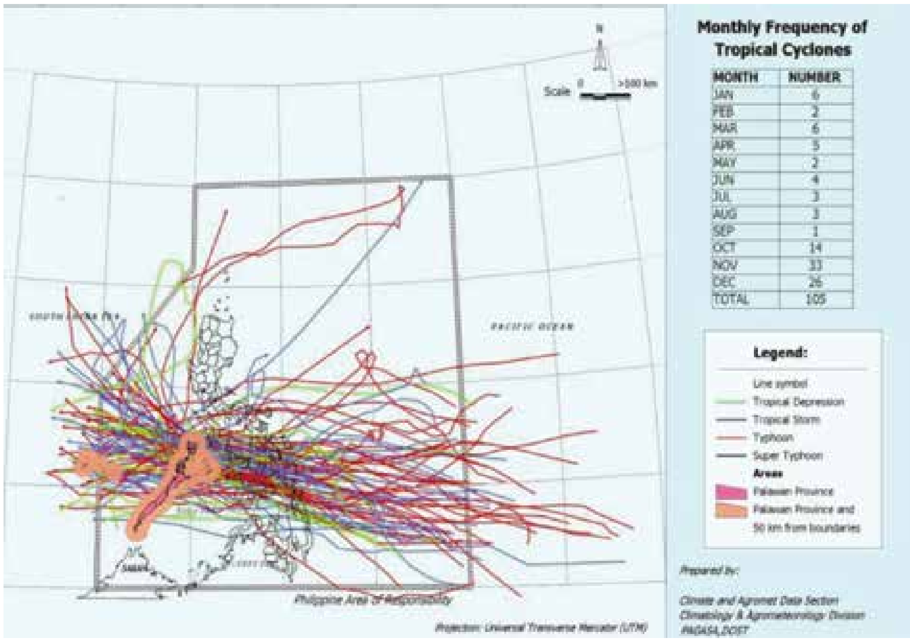


Figure 3.27. Track of tropical cyclones that crossed Palawan from 1948-2011 (50 km from boundaries)

On the contrary, when the rains received are less than what has been normally expected, farmers are unable to plant on time, and in cases when crops have already been sown, water shortage prevents the healthy growth of the crops. As shown in the hazard assessment, a total of 10,000 ha of rice lands and 1,395 ha of areas coconut farms are susceptible to drought, of which 3,964.6 ha rice farms and 1,115.7 ha of coconut are severely vulnerable, especially *Brgys.* Caruray and Kemdeng. Intense heat events have been observed to lead to wilting of crops, often times resulting to crop damages, given that there are no available intervention measures such as irrigation. Additionally, with rice, if the maximum temperatures become extremely warmer during the grain filling stage, crop harvest diminishes due to less grain filling. In coconuts, nuts are observed to be smaller after hot events or dry spells. Higher temperatures turn rice flowers sterile, leading to lesser grains produced thereby decreasing yield. Changes in minimum temperatures at night also affects rice yield– IRRI research indicates that a rise in nighttime temperature by 1°C may reduce rice yields by about 10%.

Both extreme cases, either severely wet or dry season, are prone to pest infestation. Weed infestation and rice-weed competition are predicted to increase and will represent a major challenge for sustainable rice production. Also, according to the IRRI, extreme weather events have recently led to dramatic rodent population outbreaks due to unseasonal and asynchronous cropping.

Insect and rat infestation is an offshoot of changes in the climatic conditions when such conditions favor the rapid multiplication of insect and rats that feed on agricultural crops. Not indicated in the outputs of the FGDs are the impacts of changes in climate on agricultural production in areas situated near the coasts that are already being manifested. These include cases when rice crops are damaged due to heavy rains coinciding with high tide occurrences that cause rice fields situated near the coasts to have less yield, etc.

Agriculture's sensitivity to the biophysical impacts of climate change

The sensitivity of the farming systems and communities to the adverse biophysical impacts resulting from changes in local climate attributes was also assessed. It is assumed at this stage that the non-climate stressors (e.g., lack of access to production inputs, infrastructure such as post-harvest services, etc.) do not have a substantial influence on crop production. It is highly important to assess sensitivity to the different changes in the climate attributes because these are local-specific and due partly to the different climate type regimes in the Philippines. For example, when El Niño develops, the whole country is differentially affected in terms of rainfall received as the dry periods in different regions of the country do not come at the same time. It should also be noted that in recent years as more analyses are being done, no two El Niño events impact on local climate similarly.

Crop production in San Vicente is most sensitive to:

Changing rainfall amounts and rainfall patterns

- Excessive rains and floods, La Niña (*Brgys.* Alimanguan, New Agutaya, Caruray, Binga)
- Too little rains and droughts, El Niño (*Brgys.* Caruray and Kemdeng)
- Losses in production inputs increase during flood events and also, when there is very little rainfall

Tropical cyclones (commonly called *bagyo* or typhoons)

- The strong winds coupled with heavy rainfall associated with tropical cyclone occurrences in Palawan are increasingly being seen to cause damage to crops
- Increasing temperatures

High temperatures, especially during critical development periods of the crops, are observed to adversely impact crop production

Overall, the impacts of climate change on farmers are losses in production inputs and decrease in harvest. This leads to less income thereby affecting their livelihoods and well-being (e.g., more people getting sick, malnutrition, conflict among household members, displacement or migration to places where other jobs are available, inability to send children to school, etc.). Generally, this will have far-reaching socio-economic implications such as food insecurity, malnutrition, and poverty especially on more than 200 farming households classified below the poverty threshold.

Adaptive capacity

The current adaptive capacity of the farming communities in the municipality was also assessed. The analysis was based on: (1) the state of resources in the municipality; (2) support being provided by the LGU to the farming communities; (3) local development plans by the LGUs; and (4) societal values (core beliefs and values) of the farming communities. These four factors determine the adaptive capacity level of the municipality and are considered to be equally significant in contributing to how the farming communities can cope with the adverse impacts of climate change.

Assessment of future vulnerability

The future vulnerability of San Vicente's agricultural sector was assessed in terms of their

Category	Positive/Negative characteristics
State of resources	• 45.8% of households are below poverty levels; more than 50% of the households spend beyond their earnings; agricultural production not keeping up with agricultural needs (growing population); insufficient infrastructure (e.g., farm-to-market roads, irrigation systems, market facilities, etc.); limited capital for production inputs • Inherent sustainability of soil for rice productivity in some *barangays*; rice yields>3 mt/ha in rain-fed and irrigated areas with two crops.; home solar systems in some *barangays*; and abundant water source
Support by LGUs	• Technology upgrades; pest control (use of chemical-based resources), demos, provision of inputs, farm mechanization, celebration of Farmers' Day, technical assistance and trainings on vegetable, animal and seaweed production, farm facilities
Local development plans	• Possible market linkages of different crops; research on crop production as varietal and soil amelioration; farm mechanization assistance; construction of flatbed dryer, drying pavement, farm-to-market roads, mini-irrigation; facilitate fishery related production
Societal values	• Farmers are grouped into associations (e.g., water users' groups and farmers' cooperatives), and most associations try to be self-sufficient in terms of production inputs and shared resources

Table 3.89. San Vicente's adaptive capacity to climate change

projected frequency or probability of occurrence in 2020 and 2050 (the planning horizons). It is highly important to understand that uncertainties are inherent in climate projections since the uncertainties in the emissions scenarios used in as much as predicting emissions is largely dependent on how we predict changes in population, economic growth, technologies used (whether low-carbon or not), energy availability, and national and international policies all over the globe. Additionally, the very complex feedback processes in the climate system that are represented in the model runs for the downscaled climate scenarios could not be adequately modeled, hence, the added uncertainties.

The climate scenarios give the projected changes in temperature and rainfall in San Vicente while for the extreme events (defined as number of dry days, number of days with maximum temperature >35°C, number of days with rainfall >300 mm) those for Puerto Princesa, the nearest weather station with long-term climate records was used. But given the uncertainties inherent in the projections, it is recommended that the frequency of the identified hazards from the risk scenario be assessed in terms of the defined indicators as shown in **Table 3.90**.

Hazard	Very unlikely to happen	Occasional occurrence	Moderately frequent	Occurs often	Virtually certain to happen
Hazards from risk scenarios	Not likely to occur during planning period	May occur sometime, but not often during the planning period	Likely to occur at least once during the planning period	Likely to occur several times during the planning period	Happens often and will happen again and again during the planning period
Intense heat/heat waves (days with T> 35°C)				X	Y
Intense rainfall(daily rainfall>300mm)			X	Y	
Floods					X Y
Droughts					X Y
Stronger/more frequent tropical cyclones			X	Y	
Sea-level rise					X Y
Increasing sea surface temperatures				X Y	
Bigger waves				X Y	

Table 3.90. Frequency or probability of hazards for 2020 (X) and 2050 (Y)

Attributes	Potential impacts	Vulnerability
Climate projections		
	2020	
Increase in temperature 0.9°C (Sept.-Feb.) to 1.1°C (Mar.-May)	Grain formation (in rice) affected, more pest infestation	Generally higher especially if climate-smart development plans are not pursued
	2050	
Increase in temperature 1.8°C (Sept.-Feb.) to 2.1°C (Mar.-May)	Grain formation inhibited leading to less harvest, more pest infestation	Generally, higher vulnerability in most areas, in particular, if very little/inadequate technological interventions are in place, farming systems are not changed to support sustainable production, infrastructure are not adequate
	2020	
Change in rainfall -7.2% in April to May to +19.6% in Sept. to Nov.	More flooding incidences; Increased water logging	Generally, higher vulnerability if there is no effective intervention (e.g., sustainable farming systems, market mechanisms, etc.);
	2050	
Change in rainfall -9.0% (Mar.-May) to +7.3% (Dec.-Feb.)	More flooding events and possibly, more severe; Less rainfall may lead to change in cropping patterns, may lead to wilting of crops, instances of being unable to plant due to less water availability	Vulnerability is lower if the development plans, policies and programs are climate-smart.
	2020 and 2050	
Extreme events • Tropical cyclones (intensity and frequency) • Floods (intensity and frequency) • Droughts (intensity and frequency)	More damages to crops Increased soil erosion, reduced fertility levels, reduced yields Reduced agricultural productivity if irrigation services are not in place and if water availability is diminished during the relatively drier periods	Vulnerability is higher is there is little support from government (infrastructure, such as irrigation/drainage canals, etc.) Non-resilient alternative or diversified livelihoods
	2020 and 2050	
Sea-level rise	Salt intrusion in coastal agricultural areas, loss of arable lands	Vulnerability is higher if seawalls are not properly built in coastal communities and if agricultural lands are proximate to coastal waters.
Socioeconomic projections		
	2020 and 2050	
Land use change	Unabated reduction in prime agricultural areas may lead to less productivity	Vulnerability is largely dependent on the resilience of communities and of the sector: high vulnerability if technological and infrastructural interventions are not in place
Population growth	Uneven distribution of supply and demand for food	
Change in income (wealth)	Less access to food, migration	
Development plans	Could mitigate impacts if development plans are pursued; Increased resilience if development plans are climate-smart	Low to medium vulnerability if climate-smart development plans to enhance resiliency in communities and sector are relentlessly pursued
Livelihood diversification	Could mitigate social impacts if livelihoods are diversified	

Table 3.91. Pre-determined climate vulnerabilities of San Vicente for 2020 and 2050

Table 3.91 presents the pre-determined vulnerabilities (largely dependent on whether the local development plans, including how adaptation measures being planned now are pursued and implemented and also on how effective these have been in addressing the vulnerabilities) in San Vicente in 2020 and 2050.

The previous discussion on the vulnerability of the agricultural sector is summarized in an impact chain, **Figure 3.28**. The figure outlines climate hazards based on the downscaled climate projections of PAGASA and its biophysical and socioeconomic impacts on agriculture, particularly rice and coconut. Crop production is affected biophysically by changing meteorological or climate variables, including increasing temperatures (in

Figure 3.28. Climate change impact chain for agricultural sector

Climate hazard (Region 4B)

- Increase in mean annual temperature (0.8 C° for 2020; 1.8 C° for 2050)
- Shorter but drier dry season (approx. 25% decrease in rainfall)
- Longer and wetter wet season (approx. 60-115% increase in rainfall)

Exposure (agriculture)

- 2,013 ha of rice farmland (53% of total agricultural area)
- 992 ha of coconut farmland (33% of total agricultural area)
- 1,704 farmers dependent on rice production (6% of total pop.)
- 27.82% of local GDP from rice production
- 68% of the rice harvest for own household consumption
- 3,752 number of work animals

Potential impacts

Rice (decreased yield and quality)
- Very dry soil conditions and wilted crops
- Rice sterility
- Increasing incidence of pest
- Production input losses from unknown changes in cropping pattern
- Higher mortality of work animals
- Decrease in yield from extreme climate event (drought and flood)
- Decrease in available arable land

Coconut (decreased yield and quality)
- Reduced nutshell
- Desiccation of fronds and shedding of young nuts from drought
- Uprooted, fallen trees from typhoons
- Increasing incidence of pest and diseases
- Smaller fruits after prolonged dry season

Response (adaptation measures)

Technical / Infrastructure
- Construction of additional automatic weather stations
- Construction of small-scale irrigation facilities (weirs and canals)

Farm management
- Training to introduce alternative livelihood (non-timber forest products)
- Establishment of farmers' field schools and programs

particular, night time temperatures), changing rainfall patterns and increasing levels of atmospheric greenhouse gases. The biophysical effects of climate change and variability on crop production and sensitivity of crop production are highly dependent on the location of the production areas and the existing agricultural systems, and these vary with time.

- Increase number of months with extreme rainfall during the wet season
- Increase in number of days with rainfall greater than 300 mm

Sensitivity

- 218 of farming household below poverty threshold (4% of total pop.)
- 90% of farming household engaged in mono cropping

Rice
- 428.75 ha of rain-fed areas (21.3% of total rice farmland)
- 1,586.25 ha irrigated areas (78.7% of total rice farmland)
- Rice farmers dependent on work animals

Coconut
- High percentage of coconut stands are already matured
- Coconut farmers dependent on work animals

Adaptive capacity

- 10 officials in agriculture (agriculturist, technicians, farm supervisors, animal keeper, pest control)
- Rice currently harvested are considerably tolerant and resistant to climate change
- Use of chemical-based nutrient system
- Existence of alternative crop production (root crops)
- Local policies in place (local ordinances on food sufficiency; appropriate skills training for the community)
- Training on farming and livelihood (farmers training and seminars; livelihood training for women)
- Water user's groups and farmer's cooperative in place (Caruray Irrigators Services Association; Inandeng Irrigators Association)

Socio-economic
- Increase in poverty level (loss of jobs and decreased household income)
- Increased out migration
- Decreased rice self-sufficiency
- Higher risk of malnutrition

Farming practices
- Introduce new crop varieties, including hybrids, to increase tolerance and suitability of plants to temperature, moisture and other relevant climatic conditions
- Change cropping pattern/calendar and practices

Adaptation options identified by stakeholders for the agriculture sector

Below are some of the preferred adaptation strategies, and also specified constraints and needs by the stakeholders during the focus group discussions.

Adaptation strategies	Constraints	Needs
3-km farm-to-market roads (between San Isidro and New Agutaya)	Estimated cost: PhP3 million	Financial assistance
Construction of irrigation	Lack of funds, no available area for the system, large capital outlay	Budget outlay
Farm inputs (e.g., quality seeds, knowledge on organic fertilizers and pesticides)		Coordinate with agricultural agencies Coordinate with the MAO
Marketing strategy/outlets	Lack of coordination with municipal government Lack of knowledge Lack of funds	Coordinate with agricultural agencies Coordinate with the MAO
Promotion of organic farming system	Lack of inputs, labor-intensive, long duration of preparatory work	Technical assistance, transfer of knowledge capital/inputs
Alternative livelihood programs (e.g., handicrafts, neto and livestock raising, aqua farming, vegetable farming)	No source of animals for starting the livestock project, lack of start-up capital, lack of technical knowledge, lack of seeds	Seminars/technical know-how, capital, development of markets
Risk-transfer mechanisms (weather-based insurance)	No PAGASA weather station	Insurance provider (e.g., Microensure) Awareness raising
Development of diversified products (e.g., abaca)	Lack of plants and market for products	Technological knowledge, technical assistance (FIDA), capital, market development

However, following the E-S-CA vulnerability framework, the prioritized adaptation measures must address the current and future vulnerabilities. Using the results of the vulnerability assessment and considerations of adaptive capacity as well as the inputs of local stakeholders, the menu of adaptation measures was finalized to address both the biophysical and socio-economic impacts of climate change. These will be prioritized accordingly in the next section. The shortlist is summarized as follows:

Technical/Infrastructure

- Small-scale irrigation systems
- Farm-to-market roads
- Post-harvest facilities
- Early warning systems
- Weather stations

Governance and policy

- Training for alternative livelihood

- Programs to enhance the value chain of agricultural sales
- Establishment of farmer's field schools and programs
- Weather-based insurance programs (risk-transfer mechanisms, microfinance)

Farming practices

- Use of new crop varieties– drought and/or flood-resistant cultivars
- Crop diversification
- Organic farming practices
- Balanced fertilization strategies to sustain soil quality
- Change in cropping pattern/calendar and practice
- Increased disease and pest management practices

2. Coastal and marine sector analysis

All of the 10 *barangays* of San Vicente can be classified as coastal. Aside from the 10 inland *barangays*, the municipality also has a territorial jurisdiction over 22 island communities scattered in the South China Sea (**Table 3.92**). The *barangays* have been heavily depending on the sea for food, shelter, livelihood and recreation.

Barangay	Island	Area (ha)
Binga	• Manamburao	5.00
New Canipo	• Imuruan	136.05
	• Lampiligan	14.14
Poblacion	• Boayan	1,327.31
	• Niaporay	19.43
	• Talontonen	13.18
	• Mayakli	4.71
Kemdeng	• Mialbok	24.34
Port Barton	• Albaguen	175.62
	• Cagnipa	507.94
	• Exotic	6.41
	• Capsalay	79.32
	• Inaladoan	17.24
	• Malindag	3.94
	• Bongot	10.55
	• Ibalalon	38.39
	• Kayoya	20.72
	• Moraday	18.23
	• Paradise	5.00
Caruray	• Catalat	261.12
	• Cacbolo	80.31
	• Bay Island	80.00
Total		2,848.95

Table 3.92. Island communities identified in San Vicente

Fishing effort map & fishing gear and catch inventory

This section presents an overall picture of fishing activity in the area based on the actual data of municipal fisherfolks and observations of commercial fishing activity. This will be the basis for identifying important fishing grounds and suggesting the appropriate fishery management strategies for the area. The Fishing Gear inventory and Fish Catch Inventory is simply a list of the gear used and the fishery species in the area (**Table 3.93**).

No. of fisherfolk	64 Female; 4,109 Male
No. of non-motorized boats	243
No. of motorized boats	1,961
No. of fish landing sites/buying stations	32 fish landing sites; 13 buying stations
No. of fish traders	16 Female; 44 Male
No. of fisherfolk owning their own boat	5 Female; 1,896 Male
No. of fisherfolk renting boats	35
No. of fisherfolk owning their own gear	5 Female; 1,169 Male
No. of fisherfolk renting gear	25
System for renting	Percentage: 3 to 1; 1% to owner; 2% for rent
How much is the fuel for the boats	1-4L @ P74-75/L gasoline 2-8L @ P67-70/L diesel Large Boat: 60L
No. of *BantayDagat*	1 Female; 30 Male
No. of patrol boats	8
No. of fisherfolk organizations	13
Species no longer observed and date last seen	Long ago: Dolphin 1998: Dugong Whale Shark

Table 3.93. Fishing effort of San Vicente

General risks

a. Coastal erosion and inundation

Due to the presence of numerous island communities, the greatest threat to San Vicente is coastal erosion and aggradation (increase in land elevation due to the deposition of sediment). This may be aggravated by the construction of walls or piers consisting of boulders that jut out to sea. Long shore currents, also found near shore, transport sand parallel to the beach. A wall or a pier consisting of boulders will interfere with the long shore currents and will consequently cause erosion of one side and aggradation on the other side. The perceptions of the covered San Vicente communities were collated during a hazard mapping exercise. The perceived timeline of natural hazard events affecting coastal and marine resources is shown in **Table 3.94**.

Year	*Barangays*									
	Alimanguan	Binga	Caruray	Kemdeng	Port Barton	Sto. Niño	New Agutaya	New Canipo	Poblacion	San Isidro
1972	Typhoon Senyang									
Nov 22, 1979							High waves, *Habagat*			
Nov 4, 1989	Typhoon Roping									
1991	Falling of ash: Mt. Pinatubo									
Aug 1995	Storm Rosing									
Oct 29, 1995	Typhoon Pepang: flashflood, landslide									
Dec 11, 1997	Super Typhoon									
1997-1998							El Niño/Drought			
Dec 1998	Storm Norming									
Oct 2005	Storm Pepang: landslide, flood									
May 2007							Algal bloom (Caruray-Poblacion)			
Dec 18, 2007	Storm									
Apr 2009	Drought									
							Tropical Storm Ondoy			
June 5, 2012							High waves, *Habagat*			
Dec 4, 2012	Typhoon Pablo, Heavy Rain									
	1 typhoon: storm surge									
	2 flooding						2 high waves; *Habagat*			
	3 drought/El Niño									
	4 landslides (rain-induced)							4 algal blooms		
	Others: soil erosion, silting, fire, sea-level rise, La Niña							Others: ashfall		

Table 3.94. Timeline of natural hazard events based on FGDs

In general, San Vicente lies outside the usual typhoon path in the Philippines, and therefore, is relatively safe from potential destructive impacts of typhoons. However, it has experienced strong typhoons in the past 30 years and climate change projections indicate that this trend will intensify. Housing in the coastal areas are usually made of light materials (e.g., wood, bamboo, *sawali* and other locally available materials), which make these infrastructure vulnerable to extreme storm surge. Coastal inundation poses a huge threat to the nearby communities especially when heavy monsoon winds and storm surges occur simultaneously, with high tides and erosion of beaches, particularly in low-lying small islands. There is no data to assess magnitude of sea-level rise in San Vicente. However, site visits confirmed that in the coastline of Port Barton (**Figure 3.29**), resorts and restaurants are located within three meters from the strandline during high tide, which heightens the risk of being displaced at the height of extreme coastal flooding. Seawalls have been constructed to mitigate coastal flooding but extreme weather conditions might cause the collapse of these seawalls and thus might render it ineffective in preventing coastal inundation.

Figure 3.29. Short distance (within 3 m) of resorts from the coastline in Port Barton

Having tourism as one of the flagship development priorities of San Vicente, the Long Beach, a 14 km strand traversing New Agutaya and Alimanguan, is identified as one of the key areas to be developed for tourism. Based on the projection of sea-level rise of 27 cm by 2050, considering 20 m to 30 m width of strand and about 1 m difference of latitude from the coastline to the beachfront properties, the area might suffer from the impact of big waves during high tides. The flat area which will host tourism facilities is only about 1 m above from the coastline at low tide, and has been dedicated mostly to coconut farm. In the development plan of this area, risk management plan and adaptation measures for potential risks of storm surge and tsunami need to be incorporated. There should be a buffer region from the shore, as the forefront edges of the private lands are quite close to the shore.

b. Deterioration of mangroves

Mangrove areas are estimated at more than 1,000 ha, mostly located at Port Barton. Port Barton mangrove area is designated as conservation area by the municipality. Mangrove grows in a saline swamp and has a unique ecosystem supporting fishery production and providing a good habitation to marine organisms such as algae, oysters, sponges, shrimps, mud lobsters and mangrove crabs, and even birds and snakes. Mangrove forests also protect coastal areas from erosion, storm surge, and tsunamis. Unfortunately, there is no flora and fauna inventory in San Vicente's mangrove forest that was found.

Sea-level rise poses threat to mangrove species. Ideally, sediment surface elevations should keep pace with sea-level rise; otherwise, mangroves face the high risk of substantial

Figure 3.30. Mangroves in Port Barton

reduction. In order to preserve mangrove areas, there should be a management plan to control the inflow of the source of pollution from inland or aquaculture. Also, the plan needs to consider potential impacts by increased sea temperature by climate change.

Increased surface temperature is expected to affect mangroves by: (1) changing species composition; (2) changing phenological patterns (e.g., timing of flowering and fruiting); (3) increasing mangrove productivity where temperature does not exceed an upper threshold; and (4) expanding mangrove ranges to higher latitudes where range is limited by temperature, but is not limited by other factors, including a supply of propagules and suitable physiographic conditions (Field, 1995 and Ellison, 2000).

c. Coral reef bleaching

Various stressors and threats have historically impinged on the coral reefs and fishery resources of San Vicente, and their exposure to each successive stressor has made it more vulnerable to further degradation. The open coastal waters and coral reefs have been affected by the rising sea surface temperatures, resulting in episodes of coral bleaching that has had some impact on the fisheries of coral reefs. Aside from the natural threats brought by climate change, sea grass beds and coral reefs also face threats from man-made destructive practices such as fishing methods.

A coral reef assessment in 1997 found some sites in good coral condition. Specifically, eight sites (Old Caruray, Barongbong, Albaguen Island, Queen's Bay, Capsalay Island, Port Barton, New Agutay,a and Cauban) had more than 50% of total live corals, with hard and soft coral cover, while two sites (Albaguen Island and Capsalay Island) had about 50% hard coral cover.[19] Majority of sites, however, had 60% abiotic, i.e., a benthic life form condition characterized by the dominance of rock, silt, sand, and rubble.[20] Nañola's observations during the recent May 2013 survey confirmed the impact of sedimentation on some of the reefs, especially in the embayment of Caruray, Port Barton, and Poblacion. Some sites have less abiotic level compared to the 1997 assessment possibly because land clearing and the resulting sedimentation are taking place deeper inland and upstream and much further from the coastal areas.[21]

Apart from the adverse impact of siltation on some reefs from river run-offs and sedimentation from coastal development and proximate upstream land clearing, the 1998 El Niño is another event that has had a damaging effect on the coral reefs. This event hit both the northern and western coast of Palawan, including San Vicente, and caused the coral bleaching of an undetermined area on the western coast. There is no visual record on how hard the western area was hit, but the bleaching event for the adjacent northern Palawan shelf was estimated

19 *The Coral Reef Study* of Curran and Comer (1998) found that reefs within the MPA had a hard coral cover of around 30% while sites outside it had only about 15% coral cover.

20 All in all, 17 out of 27 sites were highly biotic (about 60% or more). These included all of the sites in Poblacion, three out of four sites in Caruray, two out of the eight in Port Barton, and Sto. Niño, New Canipo, Villafria, San Isidro, Imuruan and Binga Proper (San Vicente Baseline Report on Coastal Resources, September 2006).

21 As a result, these land clearing activities would be affecting inland streams, waterways and reservoirs.

to have damaged more than 10% of its live coral cover (Arceo et al., 2001). The more recent El Niño episode in 2010 is said to have had an almost comparable impact as that of the earlier one (Nañola, 2013).

Higher sea surface temperatures and ocean acidification would increase the risks of coral bleaching events that can lead to loss of critical habitat (Karl et al., 2009). It has been observed or deduced that the onset of El Niño and the consequent bleaching of the corals have also made the affected corals vulnerable to infestation in particular by the crown of thorns (COTs). As observed, the location of bleached corals generally coincides with the areas infested by the COTs. Nañola's survey of 21 coastal marine sites suggests that the status and location of a site, as well as the level of fishing effort account for the reefs' vulnerability to coral bleaching and infestation. The inner, sheltered group consisting mainly of the core protection and buffer zones was, as noted by Nañola, not greatly affected by coral bleaching, and hence by inference has not been seriously affected by the COT infestation. The reef of San Vicente is alarmingly shifting from a coral dominated to an algal dominated reef, which necessitates the establishment of more core zones. The maximum goal perhaps is to cover half of the total area.

The Philippines' strategy on climate change adaptation recommends that deep reefs (in 20-30 m depth) may need to be protected as refugia for marine species. Moreover, as possible sources of coral and fish, it should be protected as marine reserves and relative vulnerabilities of reef systems need to be determined so that priorities can be decided.

d. Depletion of fish stock and other marine resources

The rich fishing grounds of San Vicente, Palawan has been losing its natural richness. Based on a recent reef and demersal species inventory, the biomass is in an overfished state, and the reefs are infested, dying and vulnerable to climate change, and are shifting from a coral-dominated to an algal-dominated one. From a comparative study of three sites (the inner-sheltered zones, the outer A and B areas, the following findings may be stated: 1) the overfished state was already evident a decade ago; 2) the decline in herbivore biomass is apparent in all sites, even the protected ones, and has resulted in algal infestation; 3) the predominance of farming herbivores in the outer B sites spells the demise of its reef; and 4) outer A is in a phase shift towards the condition of outer B unless immediate intervention is made to improve ecosystem resilience.

One source of richness of its fishing grounds are the coral reefs. According to the 2000 report of the Palawan Council for Sustainable Development, San Vicente's coral reefs covering only a limited area of 4.244 km^2 are said to be in fair or good coral conditions but relatively low fish density for target fishes. The density (number of individuals per ha), however, of groupers in particular is generally higher in San Vicente relative to other municipalities. Thus, the living coral reefs in San Vicente contribute to total national fishery production, like other sites within the country, whose contribution ranges from 8 to 20%, to as high as 70% for some island reefs (Aliño et al. 2004).

Overfishing has had other profound consequences for the reef and fishery resources of San Vicente. It did not only result in smaller-sized fishes and fewer target species. The harvesting of the more commercially viable target species which are bigger in size relative to the non-target species has also changed species composition. Non-target species with low commercial value, like the herbivore *Scaridae* or parrot fish, have thus become more dominant. So whatever densities of smaller fishes may be observed in the overfished sites may actually be the densities of non-target species.

San Vicente's reef system is losing its functional diversity or integrity because there is not enough herbivore biomass to trim down algae and allow recruitment. Thus, with critically low herbivore biomass, coral reefs that have naturally been dominated by corals are now being engulfed by algae.

Future vulnerabilities and potential impacts of climate change on coastal and marine - Participatory Coastal Resource Assessment, Mapping and Development

a. Coastal area checklist

This is designed to determine and characterize the geographical and physical features including the past and present land uses of a particular coastal area to produce a standardized checklist.

	Land Use System	Ecological Condition (% good condition)	Community Activities	Problems
Open Sea		Approx. 40-50% good condition of corals offshore Average: 45%	• Fishing (fish net and fish hook)	• Low fish catch • Many fishers • Encroachment of illegal fishing activities • High waves
Coral		30-90% Average: 60%	• Fishing • Shell collection	• Illegal fishing: cyanide, dynamite and compressor fishing; illegal use of fishing net • Illegal collection of corals • Making riprap surrounding island • Coral bleaching • Chemical runoff from agri-lands • Degraded due to typhoon and strong waves
Seagrass/ Seaweed		30-100% Average: 67%	• Planting of *lato* and seaweeds	• Public destruction • Fish habitats degraded
Mangrove	Fish nursery, Bird shelter	40-100% Average: 66%	• Replanting of mangroves • Shell collection • Crab collection • Firewood production • Fishpond • Conversion to tourism due to high demand and price (of land)	• Cutting of mangroves for housing, charcoal • Conversion to fishponds • Fish and bird habitats degraded • Seashore damaged by water run-off • Conversion to tourism due to high demand and price (of land)
Beach	Public and Tourist Use	80-100% Average: 91%	• OPLAN-Linis • Sand quarrying • Recreational area • Boat anchoring • Dry docking area of sail boats and pump boats • Collection of shells • House construction • Fishing • Fish landing • Drying of fish • Sunbathing	• Lack of solid waste management • Need for coastal cleanup • During floods waste collects on shoreline • High waves during *Habagat* • Quarrying

Table 3.95. Coastal profile

b. Problem and issue ranking

Problem and issue ranking is a tool used by a community to identify and rank problems and issues in order of priority by assessing their relative importance by using a set of criteria.

The issues cited by the participants are as follows:

- Low fish catch
- Encroachment of commercial fishing vessels (CFVs)
- Fish sanctuaries unprotected
- Illegal fishing practices (e.g., cyanide, compressor, dynamite, nets, trawl – *salisiw*, *tubli*, electro-fishing, *lintig*)
- Mangrove deforestation
- Pollution
- Low income
- Sand quarrying
- Lack of water or irrigation
- Degraded coastal resources

- Lack of farming inputs
- Poor soil condition
- Land conversion for tourism
- Restricted access to coastal resources
- *Kaingin*
- Poor waste management and pollution
- Sea grass and seaweed degradation
- Coral degradation
- Coral bleaching
- Illegal collection of corals
- Boat docking
- Over population
- Floating areas
- Run-off from agricultural lands
- Flooding
- Denuded forests
- Illegal cutting of forest products
- Rice shortage
- Poor irrigation
- Oil spill and bilge pumping

Criteria for ranking problems included:

- Extent or scope (number of people or areas affected by the problem)
- Degree of impact on a particular resource (how serious are the effects of the problem on the resource e.g., destruction of reefs, decline in fish stocks)
- Occurrence or regularity (how frequent the problem occurs, during what season, etc.)

Each problem is analyzed according to the criteria set and given a score i.e., on a predetermined scale of 1-5 with 5 being the highest. The total sum for each problem reveals the relative importance of the problem and how it ranks compared to the other problems. The community can then prioritize their problems and issues so that they can focus their energies and resources to the most important problems. The top prioritized issues for each *barangay* (**Table 3.96**) were then analyzed through a problem tree as shown in the succeeding figures.

Issue	Low fish catch	Illegal fishing (compressor, cyanide, nets)	Mangrove deforestation	Quarrying (sand)	Irrigation	Degraded coastal resources	Coral degradation
Alimanguan	1						
Binga		1					
Caruray	3		1				
Kemdeng				1			
New Agutaya	1	2					
New Canipo					1	3	
Poblacion			3			1	
Port Barton		3	2				1
San Isidro	1		2				
Sto. Niño		1					

Table 3.96. Priority issues

Data from the Municipal Fisheries Office also supports the declining fish catch with both commercial and municipal fisheries from 2010-2012 (**Figure 3.31**).

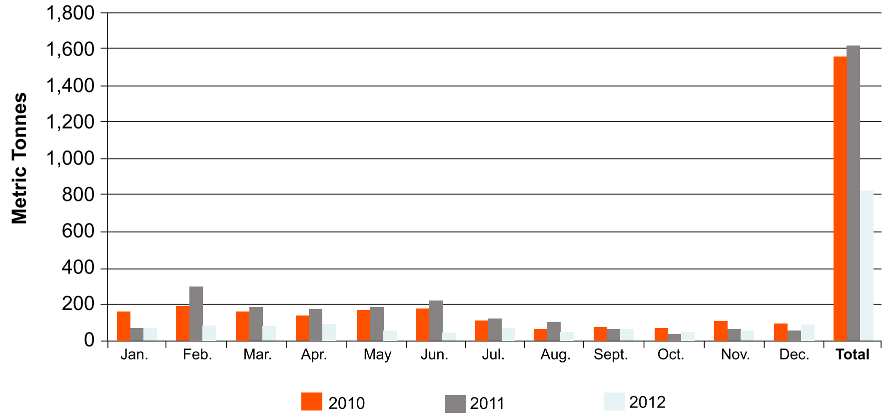


Figure 3.31. Total average volume of fish caught 2010-2012

Issue	Initiative	Gaps	Recommendations
Coral degradation	Artificial reefs	*Bantay Dagat*; marine sanctuary	Additional or stricter law enforcement
Degradation of other coastal resources	Fish sanctuary; Deputized *Bantay Dagat;* Mangrove reforestation; IEC against illegal fishing	No local ordinance No support	Craft ordinance for fish sanctuary; Illegal fishing monitoring; Continue reforestation; Heavier penalties for illegal perpetrators particularly cyanide fishing
Illegal fishing	Conduct training on R.A. 8550; IEC against illegal fishing; campaign against illegal fishing	Inactive implementation of laws	Implementation of *R.A.8550*; Continued IEC; More *Bantay Dagat* and *Bantay Gubat* personnel; Deputize every *sitio* leader as law enforcer; Equipped *Bantay Dagat* with honorarium
Coral bleaching (cyanide fishing)	Monitoring and law enforcement	Marine sanctuary	Livelihood options; Re-organize fisherfolk
Cutting of mangroves	Mangrove planting program; mangrove rehabilitation or reforestation (13.5 ha planted); IEC campaign		Continued mangrove reforestation
Low fish catch	Request to conduct IEC on protection of coastal resources; Request for implementation of laws pertaining to the protection of fishing resources; Mangrove protection	*Bantay Dagat* and equipment for patrolling	Conduct IEC on protection of coastal resources; Strict implementation of laws

Table 3.97. Adaptive capacity of the coastal and marine sector

c. Perceived changes in local climate

The following were highlighted as perceived changes in local climate:

- Low fish catch especially with use of baby purse seine and *kawil* gears.
- Fish migration out of area or to deeper and cooler waters– due to warmer sea surface temperatures.
- Seasonal fluctuations in fish catch and composition
- Higher temperatures
- Higher rainfall events
- Flooding

d. Expected impacts of changes in local climate

- Coastal structures (houses, boats) affected by storm surges and coastal erosion
- Sea-level rise
- Need to fish further out to sea as there are fewer fish observed close to shore
- Health issues

Barangay	Perceived greatest impact of climate change
Alimanguan	• Flooding • Coral bleaching • Storm surges
Binga	• Coral bleaching • Flooding • Sea-level rise
Caruray	• Flooding • Sea-level rise • Storm surges
Kemdeng	• Flooding • Fish migration • Increasing sea surface temperatures • Sea-level rise • Health issues
New Agutaya	• Flooding • Storm surges • Ensuing health issues
New Canipo	• Sea-level rise • Flooding
Poblacion	• Flooding • Coral bleaching
Port Barton	• Fish migration • Increasing sea surface temperatures • Sea-level rise • Flooding
San Isidro	• Sea-level rise • Storm surges • Health issues
Santo Niño	• Storm surges • Health issues

Table 3.98. Perceived impacts of climate change

The outputs from the above can be represented in an Exposure, Sensitivity and Adaptive Capacity (E-S-AC) Framework as shown below.

Climate Stimuli	Exposure	Sensitivity	Impacts	Adaptive capacity/Adaptation measures
Increasing sea surface temperature	Coastal resources; population (total population = 27,052; number of fisherfolk = 7,953)	Migration of fish/ demersal fishes die off (fish kill); reef fish trophic structures; density of coral dependent species; habitat quality; Catch-per-unit effort	Coral bleaching; low fish catch; low income	Coral reef rehabilitation
Saltwater Intrusion	Mangroves, estuarine fish, animals, plants, population	Habitat quality; denuded mangroves	Top-dying of mangroves; economic impact: shortened for marine food supply; access to potable water (saltwater enters groundwater supply)	Mangrove reforestation and management
Storm surges	Coastal resources; population; houses; boats	High waves; unproductive fishing season Reduction in herbivorous fish stocks; Catch-per-unit effort Degraded coral habitats Fishing grounds	Mangroves uprooted/washed-out; infrastructure damaged; low fish catch; low income; decreased food supply Uprooted seagrass; low fish catch; low income Faster growing coral species (especially branching, foliate and table corals) broken/destroyed by high wave action; Low fish catch; low income; malnutrition Education Flooding; access to potable water – saltwater enters groundwater supply; health diseases	Tree-planting Relocation (sites identified); seawall; seaweed rehabilitation and seagrass planting Marine Protected Areas Passed a 65-ha endorsement for a coral reef rehabilitation area in Daplak Active law enforcement activity; fisherfolk organizing
Sea-level rise	Population; coastal resources	Residential land area Denuded habitats	Displaced population; flooded areas Coral growth; food supply chain	Relocation (sites identified); seawall Coral reef rehabilitation; seagrass planting; mangrove reforestation and management

Table 3.99. The exposure, sensitivity and adaptive Capacity (E-S-AC) framework for the Municipality of San Vicente, Palawan

Climate hazard (Region 4B)

- Increase in mean annual temperature (0.8 C° for 2020; 1.8 C° for 2050)
- Shorter but drier dry season (approx. 25% decrease in rainfall)
- Longer and wetter wet season (approx. 60-115% increase in rainfall)
- Increase number of months with extreme rainfall during the wet season
- Increase in number of days with rainfall greater than 300 mm
- Increase in storm and storm surges

Exposure (coastal and marine)

- 7,953 fisherfolks (29.4% of pop.; 60.8% of HH)
- 164 employees (on 39 establishments) depend on tourism
- 120 km of coastline
- 140,805.5 ha of municipal fishing ground zone (disaggregated according to zones)
- 75% live coral cover
- 1,095.75 ha of mangrove forest

Sensitivity

- 309 of fishing household below poverty threshold (11% of total)
- Households living long the coastline
- Houses in coastal areas made of light materials
- Income from demersal and pelagic species
- Coral species sensitive to increase in temperature;
- Major tourism activities are marine oriented (diving, snorkeling, island hopping, swimming)
- Tourism establishments are concentrated in low elevations

Adaptive capacity

- 92.9% of fishing household using motorized boats
- 25.46 % of fishing household with (motorized or non -motorized) boat
- 10 specialized officials in fisheries
- Presence of fish processing facilities (i.e., freezer and fish drying facilities)
- PhP4.12 million fund for the Municipal Disaster Risk Reduction and Management Plan
- Presence of Municipal Fishery Regulatory Board
- Presence of *Bantay Dagat* (at least five) in every *barangay* with annual budget of PhP900,000
- Availability of SEAK Loan and other assistance from national government (4Ps)
- Existence of other livelihood activities, such as seaweed farming and sardines making
- Established fish sanctuaries and marine parks

Potential impacts

Coastal resources (decrease in quality and quantity

- Coral bleaching
- Fish migration
- Top-dying of mangrove
- Less variety in fish catch
- Decrease in fish stock

Coastal communities and tourism (damage to infra, settlement areas)

- Coastal flooding
- Coastal erosion and sedimentation
- Salt water intrusion
- Damage to properties

Socio-economic

- Increase in poverty level (decrease in available number of fishing days; limited access to coastal resources)
- Increase in the number of illegal fishing activities
- Decreased opportunity for tourism
- Higher mortality risk due to extreme climate events

Response (adaptation measures)

Technical / Infrastructure

- Establishment of sea walls and dikes in Port Barton
- Set-up of early warning system
- Mangrove deforestation

Fishing practices / Coastal management

- Total fish-catch monitoring
- Monitoring illegal fish catch practices
- Organize and strengthen fisherfolk organizations
- Coral rehabilitation (i.e., undertake herbivore seeding, establish the necessary mix of marine habitat types to enhance coral resiliency)

Governance and policy

- Training for alternative livelihood
- Promote private sector involvement in coastal planning and management
- Trainings and orientation on disaster risk reduction and management
- Enhanced Information/ Education/ Communication on coastal and marine
- Policy for water resource use conflict resolution

Figure 3.32. Climate change impact chain for coastal and marine resources of San Vicente

Adaptation options identified by stakeholders for coastal and marine

Recommendations for adaptation measures:

- Illegal fish catch monitoring
- Fish catch monitoring
- Ban illegal fishing practices together with provision of climate-resilient livelihood assistance
- Develop local policy environment for coastal resources management
- *Bantay Dagat* – working closely with Philippine National Police (PNP)
- Patrol boats
- Organize and strengthen fisherfolk organizations
- Mangrove guards (*Bantay Gubat*) – working closely with PNP
- Enhance local policies
- Water resource use conflict resolution
- Multi-stakeholder partnerships
- Identify and establish creek-mangrove-reef continuum for protection
- Full resource inventory
- Explore pilot study on brood stock culture
- Brood stock culture, hatchery and nursery development
- Increase number of marine protected areas
- Reforestation of mangroves
- Community-based forest management
- Improve seaweed production, marketing and trading
- IEC such as trainings on coastal and marine, climate change, disaster risk reduction management
- Establish early warning systems for storm surges, floods, sea-level rise
- Control development in vulnerable coastal areas
- Climate-resilient supplemental livelihood provision (based on study of available local resources
- Further develop ecotourism based on coastal resources & IEC
- Mangrove tours
- Coastal resources management education centers: turtles, MPAs, mangroves
- Turtle conservation: *Bantay Pawikan*
- Island life tours
- Improve tourism infrastructure: water, food supply, power, communications

Using the results of the vulnerability assessment and consideration on their adaptive capacity, adaptation measures are identified to address both biophysical and socio-economic impacts brought about by climate change on coastal and marine. Adaptation options are summarized below:

Technical/Infrastructure

- Establishment of sea walls and dikes in Port Barton
- Set up of early warning system

- Mangrove reforestation

Fishing practices/coastal management

- Implementation of open and close fishing season
- Introduction of alternative non-fishery-based sources of income (e.g., non-timber forest products)
- Extend core protection zones
- Coral rehabilitation (i.e., undertake herbivore seeding, establish the necessary mix of marine habitat types to enhance coral resiliency)
- Training for alternative livelihood

Governance and policy

- Moratorium on the catching of herbivores, depleted demersal and pelagic species
- Induce participation of private sector in coastal planning and management
- Control development in vulnerable coast line areas
- Trainings and orientation on disaster risk reduction and management
- Strict enforcement of the *Fisheries Code* and other related laws
- IEC on coastal and marine

3. Health sector analysis

Health profile of San Vicente

The municipal health office of San Vicente needs to cater to the concerns of its 10 *barangays*, 6,460 households (with an average of five members) and a total of 30,565 residents. The local population continues to increase at a rate of 6%, with *Barangays* Poblacion, Binga and Alimanguan having the highest population density. The most vulnerable to the impacts of climate change are the children and elderly and in the case of San Vicente, wherein 39.63% of its total population are young dependents (0-14 years old) in 2008 and 3.18% are elderlies (65 years and over). Thus, the overall dependency ratio in 2008 was 42.81%, that is, for every 100 persons aged 15 to 64 years, there were about 43 dependents (40 are young and 3 year are senior dependents).

In terms of nutrition, the preschoolers who were weighed and found to be nutritionally of normal status is about 87.01% or 3,274 in 2008. Those who belong to below normal low status, below normal, and very low have also improved in 2008 compared to the previous year. Aside from the preschoolers, the nutritional status of elementary school children showed that 72.60% or 3,230 of those weighed were normal, 23.29% or 1,036 were below normal, and 4.11% or 183 were above normal. In terms of sexes, the data showed that 52.26% or 1,688 boy enrollees belong to normal nutritional status compared to girl (47.74% or 1,542) school children weighed.

The leading causes of morbidity in San Vicente include acute respiratory infection, influenza, diarrhea, malaria, urinary tract infection and hypertension. The leading causes of mortality, on the other hand, are pneumonia, heart diseases, pulmonary tuberculosis, measles and diabetes, among others. There is one Rural Health Unit (RHU) in Poblacion that caters to the whole municipality, along with three *barangay* health stations in Alimanguan, Port Barton, and Caruray. The RHU is staffed with one municipal health officer or doctor, four nurses, six midwives, a rural sanitary inspector, a microscopist, two dentists, and seasonal medical interns, whereas the *barangay* health stations are manned by nurses and *barangay* nutrition scholars. There is only one ambulance for the whole municipality. Since the RHU can only perform minor surgeries, more serious operations are undertaken in Puerto Princesa, which is a four-hour drive from San Vicente.

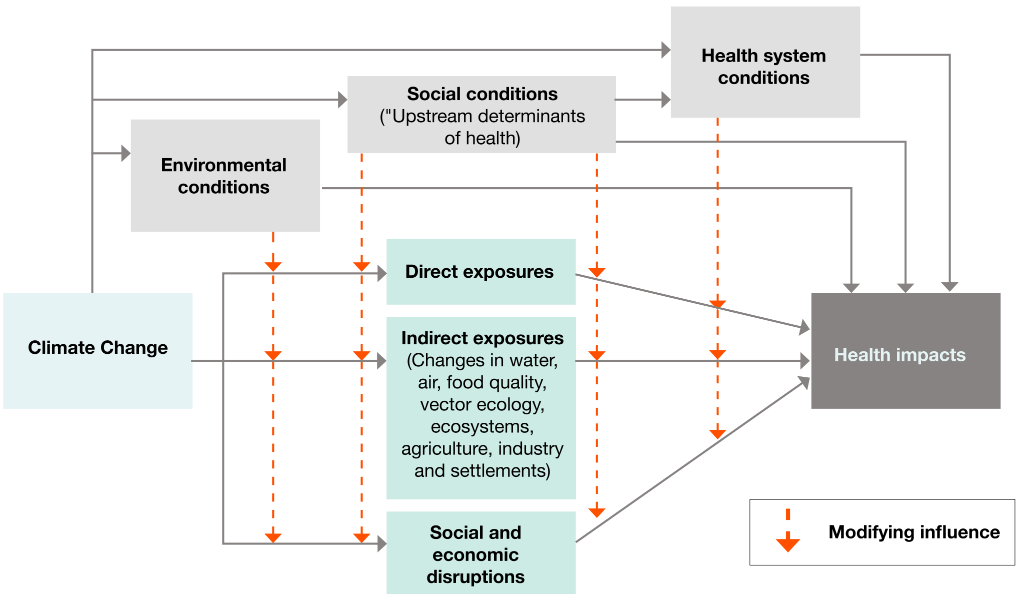
Figure 3.33. Actual photos of the Rural Health Unit (RHU) in San Vicente

Residents and visitors can buy prescription drugs and over-the-counter medicines in pharmacies available in several areas in San Vicente. However, the supplies can be limited and also quite more expensive considering the transport cost from Puerto Princesa to San Vicente. Paracetamols and medicines for coughs or colds are readily available and oral medicine, vaccine and insect-repellant lotions against malaria are also common. The RHU also provides basic medicines free of charge. Despite this benefit, some residents still resort to faith healers to cure their diseases.

General risks

The health impacts of climate change pose threat to the local health system. Awareness to this phenomenon is minimal to nil and there are no baselines where to start measuring population health vulnerabilities. A systematic assessment of the vulnerabilities of an area to the changing climate includes the analysis of constraints, gaps, and needs of the prioritized strategies.

Regarded as a significant and emerging threat to public health, climate change, according to World Health Organization (WHO), puts at risk the basic determinants of health: clean air and water, sufficient food, and adequate shelter. Moreover, it ponders infectious disease control more challenging. Many of the major causes of death are highly climate-sensitive especially in relation to temperature and rainfall, including cholera and the diarrhea, as well as diseases including malaria, dengue and other infections that are vector-borne (MDG Final Report on Health 2011). Increasing global average temperature, sea-level rise, and extremes in the hydrologic cycle can also have negative impacts on health (Ebi et al. 2006).



Source: IPCC 2007

Figure 3.34. A schematic diagram on the effects of climate change to health

The Fourth Assessment Report of the IPCC developed the schematic diagram (**Figure 3.34**) of pathways wherein climate change affects health, and concurrent direct-acting and modifying (conditioning) influences of environmental, social and health-system factors. IPCC published evidences indicates that:

a. Climate change is affecting the seasonality of some allergenic species as well as the seasonal activity and distribution of some disease vectors.
b. Climate plays an important role in the seasonal pattern or temporal distribution of malaria, dengue, tick-borne diseases, cholera and some other diarrheal diseases.
c. Heat waves and flooding can have severe and long lasting effects.

Vector-borne diseases

IPCC (2007) defines vector-borne diseases (VBD) as infections transmitted by the bite of infected arthropod species, such as mosquitoes, ticks, triatomine bugs, sandflies and blackflies. VBDs are highly associated with climate change due to their widespread occurrence and sensitivity to climatic factors.

Dengue. Guha-Sapir and Schimmer (2005) pointed that dengue is the most important arthropod-borne viral disease of public health significance. The disease manifestations range from an influenza-like disease known as dengue fever to a severe, sometimes fatal disease characterized by hemorrhage and shock. Oishi et al. (2008) reported that dengue is the leading cause of childhood hospitalization in the Philippines. From January to September

2013, a total of 117,658 dengue cases was reported nationwide, and most cases were from Region VI (14.82%), Region IV-A (13.98%), and Region VII (9.38%). In Region IV-B where the province of Palawan is part of, DOH-NEC Disease Surveillance Report showed a 101.88% increase in the number of dengue cases from 1,392 in 2012 to 2,683 in 2013. Death from dengue also increased from 9 (2012) to 11 (2013).

Malaria. Malaria is a serious and sometimes fatal disease caused by a parasite that commonly infects a certain type of mosquito which feeds on human. The Global Fund noted that children under five years of age and pregnant women are most severely affected by malaria, as their immune system is less able to fight Plasmodium infection. Malaria is the 9th leading cause of morbidity in the country. As of 2013, there are 58 out of 81 provinces with confirmed malaria cases and 14 million people are at risk. In response to this problem, the Department of Health coordinated with its partner organizations and agencies to employ key interventions on malaria control. The Philippines' efforts on addressing malaria have been proven effective when malaria cases declined from 43,441 in 2003 to 9,642 in 2011.

Water-related diseases

Access to safe water remains an extremely important global health issue. The IPCC concluded that changes in environmental temperature and precipitation could become more frequent in many parts of Asian countries and as result could lead to outbreaks of many water-borne diseases (Shrestha et al. 2000).

Typhoid fever. A systematic infection caused by bacterium *Salmonella typhi*, it is a significant cause of morbidity and mortality in the overcrowded and unsanitary urban conditions. Humans are the only natural hosts and reservoirs, and the disease is spread by fecal-oral transmission. Typhoid fever is traditionally considered to occur during summer and monsoon seasons (Regmi et al. 2008). There have been several outbreaks in the Philippines for 2013 alone – 29 cases in Badian, Cebu in February, and 66 cases in Albay Province in June.

Cholera. While cholera epidemics are caused by multiple factors, climate plays an important role in the season pattern and distribution water diseases such as cholera and typhoid fever. In many countries, cholera transmission is primarily associated with poor sanitation, fecal contamination of water supply and flood events. However, evidence is documented over the past 30 years of El Niño events in the Bay of Bengal which has led to conclusions from Yale University that if climate change leads to more extremes, it will have an impact on cholera. In the Philippines, several cholera outbreaks were observed for 2013 in Palawan, Catanduanes, and Maguindanao.

Vulnerability to climate change-related diseases is a function of several factors. In a study under the MDG Achievement Fund (MDG-F) Project, relevant factors are identified and classified into: (1) individual or community, (2) health systems and infrastructure, (3) pathogen or vector factors, (4) socioeconomic factors, (5) environmental factors, and (6) health and environmental policy. Specific indicators in each factor define the degree of vulnerability of human population to climate change-related diseases. The vulnerabilities to these diseases are summarized in the **Table 3.100** indicating only the highly vulnerable sector of the population.

Reinforcing the vulnerability indicators are the projections of potential number of disease cases through disease impact models developed out of the existing health and climate change data. The MDG-Fund Project developed disease impact models for dengue, malaria, and cholera from the Provincial Health Offices (PHO) of Palawan, Pangasinan, Rizal, and the National Capital Region. This model was used to project diseases impacts in 2020 and 2050. The predictive capacities of the models are highly dependent on the accuracy of the health and climate change data. In the report of the MDG-Fund Project (2011), based on the climate scenarios and vulnerability assessment tool, disease projections are the following:

Vulnerability Indicator	Dengue	Malaria	Leptospirosis	Cholera	Typhoid
Individual, family, community	Young and old ages that are exposed outdoor activities during dawn and dusk with poor sanitary practices and facilities, low immune system, poor hygienic practices, no access to sanitary water, and lack of health facilities are highly vulnerable.	All ages with poor sanitary practices and facilities, low immune system, poor hygienic practices, no access to sanitary water, lack of health facilities are highly vulnerable.	All ages, families, communities exposed in flood-prone areas where population of rats and animals are high are highly vulnerable.	All ages where water systems are easily contaminated with septic waste leakages during floods are highly vulnerable.	All ages foods and water taken are spoiled and contaminated are highly vulnerable.
Health systems and infrastructure	Highly vulnerable are those that have no access to clinics and hospitals and drug stores including other important medical facilities.				
Pathogen/ vector factors	Communities and households environment that have no proper sanitation, no waste management system, presence of canals and water bodies that are habitat of pathogens and vectors are highly vulnerable				
Socio-economic factors	Highly vulnerable are the poor sector of the population. Those that are below poverty income threshold level and cannot afford doctor's treatment as well as medicines.				
Environmental factors	Highly vulnerable are communities close to bodies of stagnant water, unsanitary environment, lack of waste management system, temperature, rainfall and relative humidity favoring the growth of pathogens and vectors.				
Health/ environmental policy	Highly vulnerable are communities and families not covered by policies on the regular monitoring and treatment of diseases and maintenance of a sanitary environment.				

Table 3.100. Vulnerability indicators of climate-sensitive diseases

a. By 2020, there will be 143 new cases of cholera and 99 new cases by 2050.
b. Malaria is projected to have 187 potential new cases by 2020. Total required fund for diagnosis and cost of treatment is PhP0.68 million. The costs of preventing malaria is PhP0.28 million.
c. In terms of dengue, there will be about 1,700 potential cases in Metro Manila in 2020. This will require a total cost of PhP7.59 million for diagnosis, treatment cost of PhP4.28 million and a total income loss of PhP2.11 million from families that will be affected. If prevention measures will be done, the cost is estimated at PhP2.8 million.

In the case of San Vicente, both vector- and water-borne diseases can be worsened by the changing climate specifically the increasing amount of rainfall brought by typhoons. Palawan is covered by cyclone path exposing the population to extreme weather conditions. Tropical cyclones are distributed monthly with high concentration from October to December. This climatic condition exposes the population to flooding and rain-induced landslides. As revealed in the hazard assessment, in terms of population exposure to flooding, the most vulnerable *barangays* are: (1) Binga (48.02%); (2) New Canipo (19.26%); and (3) Poblacion (18.95%). In terms of population exposure to rainfall-induced landslides, the top three *barangays* are: (1) San Isidro (99.47%); (2) Kemdeng (99.42%); and (3) New Agutaya (99.33%). Based on the average scores given to the two exposures (flooding and rain-induced landslides), *Barangays* Kemdeng, New Agutaya, and San Isidro revealed the highest vulnerability.

Climate change will likely exacerbate water problems such as excessive water supply or the lack of it. Problems on water are usually aggravated by the deterioration of water quality due to pollution from untreated domestic sewage, agricultural run-offs and salt water intrusion. During dry season, the flow of water is low and in the rainy season, the water becomes cloudy, which triggers the outbreak of water-borne diseases such as cholera and typhoid fever. Vector-borne diseases such as malaria and dengue are also observed due to the sensitivity of these diseases to climatic change.

In the municipality of San Vicente, malaria has the highest number of cumulative reported cases, followed by dengue, then typhoid fever. Using the Pearson correlation, the trends showed weak linear relationship between selected weather parameters from 2002 to 2011 (such as total annual rainfall, maximum and minimum temperatures, and relative humidity), and the behavior of the two climate-sensitive diseases– typhoid fever and dengue. Occurrence of such diseases can also be attributed to other environmental and social setbacks. This could include access of safe drinking water, waste management, nutrition and sanitation, education and income. However for malaria, if focusing on the number of reported cases in 2007 to 2011, there seems to be an inverse or negative relationship between the amount of rainfall and percent relative humidity and the number of reported cases. There is no reported case of cholera from 2002 to 2011.

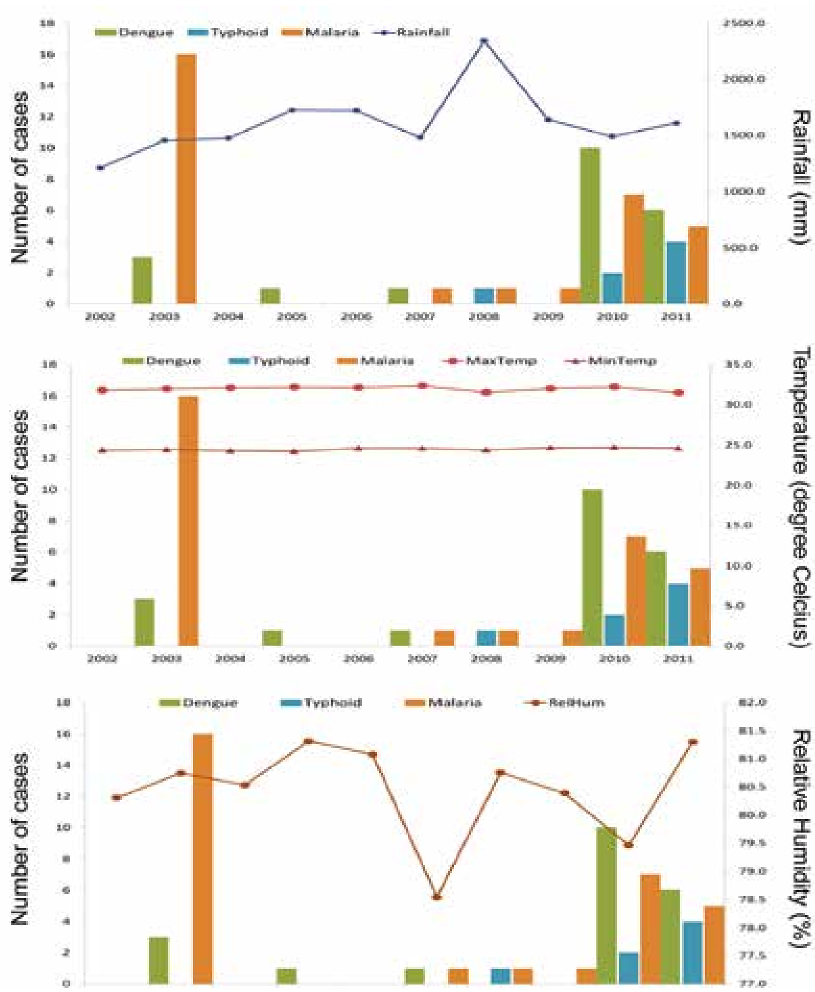


Figure 3.35. Correlation between weather parameters and climate-related diseases

Perceived health vulnerabilities

The responses below were perceived to be the vulnerabilities in terms of health infrastructure and diseases identified by the health workers and community. They further ranked them in their order of significance and effects on the population. They also emphasized the perceived non-health vulnerabilities, which they think contribute to the health vulnerabilities such as poverty, distance from main city, and the presence of migrants.

Infrastructure	Diseases
1. Lack of medicine	1. Diarrhea
2. Lack of health personnel	2. Dengue fever
3. Poor quality of roads	3. Tuberculosis
4. Lack of electricity in some villages	4. Asthma
5. Absence of service vehicle such as ambulance	5. Malaria
	6. Ulcer
	7. Urinary Tract Infection (UTI)
	8. Typhoid fever
	9. Cough and colds
	10. Hypertension

Table 3.101. Ranking of health issues from the perspective of health workers in San Vicente

Diseases	Affected population	Triggering factor	Response
• Malaria • Tuberculosis • Measles	5% Measles – during hot weather; Malaria – during cold weather	Brought by humans and bacteria	• Looking for international fund to finance the provision of medicines to the affected people such as Shell Foundation and Global Fund for anti-measles vaccine Shell Foundation/ Global Fund – TB • World Vision – TB • Conduct seminar for health workers to provide appropriate information • NGOs – provide medicine, mosquito nets, trainings, microscope, etc. • LGU – provide funds for information dissemination
• Dengue fever	30 patients (teenager) at *Barangay* Poblacion	After the typhoon	• Stream clearing; • general cleaning; • Government: fogging, IEC on dengue awareness
• Cough and colds	All *barangays*	Climate change	• Provision of medicine
• Hypertension	All *barangays*	Climate change	• Health worker – test for blood pressure to be referred to the government for maintenance of medicine
• Dengue	*Barangay* Poblacion	Rainy season	• Fogging, IEC, construction of canals, stream clearing

Table 3.102. Response to climate-sensitive diseases

Adaptive capacity

As of 2012, San Vicente has 17 specialized officials in the health sector (i.e., doctor, dentist, nurses, medical technologist, and midwives) stationed in the RHU and *barangay* health stations. There is one rural health unit for the whole municipality, one health station for each of the 10 *barangays* and three *barangay* drug stores. Current programs on infectious diseases and international donor projects such as Malaria Global Fund *"Kilusan Ligtas Malaria"* or KLM and Global Fund Tuberculosis Program are also running. The municipal government is also leading the implementation of the “4 o’clock habit” (simultaneous clean-up activity), fogging activities as well as other health-related IEC campaigns.

San Vicente has yet to address the low poor nutrition status of its children to strengthen their immunity against climate-related diseases. As far as the elementary schools are concerned, where the weighed children were enrolled, Albaguen, Pagdanan, and Bunuangan Elementary School of Port Barton, the Panindigan Elementary School of *Barangay* Poblacion and the Decala Elementary School of *Barangay* Caruray were the top five schools with the highest percentage of school children below normal nutritional status. On the other hand, five elementary schools with relatively lower percentage of children in terms of nutritional status below normal are the Alimanguan Elementary School of *Barangay* Alimanguan, Barongbong and Baybay Daraga Elementary School both of *Barangay* Port Barton, and Catalat and Sta. Cruz Elementary School, both of *Barangay* Caruray.

The quality of water supply in San Vicente also needs to be considered in assessing the adaptive capacity of its health sector against climate change impacts. Supply of potable water is currently managed by San Vicente Water System which sources its water from the Little Baguio and Port Barton falls using a tank and gravity system of delivery. Based on the CBMS standards on water supply, Level III and II are safe water sources. However, in the dry season, the flow of water is low, and in the rainy season, the water becomes cloudy, which has led to the prevalence of water-borne diseases observed. So while access to potable water has increased, there are still seasonal variations in the quantity and quality of water available. For San Vicente, the climate scenarios show an increase in the amount of rainfall especially for the months June, October and November, and the number of dry days throughout the year will increase as will the number of days with temperatures above 35°C.

Regarding waste disposal, the most common manner practiced by the constituents of the 10 *barangays* is by burning, followed by throwing into closed pits and composting. Since there is no central waste disposal system, most residents resort to either burning or burying their garbage. About 25% to 57% of the total number of households still does not have toilet facilities, others availed of springs, rivers, streams, and the lake (about 12.27% in 2008). There are still 5.46% in 2008 who availed of water from shallow wells for their domestic use.

Future vulnerabilities and potential impacts of climate change on health

In general, the vulnerability of a population to a health risk depends on the local environment, level of material resources, effectiveness of governance and civil institutions, and the quality of public health infrastructure and the access to relevant local information on extreme weather threats (Woodward et al. 1998). Moreover, public health threats, manifested through outbreaks of climate-sensitive diseases and high exposure to climate hazards, such as flooding and rain-induced landslides further heighten the degree of vulnerability.

Increase in morbidity rate (infectious, vector- and water-borne diseases), changes in vector ecology and incidence of direct physical injuries and death due to extreme events such as typhoons, flood and drought are the potential impacts of changes in the climate to public health of San Vicente. This would pose greater pressure to socio-economic condition of the municipality through increase in poverty level (increase in number of sick days), decrease work productivity, increase incidence of post-traumatic stress disorder, and mortality rate and higher risks of malnutrition.

Through a series of consultations, workshops and data gathering, the impact chain for the health sector for San Vicente is shown in **Figure 3.36**. This outlines climate hazards based on the downscaled climate projections of PAGASA and how this would affect public health and the socio-economic conditions of San Vicente.

Climate hazard (Region 4B)

- Increase in mean annual temperature (0.8 C° for 2020; 1.8 C° for 2050)
- Shorter but drier dry season (approx. 25% decrease in rainfall)
- Longer and wetter wet season (approx. 60-115% increase in rainfall)
- Increase number of months with extreme rainfall during the wet season
- Increase in number of days with rainfall greater than 300 mm

Exposure (health)

- 30,803 people living in San Vicente
- 46.98% of the employed population are fishermen
- 37.43% of the employed population are farmers

Sensitivity

- 309 of fishing household below poverty threshold (11% of total)
- Households living long the coastline
- Houses in coastal areas made of light materials
- Income from demersal and pelagic species
- Coral species sensitive to increase in temperature;
- Major tourism activities are marine oriented (diving, snorkeling, island hopping, swimming)
- Tourism establishments are concentrated in low elevations

Potential impacts

Public health

- Increase in morbidity rate
  - Heat stroke
  - Infectious, vector-, and water-borne diseases (dengue, malaria, cholera, typhoid, schistosomiasis)
  - Changes in vector ecology
- Incidence of direct physical injuries and death due to extreme events (typhoon, flood, drought)

Socio-economic

- Increase in poverty level (increase in number of sick days)
- Decreased work productivity
- Increased incidence of post-traumatic stress disorder
- Increase in mortality rate
- Higher risk of malnutrition

Adaptive capacity

- 17 of specialized officials in health sector (doctor, dentist, nurses, medical technologist, midwives)
- 10 of *barangay* health stations (one in each *barangay*; one Rural Health Unit and three Botika ng *Barangay*)
- Programs on infectious diseases and international donor projects (Malaria Global Fund KLM; TBS-DOTS Global Fund)
- Implementation of the "4 o'clock habit" (simultaneous clean-up activity) and fogging activities
- Information, education and communication campaigns
- Municipal water system in place

Response (adaptation measures)

Technical / Infrastructure

- Water supply systems (to level 1 and 2)
- Insecticide impregnated bednets
- Rapid treatment strips for malaria and water tablets (Puritabs)

Health practices

- Promoting regular health weighing and monitoring
- Training on early detection/treatment of infectious, water- and vector-borne diseases

Governance and policy

- Public health and hygiene training for the youth
- Implementation of zoning ordinance influenced by hazard or risk maps
- Increased enrolment in health financing facility (PhilHealth)

Figure 3.36. Climate change impact chain for the health sector of San Vicente

Adaptation options for the health sector

The NCCAP highlighted health as a key priority under the theme, human security. The goal for the current administration (2010-2016) is to have a health and social protection delivery system responsive to climate change risks, supporting the following key activities:

a. Health personnel and communities develop capacity for climate change health adaptation and risk reduction
b. Public health surveillance system are developed and implemented in all provinces
c. Health emergency response, preparedness and post-disaster management are implemented at the national and local levels

Using the results of the vulnerability assessment and with strong consideration on their adaptive capacity, adaptation measures are identified to address impacts to public health and socio-economic condition due to climate change. Adaptation options are summarized below:

Technical/Infrastructure

- Improvement of general and emergency medical services (securing adequate unit of ambulances and increasing medical manpower)
- Provision of insecticide impregnated bed nets and rapid treatment strips for malaria; water tablets (Puritabs)
- Ensure access to clean water (Level 1 and 2)
- Construction of basic sewerage system
- Provision of fans and cooling facilities
- Increase health stations

Health practices

- Disease surveillance
- Regular vector control and vaccination program
- Training and orientation on early detection of infectious, water- and vector-borne diseases

Governance and policy

- Development of a master plan for a Comprehensive Health Care Operation
- Public health and hygiene training for the youth
- Implementation of zoning ordinances influenced by hazard or risk maps
- Increased budget allocation for equipment and health personnel
- Increased enrolment in health financing facility (PhilHealth)
- Improvement of agricultural practices to be more climate-resilient. This can contribute to alleviating food insecurity and malnutrition, contributing to eradicating extreme poverty and hunger, reducing child mortality, and improving maternal health

E. Sectoral and integrated risk and vulnerability assessment: Top-down approach

As the bottom-up approach mainly focused on current impacts of climate change and response capacity of San Vicente, the top-down approach was used to identify not only current but also future impacts, and adaptive capacity. The sectoral vulnerability assessment was conducted to illustrate the relative vulnerability of San Vicente's 10 *barangays* and nine different sectors.

The top-down sectoral vulnerability assessment consists of impact analysis and adaptive capacity analysis. The impact analysis measures the relative degree of climate change impacts that the *barangays* are expected to experience in each respective sector, while the adaptive capacity analysis shows the relative capacity of the *barangays* to respond to such impacts. The outcome of this assessment gives a hint to the decision-makers which *barangay* and sector should be prioritized in implementing adaptation measures.

The assessment was based on IPCC's impact and adaptive capacity classification. The set of indicators which were applicable to the Municipality of San Vicente were developed based on the IPCC's classification with KACCCs modification. The indicators were reclassified based on the DPSIR Framework to understand the interactions between different elements. The vulnerability of *barangays* which consists of impact and adaptive capacity assessment were assessed by Principal Component Analysis (PCA). PCA statistically evaluated the relationship between indicator variables and their relevant region (*barangay*).

1. Impact analysis

The impact analysis was conducted to show which *barangay* is more exposed to impacts of climate change than others in the corresponding sectors. In **Table 3.103**, 1 means the most impacted *barangay* by climate change, as 10 indicates the least impacted *barangay* in each sector. The outcome of the analysis indicates that the impact of climate change on water resources and natural disasters is highest in Sto. Niño. The highest impact of climate change on natural resources and infrastructure was in Poblacion, while San Isidro was identified to be most vulnerable in industry and health in terms of impact. Biodiversity and living condition and poverty will be most impacted in New Canipo.

	Water Resources	Natural Disaster	Biodiversity	Natural Resources	Energy	Living Condition	Infrastructure	Industry	Health
Alimanguan	4	5	3	7	10	8	7	2	7
Binga	2	4	4	3	1	7	3	9	9
Caruray	9	9	2	10	5	5	4	10	6
Kemdeng	6	2	8	5	6	4	6	5	2
New Agutaya	8	7	10	8	9	3	8	7	8
New Canipo	3	6	1	6	3	1	9	6	10
Poblacion	7	3	7	1	4	6	1	8	4
Port Barton	10	10	9	9	8	2	5	4	3
San Isidro	5	8	6	4	2	9	10	1	1
Sto. Niño	1	1	5	2	7	10	2	3	5

Table 3.103. The impact ranking of *barangays* in each sector

2. Adaptive capacity analysis

In order to show which *barangay* has more ability to adapt to expected impacts of climate change, the adaptive capacity of the *barangays* in each sector was analyzed. Out of nine sectors, only eight sectors were able to be analyzed as there was insufficient data for the infrastructure sector.

The *barangays* were ranked from 1 to 10 based their adaptive capacity (1: highest adaptive capacity, 10: lowest). According to the analysis, the *barangays* that showed the highest adaptive capacity in each category are as follows: Binga in natural disaster; Caruray in biodiversity and living condition and poverty, and industry; New Agutaya in water resources and energy; Port Barton in natural resources; and San Isidro in health. On the other hand, the lowest adaptive capacity are observed in the following: Binga in biodiversity; Caruray in water resources and natural disaster; Poblacion in living condition and poverty; Port Barton in health; and Sto Niño in natural resources and energy.

	Water resources	Natural disaster	Biodiversity	Natural resources	Energy	Living condition	Industry	Health
Alimanguan	7	4	7	3	4	4	4	8
Binga	4	1	10	8	3	9	8	5
Caruray	10	10	1	4	2	1	1	9
Kemdeng	3	6	4	2	8	3	3	2
New Agutaya	1	8	3	7	1	8	5	7
New Canipo	8	2	9	5	5	7	5	4
Poblacion	9	5	8	9	7	10	8	6
Port Barton	2	9	2	1	9	5	2	10
San Isidro	6	7	6	6	6	2	8	1
Sto. Niño	5	3	5	10	10	6	7	3

Table 3.104. The ranking of *barangays* in each sector based on adaptive capacity

3. Impact vs. adaptive capacity integration

With the result of both impact and adaptive capacity assessments, the most vulnerable *barangays* to climate change in each sector were identified. As shown in **Figures 3.37** to **3.44**, the *barangays* highlighted in red are those expected to suffer the greatest from the impacts of climate change considering their high susceptibility and low adaptive capacity.

Figure 3.37 shows that in terms of water resources, the *barangays* including San Isidro, Alimanguan, and New Canipo are the most vulnerable.

Figure 3.38 indicates that Kemdeng was identified as the most vulnerable *barangay* in the natural disaster sector. The natural disaster sector has only one vulnerable *barangay*. Most of *barangays* seem to be equipped with adaptive capacity in some degree. It is likely due to learning effect of past natural disasters.

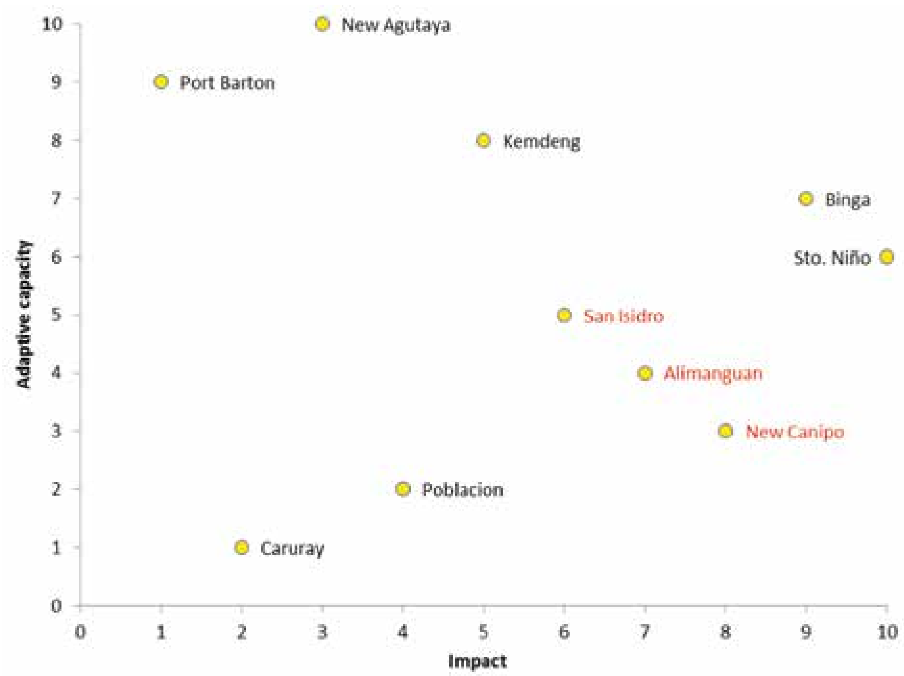


Figure 3.37. Impact vs. adaptive capacity plot by *barangay* in water resource sector

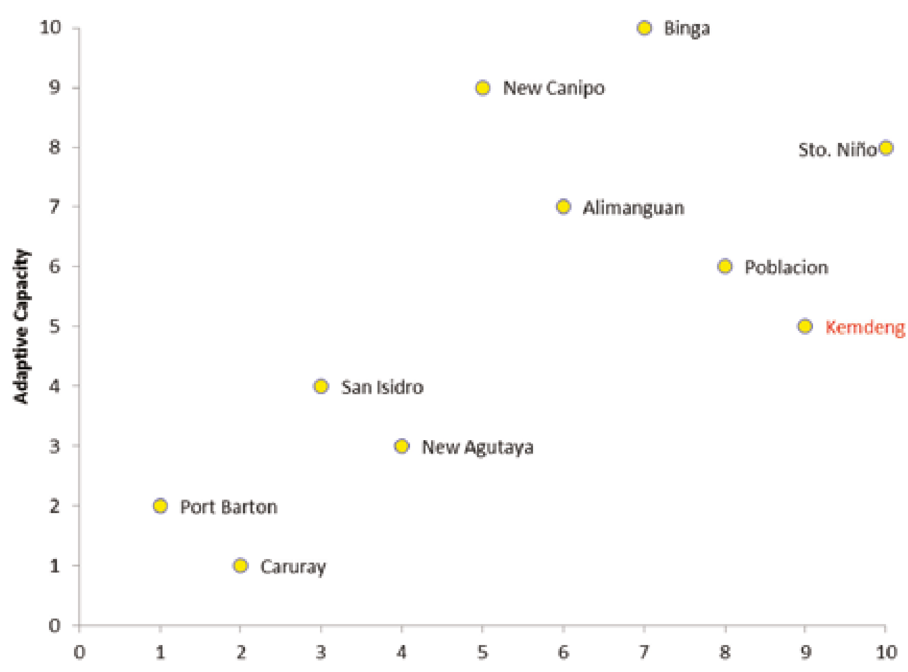


Figure 3.38. Impact vs. adaptive capacity plot by *barangay* in natural disaster

Figure 3.39. Impact vs. adaptive capacity plot by *barangay* in biodiversity sector

Three *barangays*, namely, Binga, Alimanguan and New Canipo are the most vulnerable to climate change in the perspective of biodiversity (**Figure 3.39**). New Canipo, especially, seems to be threatened most by negative impacts of climate change with the lowest adaptive capacity.

Figure 3.40. Impact vs. adaptive capacity plot by *barangay* in natural resources sector

In **Figure 3.40**, San Isidro, Binga, Poblacion and Sto. Niño are vulnerable to climate change in terms of natural resources. 40% of the *barangays* in San Vicente were assessed to be vulnerable to climate change in terms of biodiversity. Further attention to the biodiversity sector from the government is necessary.

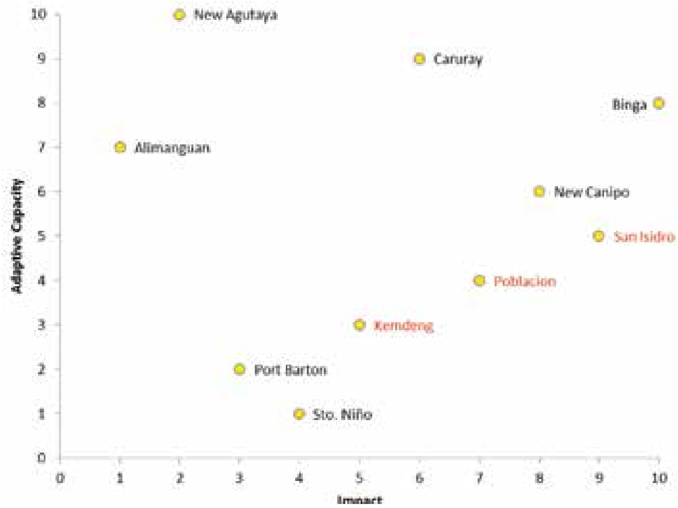


Figure 3.41. Impact vs. adaptive capacity plot by *barangay* in energy sector

In the energy sector, Kemdeng, Poblacion and San Isidro are the most vulnerable to climate change as indicated in **Figure 3.41**. However, San Isidro which is expected to experience most negative impacts of climate change seems to have a certain degree of adaptive capacity while Kemdeng is exposed to less impact with lower adaptive capacity. In this regard, the energy sector has relatively less urgency for policy actions.

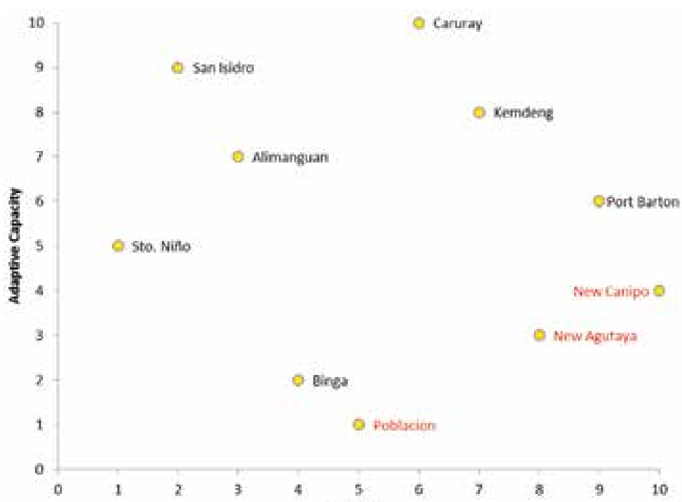


Figure 3.42. Impact vs. adaptive capacity plot by *barangay* in living condition and poverty sector

Poblacion, New Agutaya and New Canipo are vulnerable to climate change in the living condition and poverty sector (**Figure 3.42**). New Canipo is assessed to be affected the most by climate change, and have less adaptive capacity in this sector.

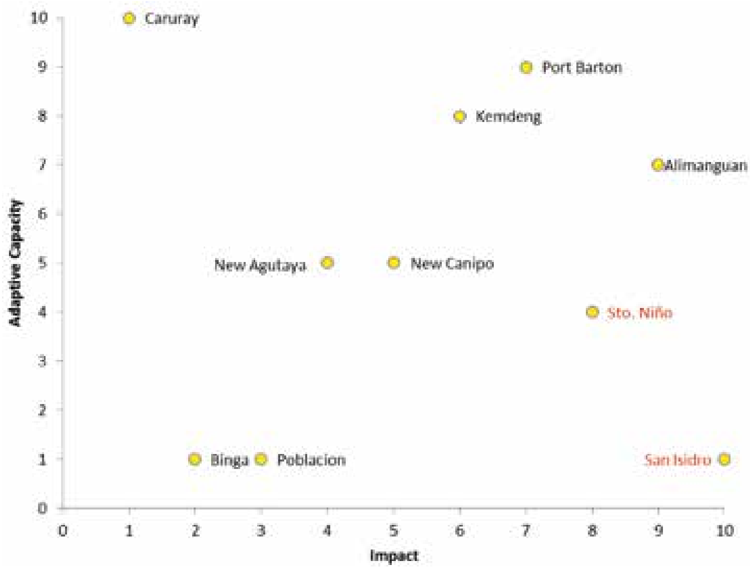


Figure 3.43. Impact vs. adaptive capacity plot by *barangay* in industries

In the industry sector, Sto. Niño and San Isidro are the most vulnerable *barangays*. San Isidro, especially, shows the highest impacts with lowest adaptive capacity. (**Figure 3.43**)

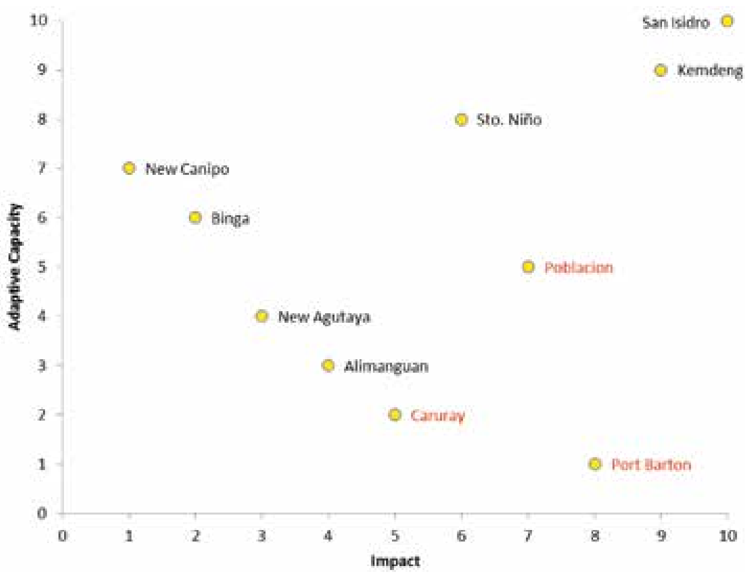


Figure 3.44. Impact vs. adaptive capacity plot by *barangay* in health sector

In **Figure 3.44**, Caruray, Poblacion and Port Barton are the most vulnerable to climate change in terms of health. Port Barton has the lowest adaptive capacity to respond to the expected high impacts of climate change.

To sum up, the *barangays* found as the most vulnerable *barangays* are mostly vulnerable not only in one sector but also in several related sectors. Alimanguan, Kemdeng, Binga and Sto. Niño are considered to be vulnerable in two different sectors. New Canipo is also vulnerable in three sectors. San Isidro and Poblacion are vulnerable in four sectors and require more attention and support from the government.

F. Cross-sectoral vulnerability assessment

The results of the three sectoral assessments of climate vulnerability revealed that climate change affects the agriculture, health, and coastal and marine sectors at different levels. To conduct a comprehensive vulnerability assessment, the sectoral data collected are viewed in a holistic approach, the outcomes of which will serve as inputs in prioritizing adaptation options to make sure that one adaptation measure selected for one sector will not have detrimental impacts on another. One concrete example is the promotion of aquaculture to ensure food security (agriculture), in a way that does not further deplete fish stock or mangroves, by providing areas for fishponds (coastal and marine).

Case in point is that researchers have found that, "adaptation strategies for forests/agriculture have mixed effect on the various institutions in the watershed. Most of the adaptation strategies recommended require additional investments." In addition, "adaptation strategies are not neutral; that is, they could affect other sectors both positively and negatively. Thus, a cross-sectoral analysis should be done at the watershed scale to ensure that negative effects are anticipated and mitigated before the implementation of adaptation strategies." (Lasco et al. 2006)

Cross-sectoral integration involves integrating impacts across related sectors. These are sectors that can be directly affected by climate change and by climate change impacts in other sectors. Cross-sectoral integration involves examining a small number of sectors that are strongly interrelated, such as water and health. For example, human health can be affected by changes in water resource management. Similarly, human health can be affected by decreases in food security, as a result of decline in agricultural production (UNFCCC).

As revealed in the natural resource assessment, the fishery sector confronts a serious problem, where the fishing practices have clearly led to depletion of fish biomass and the deterioration of marine conditions required in maintaining a sustainable fish biomass. Apparently, the reduced fish stock is already affecting the local income. If this situation worsens, this might threaten food security in the locality and lead to higher risks of malnutrition since the local residents are highly dependent on the coast as a source of food. Similarly, the potential decrease in crop yield from extreme climate event (drought and flood) will affect also affect the health of local residents due to malnutrition.

Coastal flooding can also inflict damage to agriculture. Saltwater intrusion can be detrimental because water with high salt concentration can adversely affect vegetation. Inundation of seawater for a long time after flooding will increase the salinity of agricultural lands, especially the low lying areas, which will be harmful to the crops (Ramsay, 2008). Worse, food crops and forests can be highly threatened because of the salinity of the soils or wiped out by the movement of flood waters (Nicholls, 2002).

Saltwater can also affect coastal freshwater bodies, which are the habitats for freshwater organisms and serve as sources of drinking water including lakes, lagoons and coastal freshwater aquifers (Hunt et al., 2011). Groundwater contamination caused by flooding poses serious consequences for public health. Another health risk associated with sea-level rise is diarrhea since coastal inundation might potentially decrease the freshwater supply, exacerbating overcrowding conditions, and disrupting sanitation and water supply.

In San Vicente, insect and rat infestation is an offshoot of the changes in the climatic conditions because such conditions favor the rapid multiplication of insect and rats that feed on agricultural crops. The anticipated increase in infestation especially in coconuts, brought about by the increasing temperature and changing precipitation patterns, does not only pose a threat to the local vegetation but also to the health of residents, as some pests might bring infectious or contagious diseases (shifting disease patterns or new combinations of pests and diseases may also emerge as a result of the changing climate). According to the World Research Institute, any increase in the frequency or severity of extreme weather events, including droughts, heat waves, windstorms, or floods, could disrupt the predator-prey relationships that normally keep pest populations in check. It was also emphasized that the effect of climate on pests may add to the effect of other factors such as the overuse of pesticides and the loss of biodiversity that are already contributing to plant pest and disease outbreaks.

In sum, the conduct of cross-sectoral vulnerability assessment operates on and reiterates the following points:

1. **Climate change impacts do not happen in isolation from each other**. What happens in one sector, or region, can affect other sectors or regions. Indeed, impacts that are the result of a climate impact on another sector, region or population can be as important as the direct effects of climate change (UNFCCC).
2. **Integration is necessary for prioritizing adaptation measures.** Understanding the interrelationships between sector-specific climate risks significantly guides the prioritization of adaptation options, as well as the setting of appropriate policy goals and adaptation financing accordingly.

Chapter 4

Climate change adaptation measures

Figures and tables

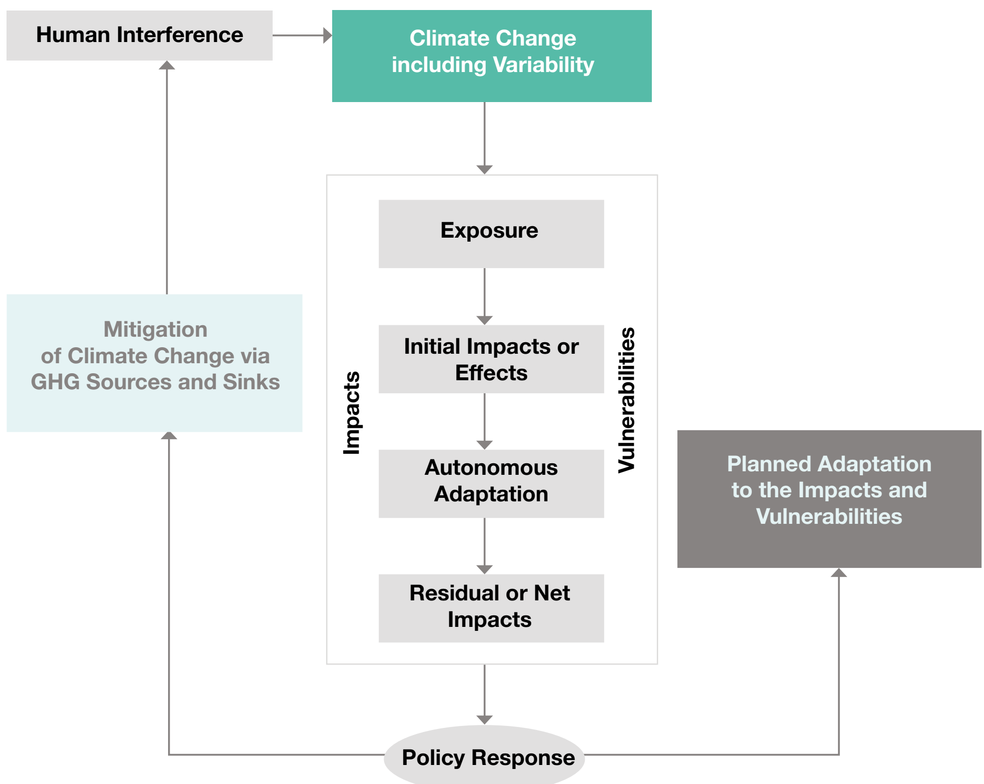
A. Formulation and prioritization of adaptation measures

1. Methodology and identification of options

Adaptation to climate change is a rapidly growing challenge, particularly for developing countries like the Philippines. Even if greenhouse gas emissions are reduced significantly in the coming years, climate change impacts such as gradual, temporal and spatial shifts in resources, as well as drought, floods, severe weather events and sea-level rise are likely to result in food shortages, increases in vector-borne diseases, infrastructure damage and the degradation of natural resources. The poor will be affected disproportionately, and development choices today will influence the adaptive capacity of people and their governments well into the future. It is necessary to not delay adaptation planning and actions to ensure that maladaptation does not exacerbate adverse climate impacts and impede sustainable development.

Adaptation, as defined by the IPCC (2007), is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. It can occur autonomously or spontaneously in reaction to impacts that are already being experienced; however, this runs the risk of being effective only in the short to medium-term. More challenging is adaption that is planned, programmatic and integrated into long-term development.

In the Philippines, mitigation[1] initiatives can also be considered adaptation, if they involve



Source: IPCC 2001, Smith et al. 2005

FIgure 4.1. Entry points for adaptation

1 Mitigation is defined as an anthropogenic intervention to reduce the antropogenic forcing the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks (IPCC,2007).

lifestyle or operational adjustments that also lessen sensitivity or build resilience, coping capacities or adaptive capacities (e.g., improved transportation systems or energy infrastructure).

The IPCC *Fourth Assessment Report* differentiates between autonomous and planned adaptation as follows:

> **Autonomous adaptation:** Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human system.
>
> **Planned adaptation:** Adaptation that is the result of a deliberate policy decision, based on awareness that conditions have changes or is about to change and that action is required to return to, maintain or achieve a desired state.

Given the biophysical impacts and the socio-economic impacts of climate stressors, the risks that these impacts pose for the achievement of development objectives are assessed at the local level. Since climate impacts are localized, depending on a number of variables, which are context-specific, adaptation measures will be identified and prioritized accordingly.

Based on the results of the natural resources assessment and the vulnerability assessment, planned adaptation measures are identified for San Vicente. Options are identified in order to increase resilience and coping capacity of the three identified sectors (agriculture, coastal and marine and health) with the current and future changes.

Identification of adaptation options

Identified 'responses' using the top-down approach of the DPSIR Framework is reinforced through a series of stakeholders' consultations. Under the principles of good adaptation, the identification and engagement of the relevant stakeholders are considered key to success. Stakeholders contribute through the knowledge and skills that they bring to the process. The more comprehensive the knowledge and skills base, the more informed the stakeholders are about the process and the underlying factors, the more likely that the resulting adaptation decision will be deemed successful (UK Climate Impacts Program).

For the eight sectors which were analyzed by VA including water resources, natural disasters, biodiversity, energy, living condition and poverty, infrastructure and key economic sectors, a list of possible adaptation measures was identified through a careful review of the science and the literature, and these were included as assessment indicators. Key adaptation options were selected by the results of VA assessment and stakeholder consultations during the field trips to the San Vicente. A long-list of adaptation measures were separately created for the focused sectors, namely: agriculture, health and coastal and marine, based on the literature review.

a. Adaptation options from the bottom-up approach

The following are the menu of adaptation options for the agriculture, coastal and marine and health sectors. The following lists are based on the VA matrix charts.

Farming practices
• Use of new crop varieties - drought and flood resistant cultivars • Crop diversification • Organic farming practices • Balanced fertilization strategies to sustain soil quality • Change in cropping pattern and practices • Enhanced disease and pest management practices
Technical measures and infrastructure
• Small-scale irrigation systems • Farm-to-market roads • Post-harvest facilities • Early warning systems • Weather stations
Governance, policy, and others
• Training for alternative livelihood • Programs to enhance the value chain of agricultural sales • Establishment of farmer's field schools and programs • Weather-based insurance programs (risk-transfer mechanisms, microfinance)

Table 4.1. Menu of adaptation options for agriculture

Fishing practices and marine management
• Implementation of open and closed fishing season • Extension of core protection zones • Coral rehabilitation (i.e., herbivore seeding) • Moratorium on the catching of herbivores, demersal, and pelagic species • Monitoring illegal fishing • Total fish-catch monitoring • Organization and strengthening of fisherfolk organizations • Improvement of seaweed production, marketing and trading
Technical measures and infrastructure
• Sea walls and dikes in Port Barton • Early warning systems • Mangrove reforestation • Patrol boats • Tourism infrastructure (water, food supply, power, communications)
Governance, policy and others
• Training for alternative livelihood • Promotion of private sector involvement in coastal planning and management • Control development in vulnerable coast line areas • Trainings and orientation on disaster risk reduction and management • Strict enforcement of the Fisheries Code and other related laws • Enhanced Information, education, and communication on coastal and marine • Local policy environment for coastal resource management • Institutional strengthening of Bantay Dagat (Watchers of the Sea) • Policy for water resource use conflict resolution • Pilot study on brood stock culture • Full marine resource inventory • Community-based forest management programs • Seagrass re-plantation • Development of ecotourism

Table 4.2. Menu of adaptation options for coastal and marine

Health practices
• Programs for vector control and vaccination • Training on early detection and treatment of infectious, water- and vector-borne diseases • Creation of community health teams • Regular health weighing and monitoring • Programs for regular water quality sampling and tests • Disease surveillance program
Technical measures and infrastructure
• Early warning systems • Water supply systems (to level 1 and 2) • Insecticide impregnated bednets • Rapid treatment strips for malaria and water tablets (Puritabs) • Basic sewerage and landfill system • Fans and cooling facilities • Emergency vehicles • Water impounding systems • General and emergency medical services
Governance, policy, and others
• Increased enrolment in health financing facility (PhilHealth) • Public health and hygiene training for the youth • Repairing roofing of housing • Programs to increase secondary growth of fast growing shade tree species • Promoting climate-resilient crops • Government seed subsidies and farm implements • Implementation of zoning ordinance influenced by hazard or risk maps • Increased government budget allocation for equipment and health personnel

Table 4.3. Menu of adaptation options for health

b. Adaptation options from the top-down approach

The adaptation options for the most vulnerable *barangays* in each sector were suggested based on the outcomes of the sectoral vulnerability assessment, literature review as well as field research to the Municipality of San Vicente.

The following tables show the typical major risk of climate change impact in each sector, and suggest the adaptation options to cope with such risks. However, the actual impact can be varied from *barangay* to *barangay* according to its geographical, economic and social environments.

Natural disaster	
Major impacts	Flood and storm, landslide
Vulnerable barangay	Kemdeng
Adaptation options	• Wetland protection program • Establishment of early-warning system and evacuation procedure guideline for flood • Construction of landslide protection facilities for excavated slopes

Table 4.4. Adaptation options for water resources

Natural disaster	
Major impacts	Flood and storm, landslide
Vulnerable barangay	Kemdeng
Adaptation options	• Wetland protection program • Establishment of early-warning system and evacuation procedure guideline for flood • Construction of landslide protection facilities for excavated slopes

Table 4.5. Adaptation options for natural disaster

Biodiversity	
Major impact	Decrease in flora and fauna species
Vulnerable barangays	Binga, Alimanguan, New Canipo
Adaptation options	• Wetland protection program • Establishment of natural ecology preservation plan

Table 4.6. Adaptation options for biodiversity

Natural resources	
Major impacts	Crop yield reduction, loss of forest resources
Vulnerable barangays	San Isidro, Binga, Poblacion, Sto. Niño
Adaptation options	• Establishment of preventive measures of crop diseases and pests • Enlargement of irrigated rice field area • Establishment of development limited area management plan

Table 4.7. Adaptation options for natural resources

Energy	
Major impact	Electricity use increase
Vulnerable barangay	Kemdeng, Poblacion, San Isidro
Adaptation options	• Establishment of action plan for renewable energy facilities development • Construction of power plant and transmission facilities

Table 4.8. Adaptation options for energy

Living condition and poverty	
Major impacts	Flood hazard, poverty
Vulnerable barangays	Poblacion, New Agutaya, New Canipo
Adaptation options	• Promotion of public awareness campaign and education on natural disasters

Table 4.9. Adaptation options for living condition and poverty

Industry	
Major impact	Reduction in production
Vulnerable barangays	Sto. Niño, San Isidro
Adaptation options	• Development of climate-adaptive crops • Establishment of development plan for alternative industry such as tourism

Table 4.10. Adaptation options for industry

Health	
Major impacts	Increase of infectious, allergic, and cardiovascular diseases, heat-related mortality
Vulnerable barangays	Caruray, Poblacion, Port Barton
Adaptation options	• Establishment of more health stations • Securement of adequate unit of ambulances • Improvement in the number of medical manpower • Development of master plan for comprehensive healthcare operation • Development of allergenic fauna and flora monitoring system • Installation of shelters for heat waves

Table 4.11. Adaptation options for health

In the case of infrastructure, some major impacts on water supply, sewage treatment, and transport infrastructure were identified by the impact analysis, but the adaptive capacity was not included due to insufficiency and irregularity of data. However, it is considered that a suitable level of water supply system, sewage treatment system, and road construction and pavement is effective to increase adaptive capacity to climate change in the infrastructure sector.

Prioritization of adaptation options

Due to limitation in resources to finance all identified adaptation options, prioritization of adaptation measures is critical in planning. The task of prioritization is working on a set of criterion which reflects the technical, economic, social and environmental aspects of a menu of options, with consideration on the given local conditions and implementation capacities.

Similar to other decision-making processes, the prioritization of adaptation options can become a highly subjective process dealing with many uncertainties. Despite the difficulties involved, there is a range of methodological approaches and analytical tools available for the prioritization of adaptation options. Of the commonly used tools are the cost-benefit-analysis (CBA), cost effectiveness analysis (CEA), and multi-criteria-analysis (MCA). Given the long-list of the adaptation options derived by the stakeholders of this study, quantitative tools were not considered as they require a significant amount of time and effort to be made in calculating a multiple number of costs and benefits per adaptation options. Another limitation of the quantitative methods is that they are relatively ineffective in tackling problems (such as climate change adaptation) where monetary estimates of the benefits are not readily available. Of the different multi-criteria tools (e.g., analytical hierarchy process, outranking, ideal point, permutation, etc.), a simple weighted-summation method was adopted as it enables a realistic representation of the decision problem to be made, and explicit understanding of the particular trade-offs.

The following criteria were selected to evaluate the long-list of adaptation options derived by the local stakeholders and groups of experts that conducted the vulnerability assessments of this study. All criteria are equally weighted.

Effectiveness: Extent to how effective the adaptation option reduces vulnerability and provides other benefits

Costs: Relative costs of an adaptation option (i.e., investment costs, costs across time, economic and non-economic costs

Technical feasibility: Extent to how the given option is achievable in terms of the technical reliability and risks

Social and cultural feasibility: Level of ease in involving stakeholders and utilizing their inputs in a meaningful process

Required time: Time required to realize the benefits of an adaptation option

Sustainability and overall impact: Level of financial input and technical ease involved in continuing the benefits of the adaptation option over time. The level of contribution by an adaptation option toward the achieving the overall goal (i.e., reducing climate change vulnerability in each sector).

While the long-list of adaptation measures was derived from a participatory approach involving stakeholders operating at different decision-making levels, the prioritization criteria listed above was selected and used by a selected group of experts. Although such practice may fail to directly reflect the different preferences and subjective views of local stakeholders in the valuation of adaptation measures, it was a decision made because local stakeholders were not given the opportunity to review and fully understand the wide range of adaptation measures available (this is an issue to be improved upon in planning future studies). Another reasoning that supported the need for expert judgment in the process of prioritization was in the failure of some stakeholders in anchoring the suggested adaptation measures to the results of the preceding activity– vulnerability assessments. The adaptation options suggested by these stakeholders were primarily focused on enhancing their livelihood conditions rather than their adaptive capacities (or reducing exposure or sensitivity to climate risks), which is conceivable considering how the two issues (i.e., livelihood and climate change adaptation) are highly interconnected.

	Effectiveness	Cost	Technical feasibility	Social/ cultural feasibility	Required time	Impact	Result
Farming practices							
Use of new crop varieties – drought and/or flood resistant cultivars	High	Medium	High	High	Low	High	High
Crop diversification	High	Medium	Low	High	High	High	Medium
Organic farming practices	Medium	High	High	Low	High	High	Medium
Balanced fertilization strategies to sustain soil quality	Low	Medium	High	Low	High	Low	Medium
Change in cropping pattern and practices	High	Low	High	High	Low	Low	High
Increased disease and pest management practices	High	High	High	Low	Low	Medium	Medium
Technical measures and infrastructure							
Small-scale irrigation systems	Medium	High	High	High	High	High	High
Farm-to- market roads	Medium	High	Medium	Medium	High	Low	Medium
Post-harvest facilities	High	Medium	Medium	Low	Medium	Medium	Medium
Early warning systems	Medium	Low	Medium	Medium	Low	Medium	Medium
Weather stations	High	Low	High	Medium	Low	High	High
Governance, policy, and others							
Training for alternative livelihood	Medium	Low	Medium	High	Low	Medium	High
Programs to enhance the value chain of agricultural sales	Medium	High	High	Low	Low	High	Medium
Establishment of farmer's field schools and programs	High	Low	Medium	High	High	Low	High
Weather-based insurance programs (risk-transfer mechanisms, microfinance)	Low	High	High	Low	High	Low	Low

Table 4.12. Prioritized adaptation measures for agriculture

	Effectiveness	Cost	Technical feasibility	Social/ cultural feasibility	Required time	Impact	Result
Fishing practices and marine management							
Implementation of open and closed fishing season	High	Low	Medium	Low	Low	High	Medium
Coral rehabilitation (i.e., herbivore seeding)	High	Medium	High	High	High	High	High
Moratorium on the catching of herbivores, demersal and pelagic species	Medium	High	Medium	High	High	Medium	Medium
Monitoring illegal fishing	High	Medium	Medium	High	High	High	High
Total fish-catch monitoring	High	Low	Low	High	Low	Low	High
Organization and strengthening of fisherfolk organizations	High	Low	Low	High	Low	High	High
Improvement of seaweeds production, marketing and trading	High	High	Medium	Medium	High	Medium	Medium
Technical measures and infrastructure							
Sea walls and dikes in Port Barton	High	High	High	Medium	High	High	High
Early warning systems	High	Low	High	Medium	Low	High	High
Mangrove reforestation	Medium	Low	Medium	High	Medium	Medium	High
Patrol boats	Medium	High	Medium	Low	Medium	High	Low
Tourism infrastructure (water, food supply, power, communication)	Low	High	Low	Low	High	Medium	Low
Governance, policy, and others							
Training for alternative livelihood	High	Low	High	High	Low	Low	High
Promotion of private sector involvement in coastal planning and management	High	Low	High	High	Low	Medium	High
Control development in vulnerable coastline areas	High	High	Medium	Low	High	High	Medium
Trainings and orientation on disaster risk reduction and management	Medium	Medium	High	High	High	Medium	High
Strict enforcement of the Fisheries Code and other related laws	High	Low	Medium	Low	Low	High	Medium
Enhancement of information, education, and communication on coastal and marine	High	Low	High	High	Low	High	High

	Effective ness	Cost	Technical feasibility	Social/ cultural feasibility	Required time	Impact	Result
Local policy environment for coastal resource management	Medium	Low	Low	Medium	High	Medium	Medium
Institutional strengthening of *Bantay Dagat* (Watchers of the Sea)	Medium	Low	Low	Medium	High	Medium	Medium
Policy for water resource use conflict resolution	High	Medium	High	High	High	Medium	High
Pilot study in brood stock culture	Medium	High	High	Medium	High	Medium	Medium
Full marine resource inventory	Medium	High	High	Medium	High	Medium	Medium
Community-based forest management programs	High	Medium	Medium	Medium	High	Medium	Medium
Seagrass replantation	Medium	High	High	Medium	High	Medium	Medium
Development of ecotourism	Medium	High	Low	Low	High	High	Low

Table 4.13. Prioritized adaptation measures for coastal and marine

	Effective ness	Cost	Technical feasibility	Social/ cultural feasibility	Required time	Impact	Result
Health practices							
Programs and vector control and vaccination	High	High	Medium	Medium	Low	High	Medium
Training on early detection/ treatment of infectious, water- and vector – borne diseases	High	Medium	Medium	High	Medium	High	High
Creation of community health teams	Medium	Medium	Low	Medium	High	Medium	Medium
Regular weighing and monitoring	Low	Low	High	High	Low	Low	High
Programs for regular water quality sampling and tests	Low	High	Low	High	High	Low	Low
Disease surveillance program	Medium	High	High	Medium	High	High	Medium
Technical measures and infrastructure							
Early warning systems	Low	Low	Medium	Medium	Low	Low	Medium
Water supply systems (to level 1 and 2)	High	High	High	Medium	High	High	High
Insecticide impregnated bednets	Medium	Low	High	High	Low	Medium	High
Rapid treatment strips for malaria and water tablets (Puritabs)	Medium	Low	High	High	Low	Medium	High
Basic sewerage and landfill system	Medium	High	High	Medium	High	High	Medium
Fans and cooling facilities	High	Low	High	High	Low	Medium	High
Emergency vehicles	Medium	Medium	Low	Medium	Low	Low	Low
Water impounding systems	Low	High	Medium	Medium	High	Low	Medium
General and emergency medical services	Medium	High	High	Medium	High	High	Medium

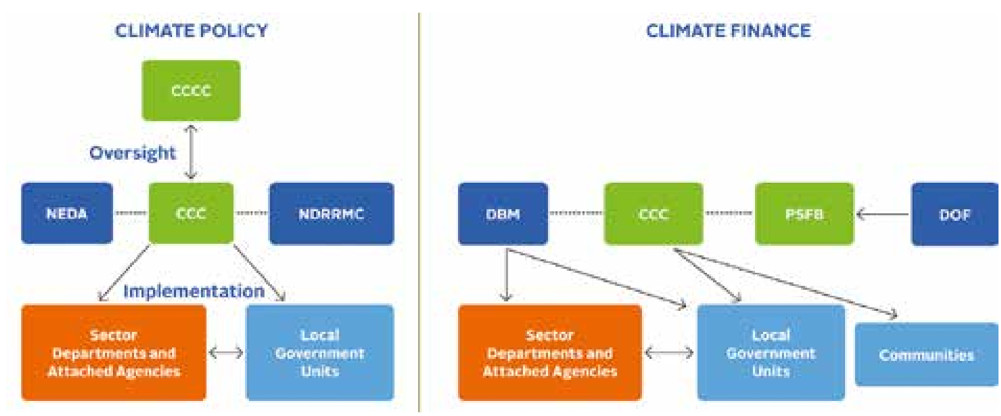
	Effectiveness	Cost	Technical feasibility	Social/ cultural feasibility	Required time	Impact	Result
Public health and hygiene training for the youth	High	Low	Medium	High	Low	High	High
Repairing roofing of housing	Medium	High	Low	High	High	High	Medium
Programs to increase secondary growth of fast growing shade tree species	Medium	Medium	Low	High	High	Medium	Medium
Promotion of climate-resilient crops	Low	High	Medium	Medium	High	High	Low
Government seed subsidies and farm implements	High	High	Low	High	High	Medium	Medium
Implementation of zoning ordinance influenced by hazard or risk maps	Medium	Low	High	Medium	Low	Medium	High
Improvement in government budget allocation for equipment and health personnel	High	High	Low	High	High	High	Medium

Table 4.14. Prioritized adaptation measures for health

B. Financing schemes

1. Internal sources

The finance structure of the Philippines shows that both the national and local government units have several access points to climate finance. As illustrated in the Philippine Climate Public Expenditure and Institutional Review (CPEIR), the Department of Budget and Management (DBM) leads the public expenditure management of the national and local governments. The LGUs have several options financing their local programs, specifically adaptation measures.



ACRONYMS

BUB	Bottom-Up Planning and Budgeting	DBM	Department of Budget and Management
CCC	Climate Change Commission	DoF	Department of Finance
CCCC	Cabinet Cluster on Climate Change	LDF	Local Development Fund
NEDA	National Economic and Development Authority	LDRRMF	Local Disaster Risk Reduction and Management Fund
NDRRMC	National Disaster Risk Reduction and Management Council	PCF	Performance Challenge Fund
		PDAF	Priority Development Assistance Fund
NGA	National Government Agency	PSFB	People's Survival Fund Board

Source: The World Bank, 2013

FIgure 4.2. Climate policy and climate finance environment in the Philippines

Sources of funds at the local level

The LGUs are the frontline agencies in implementing climate change adaptation at the local level. They primarily operate and implement programs and projects using their Internal Revenue Allotment (IRA). Most programs and projects relate to the delivery of basic services that are affected by climate change such as: agriculture, environment, health, and infrastructure. The amount of the IRA is mainly dependent on the total population of the LGU (50%) and land area (25%) and equal sharing (25%), per the *Local Government Code of 1991*. Aside from IRA, the other potential sources of funding for climate change related activities come from the LGU's own funds through the Local Disaster Risk Reduction and Management Fund (LDRRMF), which finances activities on disaster prevention and represents up to 5% of the General Fund.

Sources of funds at the national level

To ensure efficient implementation of climate change adaptation programs, Congress passed *Republic Act 10174* which amended certain provisions of *R.A. 9729* and created the People Survival Fund (PSF).[2] It is a dedicated source of funding for LGUs and communities for financing adaptation programs and projects. These include adaptation activities, monitoring system for vector borne diseases, forecasting and early warning systems, institutional strengthening and risk guarantee, among others. Although PSF has not yet been operationalized, it serves as a catalyst to local climate financing and thereby prepares the institutions in seeking international finance.

Also, innovative budgeting tools have been introduced that can support local climate financing, in general. These are the Program Approach Budgeting - Bottom-Up Planning and Budgeting (BUB). Under the DBM, it implemented the Program Budgeting Approach that creates convergence efforts among the national government agencies in achieving the strategic objectives of the government. Strategic programs under the five key results areas (KRAs)[3] of the *President's "Social Contract"* espoused in the Philippine Development Plan were identified and prioritized for funding.

Adaptation measures can also be financed by capitalizing on the BUB approach especially because this looks into the programs of the LGUs vis-à-vis the national government agencies. The BUB is conceptualized to ensure the "inclusion of the funding requirements for the development needs of at least 300 of the 609 selected focus local government units" that have been identified under the Human Development and Poverty Reduction Council.[4] In this approach, the budget proposals of the agencies consider the development needs of the poor LGUs based on the local poverty reduction plan which mainstreamed, among others, climate change adaptation strategies. The identified priority projects can be financed either by the LGU itself through its Annual Investment Plan or for consideration of the national agencies' proposed budgets (Department of Budget and Management, 2012).

Majority of the financial resources for climate change adaptation at the national level is sourced through the *General Appropriations Act*, Special Purpose Funds and Special Account in General Funds. Although a great part of the aforementioned funds support flood control and management-related programs and projects (The World Bank, 2013), the LGU can also tap direct funding from the appropriate agency especially for climate change actions that were previously implemented by the said national government agency.

The Performance Challenge Fund (PCF), although developmental in nature, is another

2 The PSF was established through *Republic Act No. 10174* (*An Act Establishing the People's Survival Fund to Provide Long-Term Finance Streams to Enable the Government to Effectively Address the Problem of Climate Change*...)

3 The five KRAs are Transparent, Accountable, and Participatory Governance; Poverty Reduction and Empowerment of the Poor and Vulnerable; Rapid, Inclusive, and Sustained Economic Growth; Just and Lasting Peace and the Rule of the Law; and Integrity of the Environment and Climate Change Adaptation and Mitigation. (*Executive Order No.43, Series of 2011*)

4 One of the cabinet clusters formed in response to the social contract of the gornment provided under *Executive Order No.43, Series of 2011.*

facility that is made available to finance local development projects that is supportive to the achievement of the Millennium Development Goals. It is an incentive fund available to low income class municipalities through counterpart funding of local development projects identified in the LGU's Annual Investment Plan (AIP). It puts a premium on the performance of the LGU as basis to avail of financial support for local economic development initiatives for poverty reduction, which could also be related to climate change adaptation measure (Department of Interior and Local Government, 2011).

Required Cost Sharing	Partial • Philippine Challenge Fund (PCF) (50%) • Bottom-Up Planning and Budgeting (BUB) (5-30%) • Direct spending by National Government Agencies (NGAs) (10-70%)	None • Priority Development Assistance Fund (PDAF) • Local Development Fund (not applicable) • Local Disaster Risk Reduction and Manangement Fund (LDRRMF) (not applicable)	
Eligibility	Non-restrictive • LDRRMF • LDF • People's Survival Fund (PSF)	Poverty-based • PDAF (poor LGUs; 4th to 6th class) • BUB (609 poorest municipalities)	Multiple factors • PCF (based on Performance Assessment and poverty rate) • Direct spending (Qualify if help deliver sectoral priorities)
Purpose	Adaptation and Disaster Risk Reduction and Management • LDRRMF	Adaptation only • PSF	General development (including adaptation) • LDF • PCF • PDAF • BUB • Direct spending by NGA

FIgure 4.3. Summary of the local sources for climate financing

2. External sources

At the country level, the platform for donors and national agencies to coordinate on efforts to climate change was created through the Philippine Development Forum (PDF) – Climate Change Working Group. It serves a process to develop consensus as well as get commitments from stakeholders towards the achievement of the government's agenda.

At the global level, there are a number of currently available funding mechanisms for climate change adaptation. The UNFCCC compiled 12 adaptation funding options that are available for the Philippines. These vary from grants, loans and technical assistance and focus on different sectors such as food security, agriculture, forestry, fisheries, water, population, disaster risk reduction, oceans and coastal, water and terrestrial ecosystems (**Table 4.15**). (United Nations Framework Convention on Climate Change).

Name	Sectoral focus	Description
Benefit-sharing Fund of the International Treaty on Plant Genetic Resources for Food and Agriculture	• Food security • Agriculture • Forestry • Fisheries	Shared responsibilities between government and private/business sector
Cool Earth Partnership	• Food security, agriculture, forestry, and fisheries • Water • Population & human settlements	The Cool Earth Partnership is funded by the Government of Japan. Assistance will be provided to developing countries, which are vulnerable to the adverse effects of climate change (e.g., African and Pacific island counties), to take adaptive measures.
Cooperation Fund for the Water Sector (CFWS)	• Water	The Cooperation Fund for the Water Sector (CFWS) is funded by the Asian Development Bank (ADB). It finances a coherent program of activities designed to promote effective water management policies and practices in Asia-Pacific.
Development Market Place (DM)	• Disaster risk reduction • Education and training	The Development Marketplace is a competitive grant program administered by the World Bank. The 2009 global competition focuses on climate adaptation.
Global Facility for Disaster Reduction and Recovery (GFDRR)	• Terrestrial ecosystems • Disaster risk reduction • Education and training • Food security, agriculture, forestry, and fisheries • Health • Oceans and coastal areas • Population & human settlements • Science, assessment, monitoring and early warning • Tourism • Water	The Global Facility for Disaster Reduction and Recovery (GFDRR) is funded by the World Bank. It provides technical and financial assistance to low and middle income countries to mainstream disaster risk reduction into their national plans.
International Climate Initiative	• Water • Food security, agriculture, forestry and fisheries • Disaster risk reduction • Health • Population & human settlements • Terrestrial ecosystems	The International Climate Initiative is a key element of the government of Germany in the implementation of fast-start financing.

Name	Sectoral focus	Description
MDG Achievement Fund (MDG-F)	• Food security, agriculture, forestry, and fisheries • Water • Terrestrial ecosystems • Disaster risk reduction • Health • Oceans and coastal areas • Population & human settlements • Science, assessment, monitoring and early warning • Education and training • Tourism	The MDG Achievement Fund (MDG-F) is funded by the Spanish government and is implemented through agencies such as UNDP, UNICEF and FAO. One of its funding areas is environment and climate change related activities.
Program on Forests (PROFOR)	• Food security, agriculture, forestry, and fisheries	The Program on Forests (PROFOR) is funded by the World Bank. It funds projects at all levels that are typically less than two years in length and fall in any of the following thematic areas: forest governance, sustainable forest management, cross-sectoral cooperation and livelihood approach to poverty reduction.
Small Grants Programme (SGP)	• Terrestrial ecosystems • Water • Population & human settlements • Food security, agriculture, forestry, and fisheries	The Small Grants Programme (SGP) is funded through the GEF, and is implemented through UNDP. It aims to deliver global environmental benefits in areas, including biodiversity conservation and protection of international waters through community-based approaches.
Special Climate Change Fund (SCCF)	• Food security, agriculture, forestry, and fisheries • Terrestrial ecosystems • Oceans and coastal areas • Health	The Special Climate Change Fund (SCCF) is funded through the GEF. It assists developing countries in implementing adaptation measures that reduce the vulnerability and increase the adaptive capacity of countries.
Strategic Climate Fund (SCF)	• Terrestrial ecosystems • Disaster risk reduction • Education and training • Food security, agriculture, forestry, and fisheries • Health • Oceans and coastal areas • Population & human settlements • Science, assessment, monitoring and early warning • Tourism	The Strategic Climate Fund (SCF) is funded by the Word Bank, the African Development Bank (AfDB), the Asian Development Bank (ADB), The European Bank for Reconstruction and Development (EBRD), and the Inter-American Development Bank (IDB). It provides financing to pilot new or scale-up existing activities on specific climate change challenges.

Name	Sectoral focus	Description
Water Financing Partnership Facility (WFPF)	• Water	The Water FInancing Partnership Facility (WFPF) is funded by the Asian Development Bank (ADB). It offers technical assistance and loans in three key areas: rural water, urban water, and basin water. The funding in water management projects will promote IWRM and healthy rivers.

Source : United Nations Framework Convention on Climate Change

Table 4.15. External funding options for adaptation in the Philippines

C. Climate proofing of local development plans

1. Methodology

In the preparation of a municipality or city's Comprehensive Land Use Plan (CLUP), local government units are guided by the Guide to Comprehensive Land Use Plan Preparation (2006) by the Housing and Land Use Regulatory Board (HLURB). This document provides the basic steps in preparing the CLUP, one of the fundamental tools for local governance and decision-making.

The Guidebook is comprised of five separate but complementary volumes, which provide the basic steps in the CLUP process (participatory and consultative), starting from "Getting Organized" (Step 1) up to Monitoring and Evaluation (Step 12), as well as the guide to sectoral studies including the integrating frameworks, analytical tools, methods, standards and other tools necessary in undertaking the studies; basic elements for a GIS and other information systems needed in plan preparation process; guidelines for the application of the strategic planning process in the preparation of the CLUP and to important urban area issues and problems including guides for community consultation, and model zoning ordinance.

Combining bottom-up and top-down approaches is recommended in preparing the CLUP. Depending on the approach, planning process at the *barangay*, municipal and provincial levels should be integrated in a consistent structure and the goals for each planning process for each level involves:

> ***Barangay:*** Integration of community participation (Council and community support) for planning as basis for CLUP. This helps ensure ownership and compliance with zoning regulations.
>
> **Municipality or City:** Devise development strategies that are based on the directions of the Provincial Development Physical Framework Plan (PDPFP) and the formation of a Municipal Implementing Team to facilitate the planning process. The municipality/city also develops their investment programs and implements plans.
>
> **Province:** Uses the development directions provided by the PDPFP for municipalities.

It is within the "Analyzing the Situation" (Step 4), where analytical and diagnostic elements become relevant; this step is geared towards identifying certain issues, future development needs and spatial requirements of the municipality. The expected outputs in this step are:

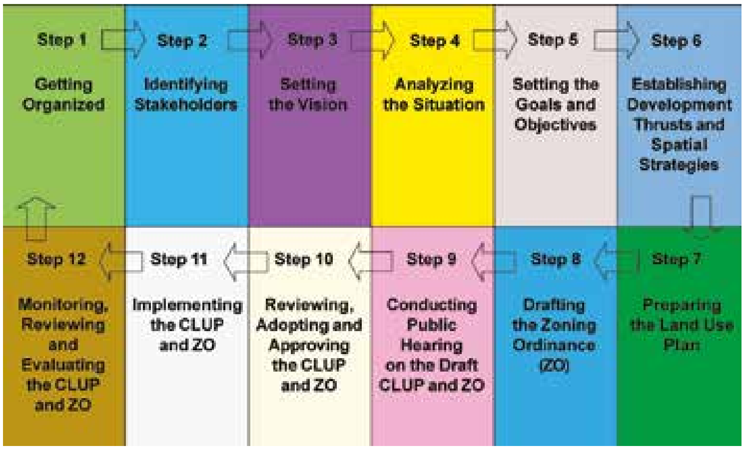


FIgure 4.4. The 12-step process of the Comprehensive Land Use Plan (CLUP)

1) socio-economic, demographic, physical and environmental profile or data base of the municipality; 2) consolidated, prioritized major and significant development needs, issues, strengths and potentials of the LGU which have spatial components and are necessary in the achievement of the vision; and 3) existing land use map, thematic maps and analytical maps of the entire area covered by the city or municipality, including the marine and coastal areas and freshwater wetlands, such as rivers and lakes.

In this step, assessment of the natural/ physical/ environmental features and existing land uses of the municipality is conducted. It aims to: 1) identify the needs, issues, strengths, comparative advantages and potentials of the LGU, including the existing socio-economic and physical and environmental characteristics of the LGU; 2) identify development constraints or issues and concerns sical growth and development of the LGU, as well as opportunities potentials that can be tapped to achieve the LGUs vision; 3) identify Indigenous Knowledge Systems and Practices (IKSP); and 4) identify land requirements of the sectors and potential development areas.

2. Climate proofing San Vicente's local development plans

Overview of the local development planning process

The Local Government Code of 1991 has devolved and decentralized selected functions to local government units (LGUs), entitling them to be the frontliners in delivering the necessary and basic services to their constituents. LGUs have been accorded the primary responsibility to manage the welfare and development of their territories. Among their primary functions is the preparation of their respective local development plans, that articulate the needs and development priorities of their constituencies. For cities and municipalities, the principal local development plans are the Comprehensive Land Use Plan (CLUP), which presents the physical allocation of the LGU territory, and the Comprehensive Development Plan (CDP) that outlines the sector priorities and programs that complement the CLUP. Provinces, on the other hand, are required to prepare the Provincial Development and Framework Plan (PDFP) that covers both physical and sector based components.

Aside from being the long-term guide for the physical development of a city or a municipality, the CLUP provides the basis for preparing the Zoning Ordinance, which is a law designating the use and allocation of land within the political territory. On the other hand, the CDP is considered a medium-term planning document that guides an LGU in pursuing sectoral development programs and provides basis for formulating the Executive-Legislative Agenda (ELA) of each local administration. The projects identified in the CDP are consolidated in the Local Development Investment Program (LDIP), which also has a medium-term timeline. The projects in the LDIP are prioritized and captured in the Annual Investment Plan (AIP), which serves as reference in formulating the Annual Budget Allocation of the concerned LGU.

The local development planning process is both a political and technical exercise and therefore it is essential that the CLUP and CDP are able to objectively capture the development challenges and priorities of a particular LGU otherwise these will not be addressed and realized. The concern, however, is that the technical capacity to prepare realistic plans vary significantly across LGU income classes. In general, LGUs that belong to the lower income classes tend to have insufficient technical capacity to prepare these plans on their own; and limited financial capacity to avail of competent consulting services to prepare these. The political aspect also comes into play as these plans, specifically the CLUP and Zoning Ordinance, are subject to the mandate and review of the LGU Legislative Council and requires a series of consultations with stakeholders. Hence, the preparation of these plans is a complex and dynamic procedure in as much as it is fundamental to local governance.

Recently, the passage of the *Climate Change Act of 2009* has directed LGUs to prepare Local Climate Change Action Plans (LCCAP) to identify measures that will enable them to respond to climate change impacts with the assistance of the Climate Change Commission (CCC). While this new task adds to the challenge that LGUs already contend with in preparing the CLUP and CDP, it is considered a necessary assignment given that the threat of climate change is real and at hand. In view of this, the Demonstration of Eco-Town Project, implemented by the CCC and the GGGI, has extended technical assistance to the Municipality of San Vicente to help the said LGU understand its exposure to climate change risks, identify the corresponding adaptation measures to address these, and determine options to climate-proof its CLUP and CDP.

Objective

The climate proofing exercise is undertaken in view of the following objectives: a) examine the extent to which climate change impacts have been considered in the existing Comprehensive Land Use Plan (CLUP) and Comprehensive Development Plan (CDP) of the municipality; and b) determine the climate change adaptation and mitigation measures necessary to “climate-proof” these documents such that the municipality is able to respond to the impacts of climate change.

Scope

The climate proofing exercise focused on three primary sectors, namely: Agriculture, Forest and Marine Resources, and Health and involved the following activities: a.) Review of the Comprehensive Land and Water Use Plan (CLWUP) and the Municipal Medium Term Development Plan (MMTDP), which serves as the as CDP of the LGU; b.) Consultation and discussion about the prospective climate change adaptation measures with the LGU officials and personnel, as well as other stakeholders; and c.) Identification of the necessary steps to facilitate the integration of these measures to “climate proof” the CLWUP and MMTDP.

General features of the CLWUP and MMTDP

The CLWUP was formulated with a planning period of 11 years (2009 to 2020) and prepared under the administration of the previous Local Chief Executive. On the other hand, the MMTDP was developed in the first term of the incumbent Mayor and has a timeframe of three years (2011 to 2013). While these documents were developed under different administrations, there is general alignment between the two plans as the MMTDP was prepared to operationalize the priorities identified in the CLWUP.

In terms of vision and mission, the CLWUP emphasizes “balancing agriculture, industrialization and tourism while at the same time promoting health, ecological and environmental stability." The MMTDP, on the other hand underscores the importance of "instilling good governance" as a mechanism to effectively provide basic services and develop the municipality as a self-reliant and peaceful place to reside.

Both documents adopt a methodical approach that presents the development challenges and the proposed initiatives to address these. Hence, the cause and effect relationships between the issues and the identified solutions are clearly laid-out. It is also interesting to note that while the CLWUP is expected to focus on the spatial and physical attributes of the municipality, the said document also has a section entitled "Comprehensive Development Plan" that articulates the various sector challenges and projects. The MMTDP, on the other hand is developed exclusively as a sector-planning document that focuses on the following areas: Social, Economic, Infrastructure, and Governance. The social sector discusses concerns related to health and nutrition, housing, education, and disaster risk reduction; while the economic sector addresses the challenges related to agriculture, tourism, cooperatives, and environment. The infrastructure sector, on the other hand, presents issues related to provision of roads and bridges, electricity and water services, and other public utilities. The governance sector is a cross cutting theme because the LGU considers good governance as the mechanism through which the priority programs in the MMTDP could be effectively accomplished.

Climate change related features of the CLWUP and MMTDP

The CLWUP and the MMTDP were examined to determine the development challenges confronting the aforementioned priority areas, namely Agriculture, Forest and Marine Resources, and Health, which are considered most vulnerable to climate change impacts. The corresponding interventions that have been conceived to generally safeguard and further promote the development of the said sectors were also reviewed. As these sectors have significant levels of climate change vulnerability, strengthening them also indirectly enhances the resilience and adaptability of the municipality to the impacts of climate change. The development challenges and proposed actions are discussed in the following sections.

a. Agriculture

The economic activities of the municipality are focused mainly on agriculture with farming and fishing as the staple sources of livelihood. About 50% of the total number of households derive income from fishing, 35% from farming, and the remaining 15% from other activities. However, the potential of agriculture is not fully realized and yet it also faces significant threats from climate change, which will further reduce its productivity. For instance, the potential land area for lowland agriculture is estimated at 3,424 hectares yet only 33% of said area is cultivated. Of the said cultivated area, only about 100 hectares are irrigated and the rest are rain-fed.

The condition of the agriculture sector attributed largely to the inadequacy of supporting infrastructure such as irrigation systems, farm-to-market roads, and pre-and post-harvest facilities to boost productivity. There is also a pronounced gap in soft-interventions such as agricultural support facilities and extension services, and inadequate financial institutions to service fishermen, farmers and traders for their capital investments and business expansion needs. This has serious implications in the ability of the municipality to promote its tourism potential given that food sufficiency is a basic consideration in the formation of tourism hubs. This is further heightened by the potential impact of climate change in agricultural productivity given that more than 90% of the cultivated agricultural areas in the low lands relies on rain for irrigation.

Proposed initiatives. To address these challenges, the CLUP and the MMTDP have identified key initiatives to be undertaken within the 11-year planning period and the three-year term of the current administration, respectively. These include the following:

- Agriculture infrastructure development, such as the construction of additional irrigation facilities, farm-to-market roads, and fish landing;
- Capacity development for local farmers and fishermen and agriculture support offices through skills training and introduction of new technologies;
- Policy interventions to promote people's rights and protect prime agricultural lots; and
- Enforcement of regulations, such as the creation of a Municipal Fishery Regulation Board, to address illegal fishing and utilization of land resource.

b. Forestry and marine resources, and tourism

Discussions related to tourism were included in the analysis of the forestry and marine resources section of the CLWUP and the MMTDP because the thrust of the LGU to promote ecotourism has serious effects on its ability to nurture its forest and marine-based natural assets. The municipality is endowed with more than 10 km of pristine beach that is relatively unexplored and rich forest resource given that 86% of its total land areas are under forest cover. These natural characteristics present the opportunity to pursue ecotourism and already a number of local and foreign investors have ventured on tourism related business such as the establishment of tourism sites and facilities for lodging and accommodation. It presently takes tourists about five hours to travel by land from the provincial capital, Puerto Princesa City, however, the completion of the San Vicente Airport in the next two years is expected to make San Vicente more accessible and can increase significantly the inflow of tourists.

While the LGU is poised to realize economic gains from tourism-related activities, these could also impact negatively on the forestry and marine resources of the municipality if the necessary planning and safeguards are not undertaken. Relative to this, the CLWUP and MMTDP have identified the key issues affecting the growth of local tourism and the forest and marine resource in San Vicente. These issues include the inadequacy of basic utilities such as steady and continuous supply of electricity; the limited number of personnel with the qualifications to manage tourism development and mitigate tourism impacts on natural resources; the insufficient tourism facilities both in number and quality; the uncoordinated tourism program and lack of policies to regulate tourism activities among local investors and businessmen; and the absence of a tourism master plan.

Proposed initiatives. Considering the aforementioned challenges, the CLWUP and the MMTDP underscore the need for continuing capacity development among LGU staff, the community, business sector, and consumers. The primary interventions that have been identified include the following:

- Conduct of community-based forest management programs to educate and empower the communities in managing tourism and safeguarding natural resources;
- Knowledge development for LGU technical staff such as the Tourism Office and the Municipal Environment and Natural Resources Office to facilitate understanding of various ecotourism models and potential application in San Vicente;
- Policy support to facilitate the formulation and issuance of resolutions and ordinances to effectively manage and regulate local tourism;
- Formulation of a Tourism Master Plan that will serve as the blue print in the growth of the local tourism industry in San Vicente;
- Regulation and inspection of tourism establishments; and
- Programs to encourage private investors to operate power plants and augment the supply of electricity in the locality.

c. Health and environment

The CLWUP and the MMTDP present health issues and environmental concerns in the LGU as significantly related. Given this the assessment covered both areas to capture this relationship. Although the LGU is considered a 1st income class municipality, its health sector is beset with fundamental problems that affect the ability of its constituents to have easier and affordable access to health services. The numbers of Rural Health Units, medical facilities, and trained medical personnel are inadequate to respond to the health requirements of a growing population. Augmenting these remain a difficulty given the insufficient LGU budget for health services. Proper nourishment is an issue with the limited food intake among pre-school children and the lack of nutrition information campaigns. The poor road network makes it even more difficult to refer patients to secondary and tertiary hospitals located at a distance outside of the municipality.

In terms of environmental management, the increasing formation of informal settlements in the urban areas and their encroachment within the coastal buffer zones are among the primary concerns that the LGU faces. This man-made phenomenon leads to deterioration in solid and wastewater management practices that ultimately cause poor health conditions. The unregulated conversion of land is also a fundamental issue to contend with because this leads to inconsistent land utilization and environmental degradation. Hence, the LGU sees the need to strictly enforce environmental regulations and conduct an effective assessment of its vulnerability to natural disasters to understand the potential risks caused by inappropriate environmental management, which could serve as basis for pursuing statutory interventions such as local ordinances.

Proposed initiatives. Given the foregoing issues, the CLUP and the MMTDP have determined a number of interventions to improve the delivery of health services and the ability of the LGU to manage its environment. These initiatives include the following:

- Knowledge development for health workers to enhance competence in service delivery;
- Continuing program to inform and educate for healthy lifestyle, nutrition and sanitation;
- Promotion of more efficient solid and waste water disposal technology and systems at the community and household levels to address the spread of vector borne diseases;
- Promote affordable and alternative medicine to promote access by the poor and vulnerable members of the community;
- Construction of sanitary toilet to advocate health and sanitation at the household level;
- Strict enforcement of local regulations pertaining to health and sanitation;
- Feeding program to minimize malnutrition among school children;
- Increase budgetary allocation for the health sector to allow the acquisition of additional medical facilities and supplies.
- Socialized housing programs according to zoning and environmental standards to manage the formation of informal communities;
- Establishment of additional solid waste management facilities such as materials recovery facilities and sanitary landfill and related infrastructures such as drainage, sewerage and flood control systems;
- Enhance the number and competence of LGU personnel tasked to supervise and

enforce environmental regulations;

- Engage the community in environmental management through continuing advocacy at the *barangay* level, development of communal forests, and rehabilitation of watershed areas; and
- Conduct of hazard vulnerability assessment and repair of critical infrastructures in high-risk areas.

d. Other key interventions

Aside from the foregoing, the assessment underscores the following key interventions in the CLWUP and MMTDP that will also help the LGU in responding to the impacts of climate change.

Zoning Ordinance. The CLWUP has an accompanying Zoning Ordinance, which is considered a local law that specifies the various uses of lands within the municipal jurisdiction. It effectively safeguards the physical resources of the LGU and regulates the utilization of forest and marine resources to avoid exploitative practices, hence mitigating the climate change vulnerability of the forestry and marine sectors.

Disaster Risk Management. The MMTDP identifies projects that will enhance the ability of the LGU to prepare for and respond to emergencies caused by natural calamities. These include the establishment of *Barangay* Disaster Risk Reduction Centers (BDRRC); conduct of awareness campaigns; identification and mapping of evacuation centers, and the repair of roads and bridges.

Capacity development in Coastal Resource and Forest Management. The improvement in the capacity of the community to manage forestry and marine resources is a sustainable approach to protecting these from the natural and man-made causes. Aside from empowering the community, this promotes ownership and accountability among the people. At the same time, enhancing the ability of the concerned LGU officials and personnel in the same subject ensures that the necessary regulations are in place and enforced to complement community efforts.

Tourism Development Master Plan. San Vicente has a very good potential to develop as a tourism area. However, if inappropriately managed, the economic gains from tourism could easily redound to environmental losses as tourism activities exert significant pressure on the institutional capacity of the LGU, as well as on the absorptive and carrying capacity of its natural environment. Therefore, the proposed formulation of a Tourism Development Master Plan is seen as a necessary and timely initiative.

Solid Waste Management and Waste Water Management. This is a critical program to support the development of the LGU as a tourism hub. As witnessed in other tourist destinations, the influx of people and economic activities correspondingly lead to larger volumes of waste generation. Hence, the need to ensure that the necessary facilities and programs to manage solid and liquid wastes are in place well ahead of the heightened increase in tourist population to mitigate environmental strain.

Alternative power sources. The LGU suffers from intermittent and limited supply of electricity. The proposed initiatives directed at encouraging the installation of alternative means of generating electricity, such as solar, wind or hydro power, are considered relevant climate change mitigation measures as these will minimize use of fossil fuels and greenhouse gas emissions.

Climate proofing the CLUP and the MMTDP

The project enabled the Municipality of San Vicente to analyze the level of exposure to climate change risks in its Agriculture, Forest and Marine Resources, and Health sectors. Collection and processing of baseline information, such as socio-economic data, climate change projections and natural resource assessment, was initially conducted to provide an objective and scientific foundation for the ensuing stages of analyses. Vulnerability assessment, which includes risk hazard analysis and sector assessment, was subsequently undertaken with results that served as bases for identifying and prioritizing climate change adaptation and mitigation measures for possible incorporation in the CLUP and MMTDP. It should be noted, though, that these measures are not meant to replace the initiatives already outlined in these two documents. Rather, these are intended to supplement these measures and enhance the ability of the LGU to address climate change impacts. The climate proofing exercise presents the exposure and vulnerability of the subject sectors together with the prioritized adaptation measures that could be pursued by the LGU.

a. Agriculture sector

The climate change risk exposure of this sector is significant and will affect an estimated 2,000 hectares of rice land and 990 hectares of coconut land; around 1,700 farmers; and about 3,700 livestock. These impacts will substantially reduce food production and nourishment in the LGU as well as the ability of farmers to sustain their livelihood.

Climate change adaptation measures. To mitigate these climate change risks, the municipality has identified the construction of additional automatic weather stations and small-scale irrigation facilities as priority infrastructure investments. In terms of non-infrastructure interventions, the LGU will pursue the conduct of training to introduce alternative livelihood activities using non-timber forest products and the establishment of field schools and programs for farmers. Improvement of current agriculture practices will also be undertaken and will involve the introduction of new and hybrid crop varieties to increase tolerance to climate changes, and possible alteration of cropping calendar and practice.

b. Coastal and marine sector

The climate change risks confronting this sector include coral bleaching, fish migration and depletion of mangroves thus affecting the volume of fish catch; coastal flooding and erosion that will substantially affect the lives of coastal communities; and salt water intrusion which could alter the potable water resource of the municipality. As projected, these risks will impact on the natural landscape and affect 120 km of coastline; 141,000 hectares of municipal fishing ground; 75% live coral cover; and 832 hectares of mangrove forest. These will also considerably reduce the economic activities of about 7,900 fishermen and an estimated 160 residents that derive their livelihood from tourism.

Climate change adaptation measures. Flagship adaptation measures were identified to mitigate the impact of climate change in the coastal and marine sector. These include construction of infrastructure facilities such as seawalls and dikes in Port Barton; establishment of early warning system; and mangrove reforestation. To complement these infrastructure interventions, the LGU will establish a system to monitor total fish catch and illegal fishing practices; educate, organize and strengthen fisherfolk organizations as LGU partners to monitor and safeguard coastal and marine resources; and embark on coastal rehabilitation programs to improve coral resiliency. The municipality will also pursue the preparation of its Tourism Master Plan to regulate tourism-related activities and manage the effects of these in its coastal and marine sector.

c. Health sector

Manifestation of climate changes include changes in vector ecology thus exposing a higher number of people prone to vector-borne diseases such as malaria, dengue and typhoid fever; higher chances of heat stroke incidents due to variations in temperature; and an attendant increase in morbidity and mortality rates. It is estimated that about 30,800 San Vicente residents will be directly and indirectly affected by the climate change impacts on the health sector. Children aged 0-14 years old will be severely affected given that this age group accounts for almost 40% of the total LGU population.

Climate change adaptation measures. In anticipation of the climate change impacts in the health sector, the municipality has identified key capital interventions, which include improvements in water supply facilities; acquisition of insecticide impregnated bed nets and rapid treatment strips and tablets for malaria and other vector-borne illnesses; and installation of fans and cooling facilities. Alongside these investments, the LGU will conduct capacity development activities to promote the early detection and treatment of infectious vector borne diseases; training on health and hygiene for the youth; and encourage regular health consultations. The municipality will also formulate and enforce zoning ordinances based on hazards and risk maps and pursue the increased enrolment of residents in the Philippine Health Insurance (Phil-Health) program to enable access to affordable medical attention.

3. Next steps

The analysis outlines the following steps that the LGU may consider in pursuing the identified climate change adaptation measures, climate proofing the CLWUP and MMTDP, and enhancing its readiness to address the impacts of climate change:

a. Revising the CLWUP and MMTDP

The LGU may deem it necessary to update the CLWUP and MMTDP to reflect current developments in the municipality and this will facilitate the integration of the climate change related issues and measures as noted from the Demonstration of Eco-Town Project. For instance, while the CLWUP has a planning period of 11 years, the LGU may consider revising this document given this was prepared 5 years ago, and therefore could benefit from using recent data. As an example, economic projections could be adjusted to consider prospective growth pattern due to the expected completion of the San Vicente Airport. In updating the CLWUP, however, the LGU needs to consider the potential implication of such changes in the Zoning Ordinance given that this is already a law and therefore revisions would entail the appropriate local legislation. Updating the MMTDP may require a less complicated process compared to the CLWUP and could be timely since the current document expires in 2015 and therefore benefits from the incorporation of current developments.

b. Preparation of supporting and complementary plans.

As revising the CLWUP and the MMTDP could be a lengthy process, the LGU may opt to prepare instead plans that are consistent with the CLWUP and MMTDP yet detailed enough to include the proposed mitigating measures. These plans could include the Tourism Development Master Plan that could outline measures in safeguarding the local forestry and marine resources in connection with promoting ecotourism. The same approach could be explored in preparing an Agriculture Development Plan, or a Forestry and Marine Resource Development Plan.

c. Project development, financing and implementation

Aside from incorporating these climate change adaptation measures in the CLWUP and MMTDP, the LGU may already consider pursuing and implementing some of these measures to immediately realize their benefits. For instance, a climate change adaptation measure that remains consistent with the CLWUP and CDP could be included in the Local Development Investment Program and Annual Investment Plan of the municipality and to justify the provision of the necessary financial resources to implement this. Related to this, the LGU would need to mobilize human and financial resources to prepare the documents necessary to pursue the project. These will include pre-feasibility studies for simple projects or feasibility studies for complex ones to determine the viability of the proposed interventions.

These project studies will also guide the LGU in examining its ability to fund the concerned interventions. In cases where the internal resources of the LGU is inadequate, it may resort to commercial borrowing from government financial institutions, such as the Land Bank of the Philippines (LBP) and the Development Bank of the Philippines (DBP), or from Government Agencies such as the Municipal Development Fund Office under the Department of Finance. Concessional financing from Official Development Assistance (ODA) programs may also be explored.

Chapter 5

Lessons learned and way forward

A. Lessons and challenges

Reducing vulnerability to climate risks is not just an option but a necessity for a country like the Philippines, whose physical and economic survival is being threatened by the harmful impacts of climate change. The Demonstration of the Eco-town Framework Project is one of the first steps in pursuing forward the goals of building ecologically stable and economically resilient communities.

It is important to link adaptation planning, being the core of the Philippine national climate change strategy, to broader development goals to deal with the perils of maladaptation. Since climate change cuts across a wide array of sectors such as health, agriculture, water and infrastructure, among others, mainstreaming climate change adaptation into development plans is urgently and expediently necessary. Failing to do so will result to climate change impacts impeding intended development gains achieved along the way. The succeeding discussion tackles the culminating lessons gained throughout the project implementation and will hopefully guide project managers, policy makers, and other stakeholders in undertaking similar endeavors in the future.

1. On Project implementation

Strong political buy-in emanates from smooth alignment of priorities among key stakeholders. One of the strengths of the project lies in the strong political buy-in from the national and local government units. The strong commitment and direct involvement of the CCC as well as the municipal mayors, local officials, and relevant department heads assured that all project's components will be realized in full completion. This came about as GGGI was able to align its strategy and work plan with the development priorities of both national and local governments.

The presence of an overarching policy framework builds a strong legal and institutional foundation for effective partnership.
It is also worth noting that in the context of the Philippines, the overall national policy framework on climate change response has already been put in place, reflecting the country's steadfast commitment to address climate change threats. The highly decentralized governance structure also helps to ensure that local governments take ownership in project implementation. These factors facilitated a smooth forging of partnership between GGGI and the Government of the Philippines.

Synergizing top-down and bottom-up approaches is meaningful yet challenging.
Pursuing both top-down and bottom-up approaches ensures that the interests of key takeholders – from the higher ranks down to the grassroots – are taken into consideration.
Taking on a bottom-up approach, through the conduct of a series of capacity-building programs, helps maintain regular contact with stakeholders, thereby fostering trust and ownership. During the process when the local consultants sought the participation of the local stakeholders in identifying adaptation measures, strict guidance from the experts is required to safeguard the analytical linkages between the identified vulnerability and adaptation outcomes. This was due to the fact that many of the adaptation measures identified by the local stakeholders were not based on rigorous climate change risk assessments, thus emphasizing the need for serious expert supervision during consultations. In tackling top-down approach, on the other hand, the results relied strongly on limited information and well-established conventional ideas (lacking tailor-made information for the local context), thus necessitating the validation of results by the local stakeholders. The bigger challenge lies in finding the common ground between the two approaches, specifically the sectors analyzed, which could be attributed to methodology design. Apparently, health is the only sector that qualifies as a common denominator whereas coastal and marine and agriculture hardly fit in the categories under top-down approach.

Overlooking the influence of a group of stakeholders can cause delays in project implementation.
In the initial process of data gathering, the project was not able to foresee that the Indigenous Peoples (IPs) would perceive the project in a different light due to cultural concerns. Making sure that the interests and rights of the IPs are upheld in compliance to the protocols of their Free Prior and Informed Consent (FPIC) and other related processes are important in order to prevent any potential gridlock in project implementation. This requires a careful consideration of the uniqueness of circumstances and specificity of interest of every stakeholder during the scoping process.

An appropriate entry point is to clarify what it is to be achieved in the first place.
Since its inception, the project has clearly articulated its objective of revising the local development plans, reflecting the results of the studies on climate change risk, exposure, vulnerabilities, adaptive capacities, adaptation measures, and opportunities for green growth. This intention was conveyed to the local partners by highlighting how their locality would directly benefit from the outcomes, thereby resulting in a positive reception among stakeholders.

Building trust requires allowing mutual influence and managing expectations.
Community heads were given the opportunity to validate the results obtained from ground activities. Local planners were continuously aware of the recent developments and were kept engaged to keep expectations realistic. These considerations are instrumental in establishing rapport and eventually winnning the trust of the stakeholders.

Capacity-building activities constitute an effective platform for constant communication and monitoring.
Engagement forums such as group discussions and capacity-building activities enabled the local stakeholders to develop a better understanding of the issues at hand and take responsibility accordingly. The capacity-building activities completed such as the trainer's training workshop on natural resource assessment, GIS-mapping, project development, microfinance and green services, climate proofing, and cross-visits were aimed at developing a platform for shared understanding and objectives, encouraging participation, enhancing a sense of ownership and responsibility, and improving the quality of results.

Providing information on access to finance is a huge leap toward the operationalization of the proposed adaptation measures.
Financing climate change adaptation projects is often overlooked in adaptation planning. Engaging the stakeholders to seek access to finance by providing the right information (sources of fund) is a critical step prior to project closure. Integrating adaptation efforts into 'development fund stream' may be a viable option.

The successful implementation of the proposed adaptation measures will greatly depend on the project development skills of local officials.
Conceptualizing and designing a feasible project that attracts fund sources (donors) is a skill that is often neglected. Stakeholders showed high interest in understanding the cost and benefits of adaptation efforts – an important basis to designing adaptation projects. Providing sufficient training to hone their skills in project proposal writing, investment reports, etc. will be beneficial in the long term.

Enabling, rather than directing, development is the rule of thumb.
Performing the role of an 'enabler' rather than a 'donor' and treating stakeholders as 'development partner' instead of 'recipient' goes a long way in fostering stakeholder engagement. Dictating development, instead of enabling it, always runs the risk of compromising project ownership and stakeholder engagement.

2. On the Demonstration of the Eco-town Framework

Approaching vulnerability assessment objectively still leaves much to be desired.

Since vulnerability assessment is relatively a new research undertaking, it still remains as a largely subjective exercise. It is often assessed as a relative measure, making it difficult to gauge vulnerability in absolute terms. Defining a common criteria or metrics can help compare vulnerability levels across municipalities and hence deploy resources to the most vulnerable. The bottom line in making the assessment as objective, robust, and comprehensive as possible is to tap a pool of experts from various disciplines (e.g., climate science, resource economics, sociology, geographic information system, engineering, finance, local governance, etc.) and have them work together toward a common goal.

Integrating scientific findings and local community knowledge aids in dealing with uncertainties.

In the context of climate change adaptation, dealing with uncertainties in decision-making can be dealt with by developing scenarios based on a systematic, scientific and objective assessment of related threats and impacts. Such scenarios will serve as the basis for formulating flexible adaptation plans that are responsive to the degree of risk and uncertainty. In creating climate scenarios, it is important to integrate scientific findings and local knowledge of the community to improve accuracy and thus reduce uncertainty. The integration of climate science and knowledge of the local community is paramount in reducing discrepancies for laying out climate scenarios.

In the context of climate proofing, strong relationship between adaptation measures and economic activities are apparent.

Conventional approaches often set apart climate change adaptation and economic growth as distinct processes. However, the menu of risks and adaptation measures identified by the local stakeholders were directly or indirectly related to their income-generating activities. Thus, there is a need to carefully assess the economic implications of climate change adaptation, specifically delving into how adaptation efforts can serve as drivers for innovation and economic growth.

Adaptation is key to resilience, just as resilience is key to sustainability.

According to Resilience Alliance, adaptation refers to distinct actions – with specific beginning and end – aimed at reducing vulnerability to climate change impacts. On the other hand, resilience is a continuous process that re-evaluates, anticipates, and evolves with the changing vulnerabilities and risks to capacitate communities to absorb disturbances, while retaining the same basic structures and services. Given this context, it is important not to lose sight how the various adaptation measures will add up to enhance resilience to climate risks and how, in the long term, these can contribute in laying out a sustainable development path.

Finding the synergy in the implementation of different Eco-towns can help fill research gaps in strengthening the linkage between climate change adaptation and green growth.

Since there are currently 10 Eco-town project sites in the Philippines funded by different donors, it is important for the various players to coordinate their efforts and develop a common understanding to effectively harmonize aid, in consultation with the government and other relevant stakeholders and as envisioned in the Paris Declaration and the Accra Agenda for Action. GGGI's role in this project was geared toward key areas where it can add more value in terms of green growth such as reducing vulnerability to climate change, poverty reduction, and promoting economic growth. Similar efforts in the future will be delivered in a harmonized manner with the government and other donors, building on GGGI's experience and efforts to date.

B. Way forward

Climate proofing is just an initial step toward becoming an Eco-town. San Vicente can rightfully consider itself as an Eco-town if it successfully implements the adaptation measures proposed in its revised local development plans. The experiences in the demonstration of the Eco-town framework in San Vicente show that climate change can be perceived not as a hindrance to growth but rather an opportunity for sustainable economic growth. The Eco-town serves as a preparation towards the bigger goal of achieving green growth.

As the NCCAP recognizes green growth as a potent approach to reduce poverty, achieve social progress, protect the environment, adapt to the impacts of climate change and optimize mitigation opportunities, the CCC will build on the lessons learned and best practices of the project to scale up at the provincial level. In this regard, San Vicente can serve as a role model for other LGUs in demonstrating green growth as a solution to achieve climate-resilient growth and sustainable local development. It can also initiate the shift of green growth momentum from the LGU to the provincial, national and sectoral levels, thereby embedding green growth as a core strategy in development planning at all levels.

Going forward, as the objectives of the Eco-town are pursued at a larger scale through an enhanced framework called Climate-Resilient Green Growth (CRGG), the approach will be redirected in a way that affords considerable emphasis on the economic performance of the provinces to be covered, analyzing the key sectors that comprise the local GDP while applying a climate change lens into the projects, programs, and policies, of the provincial government. Throughout this process, linked opportunities will be examined such as job creation, new business markets, improved infrastructure, technological innovation, and the like based on a comprehensive and integrated analysis of local resources, growth potential, climate change adaptation, and certainly, economic transformation.

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Annexes

Annex 1: Figures

Annex 2: Figures

Annex 1: Land cover and land use maps

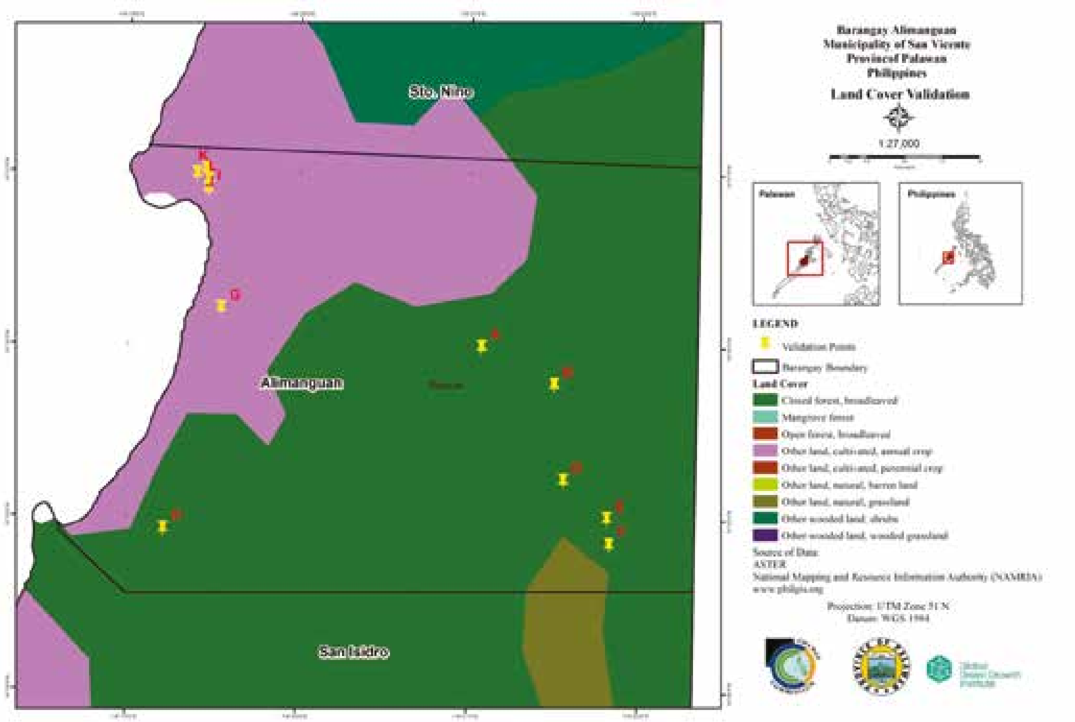
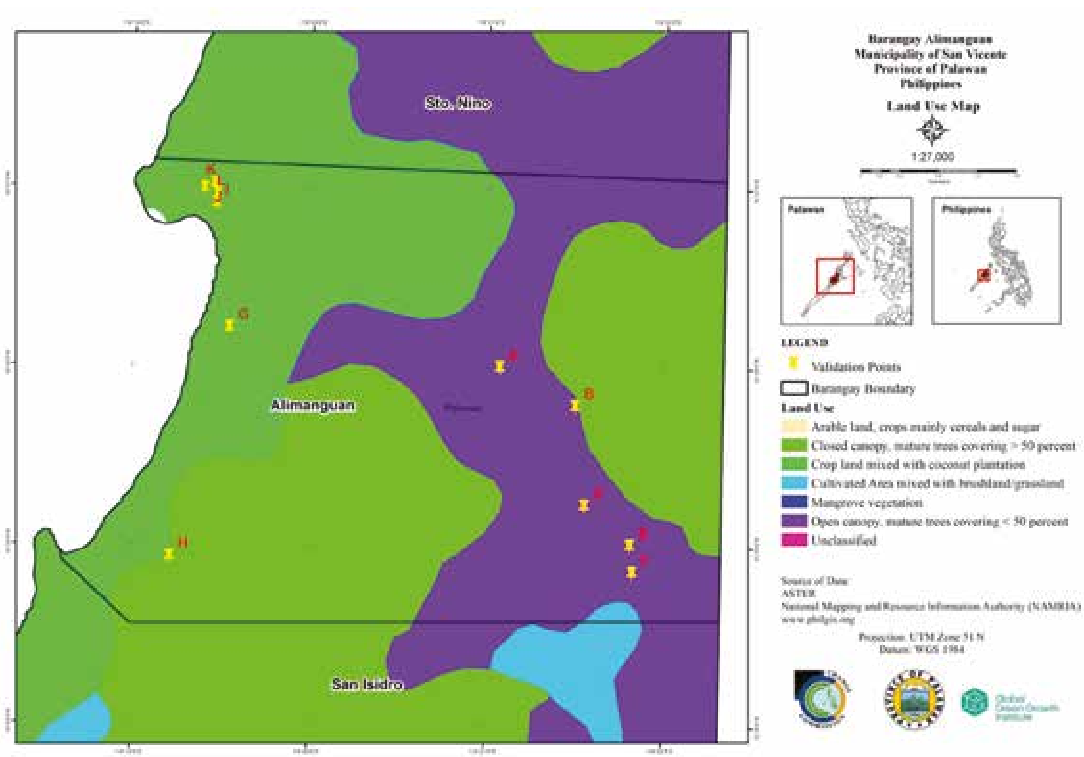


Figure A1.1. Validated land cover map of Barangay Alimanguan



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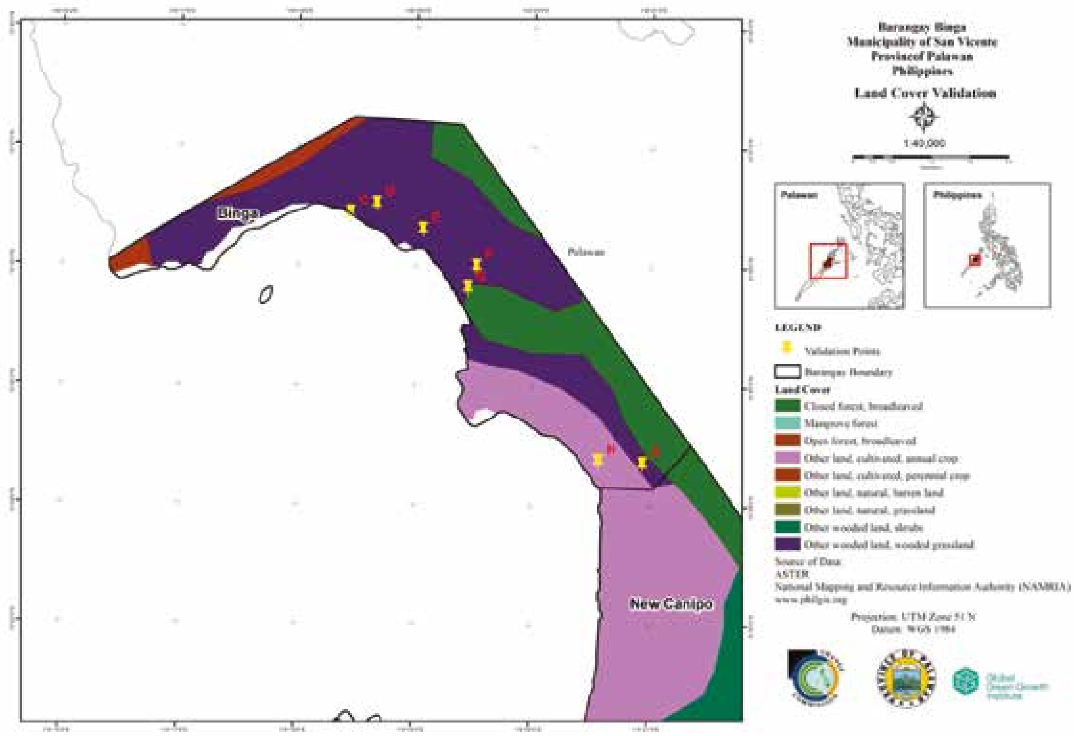

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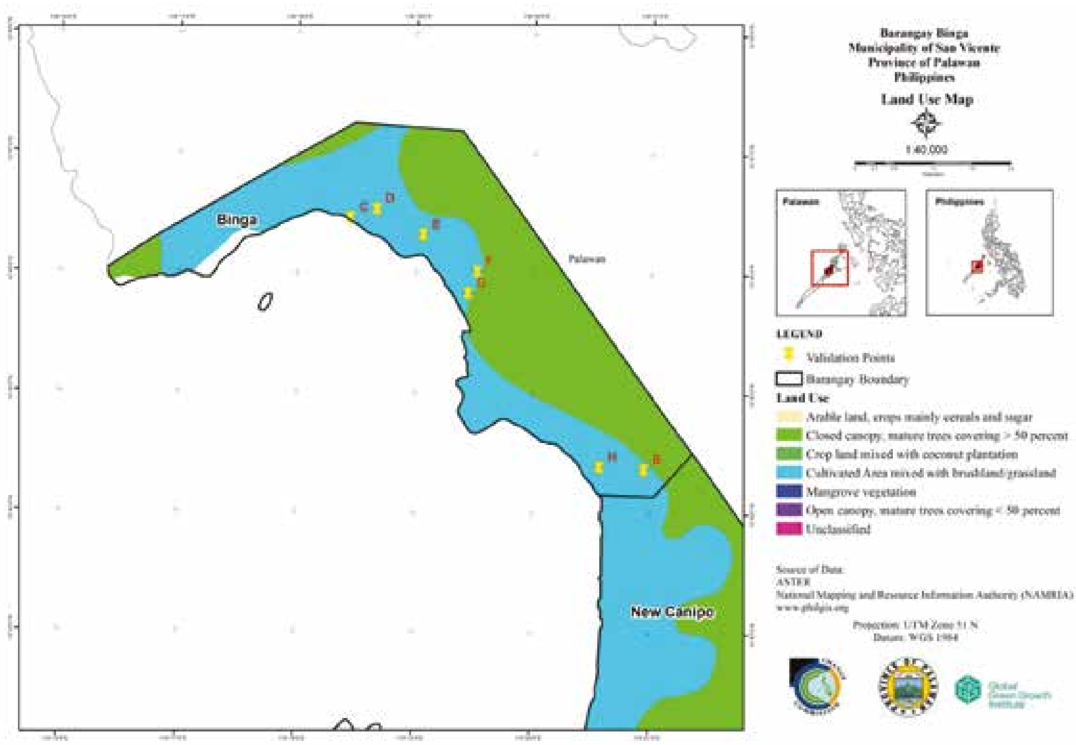

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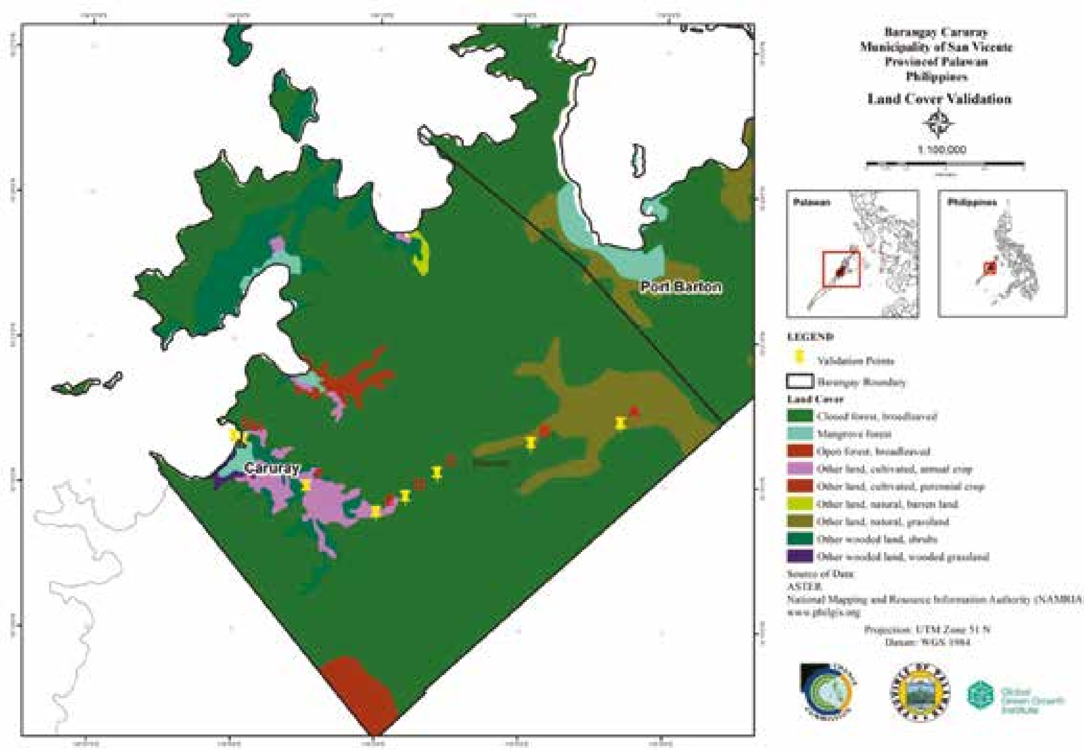
Annex 1: Land cover and land use maps



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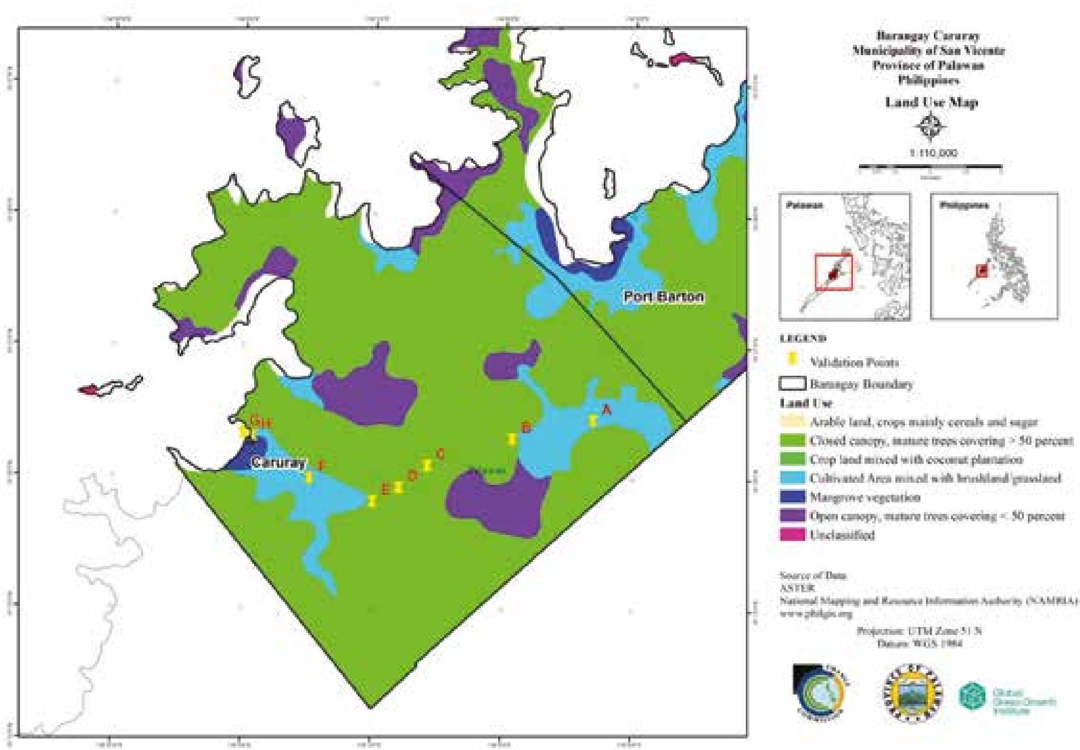

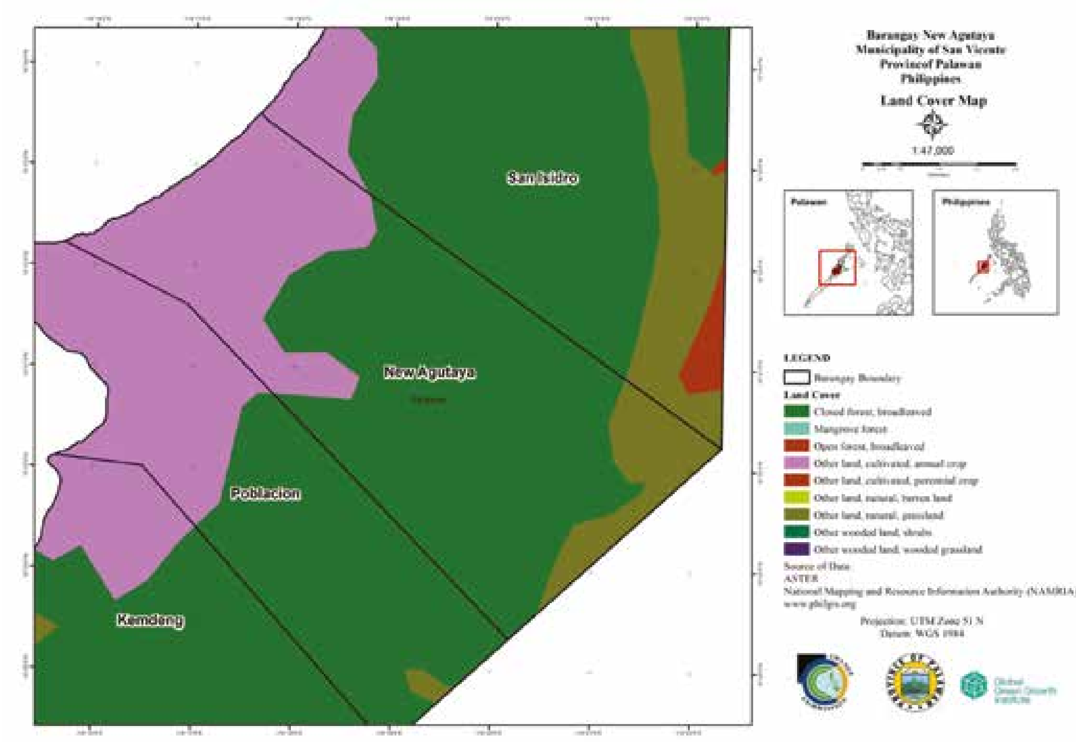

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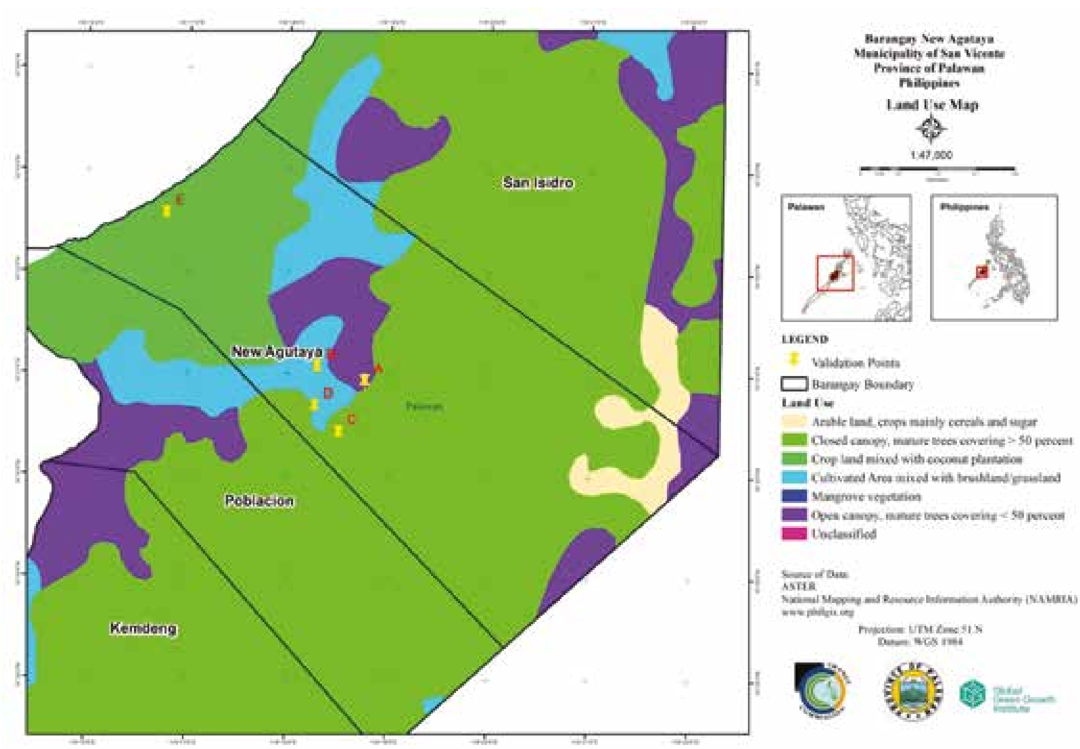


Figure A1.8. Validated land use map of Barangay New Agutaya

Annex 1: Land cover and land use maps

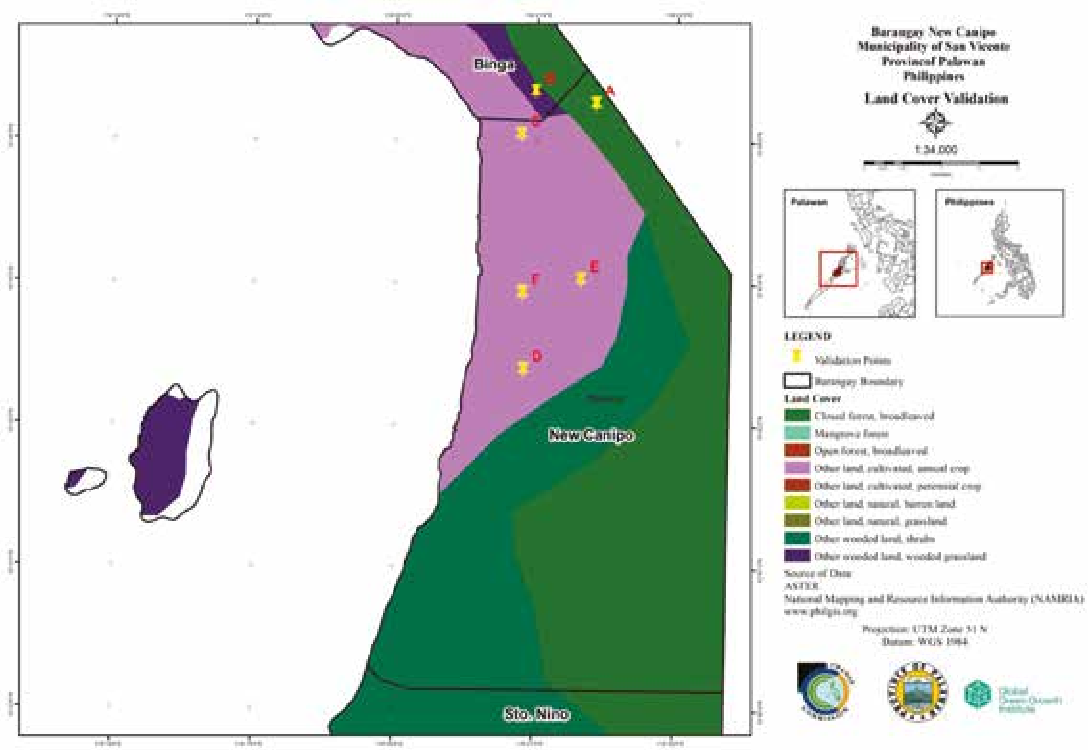


Figure A1.9. Validated land cover map of Barangay New Canipo

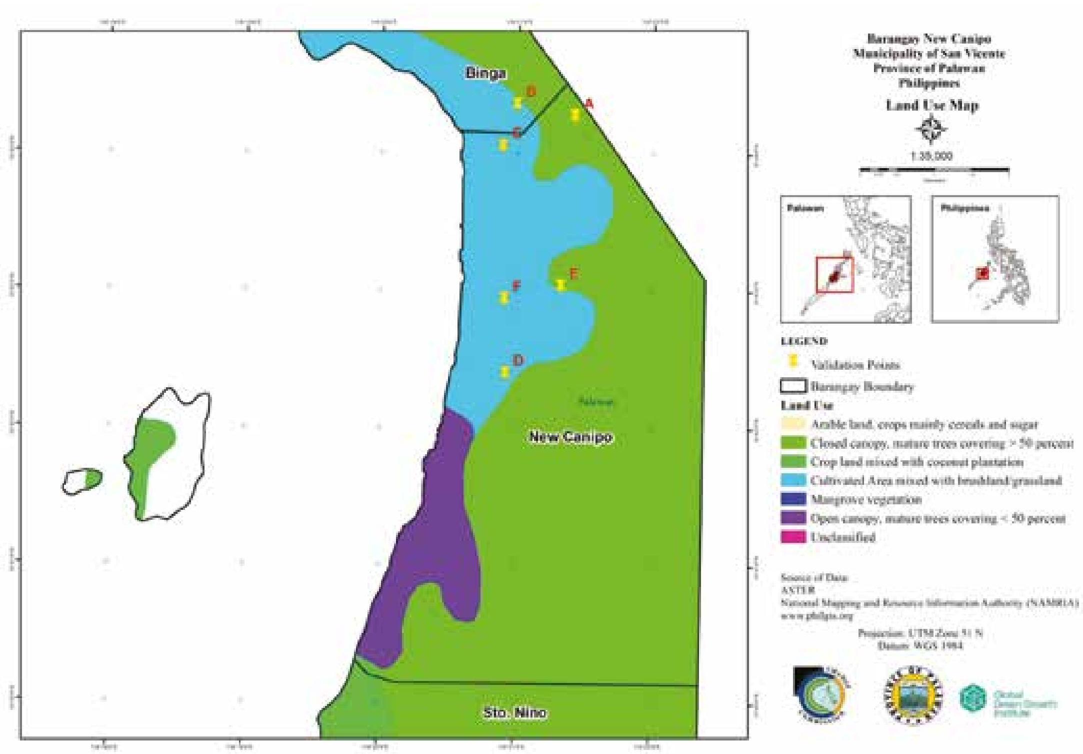


Figure A1.10. Validated land use map of Barangay New Canipo

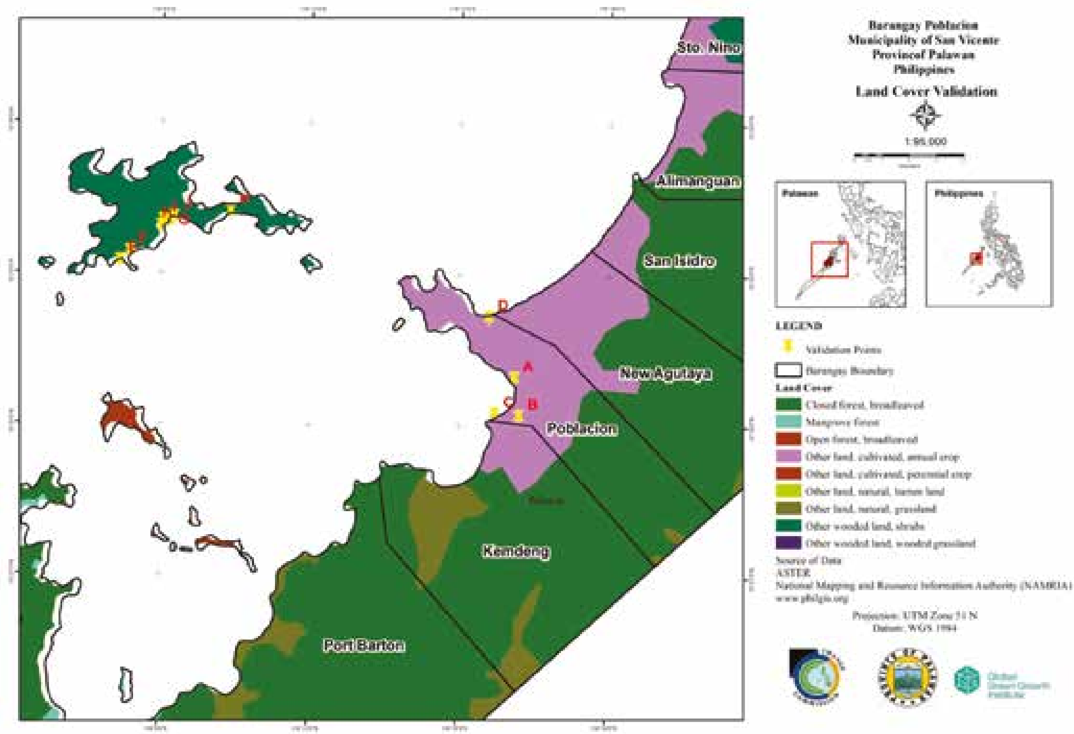


Figure A1.11. Validated land cover map of Barangay Poblacion

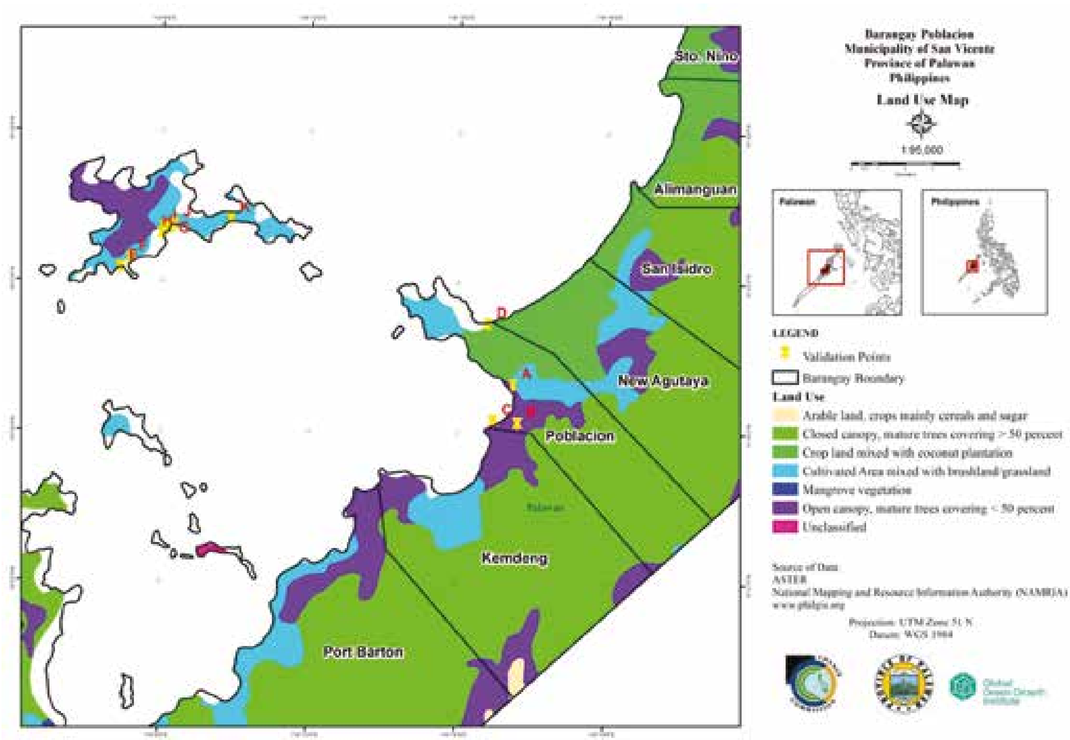


Figure A1.12. Validated land use map of Barangay Poblacion

Annex 1: Land cover and land use maps

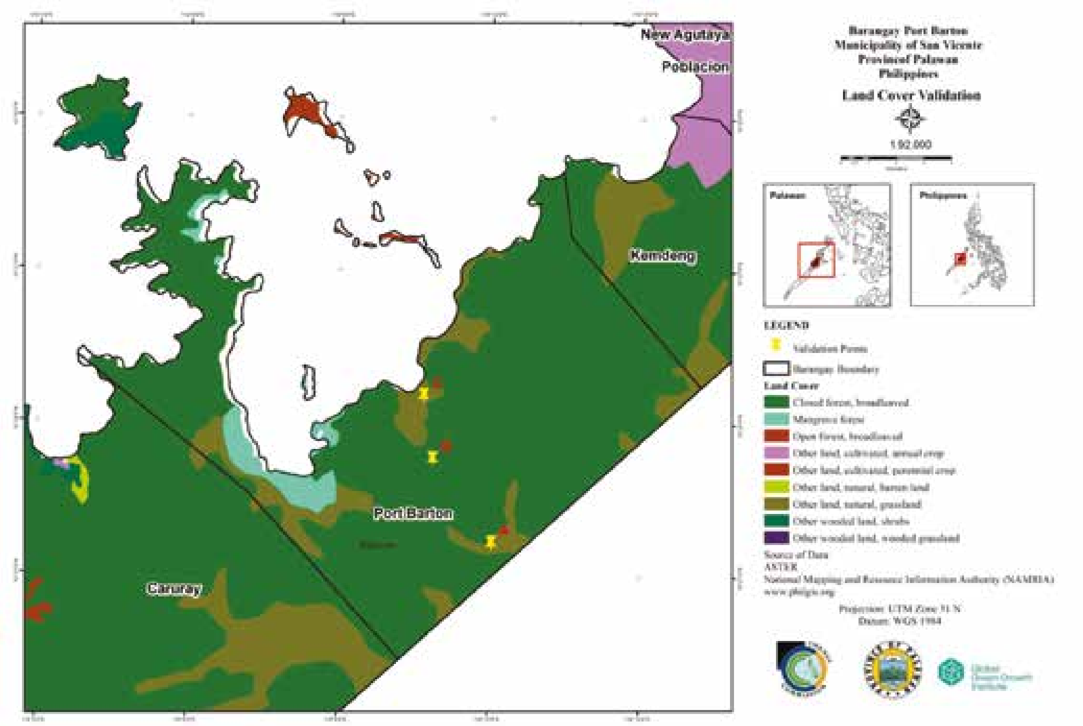
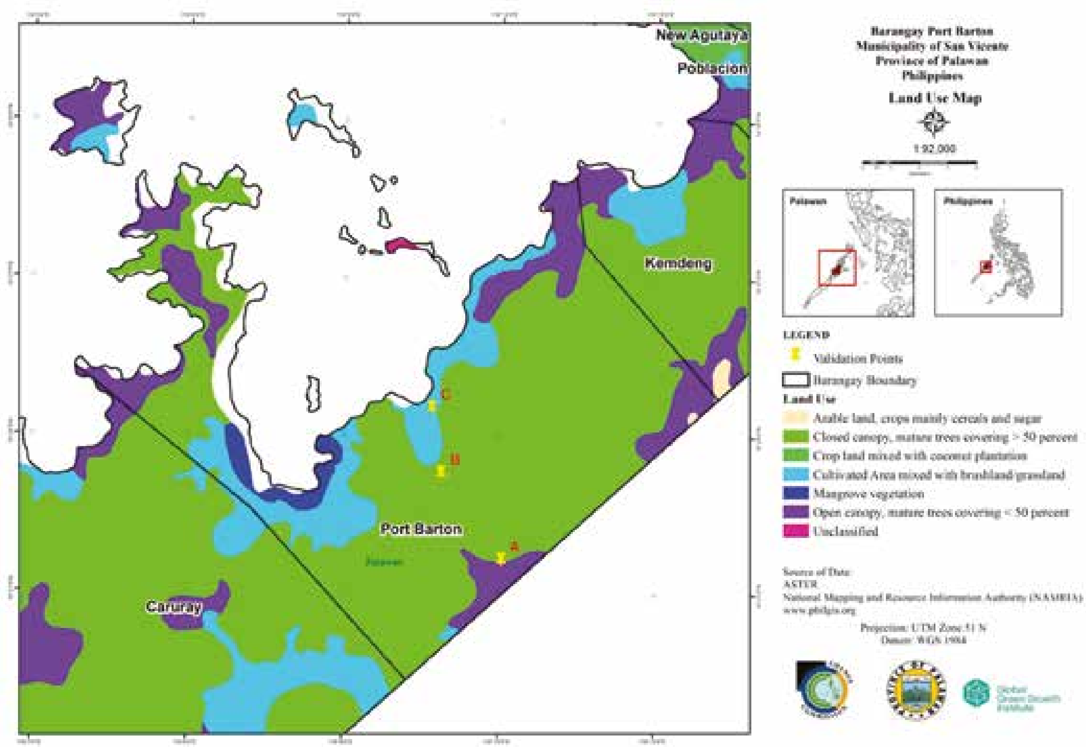


Figure A1.13. Validated land cover map of Barangay Port Barton



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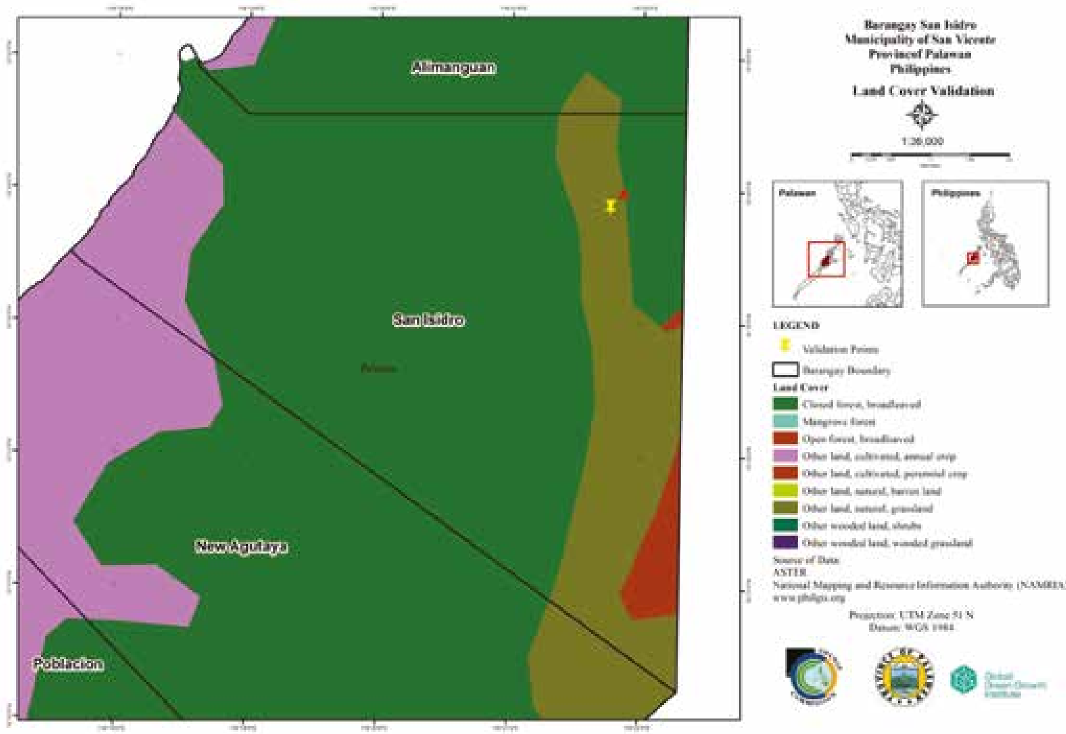

Figure A1.15. Validated land cover map of Barangay San Isidro

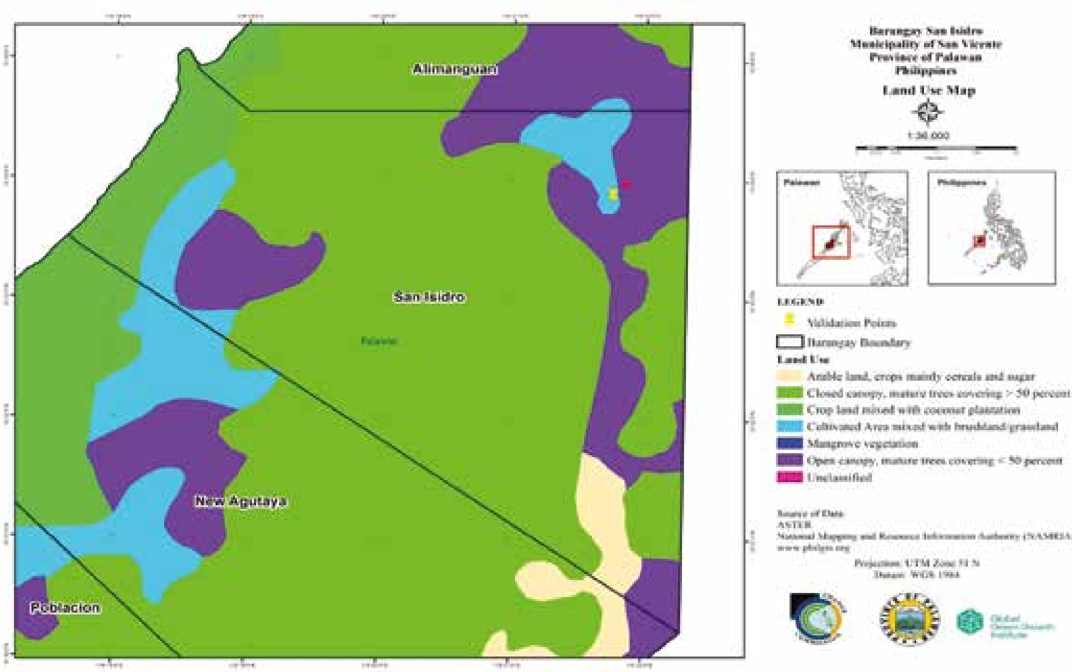

Figure A1.16. Validated land use map of Barangay San Isidro

Annex 1: Land cover and land use maps

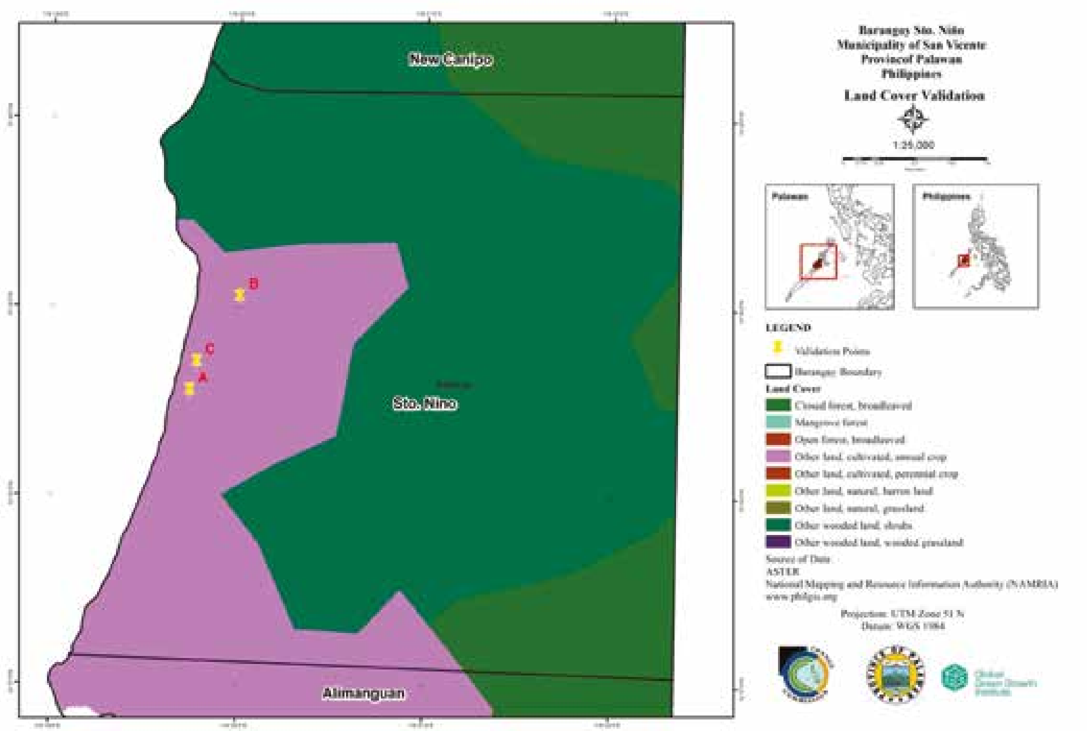

Figure A1.17. Validated land cover map of Barangay Sto.Niño

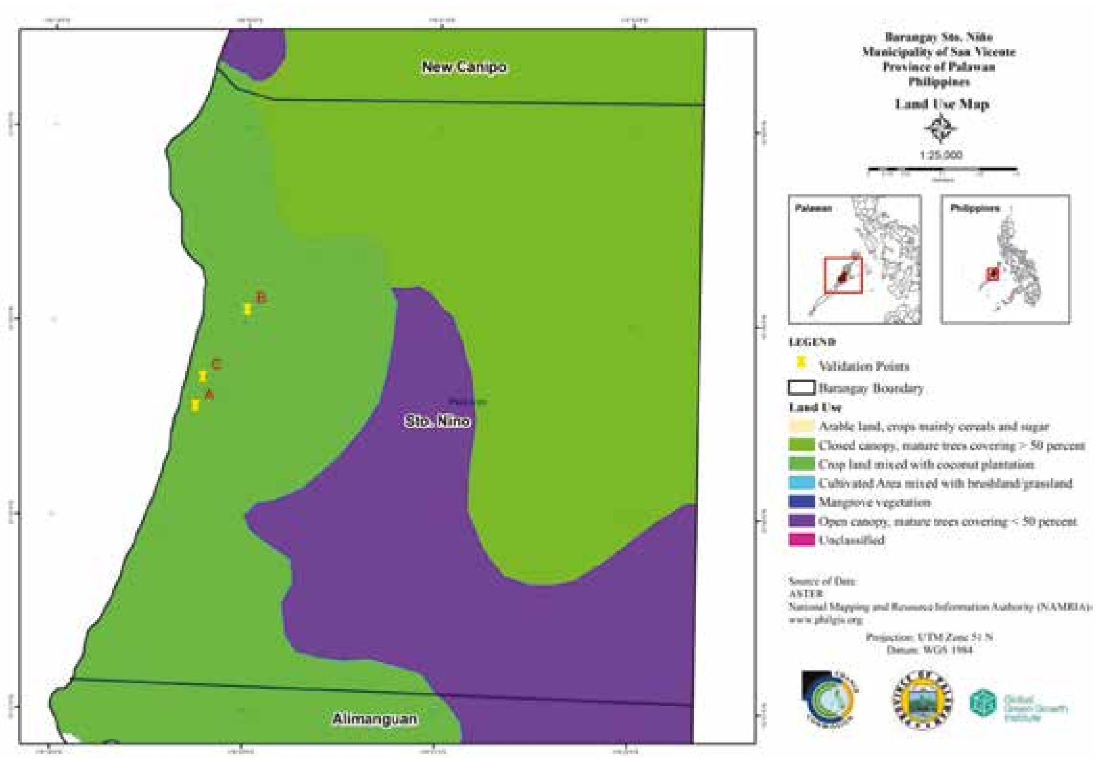

Figure A1.18. Validated land use map of Barangay Sto.Niño

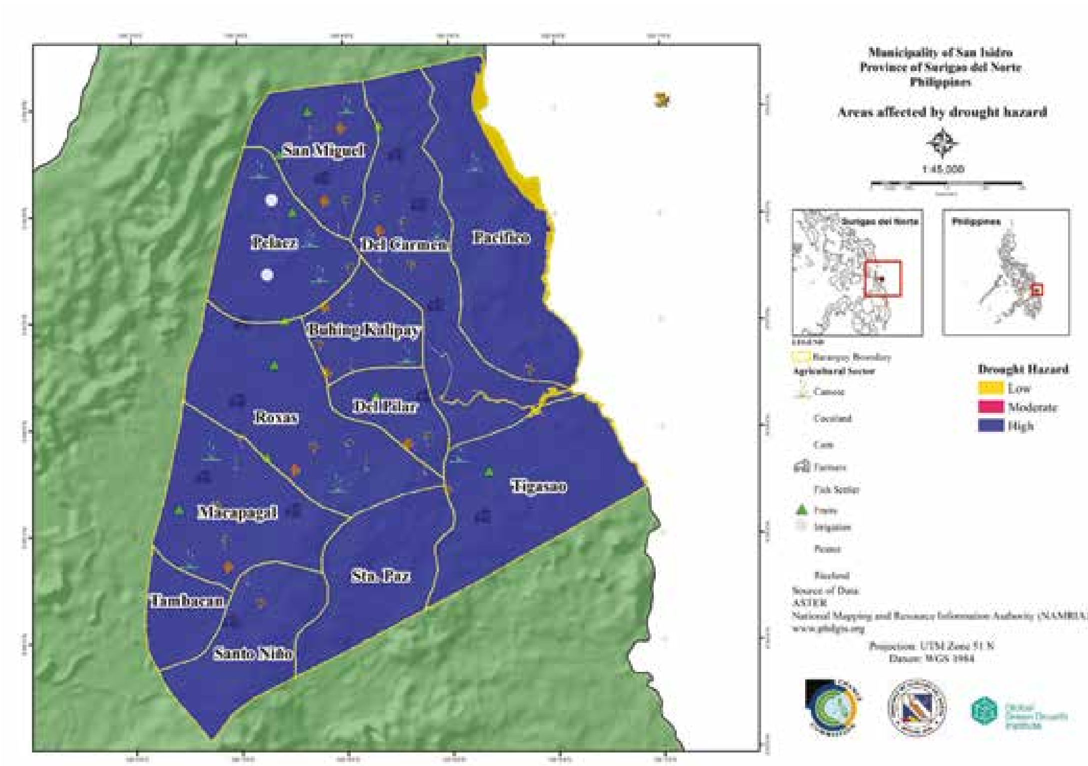

Figure A2.1. Areas affected by drought in Barangay San Isidro

Annex 2: Drought hazard maps

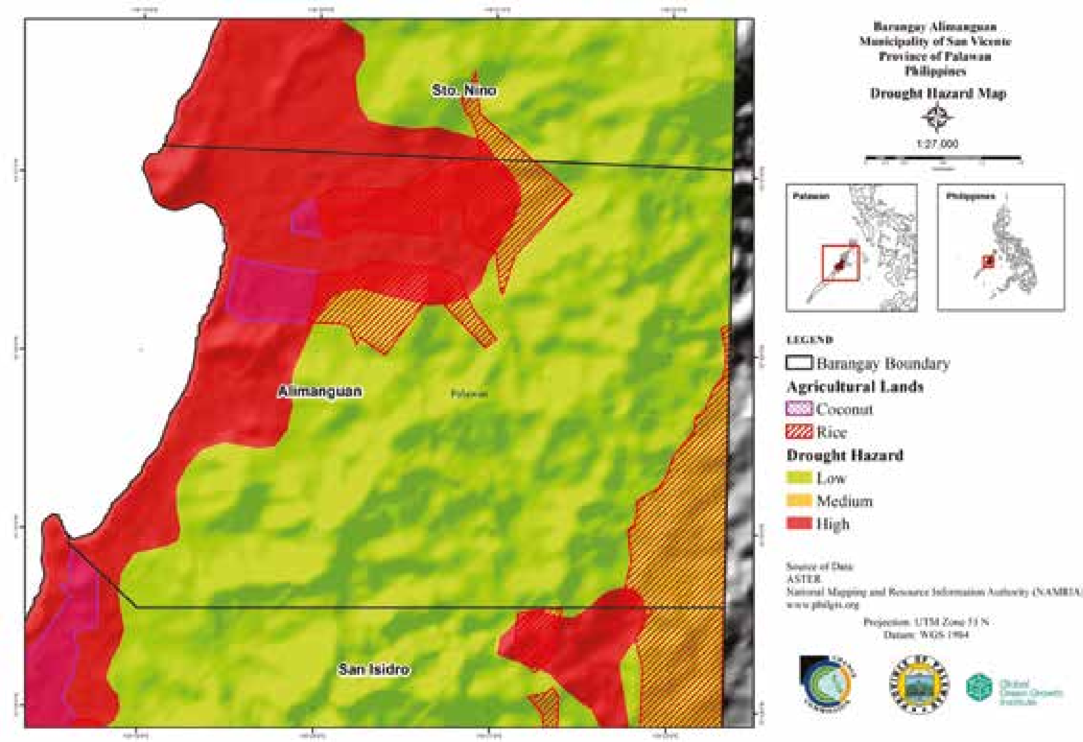

Figure A2.2. Drought hazard on agricultural crops in Barangay Alimanguan

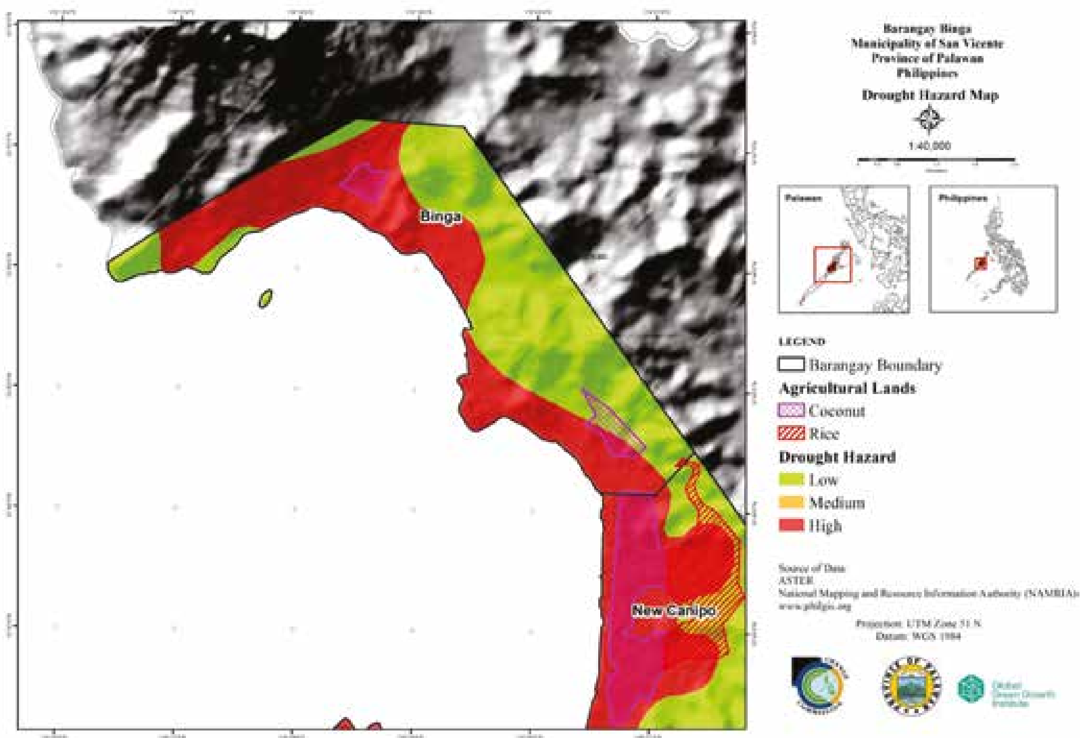

Figure A2.3. Drought hazard on agricultural crops in Barangay Binga

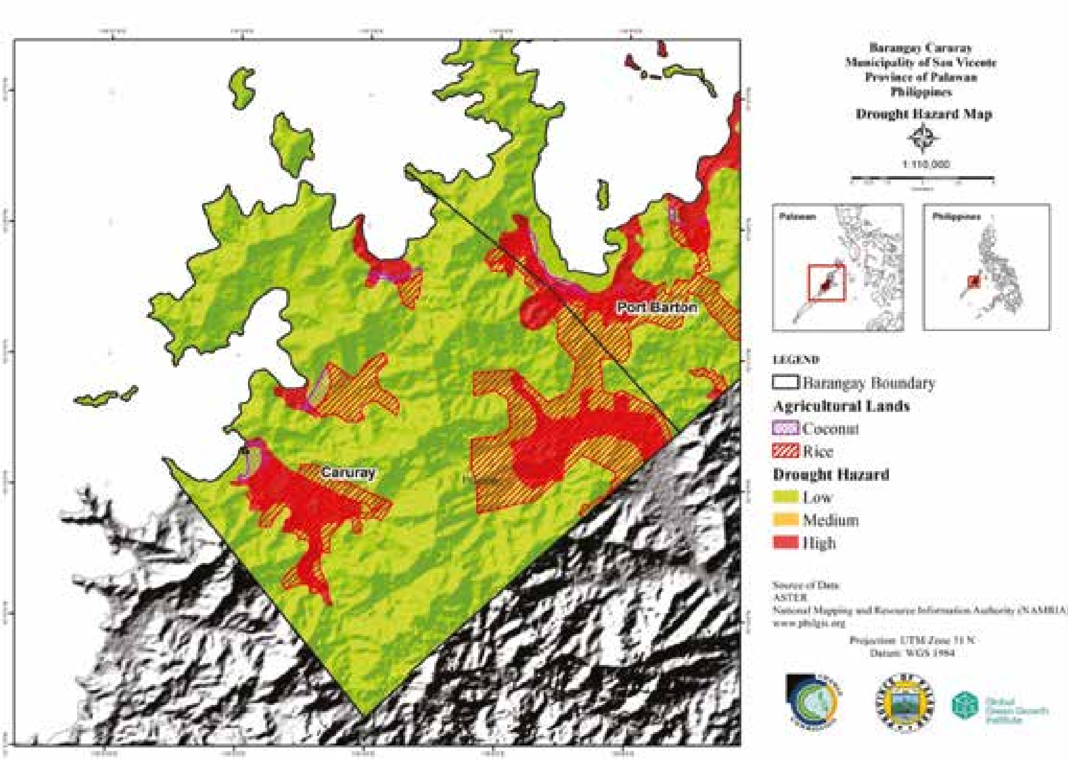

Figure A2.4. Drought hazard on agricultural crops in Barangay Caruray

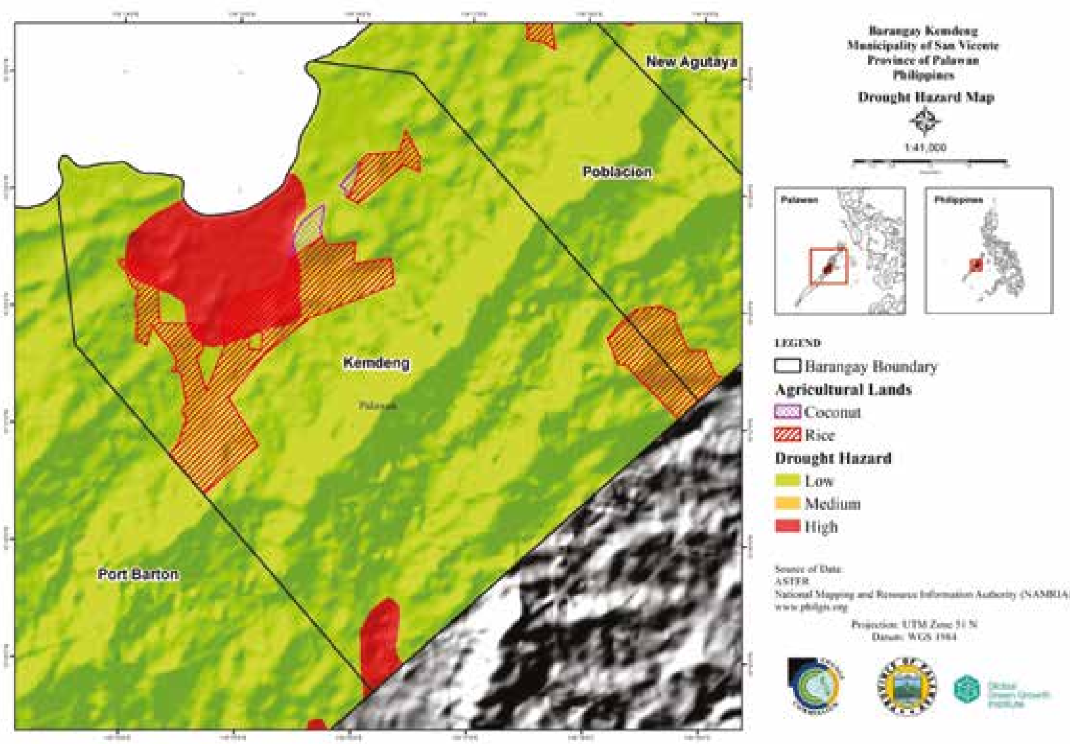

Figure A2.5. Drought hazard on agricultural crops in Barangay Kemdeng

Annex 2: Drought hazard maps

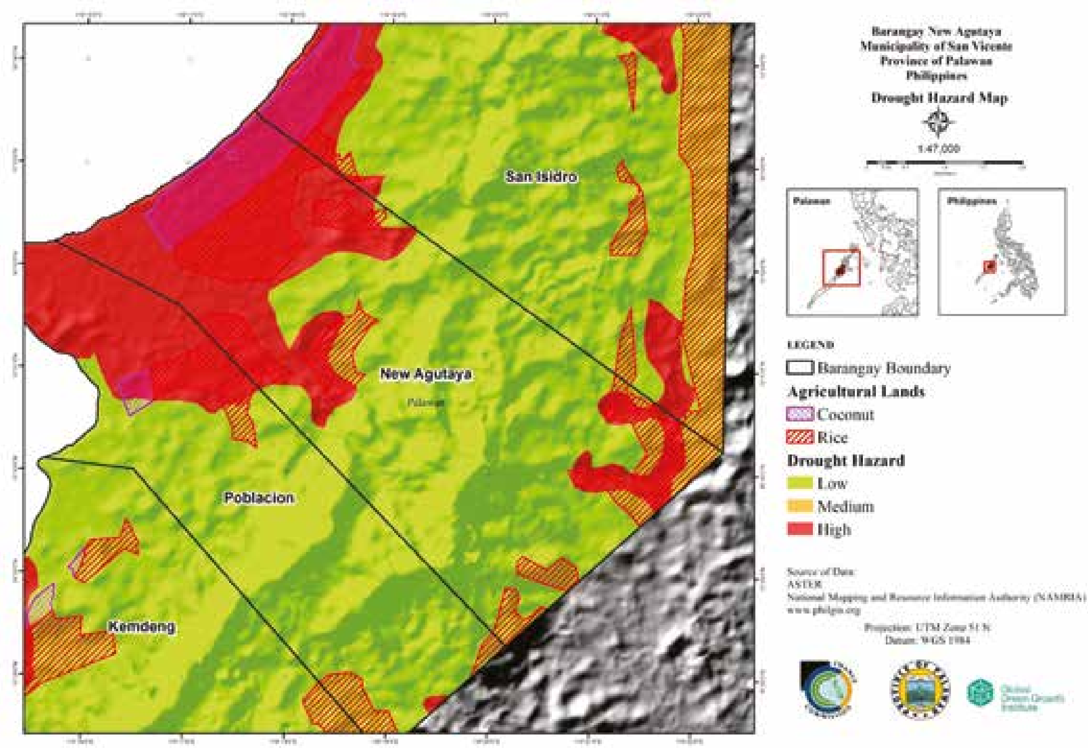

Figure A2.6. Drought hazard on agricultural crops in Barangay New Agutaya

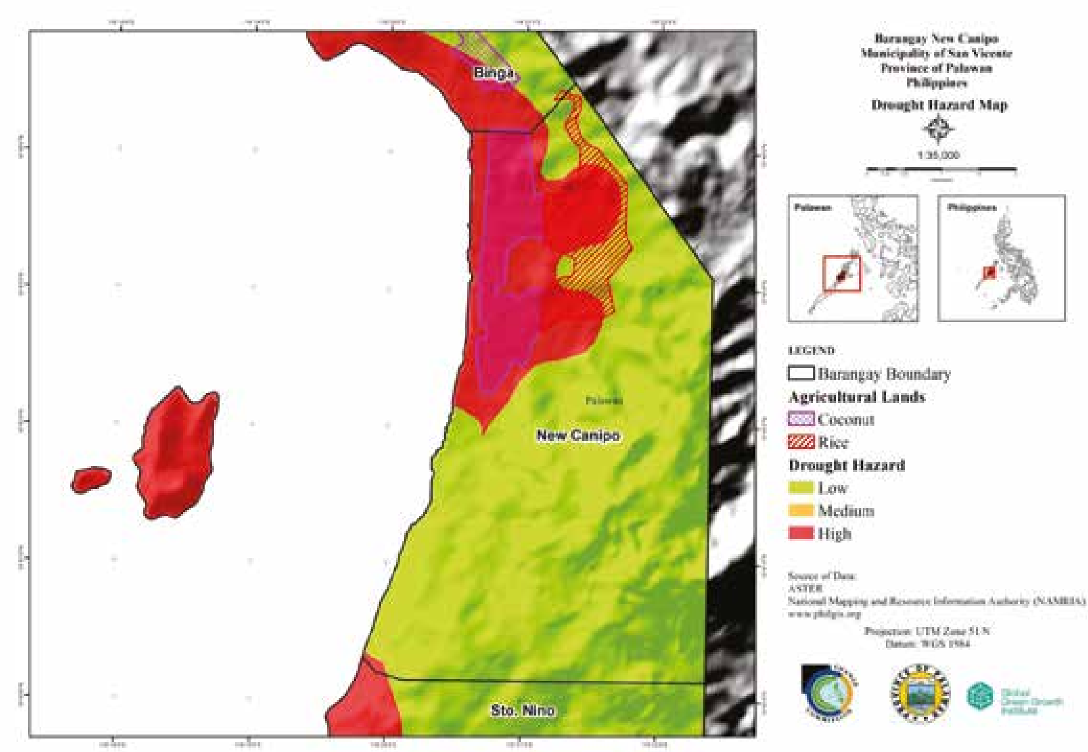

Figure A2.7. Drought hazard on agricultural crops in Barangay New Canipo

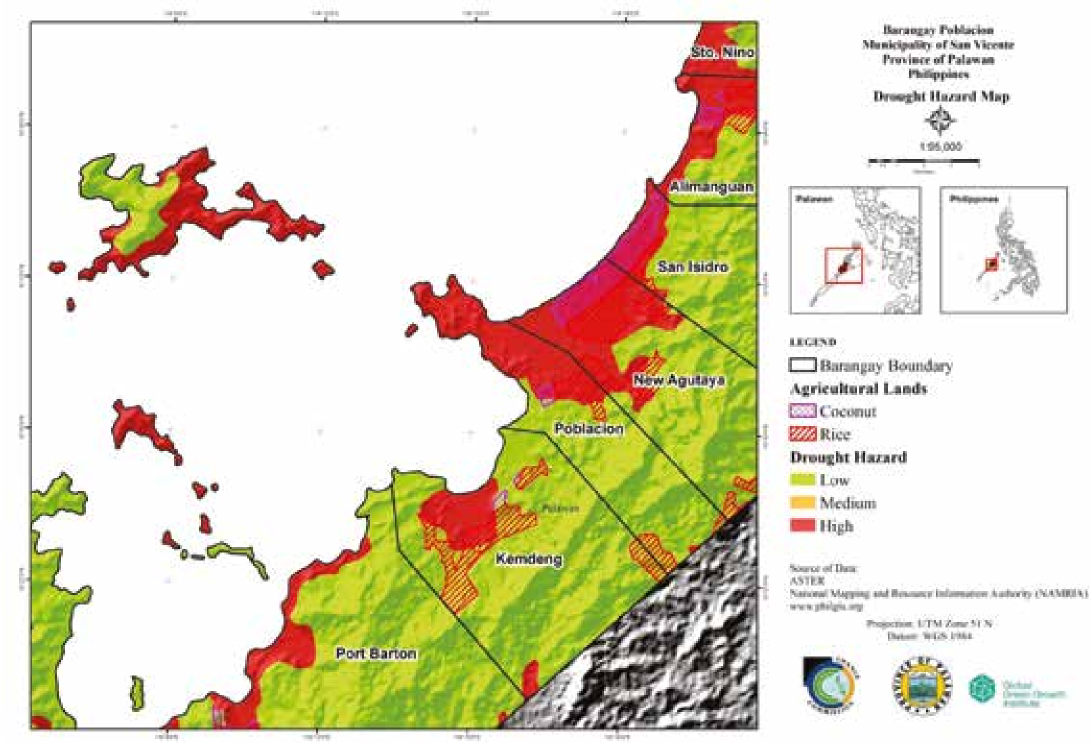

Figure A2.8. Drought hazard on agricultural crops in Barangay Poblacion

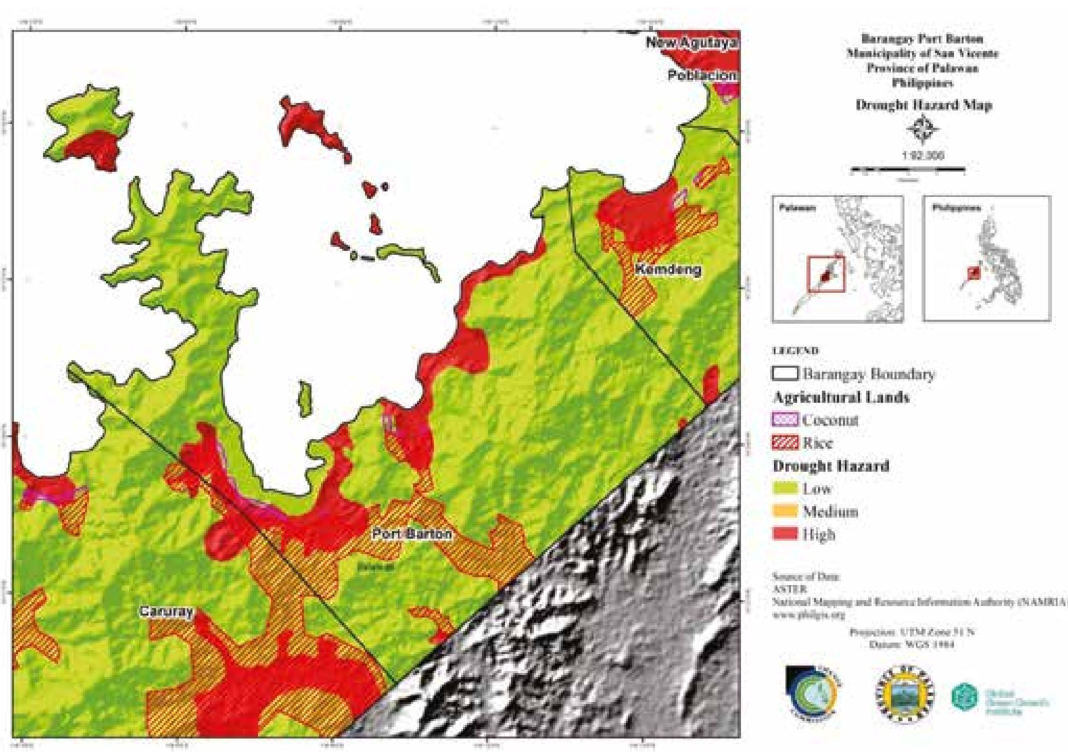

Figure A2.9. Drought hazard on agricultural crops in Barangay Port Barton

Annex 2: Drought hazard maps

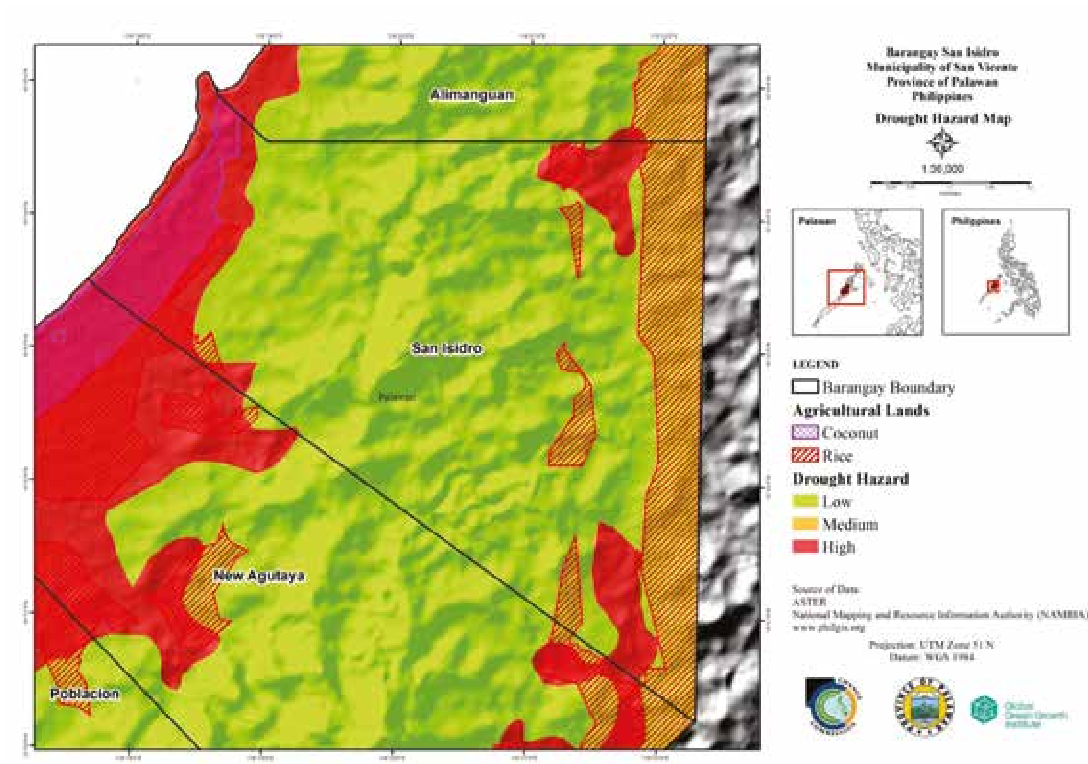

Figure A2.10. Drought hazard on agricultural crops in Barangay San Isidro

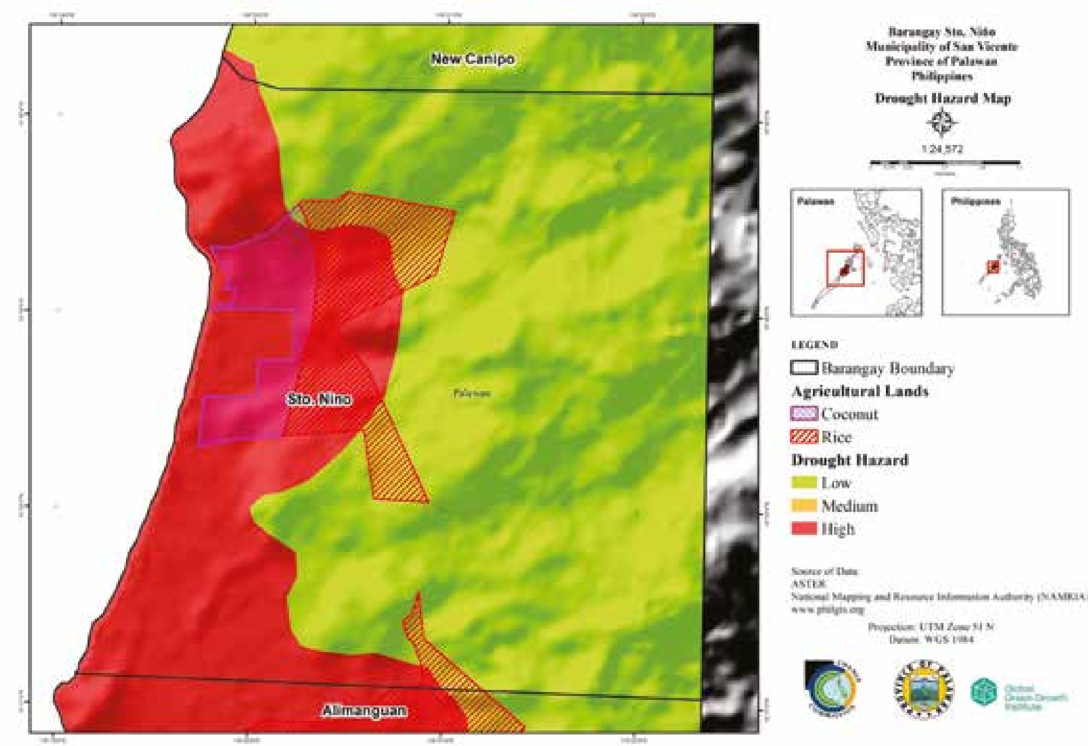

Figure A2.11. Drought hazard on agricultural crops in Barangay Sto. Niño

Date/ Period	Venue	Activity	Component	Objective/s	Participants
	San Vicente	Orientation and MOA Signing	Project Launch	To sign the Memorandum of Agreement for the Eco-town Project.	CCC Municipal mayors GGGI
3/15-18/12	Seoul, Korea	Courtesy Call to GGGI and Cross visit to Eco-town	Cross Visit	To showcase stellar examples of green growth initiatives by visiting several sites such as the GGGI Headquarters, Shiwa Tidal Wave Power Plant, Sudokwon Landfill, and the Korea National Arboretum.	CCC San Vicente mayor GGGI
	San Vicente		Data Gathering	To conduct a baseline household survey for 250 households to obtain data on climate change and agriculture, coastal and marine, and health.	CCC
5/14-20/2012	San Vicente and Manila	Data Gathering	NRA	To request data from the LGU for the Natural Resource Assessment (NRA) and Environment and Natural Resource Accounting (ENRA).	CCC LGU Local consultants
	San Vicente	LGU Orientation	NRA	To conduct the rapid scoping of the natural resources and ecosystems, including data gathering and validation of information in preparation for the ENRA.	CCC LGU Local consultants
	San Vicente (Port Barton)	Ocular Inspection: Watershed and Fishing Village;	Site Visit	To deliver updates on the progress of the project and conduct ocular visit to the project sites.	CCC LGU Local consultants GGGI
	San Vicente	Planning Workshop with LGUs		To present the Eco-town work plan in order to harmonize it with the local work plan of the LGU and identify LGU's existing climate change programs/projects that complement the Eco-town Project.	CCC LGU GGGI
	Puerto Princesa	Meeting with the Palawan Council for Sustainable		To present the Eco-town Project to PCSD and gather secondary data on studies conducted in San Vicente and Northern Palawan.	CCC Local consultant
	CCC Office, Manila	Project Updates	Meeting	To share updates on project implementation and discuss next steps.	CCC Local consultant
	San Vicente		Meeting	To brief the *barangay* captains on the process of accreditation from PCSD. A resolution was requested from the *barangay* captain stating their approval of the project.	CCC LGU
	CCC Office, Manila	Project Updates	Meeting	To meet with the SAVEMAN Board and gather information about the respective IP groups in the *barangays*.	CCC SAVEMAN Board (San Vicente Environmental Management Board)

Annex 3: Project activities

Date/ Period	Venue	Activity	Component	Objective/s	Participants
	San Vicente and Manila	Data Gathering	Data Gathering	To obtain data (names of leaders per tribe and contact information) from LGU regarding the IP groups found of San Vicente.	CCC LGU
	Ortigas	Project Updates	Meeting	To share updates on the progress of project implementation and discuss next steps.	CCC Local consultants
	NCIP Regional Office, Quezon City	Meeting with the Regional NCIP Director	Meeting	To discuss the Eco-town project and the requirements of the NCIP in relation to the issuance of Certificate of Pre-condition.	CCC NCIP
		Project Updates	Meeting	To discuss the requirements needed for the settling the IP issue, specifically the resolutions from each member and *barangay* captain.	CCC SAVEMAN Board
	CCC Office, Manila	IP	Meeting	To make the necessary preparations for the IP consultations.	CCC Local consultants
8/13-15/2012	San Vicente and Manila	Collection of	Data Gathering	To assist the LGUs in submitting the necessary resolutions that address the IP issue.	LGU
	Puerto Princesa	NCIP	Meeting	To meet with the Provincial NCIP to discuss the process of securing the Certificate of Pre-condition.	CCC NCIP
	Mayor's Office, San Vicente	Project Updates	Meeting	To meet with Mayor Alvarez and discuss the requirements and strategies of the Eco-town.	CCC Mayor Alvarez
	Barangay Caruray, Binga, and	IP		To explain the concept, components, and benefits of the Eco-town to the IP community.	CCC NCIP
	Barangay Port Barton, San Vicente	IP		To explain the concept, components, and benefits of the Eco-town to the IP community.	CCC LGU IP
	Puerto Princesa	Presentation of the Eco-town Project to the Provincial Board Members	Meeting	To present the Eco-town Project to the Provincial Board Members to obtain their support for the provincial resolution.	CCC LGU
	Baras, Rizal	Gathering of	Meeting	To discuss the progress of meeting the requirements for issuing the Certificate of Pre-condition with the NCIP regional and provincial officials.	CCC NCIP
	Quezon City	Gathering of	Meeting	To discuss the progress of completing the requirements for issuing the Certificate of Pre-condition.	CCC PCSD

Date/ Period	Venue	Activity	Component	Objective/s	Participants
11/26-27/2012	*Barangay*	VA Workshop for Agriculture	VA	To conduct a VA workshop with representatives from the agricultural sector from 4 *barangays* (New Canipo, San Isidro, New Agutaya, and Poblacion).	CCC Local Consultant LGU
12/3-4/2012	*Barangay*	VA Workshop for Coastal and Marine	VA	To conduct a VA workshop with representatives from the coastal and marine sector from 2 *barangays* (New Canipo and Poblacion).	CCC Local consultant LGU
12/6-7/2012	*Barangay* San Isidro and New Agutaya, San Vicente	VA Workshop for Coastal and Marine	VA	To conduct a VA workshop with representatives from the coastal and marine sector from 2 *barangays* (San Isidro and New Agutaya).	CCC Local consultant LGU
	Barangay New Agutaya, San Vicente	VA Workshop for	VA	To conduct a VA workshop with 30 representatives from various sector from 4 *barangays* (New Canipo, San Isidro, New Agutaya, and Poblacion).	CCC Local consultant LGU
1/7-	San Vicente	NRA for Forestry	ENRA	To pre-test the survey instrument, conduct sampling/inventory of old growth and residual forests, and conduct sampling/inventory of non-timber forest product, plantation and mangrove forests.	CCC LGU
1/21-29/2013	San Vicente	Flood Hazard Assessment	ENRA	To conduct a flood hazard assessment around San Vicente.	CCC LGU
1/29-	*Barangay*	Ocular Inspection with the KACCC	Ocular	To conduct an ocular inspection of San Vicente (i.e., Daplak and Port Barton) and meet with selected members of the LGU.	CCC KACCC Local consultants
2/2-5/2013		Key Informants Interview	ENRA	To conduct informant interview in preparation for the household survey on socioeconomic and municipal accounts.	REECS
2/2-15/2013	San Vicente	Household Survey	ENRA	To spearhead the gathering of primary data through household survey (400 households).	REECS
2/4-5/2013	*Barangay*	VA Workshop for Agriculture	VA	To conduct a VA workshop with 30 representatives of the agricultural sector from 4 *barangays* (Caruray, Binga, Alimanguan, and Port Barton).	CCC LGU Local consultants
	Barangay	VA Workshop for Socio Economic	VA	To conduct a VA workshop with 30 representatives of the socioeconomic sector from 4 *barangays* (same above).	CCC LGU Local consultants
2/6-7/2013	*Barangay*	VA Workshop for Coastal and Marine	VA	To conduct a VA workshop with 30 representatives of the agricultural sector from 4 *barangays* (same above).	CCC LGU Local consultants

Annex 3: Project activities

Date/ Period	Venue	Activity	Component	Objective/s	Participants
	Barangay	VA Workshop for Health	VA	To conduct a VA workshop with 20 representatives of the agricultural sector from 4 *barangays* (same above).	CCC LGU Local consultants
	Manila	Experts' Meeting	VA+ GIS	To coordinate the mapping of VA results for land use and development planning.	CCC Local consultants
2/24-	San Vicente	NRA for Forestry	NRA	To conduct an inventory of the forestry resources in all *barangays*.	REECS
4/17-19/2013	Ortigas	VA Integration Workshop	VA	To integrate and synthesize the results of ground activities including hazard analysis, VA, GIS mapping, and ENRA; and discuss the prioritization of the adaptation strategies, M&E indicators, and further actions for Siargao Islands and Palawan.	CCC GGGI KACCC Local consultants External experts
6/7-10/2013	Puerto Princesa	VA Validation Workshop	VA	To verify data gathered during the previous VA Workshops.	CCC GGGI Local consultants
5/7-21/2013	San Vicente	Coastal and Marine Assessment	NRA	To conduct coral and reef fish assessments and interviews.	LGU Local consultants
5/19-	San Vicente	Household Survey for NRA	NRA	To conduct a household survey for the municipal accounts.	LGU Local consultants
5/29-30/2013	Manila	Review of VA Results	VA	To review the VA results, specifically the VA matrix charts, for coastal and marine, agriculture, and health.	CCC GGGI
6/3-18/2013	San Vicente	Water Resource Assessment	NRA	To conduct a water resource assessment through site visits and interviews.	LGU Local consultants
6/9-13/2013	San Vicente	Ecotourism Assessment	NRA	To conduct an ecotourism assessment activity in San Vicente – surveying various sites and interviewing LGU officials.	LGU Local consultants
6/14-17/2013	San Vicente	Ocular Inspection	Ocular	To conduct ocular inspection of selected sites.	KACCC CCC
7/8-12/2013	Pasig City	Climate Smart Planning Training	Capacity Building	To capacitate SVP local officials on climate proofing their local development plans.	CCC GGGI LGU Experts
	Makati	High-level		To discuss future GGGI-CCC collaboration and the opening of project office in Manila.	CCC GGGI
8/16-20/2013		Capacity Building (ENRA)	ENRA	To provide training on Environment and Natural Resource Assessment and Accounting as an initial step for the formulation and implementation of innovative policy measures and programs.	CCC REECS LGU Local consultants

Date/ Period	Venue	Activity	Component	Objective/s	Participants
8/19-23/2013	Albay, Bicol	Eco-town Cross Visit	Capacity Building	To learn about best practices in climate change adaptation of Albay Province.	CCC GGGI LGU
8/24-27/2013	San Vicente	Scoping Activity on Economic activities	Scoping Activity	To map the economic activities in the area and the availability of local financial service providers in preparation for the development of financing schemes and capacity building on microfinance.	CCC SEDPI
8/27-28/2013	San Vicente	Capacity Building Workshop on Project	Capacity Building	To enhance participants' knowledge and capacity in project development with regard to climate change adaptation; to enable participants understand the tools and techniques of drafting effective project proposals.	CCC GGGI KACCC LGU
	Makati	Participation in the Asia LEDS Forum (Low Emissions		To present the best lessons and challenges in stakeholder management based on the experiences of the Eco-town Project.	GGGI Siargao mayor
10/2-10/2013	Makati	Writing the Final Project Report	Writeshop	To consolidate all the deliverables from local consultants and come up with a Final Project Report.	CCC GGGI KACCC
	Makati	Media Briefing		To share the progress and achievements of the Eco-town Project with different media outlets.	CCC GGGI Media
11/24-27/2013	Pasay City	National Climate Change	National	To showcase the Eco-Town Project in an exhibition booth – distributing project brochures and entertaining inquiries from the participants of the summit.	CCC GGGI LGUs Foreign donors
	Puerto Princesa	Climate Proofing Workshop	Capacity Building	To present the results of the VA and ENRA and the menu of adaptation measures to the local stakeholders as an initial step for integrating green growth and climate resilience plans in local development strategy.	CCC GGGI LGU Local consultants
12/12-14/2013	San Vicente		Capacity Building	To enable the local residents of San Vicente to have a better understanding of the importance of financial literacy to improve their own financial situation.	CCC SEDPI GGGI LGU
1/1-31/2014	Seoul and Manila	Project Wrap-up		To finalize all deliverables and officially close the books for the successful completion of the project.	CCC GGGI