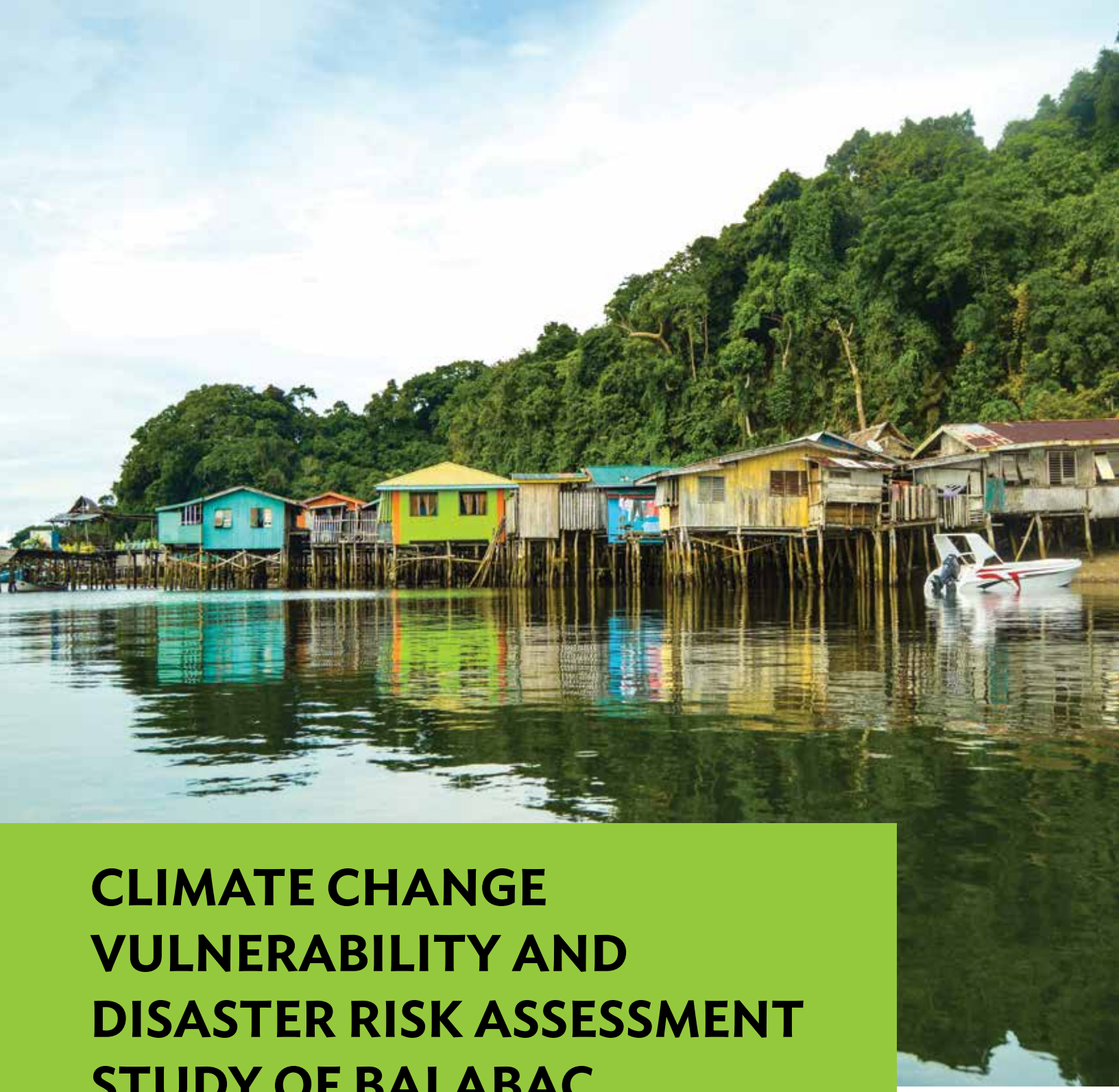


CLIMATE CHANGE VULNERABILITY AND DISASTER RISK ASSESSMENT STUDY OF BALABAC MUNICIPALITY, PALAWAN

Coastal and Marine Resources Management
in the Coral Triangle - Southeast Asia

CORAL TRIANGLE
INITIATIVE
ON CORAL REEFS, FISHERIES AND FOOD SECURITY

CLIMATE CHANGE VULNERABILITY AND DISASTER RISK ASSESSMENT STUDY OF BALABAC MUNICIPALITY, PALAWAN

CLIMATE CHANGE VULNERABILITY AND DISASTER RISK ASSESSMENT STUDY OF BALABAC MUNICIPALITY, PALAWAN

Coastal and Marine Resources Management
in the Coral Triangle - Southeast Asia

CORAL TRIANGLE
INITIATIVE
ON CORAL REEFS, FISHERIES AND FOOD SECURITY

This report was prepared by the Coastal and Marine Resources Management in the Coral Triangle–Southeast Asia (TA 7813-REG), a regional technical assistance project funded by the Asian Development Bank (ADB) and the Global Environment Facility (GEF).

Published in 2017.
Printed in the Philippines.

Suggested Citation:

ADB. 2017. *Climate Change Vulnerability and Disaster Risk Assessment Study of Balabac Municipality, Palawan.* Consultant's report. Manila (TA 7813-REG).

Note:
In this publication, "$" refers to US dollars, unless otherwise stated.

Chief Editor: Elvira C. Ablaza
Technical Editor: Raul G. Roldan
Copy Editor: Radmila Santos Natividad
Author: Dr. Candido A. Cabrido
Production Manager: Dana Rose J. Salonoy
Layout: Criselda C. Escalante

Photo Credit
Front Cover: Edgar D. Bagasol, Jr./TA 7813-REG

For more information, please contact:

Asian Development Bank
6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines
Tel: +63 2 632 4444; Fax: +63 2 636 2444
www.adb.org

ABOUT THE PROJECT

The Asian Development Bank (ADB) and Global Environment Facility (GEF) - funded Regional Technical Assistance for Coastal and Marine Resources Management in the Coral Triangle – Southeast Asia (TA 7813-REG) operates in the Sulu-Sulawesi Marine Ecoregion, specifically in Indonesia, Malaysia, and the Philippines (or the CT3). The project was implemented from August 2012 to November 2017.

For the Philippines, TA 7813-REG has five project sites: Taytay Municipality and Balabac Municipality in Palawan; Dumanguillas Bay in the Zamboanga Peninsula covering six municipalities; Tañon Strait in Central Visayas; and the Turtle Islands Wildlife Sanctuary in Tawi-tawi.

The project works with communities and local leaders to help them better manage their resources, become better prepared to face climate change effects, and to adopt environment-friendly and sustainable livelihood options.

The project also aims to address natural resource degradation, poverty within coastal communities, and weakness in coastal and marine resources management policy implementation.
The project has three main outputs:

- Supporting CT3 governments in establishing an enabling environment for sustainable coastal and marine resources management;
- Addressing constraints to sustainable fisheries management and economic development in the coastal zone, such as illegal, unreported, and unregulated fishing, overfishing, and natural habitat destruction, among others; and
- Establishing a project management system to ensure effective project implementation.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

Output 2 of TA 7813-REG (also known as RETA 7813) includes one regional subproject, viz., ***Vulnerability Assessment of Coastal and Marine Ecosystems and Resources and Adaptation of Coastal Communities to Climate Change.*** The objective of this subproject is to prepare coastal communities in identified subproject sites in each of the three Coral Triangle countries (Indonesia, Malaysia, and the Philippines) to adapt to the impacts of climate change through the development and pilot implementation of adaptation measures in order to reduce the accompanying effects of climate change, such as floods, storm surges, landslides, and sea level rise to their localities, well-being, properties, and livelihood.

Adaptation measures are needed to address the threats of climate change to the critical natural environment, which provides ecological services, goods, and materials needed by the communities for their existence. And as climate change exacerbates natural hazards, it cannot be dissociated or delinked from disaster risk. Thus, climate change adaptation (CCA) measures have to be accompanied by disaster risk reduction and management (DRRM) interventions that will enable vulnerable communities to cope with both climate change and natural disaster risks, such as typhoons, floods, rain-induced landslides, and sea level rise (SLR), among others.

Unfortunately, however, the lack of empirical studies on climate change impacts has made it difficult to make conclusions on the effects of increasing temperature and changes in rainfall pattern and distribution on natural habitats and resources. Instead, scientific findings and observations done at international and national levels on climate change impacts have been used as bases for most CCA and DRRM plans, especially at the local level.

It was against this background that a ***Climate Change Vulnerability and Disaster Risk Assessment Study*** was designed and implemented in Balabac Municipality in Palawan Province in study duration as part of the abovecited regional subproject of RETA 7813. The study aimed to: (i) conduct climate change vulnerability and disaster risk assessment; and (ii) formulate appropriate climate change adaptation and disaster risk reduction measures to address the present and potential problems of the municipality. It covered six *barangays* (villages) in the municipality of Balabac (Agutayan, Bancalaan/Matanggule, Catagupan, Pasig, Rabor, and Salang), which are usually affected by floods, as shown in the map obtained from the Balabac local government unit (LGU).

The study involved the conduct of (i) a desk review of relevant information available in municipal government office of Balabac, (ii) key informant interviews (KIIs) with selected local stakeholders, and (iii) a consultative workshop[1] with *barangay* officials and community representatives. In addition, various GIS-based hazard risk exposure maps and tables of population, physical assets, and natural environment of all the *barangays* in the municipality were prepared with the technical support of a GIS Specialist. The results of the spatial analyses were then used as bases for formulating the *Proposed CCA and DRRM Framework Plan for Balabac Municipality.* The CCA and DRRM measures contained in the said Framework Plan are proposed for mainstreaming in the *Comprehensive Land Use Plan (CLUP) of Balabac* and used in the preparation of mainstreaming guidelines for LGU planners.

The study was implemented in two phases. In Phase 1, climate change vulnerability and disaster risk assessment participatory household and key informant interviews were conducted to: (i) generate information on the natural hazard profile of the municipality; (ii) determine the perception of the *barangay* communities on climate change and the impacts of past disaster events on their families; and (iii) assess the status of DRRM implementation by the municipal government and the CCA/DRRM coping mechanisms of families. In Phase 2, the CCA/DRRM Framework Plan for Balabac was formulated. Hazard maps available from various official sources were generated and overlaid with population, physical assets, natural environment, and land use maps to: (i) assess the level of exposure of the population, physical assets, natural environment, and land use of Balabac municipality to climate change and disaster risk; (ii) formulate the framework and measures for CCA and DRRM for Balabac municipality; and (iii) recommend guidelines for the mainstreaming of CCA and DRRM into the CLUP, CDP, and AIP.

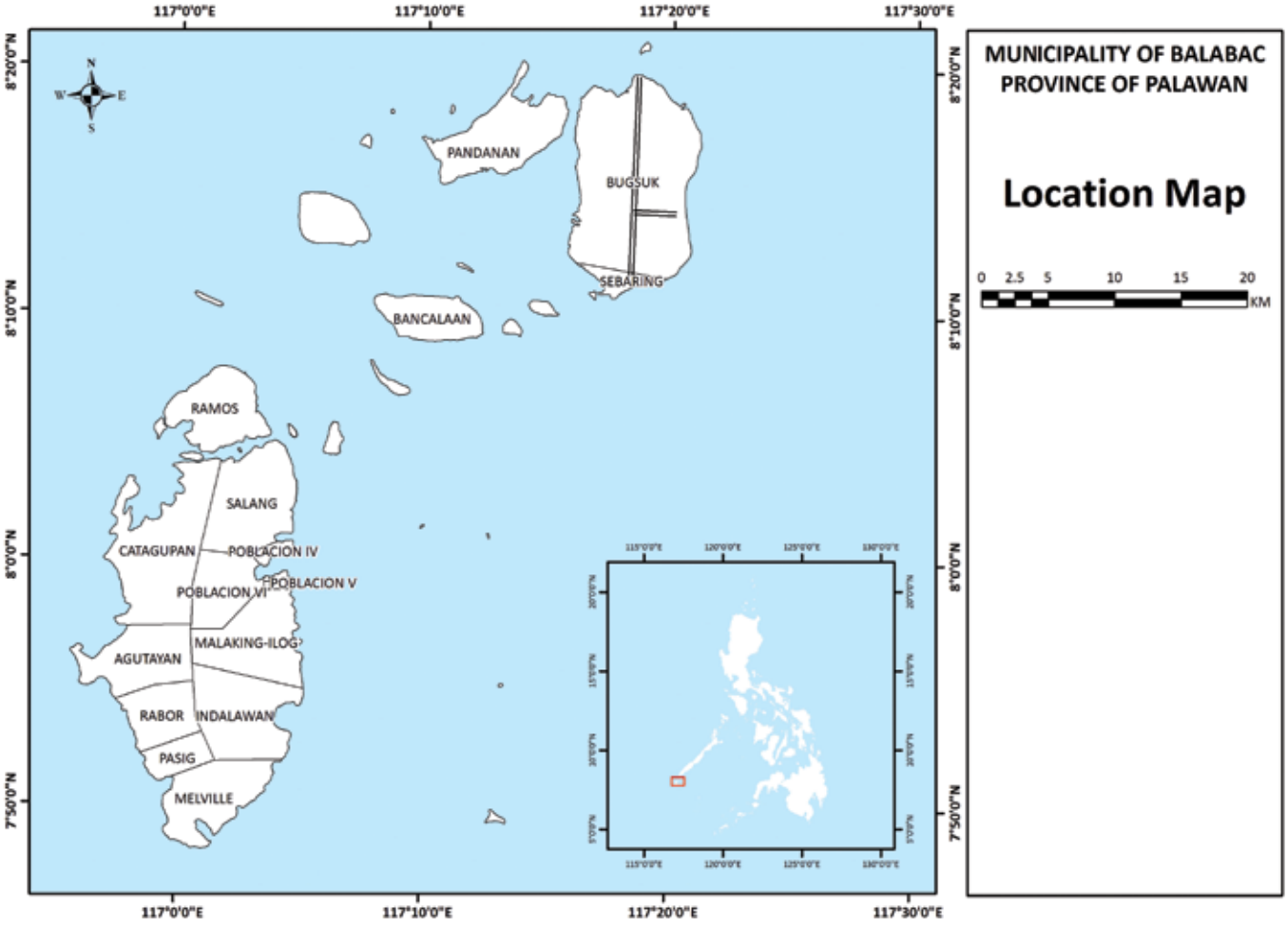
[1] A Workshop on Hazard Characterization of Barangays in Balabac Municipality was held at the A&A Plaza Hotel in Puerto Princesa City, Palawan on 14 February 2014, with barangay chairpersons and other local officials in attendance.

This report presents the results of the climate vulnerability and disaster risk assessment conducted in Balabac Municipality under RETA 7813. It includes maps of the spatial location and extent of various natural hazards and disaster risks, as well as the level of exposure of the communities and the physical and natural assets covering the whole municipality. Most importantly, the report contains the *CCA/DRRM Framework Plan for Balabac,* which was formulated as part of the study with the active involvement of local government officials at the municipal and *barangay* levels.

II. THE STUDY AREA

The municipality of Balabac is located in the southern tip of the mainland of Palawan, about 180 kilometers (km) from Puerto Princesa City. It is bounded in the north by Balabac North Channel, in the south by Balabac South Channel and Borneo, in the east by Sulu Sea, and in the west by South China Sea (Figure 1).

Figure 1. Location Map of Balabac Islands



Balabac Municipality comprises 6 islands and 20 *barangays* (Figure 2). The whole municipality, including its islands and islets, covers 63,757 ha. The main Balabac island, where the town center and seat of local government is located, is generally characterized by hills and mountains and fertile valleys traversed by rivers. The highest peak of the Balabac mountain is about 1,867 meters (m), and its forest vegetation cover is still in a relatively good condition. The island is mainly populated by fishing families who migrated there from the Sulu archipelago, Palawan mainland, and other provinces starting in the late 1960s. Based on the NSO census for 2010, Balabac has a total population of 35,758, and its annual population growth rate is about 1.5% (CLUP, 2000). The land area, population size, and sample size of the household surveys conducted in the study *barangays* are shown in Table 1.

Figure 2. Barangays and Islands Comprising Balabac Municipality

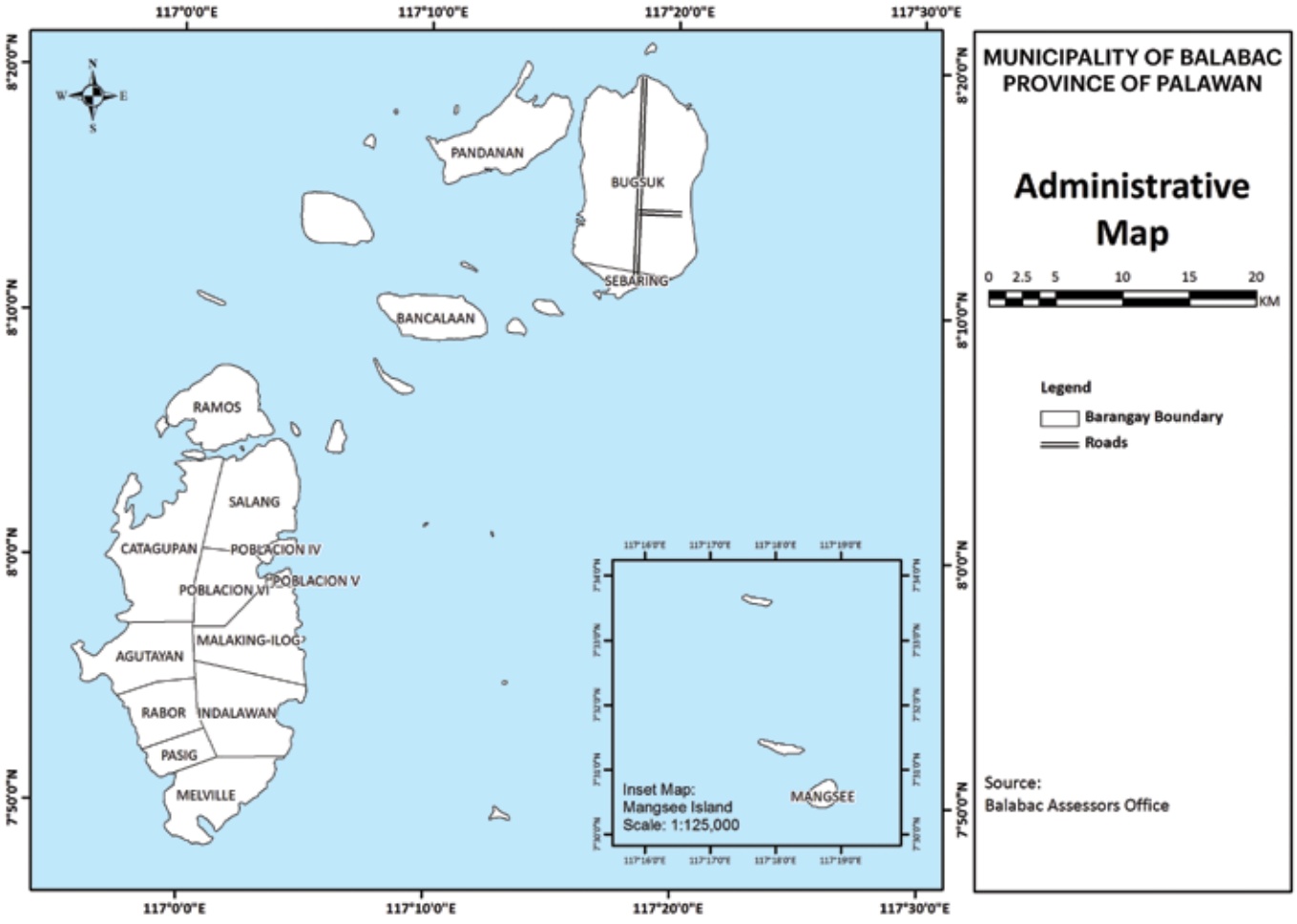


Table 1. Land Area, Population, and Sample Size of Study *Barangays* in Balabac

Study *Barangays*	Land Area (ha)	Population (2010)	Sample Size	% of Population
Agutayan	3,322.74	711	97	13.64
Bancalaan/Matanggule	3,757.63	10,427	223	2.13
Catagupan	6,439.10	1,954	95	4.86
Pasig	2,364.86	340	86	25.29
Rabor	2,023.46	312	96	30.76
Salang	10,937.10	2,533	96	3.78

A. Physical and Biological Environment and Land Use

1. Climate Profile

The municipality falls under Type III of the Corona Climate Classification. It has a distinct wet season from June to December and a dry season from January to May. The month of November has the highest volume of rainfall. Strong winds and rough seas are brought by the northeast monsoon from November to March, and the southwest monsoon from July to September. Calm months are experienced during the months of April to May and sometimes from September to October. The municipality is reportedly rarely hit by typhoons but strong winds or gales could be experienced during the months of October to November. However, with climate change, it is possible that the frequency of tropical cyclones could affect the municipality and cause more floods and storm surges.

2. Biological Environment

The biological environment of the island municipality is characterized by upland forests; mangroves along the coastal areas; fringing coral reefs, seagrass, and algal beds; and wildlife, including marine mammals. The municipality is rich in biodiversity, making it an important protection and conservation area. Presently, these habitats and resources are threatened by overexploitation by the increasing local population and the growing demand for marine products by other provinces and neighboring Malaysia.

There are 27 species of mangroves in the municipality and its islands. Harvesting of mangrove timber for firewood and construction and the extraction of wood bark from the *tangal* species for processing into cloth dye are exerting severe pressure on the island's remaining mangrove resources. The land cover maps of Balabac produced by NAMRIA in 1998 (Figure 3) and 2010 (Figure 4) show that there are no mangroves in Bancalaan and Matanggule islands, thereby making these two *barangay*s susceptible to the impacts of storm surges. (Mangrove stands serve as natural frontline protection against strong winds and waves.) Instead, the coastal areas of these islands have wooded shrubs and grasses. Good to fair mangrove cover is still found in the coastal areas of Ramos, Salang, Catagupan, Poblacion VI, Agutayan, Rabor, Pasig, and Melville, as well as in the islands of Pandanan and Sebaring. Old growth and residual forests are found in Agutayan, Rabor, and Pasig. On the other hand, Catagupan, Salang, and Bancalaan have few pockets of forest cover, while Matanggule has good forest cover remaining in the southern side of the island.

Figure 3. Land Cover Map of Balabac Municipality, 1998

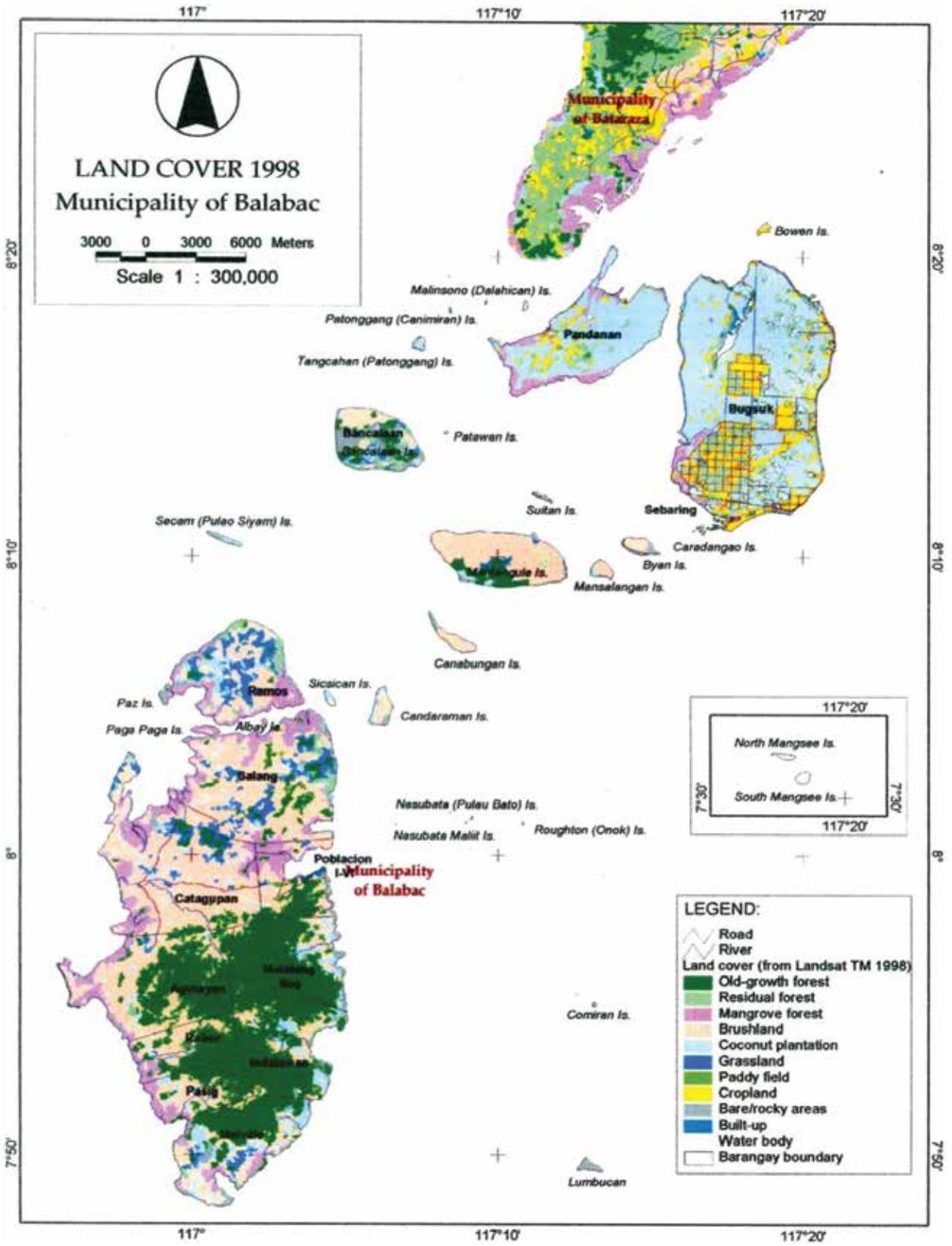
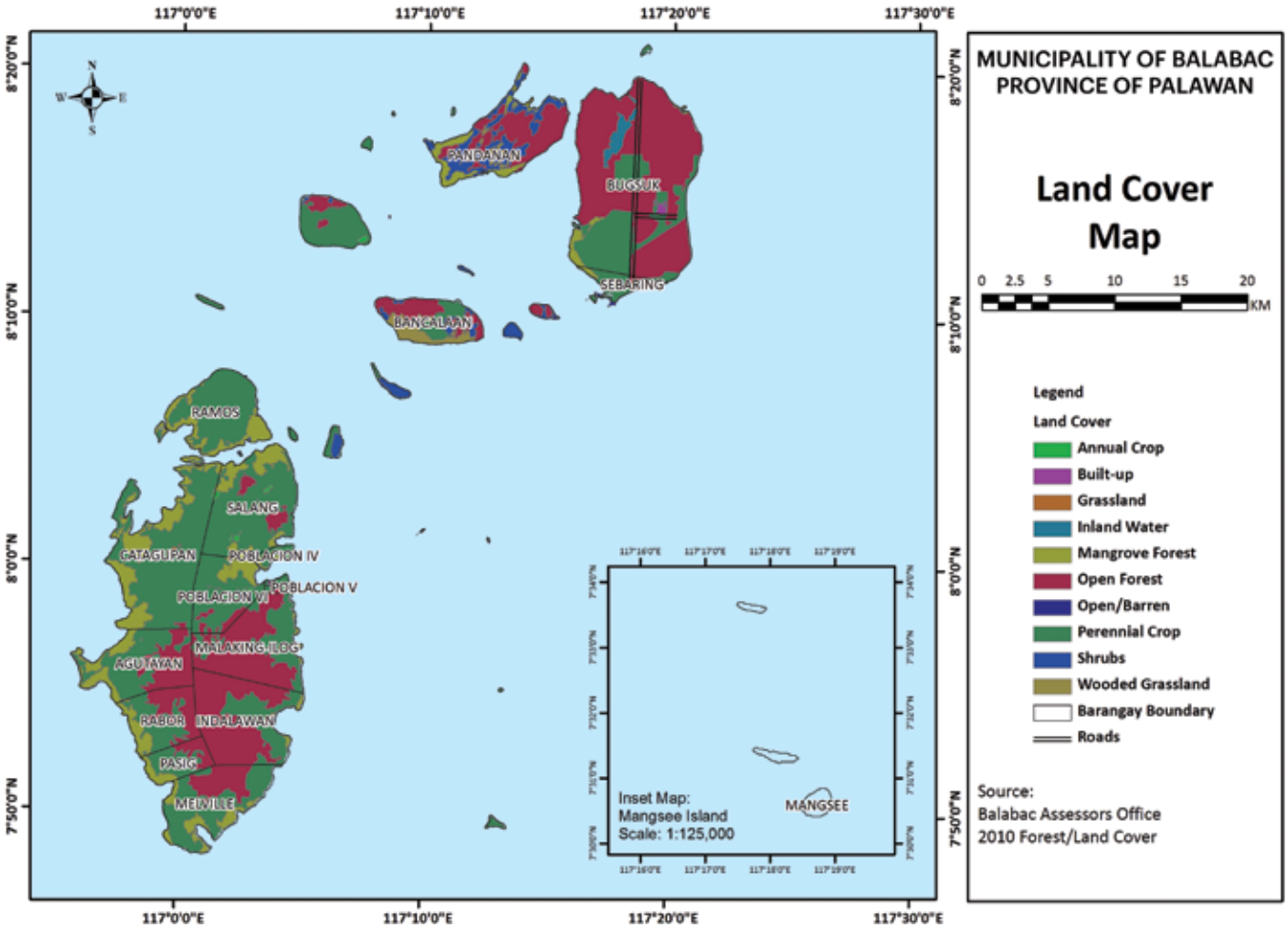


Figure 4. Land Cover Map of Balabac Municipality, 2010



3. Existing Land Use

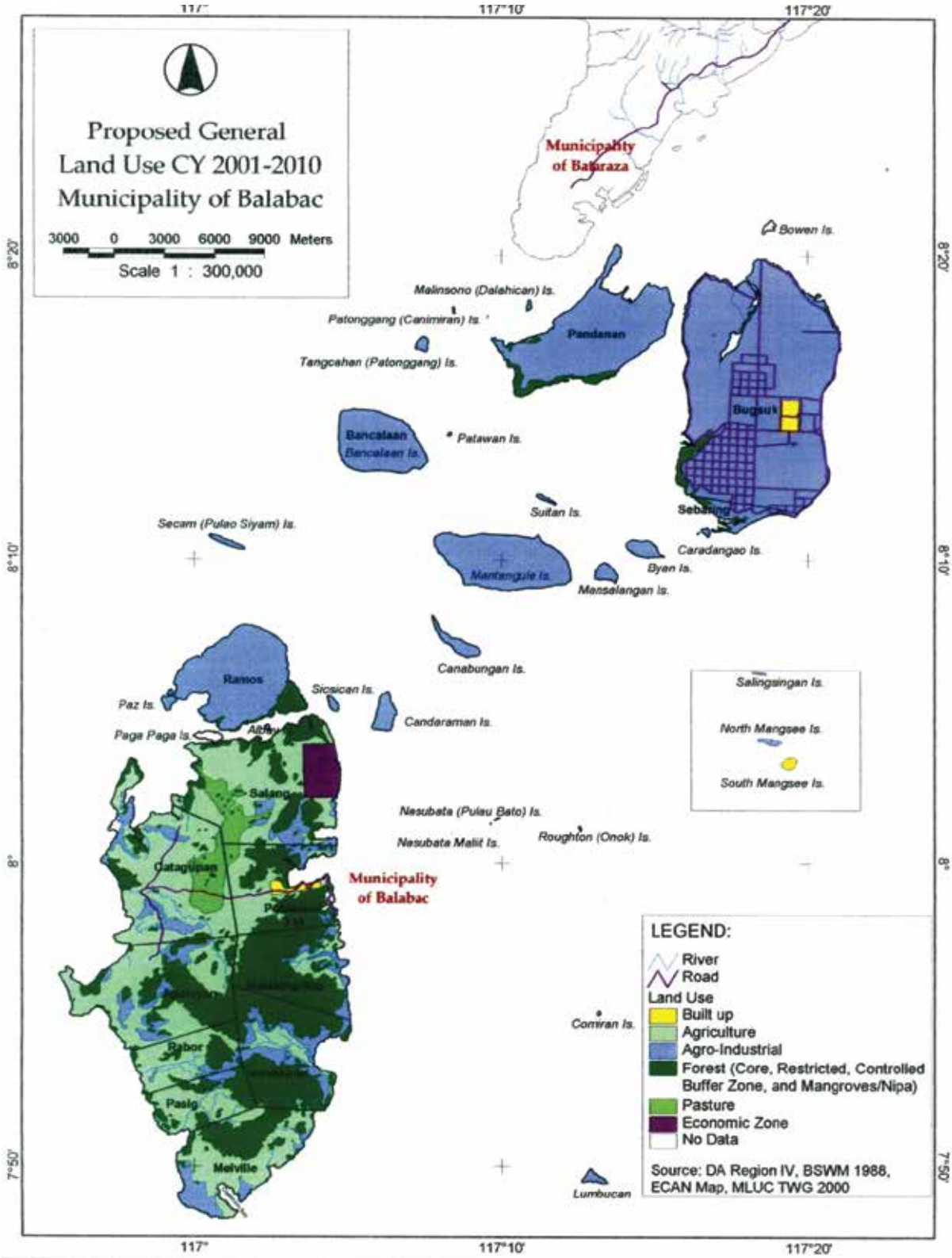
The existing land uses of the municipality are shown in Table 2 and Figure 5. Most of the area is used as Pasture/Grassland (36%), followed by Agriculture (34%), and Forest (18%). Mangroves occupy about 10% of the total land area of the municipality. Although the built-up areas occupy only 1% of the total land area of the municipality. It is highly likely that this land use category will expand in the coming years to meet the demand of the growing population living in the town center or *poblacion.*

Table 2. Existing General Use of Balabac Municipality

Land Use Category	Area (ha)	% of Total Area
Built-up Areas	699.88	1.20
Agriculture	19,936.12	34.27
Forest	10,605.00	18.23
Special Uses - Pasture/Grassland - Mangrove/Swampland	 20,989.00 5,936.00	 36.08 10.21
Total	**58,166.00**	**100.00**

Source: CLUP, 2000

Figure 5. Proposed General Land Use Map of Balabac Municipality, 2001–2007



4. Socioeconomic Status

Balabac is a second-class municipality whose economy is very much dependent on fishing and farming. The settlement areas in the municipality still lack basic services and other social amenities. There is no available comprehensive information on the impacts of natural hazards (such as typhoons, floods, and storm surges) on the population and the physical and natural assets of the municipality.

Common illnesses reported in the municipality are malaria, diarrhea, cough and colds, and skin diseases, which are due to poor sanitation and poor water quality for drinking and domestic uses. These diseases may be further aggravated by climate change in the near future.

About 64% of the population is considered poor, with an annual income below Php30,000; 32% are middle-income earners with an annual income of Php40,000-100,000; and 4% are in the upper income class with an annual income greater than Php100,000. The poverty level in the six study *barangay*s ranges from 55-90% (Table 3). Those populations living below the poverty line are highly vulnerable to climate change and disaster risk because of their low coping capacity to protect their families and to recover from the impacts of disasters.

Table 3. Poverty Level in the *Barangays* Covered by the Study

Study *Barangays*	% of Poor Population (Annual Income below PHP 30,000)
Agutayan	80
Bancalaan/Matanggule	60
Catagupan	90
Matanggule	
Pasig	55
Rabor	99
Salang	70

B. Development Issues and Challenges

Destruction of coral reefs and cutting of upland forests through *kaingin* (slash and burn clearing) and the harvest of mangrove trees for use as fuelwood and housing materials have reportedly continued over the last 10 years despite efforts of the LGU to contain these problems. Local and foreign commercial fishing vessels practice illegal fishing and poaching, which result in the massive exploitation of fish resources and marine turtles and the destruction of coral reefs.

The lack of enforcement of environmental (forestry and fishery) laws and the need to educate local farmers and fishermen on the value of the natural resources and environment are the main challenges to the proper management and conservation of the municipality's natural resources.

III. RESULTS AND DISCUSSIONS

A. Hazard Characterization and Frequency Analysis for Balabac Municipality

1. Methodology

Hazards found in the study of barangays of Balabac include typhoons, floods, earthquakes, and storm surges. Their frequency was estimated based on information gathered from secondary data and the results of the household survey.

Risk assessment was done by determining the areal extent (in ha) of the *barangays* and the number of people exposed to floods, landslides, tsunamis, and SLR. The risk of exposure was analyzed by overlaying the hazard maps (viz., flood susceptibility, landslide susceptibility, vulnerability to tsunami and to SLR at 0.5, 1, and 2 m) on the administrative map of the municipality (with the *barangay* boundaries delineated) and on the population density map. The results of the GIS-aided overlays enable the identification of the *barangays* and populations exposed to different risk levels of flooding (high, low, none),[2] landslides (high, moderate, low, none),[3] tsunamis (prone, not prone), and SLR (affected, not affected).[4] To anticipate the possible consequences of climate change, the areas that will be affected or exposed to SLR by 0.5, 1, and 2 m were determined, and the extent of areas and the coastal population that will be submerged by SLR were analyzed.

Based on historical records, interviews, and a consultation, Balabac is periodically affected by floods, earthquakes, and storm surges. Landslides are quite few or rare and are not usually reported as damaging, although there are many landslide-prone areas identified by the Mines and Geosciences Bureau (MGB) in the municipality. It is rarely affected by typhoons.

2. Findings

The hazards identified in the study *barangays* of Balabac include typhoons, floods, earthquakes, and storm surges. Their frequency was estimated based on information gathered from secondary data and the results of the household survey. The hazard characterization of the different *barangays* making up Balabac Municipality is shown in Appendix 1. The information for the profiling of hazards in the municipality was provided by the participants of the February 2014 Hazard Characterization Workshop held in Puerto Princesa City.

Typhoons hit the study *barangays,* on the average, once every 2-3 years, although several respondents reported experiencing typhoons more frequently. Based on Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) data on the tracking of typhoons, most of the typhoons that land in the country affect the central up to the northern parts of Palawan and seldom pass through the southern portion, where Balabac is located.

Flooding occurs almost every year during heavy rains, monsoon seasons, and typhoons. Most of the low-lying *barangays* suffer from floods but the level of flooding varies from one location to the other. Often seriously affected are *Barangays* Catagupan, Pasig, Rabor, and Salang, where the depth of regular floods varied from 0.3–1.5 m, while the worst floods ranged from 0.9–1.5 m and lasted for 1-3 days. However, *Barangays* Bancalaan and Matanggule were seldom affected by floods.

---

[2] High flood refers to areas: (i) with greater than 1-m flood heights; (ii) that are immediately flooded during heavy rains of several hours; and (iii) with low topography, such as those of active river channels, abandoned river channels, and areas along river banks. Moderate susceptibility refers to areas: (i) with 0.5 to 1-m flood heights; (ii) subjected to widespread flooding during prolonged and extensive rainfall; and (iii) with land forms, such as river terraces, alluvial fans (fan-shaped deposits of sediment built up by streams), and in-filled valleys. Low susceptibility refers to areas: (i) with 0 to 0.5-m flood height, such as in low hills and gentle slopes; and (ii) with sparse to moderate drainage density.

[3] High landslide susceptibility means: (i) presence of active and/or recent landslides; (ii) presence of numerous and large tension cracks; (iii) areas with drainages that are prone to debris damming; (iv) areas with numerous old landslides/escarpments; (v) steep slopes; (vi) presence of weak/rock slope materials; (vii) structures (joints, beds) dipping toward the slope face; and (viii) nearness to faults. Moderate susceptibility means: (i) areas with indicative and/or old landslides; (ii) presence of small tension cracks; and (iii) moderate slopes. Low susceptibility means: (i) low to gently sloping area; and (ii) no evidence of mass movement.

[4] Floods and landslides are classified by the DENR Mines and Geosciences Bureau (MGB) as high, moderate, and low. However, in this study, flood susceptibility was classified only as high or low, while landslide susceptibility was classified as prone or not prone.

Storm surges are also experienced during the occurrence of severe typhoons. The island barangays of Bancalaan and Matanggule are the most affected by storm surges because they lack natural barriers such as mangroves. The other *barangays* (Agutayan, Rabor, Pasig, Catagupan, and Salang) still have mangrove forests that protect the coastal communities against storm surges. Storm surges affecting *Barangay* Bancalaan/Matanggule were reported to reach heights of 2.1–2.7 m. The inland reach of the waves in this barangay was reported to range from 80–100 m. The other *barangays* were rarely bothered by storm surges with waves not more than 0.9-m high and an inland reach or spread of only about 10–20 m.

A **thrust fault** is located in mainland Balabac municipality. Hence, the *barangays* located in the mainland (Agutayan, Catagupan, Rabor, Pasig, and Salang) feel ground movement whenever the fault moves. Islands located away from the thrust fault (Bancalaan and Matanggule) are less affected by earthquakes. Interview respondents estimated that earthquakes occur at an interval of about 10–20 years, but the movements that they experienced were weak, possibly much lesser than 5 on the Richter scale, and lasted less than five seconds.

Other hazards, which may not be a problem at present but could be serious threats in the future, are landslides, liquefaction, SLR, and tsunamis.

Landslides were reported to be very minimal and negligible in the study *barangays.* Those interviewed did not mention any damage or injury caused by landslides or soil liquefaction. However, denuded, steep slopes are candidates for landslides during heavy rains or strong ground movements. Thus, the municipality cannot conclusively declare that their residents are free from exposure to landslides. When the slopes of forest lands get continuously denuded, landslides will always be a possibility; triggered by continuous heavy rains or seismic activities.

Tsunamis are projected by the Philippine Institute of Volcanology and Seismology (PHIVOLCS) to affect the municipality and its small islands when the Sulu Trench moves. There is presently no record available on the last movement of the trench. However, raising tsunami alertness in the area is a defensive strategy just in case this phenomenon occurs in the future. When the trench moves and creates an earthquake with a magnitude of 7.9–8.2 on the Richter scale, a tsunami with waves higher than 3 m will submerge Balabac municipality and its islands—a catastrophe to the communities living in the coastal areas. It will be extremely difficult to escape a tsunami, considering that an emergency warning can be released not earlier than 30 minutes before a tsunami hits land; this does not give much time for people to flee to higher ground.

SLR is a quiet and creeping global disaster. There is no way of stopping the rise in sea height; only defensive and adaptation means can be put in place. Based on the US National Oceanic and Atmospheric Administration (NOAA) satellite map, the sea surface height of Balabac islands is estimated to rise by about 101–110 cm from 1992–2011. If the melting of glaciers and permafrost in the Arctic and Antartic accelerates, and sea surface temperature (SST) further heats up, causing the wider expansion of water, many scientists project that sea level will increase by about 1–2 m. However, when this will happen cannot be easily foretold or determined, however.

Table 4. Possible Impacts and Urban Planning-Related Consequences of Climate Change

Climatic Change	Possible Impact	Possible Urban Planning-Related Consequences
Increased temperature	Increase in number of hot days Sea warming Coral bleaching	Exaggerated urban heat island effects Increased energy demands for cooling Decrease in fish catch
Increased precipitation	Increased risk of flooding	Damage to infrastructure and property Interruption of food supply networks Disruption of livelihoods and city/town economies Displacement of populations occupying hazardous areas Increased incidence of waterborne diseases
Decreased precipitation	Groundwater depletion Drought Surface water depletion	Water shortages Limited agricultural production Power shortage (hydroelectric plants)
Sea level rise	Increased risk of coastal flooding Saltwater intrusion	Displacement of coastal settlements Water shortage (coastal groundwater)

Table 5. Potential Impacts of Climate Change on Critical Development Sectors

CC Variables	Critical Sector					
	Agriculture	**Forestry**	**Coastal & Marine**	**Biodiversity**	**Water**	**Health**
Temperature increase	Decrease in yield due to heat stress Increased pest outbreaks	Increase in wildfires Pest outbreaks Spread of invasive alien species	Survival of fish, corals, seagrass, mangroves, and wildlife	Loss of species due to heat stress Spread of invasive alien species	Increase in demand for water Low water supply replenishment	Heat strokes from heat waves Increase in demand for energy
Rainfall changes	Damage to crops Soil erosion Flooding	Erosion, landslides River siltation and flooding Mortality of seedlings and young trees	Coastal land flooding Water pollution and siltation Beach erosion	Loss of species due to water stress	Water supply contamination Sedimentation Damage to water supply facilities	Increase in waterborne diseases, gastrointestinal diseases, and respiratory and skin diseases
SLR	Salinity intrusion Decrease in crop yield	Mangrove and nipa survival	Seagrass, coral reef, and wildlife survival Beach erosion	Degradation of wetlands and wildlife habitats	Salinity intrusion Water supply system inundation	Waterborne diseases Pollution from household and industry wastes
SST increase	Decrease in mariculture yield	Mangrove and nipa survival	Algal blooms Coral bleaching	Coral bleaching Seagrass and reef fish survival affected	Undetermined effects	Undetermined effects
El Niño/ drought	Crop damage Increased livestock deaths	Wildfires Low seedlings survival	Increased fishing effort Decrease in mariculture yield	Loss of species due to water stress	Increase in water demand Low rate of water supply replenishment	Heat strokes Water supply deficit
Storm surge	Affects soil salinity and growth of crops	Uproots and/ or drowns newly planted and young mangroves	Beach erosion Coastal flooding Inundation of coastal settlements Aquaculture and mariculture destruction	Inundation of wetlands Temporary disturbance of wildlife feeding	Saline intrusion to groundwater Destruction of water facilities	Waterborne diseases Pollution from households and industry wastes

Climate Change Impacts. The potential impacts of climate change in urban areas (such as increased temperature and extreme variability in rainfall and SLR, are described in Table 4. The serious impacts range from heat island effects, flooding, and water supply shortages to saltwater intrusion in coastal aquifers. The impacts of climate change on critical development sectors (agriculture, forestry, coastal and marine, health, and water resources) are given in Table 5.

B. Hazard Susceptibility Assessment

1. Flood Susceptibility

The extent of the *barangays* exposed to floods at high and low susceptibility levels are given in Table 6 and depicted in Figure 6. Of the total area of all the *barangays* in Balabac, about 11% has high susceptibility to flooding; 41% has low susceptibility to flooding; and 48% is not exposed

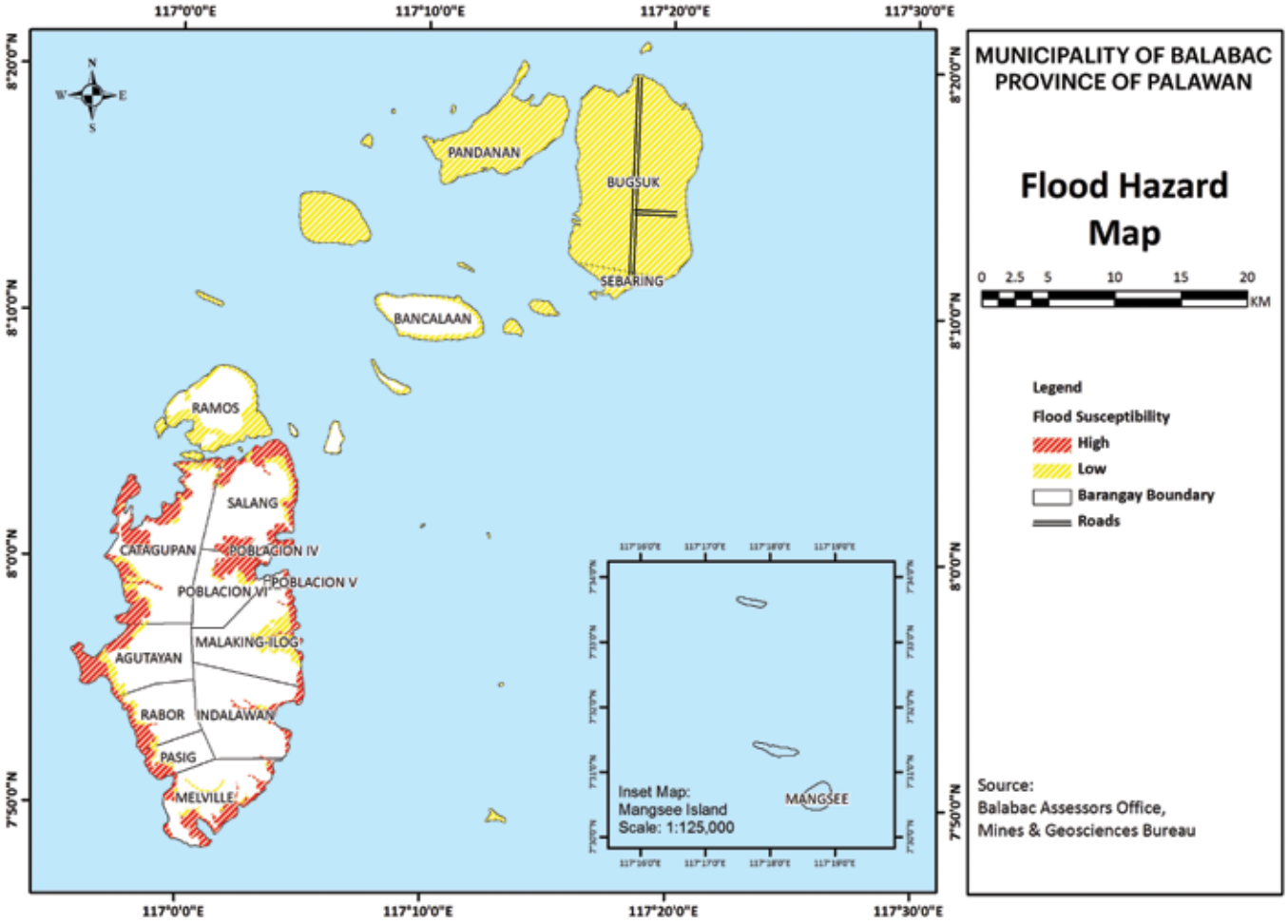
to floods. The *barangays* with 20% or more of their total areas highly susceptible to flooding are Poblacion IV (71%), Poblacion V (29%), Catagupan (27%), Salang (24%), Melville (23%), Pasig (22%), Agutayan (21%), and Poblacion VI (20%). On the other hand, the combined areas of Poblacions I, II, and III are not prone to flooding. Moreover, *barangays* with more than 70% of their total areas not prone to flooding include Indalawan (89%), Rabor (80%), Malaking Ilog (76%), Poblacion VI (76%), Agutayan (72%), Melville (71%), and Poblacion V (71%).

Table 6. Area of Barangays Exposed to Floods

Barangay	Area (ha)	Area Exposed to Flood (ha)							
		No Risk	% of Total	Low	% of Total	Moderate	% of Total	High	% of Total
Agutayan	3,350.26	2,395.87	71.51	266.25	7.95	688.15	20.54	3.04	0.09
Bancalaan	4,196.13	1,631.38	38.88	2564.75	61.12	0.00	0.00	0.00	0.00
Bugsuk	11,808.67	0.00	0.00	11,808.67	100.00	0.00	0.00	0.00	0.00
Catagupan	6,321.81	4,135.47	65.42	449.94	7.12	1,736.40	27.47	0.00	0.00
Indalawan	4,332.33	3,852.52	88.92	163.02	3.76	316.80	7.31	335.65	7.75
Malaking Ilog	4,038.46	3,055.14	75.65	691.71	17.13	291.61	7.22	919.83	22.78
Mangsee	90.73	0.00	0.00	90.73	100.00	0.00	0.00	0.00	0.00
Melville	3,493.18	2,485.17	71.14	205.51	5.88	802.51	22.97	0.00	0.00
Pandanan	4,115.78	0.00	0.00	4,115.78	100.00	0.00	0.00	0.00	0.00
Pasig	1,175.45	855.14	72.75	66.00	5.62	254.31	21.63	0.00	0.00
Poblacion I	17.26	17.26	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Poblacion II	26.58	26.58	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Poblacion III	15.51	15.51	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Poblacion IV	324.76	95.31	29.35	0.00	0.00	229.45	70.65	0.00	0.00
Poblacion V	155.47	110.75	71.23	0.00	0.00	44.72	28.77	0.00	0.00
Poblacion VI	2,388.79	1,810.33	75.78	98.86	4.14	479.60	20.08	0.00	0.00
Rabor	2,210.17	1,762.52	79.75	129.08	5.84	318.57	14.41	32.10	1.45
Ramos	3,485.60	1,861.61	53.41	1,623.99	46.59	0.00	0.00	0.00	0.00
Salang	4,946.52	3,218.34	65.06	518.64	10.48	1,209.53	24.45	0.00	0.00
Sebaring	650.07	0.00	0.00	650.07	100.00	0.00	0.00	0.00	0.00
Total	**57,143.52**	**27,328.89**	**47.83**	**23,442.99**	**41.02**	**6,371.65**	**11.15**	**1,290.62**	**2.26**

Source: (ICF-GHK, 2013)

Figure 6. Landslide Hazard Map of Balabac Municipality



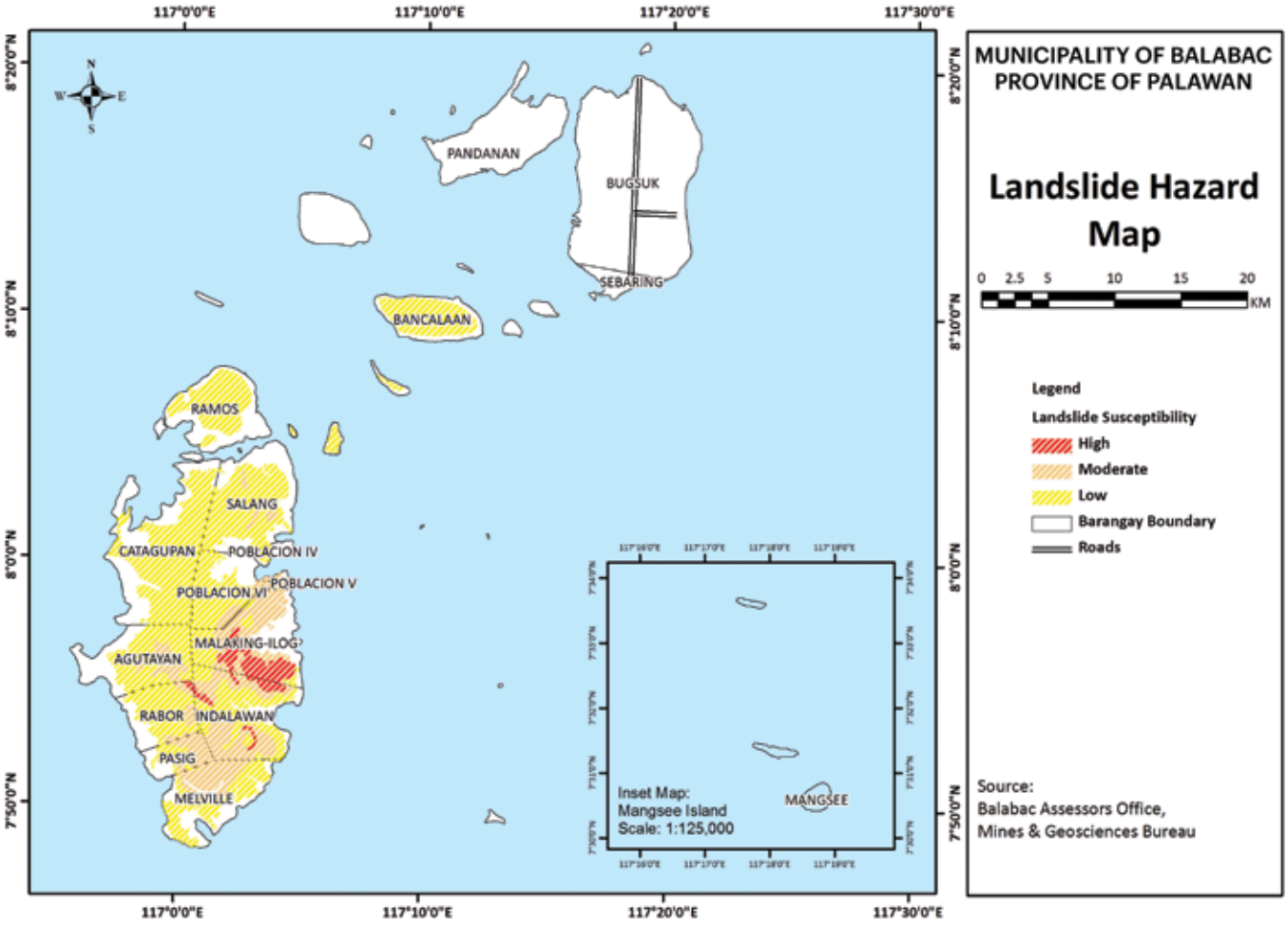
2. Landslide Susceptibility

As shown in Table 7 and Figure 7, only a small portion (2%) of the total land area of Balabac is highly prone to landslides; 11% is moderately prone; 35% is slightly prone; and 52% is not prone to landslides. Around 23% of the total land area of *Barangay* Malaking Ilog is highly prone to landslides. In *Barangays* Poblacion I, II, and III, 100% of the total land area is identified to be moderately prone to landslides. On the other hand, the *barangays,* whose total land area is not prone to landslides, include Bugsuk, Mangsee, Pandanan, and Sebaring. Landslides do not pose any risk in these *barangays.*

Table 7. Area of Barangays Exposed to Landslides

Barangay	Area (ha)	Area Exposed to Landslides (ha)							
		No Risk	% of Total	Low	% of Total	Moderate	% of Total	High	% of Total
Agutayan	3,350.26	954.40	28.49	1,846.76	55.12	546.06	16.30	3.04	0.09
Bancalaan	4,196.13	2,564.75	61.12	1,631.38	38.88	0.00	0.00	0.00	0.00
Bugsuk	11,808.67	11,808.67	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Catagupan	6,321.81	1,983.87	31.38	4,337.94	68.62	0.00	0.00	0.00	0.00
Indalawan	4,332.33	479.81	11.08	1,759.02	40.60	1,757.86	40.58	335.65	7.75
Malaking Ilog	4,038.46	983.32	24.35	674.42	16.70	1,460.89	36.17	919.83	22.78
Mangsee	90.73	90.73	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Melville	3,493.18	1,005.33	28.78	1,498.56	42.90	989.30	28.32	0.00	0.00
Pandanan	4,115.78	4,115.78	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Pasig	1,175.45	320.35	27.25	366.78	31.20	488.32	41.54	0.00	0.00
Poblacion I	17.26	0.00	0.00	0.00	0.00	17.26	100.00	0.00	0.00
Poblacion II	26.58	0.00	0.00	0.00	0.00	26.58	100.00	0.00	0.00
Poblacion III	15.51	0.00	0.00	0.00	0.00	15.51	100.00	0.00	0.00
Poblacion IV	324.76	235.79	72.61	84.29	25.96	4.67	1.44	0.00	0.00
Poblacion V	155.47	44.88	28.87	0.00	0.00	110.59	71.13	0.00	0.00
Poblacion VI	2,388.79	579.46	24.26	1,554.20	65.06	255.13	10.68	0.00	0.00
Rabor	2,210.17	447.64	20.25	1,460.34	66.07	270.09	12.22	32.10	1.45
Ramos	3,485.60	1,623.99	46.59	1,861.61	53.41	0.00	0.00	0.00	0.00
Salang	4,946.52	1,733.12	35.04	3,031.19	61.28	182.21	3.68	0.00	0.00
Sebaring	650.07	650.07	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**57,143.52**	**29,621.96**	**51.84**	**20,106.48**	**35.19**	**6,124.47**	**10.72**	**1,290.62**	**2.26**

Figure 7. Landslide Hazard Map of Balabac Municipality



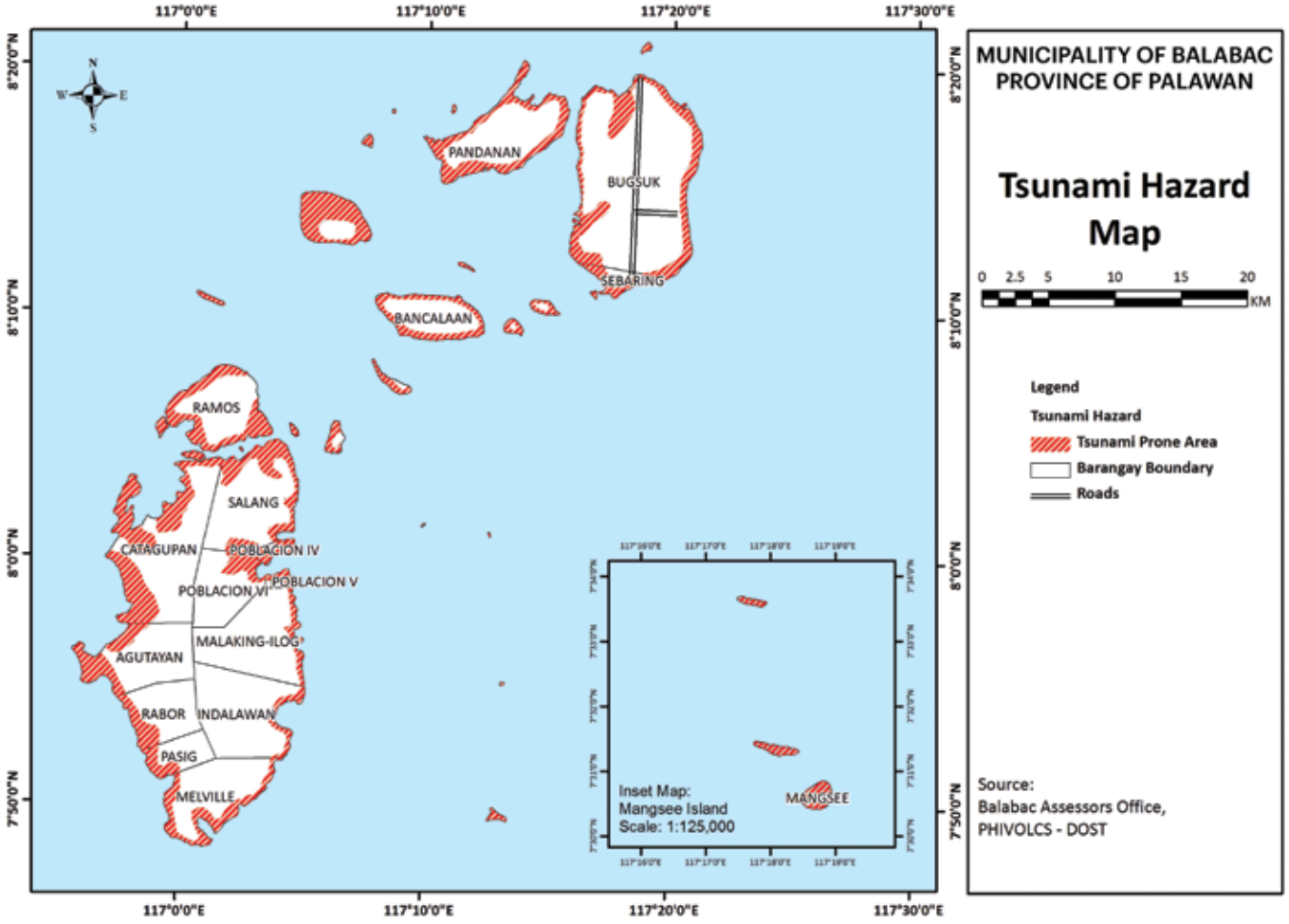
3. Exposure to Tsunami

In the event the Sulu Trench moves, PHIVOLCS projects that one of the areas that will be submerged is Palawan province, including Balabac islands. An overlay of the PHIVOLCS tsunami map on the map of Balabac revealed that about 30% of the total land area of Balabac islands will be inundated (Table 8; Figure 8). The total land area of Poblacion III and Mangsee is exposed to tsunamis, while three *barangays* (Indalawan, Malaking Ilog, and Poblacion II) have the least exposure to tsunamis. *Barangays* with more than 40% of their total land area most likely to be submerged by tsunamis are Poblacion V (67%), Bancalaan (56%), Ramos (44%), and Catagupan (41%) (Table 8).

Table 8. Area of Barangays Exposed to Tsunami

Barangay	Area (ha)	Area Exposed to Tsunami (ha)			
		No Risk	% of Total	Prone	% of Total
Agutayan	3,350.26	2,457.62	73.36	892.65	26.64
Bancalaan	4,196.13	1,832.99	43.68	2,363.14	56.32
Bugsuk	11,808.67	9,267.09	78.48	2,541.58	21.52
Catagupan	6,321.81	3,736.11	59.10	2,585.70	40.90
Indalawan	4,332.33	3,908.73	90.22	423.60	9.78
Malaking Ilog	4,038.46	3,694.37	91.48	344.08	8.52
Mangsee	90.73	0.00	0.00	90.73	100.00
Melville	3,493.18	2,479.95	70.99	1,013.23	29.01
Pandanan	4,115.78	2,553.06	62.03	1,562.73	37.97
Pasig	1,175.45	860.17	73.18	315.28	26.82
Poblacion I	17.26	14.34	83.10	2.92	16.90
Poblacion II	26.58	24.84	93.46	1.74	6.54
Poblacion III	15.51	0.00	0.00	15.51	100.00
Poblacion IV	324.76	58.42	17.99	266.33	82.01
Poblacion V	155.47	50.99	32.79	104.49	67.21
Poblacion VI	2,388.79	1,981.01	82.93	407.78	17.07
Rabor	2,210.17	1,731.63	78.35	478.54	21.65
Ramos	3,485.60	1,944.73	55.79	1,540.87	44.21
Salang	4,946.52	3,220.58	65.11	1,725.94	34.89
Sebaring	650.07	147.59	22.70	502.48	77.30
Total	**57,143.52**	**39,964.22**	**69.94**	**17,179.30**	**30.06**

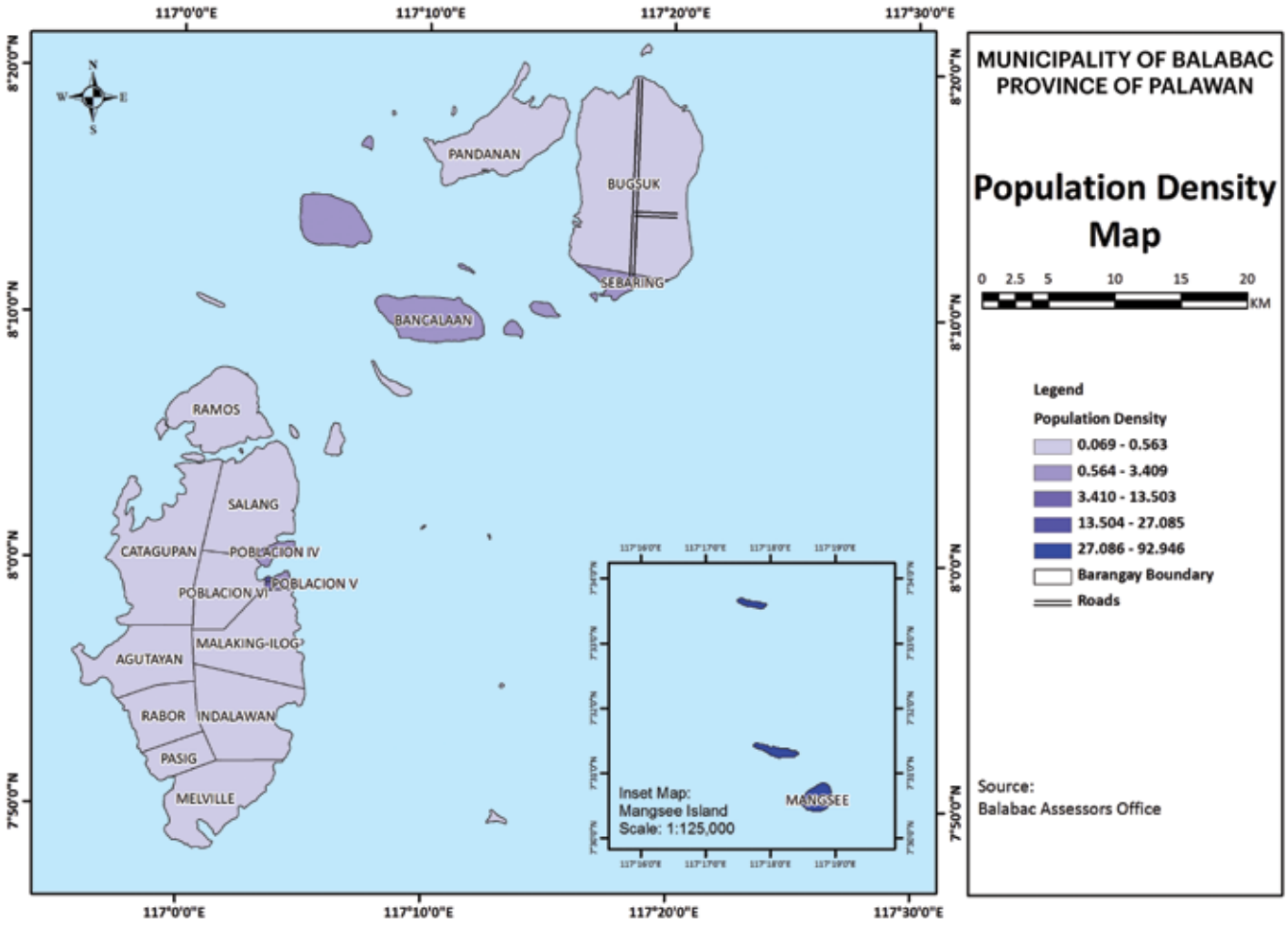
Figure 8. Tsunami Hazard Map of Balabac Municipality



C. Hazard Exposure Assessment

The exposure of the population to various hazards (such as floods, landslides, tsunamis, and SLR) was calculated based on the municipality's population density map (Figure 9), which was prepared by calculating the latest population data per *barangay* divided by the area of the *barangay.* The population density map was then overlaid with the hazard maps to estimate the percentage of the population exposed to a particular hazard (e.g., floods).

Figure 9. Population Density Map per Barangay



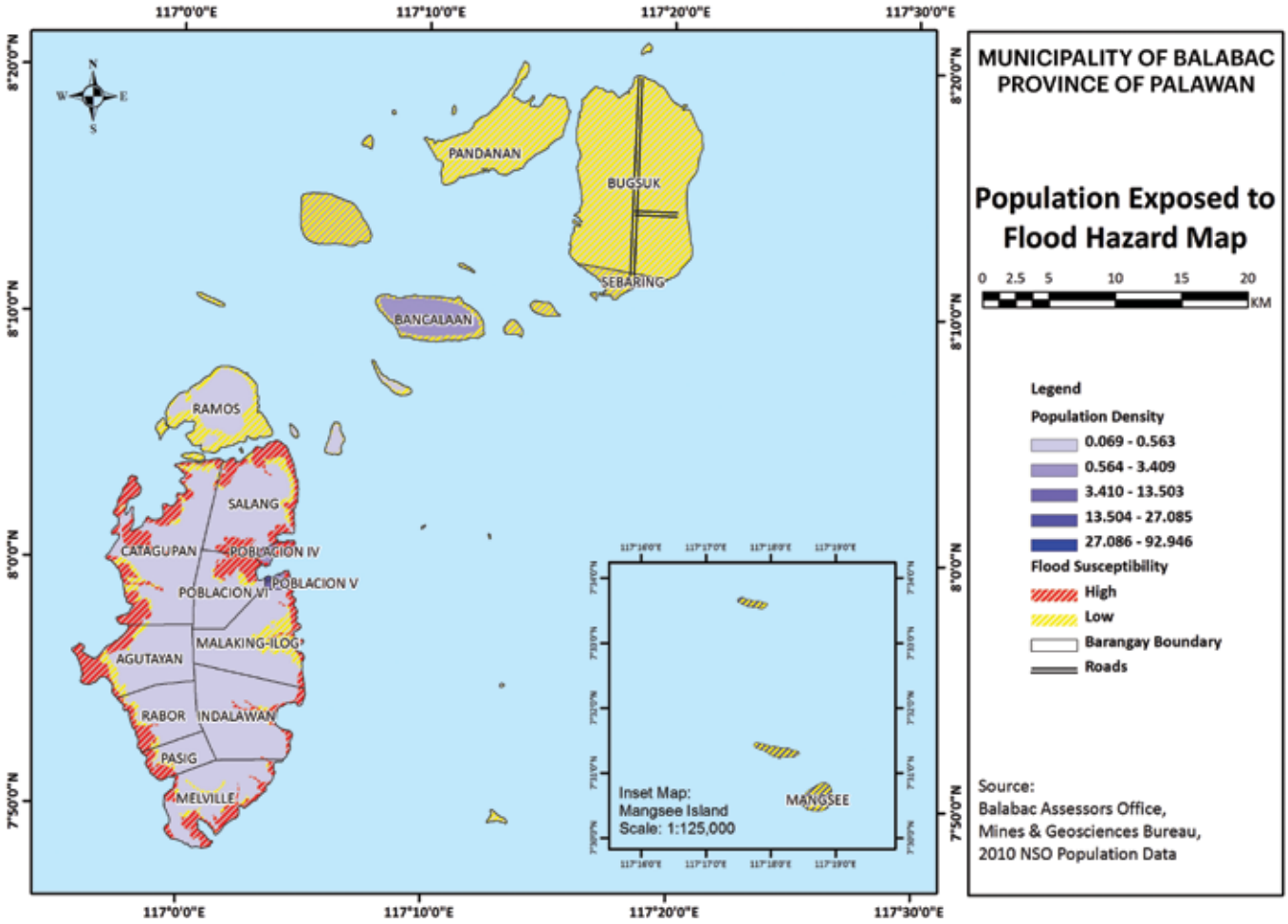
1. Exposure to Floods

Population Exposed to Floods. Only 7% of the total population of the municipality is exposed to high susceptibility flooding, 54% to low susceptibility flooding, and 39% is not exposed to flooding. Thus, about 61% of the municipality's population is exposed to low and high susceptibility flooding (Table 9; Figure 10).

Table 9. Population Exposed to Floods at Various Susceptibility Levels

Barangay	Population	Population Density (per ha)	Population Exposed to Flood					
			No Risk	% of Total	Low	% of Total	High	% of Total
Agutayan	711	0.212	508.46	71.51	56.50	7.95	146.04	20.54
Bancalaan	10,427	2.485	4,053.83	38.88	6,373.17	61.12	0.00	0.00
Bugsuk	816	0.069	0.00	0.00	816.00	100.00	0.00	0.00
Catagupan	1,954	0.309	1,278.23	65.42	139.07	7.12	536.70	27.47
Indalawan	1,270	0.293	1,129.35	88.92	47.79	3.76	92.87	7.31
Malaking Ilog	882	0.218	667.24	75.65	151.07	17.13	63.69	7.22
Mangsee	8,433	92.946	0.00	0.00	8,433.00	100.00	0.00	0.00
Melville	1,129	0.323	803.21	71.14	66.42	5.88	259.37	22.97
Pandanan	972	0.236	0.00	0.00	972.00	100.00	0.00	0.00
Pasig	340	0.289	247.35	72.75	19.09	5.62	73.56	21.63
Poblacion I	233	13.503	233.00	100.00	0.00	0.00	0.00	0.00
Poblacion II	294	11.060	294.00	100.00	0.00	0.00	0.00	0.00
Poblacion III	420	27.085	420.00	100.00	0.00	0.00	0.00	0.00
Poblacion IV	427	1.315	125.32	29.35	0.00	0.00	301.68	70.65
Poblacion V	530	3.409	377.54	71.23	0.00	0.00	152.46	28.77
Poblacion VI	1,211	0.507	917.75	75.78	50.12	4.14	243.14	20.08
Rabor	312	0.141	248.81	79.75	18.22	5.84	44.97	14.41
Ramos	1,963	0.563	1,048.41	53.41	914.59	46.59	0.00	0.00
Salang	2,533	0.512	1,648.04	65.06	265.58	10.48	619.37	24.45
Sebaring	901	1.386	0.00	0.00	901.00	100.00	0.00	0.00
Total	**35,758.00**		**14,000.52**	**39.15**	**19,223.63**	**53.76**	**2,533.85**	**7.09**

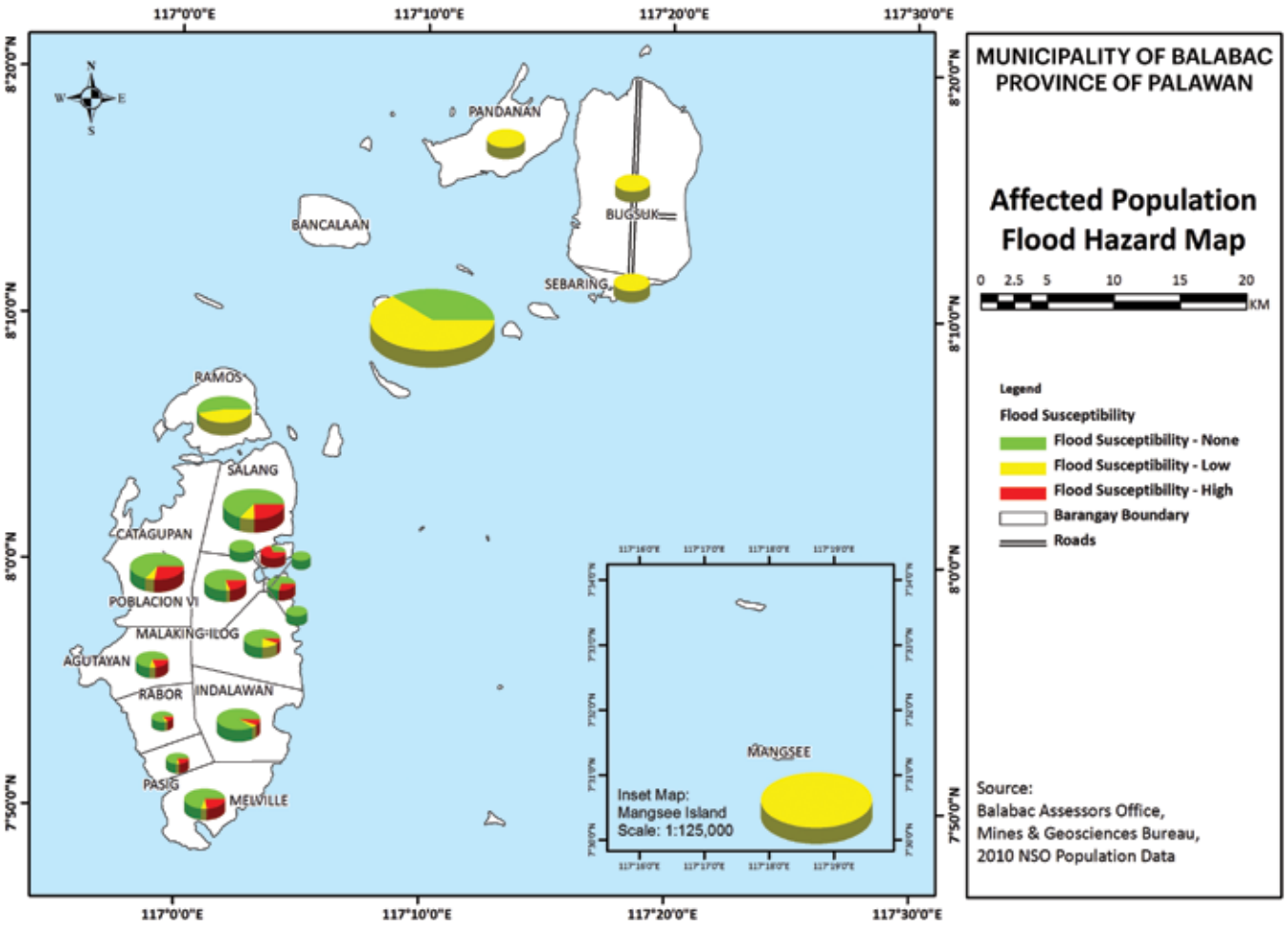
Figure 10. Population Exposed to Floods



The *barangays* with more than 20% of their population exposed to floods at high levels of susceptibility include Poblacion IV (71%), Poblacion V (29%), Catagupan (27%), Salang (25%), Melville (23%), Pasig (22%), Agutayan (21%), and Poblacion VI (22%).

In the *barangays* Bugsuk, Mangsee, Pandanan, and Sebaring, 100% of their population is exposed to low susceptibility flooding (Table 10 and Figure 10). The entire population of *barangays* Poblacions I, II, and III are not exposed to floods. In the following 10 *barangays,* more than 60% of their population is not exposed to floods are Indalawan (89%), Rabor (80%), Poblacion VI (76%), Malaking Ilog (76%), Agutayan (72%), Pasig (72%), Poblacion V (71%), Melville (71%), Salang (65%), and Catagupan (65%). The extent of the population in Balabac *barangays,* which are exposed to floods at various susceptibility levels, is shown in Figure 11.

Figure 11. Extent of Population Exposed to Floods at Various Susceptibility Levels

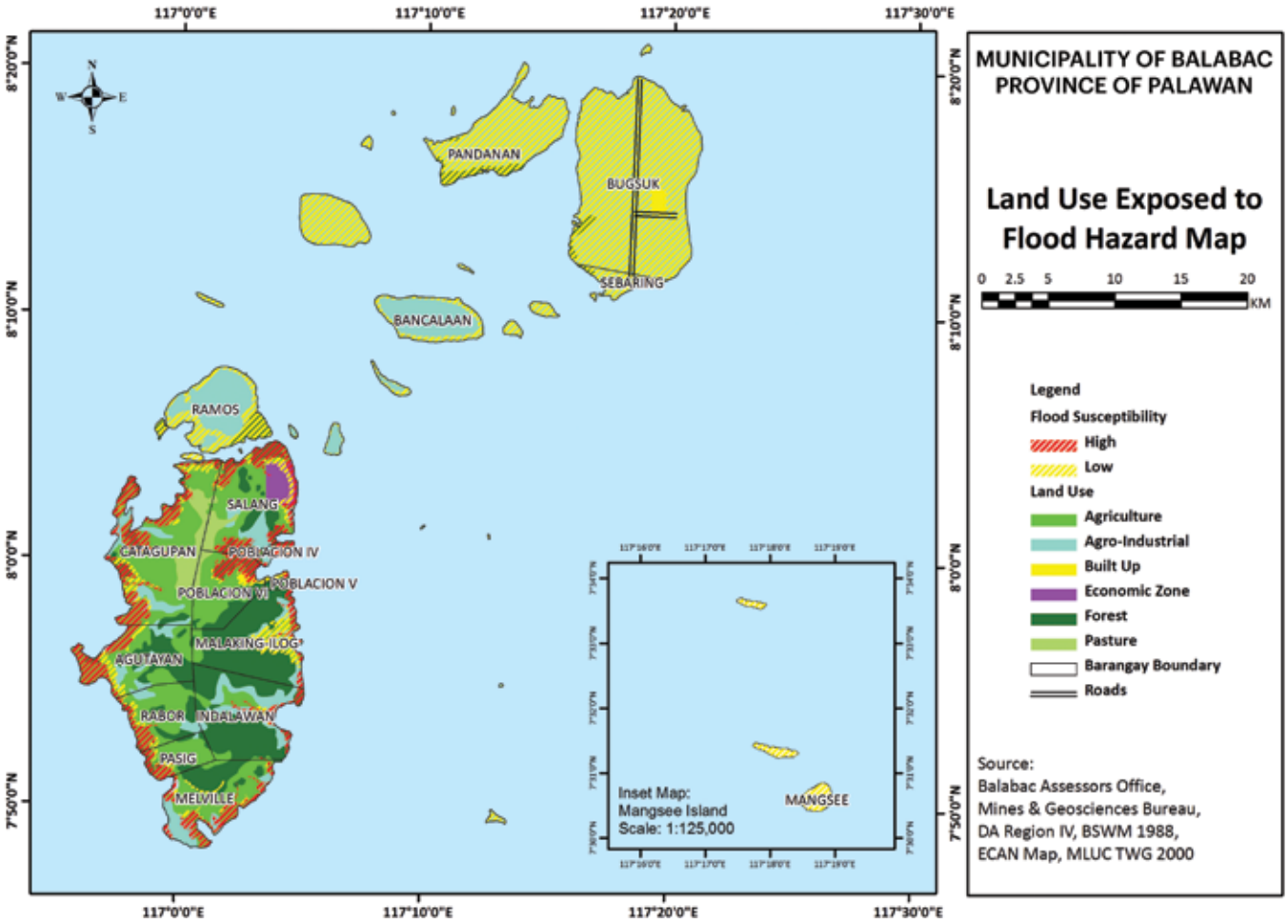


Land Use Exposed to Floods. Land uses with more than 10% of their total land area exposed to high flood susceptibility include Agriculture (23%), Economic Zone (17%), Built-up (16%), and Forest (16%). Land uses with more than 60% of their total land area exposed to low flood susceptibility are Agro-industrial (72%) and Built-up areas (67%). Land uses with more than 60% of their total area not exposed to floods are Pasture (98%), Forest (73%), and Agriculture (67%) (Table 10; Figure 12).

Table 10. Extent of Land Uses Exposed to Floods

Land Use	Area (ha)	Exposure to Flood (ha)					
		No Risk	% of Total	Low	% of Total	High	% of Total
Agriculture	14,531.42	9,688.47	66.67	1,453.72	10.00	3,389.13	23.32
Agro-industrial	27,789.21	6,948.16	25.00	19,977.18	71.88	863.15	3.11
Built-up	367.68	61.50	16.73	247.99	67.44	57.51	15.64
Economic Zone	729.27	436.51	59.86	166.98	22.89	125.55	17.22
Forest	12,073.01	8,820.36	73.06	1,378.27	11.41	1,874.26	15.52
Pasture	1,385.56	1,359.99	98.15	2.37	0.17	23.20	1.67
No Category	286.81	286.81	100.00	0.00	00.00	0.00	0.00
Total	**57,162.95**	**27,601.79**	**48.29**	**23,226.51**	**40.63**	**6,332.80**	**11.08**

Figure 12. Extent of Land Uses Exposed to High Flood Susceptibility

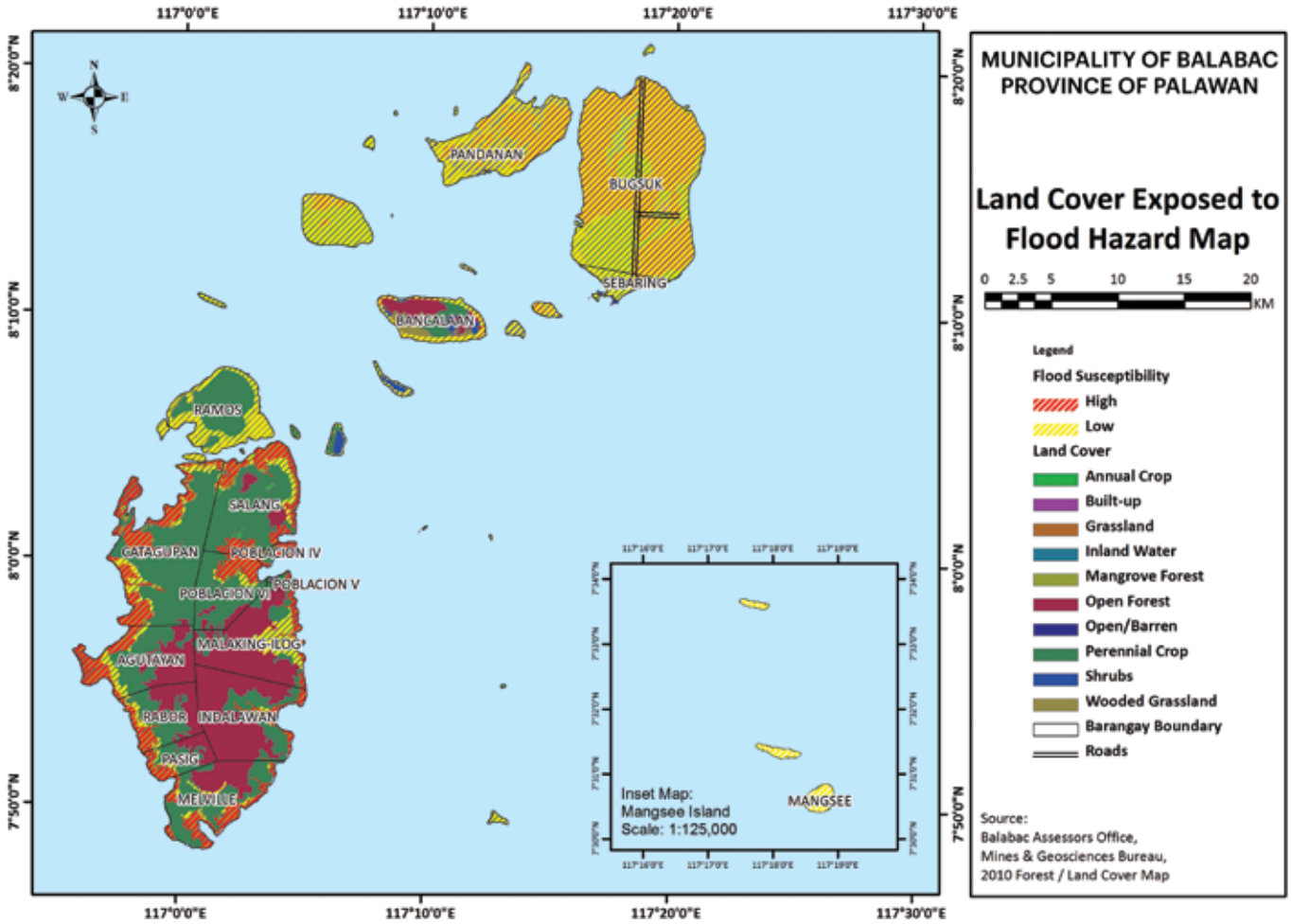


Land Cover Exposed to Floods. Although 59% of the mangrove cover in the municipality is exposed to high flooding, floods have no detrimental effects on the vegetation cover because mangroves are adapted to being submerged in sea water. The other types of land and vegetation cover with more than 50% of their total land area exposed to low susceptibility floods are: Inland Water (98%), Shrubs (84%), Built-up (80%), Open/Barren Land (54%), and Open Forest (52%). A large extent of the total land area of the following types of land cover/vegetation is not exposed to floods: Annual Crop (71%), Grassland (71%), Perennial Crop (63%), and Wooded Grassland (53%) (Table 11; Figure 13).

Table 11. Extent of Land Cover Exposed to Floods

Land Cover	Area (has)	Exposure to Flood (ha)					
		No Risk	% of Total	Low	% of Total	High	% of Total
Annual Crop	139.62	99.73	71.42	35.93	25.73	3.96	2.83
Built-up	83.09	16.82	20.24	66.28	79.76	0.00	0.00
Grassland	28.03	19.88	70.92	8.14	29.04	0.00	0.00
Inland Water	352.38	0.71	0.20	344.47	97.75	7.20	2.04
Mangrove Forest	6,556.35	608.87	9.28	2,048.68	31.24	3,898.80	59.46
Open Forest	20,793.95	9,972.03	47.95	10,797.72	51.92	24.20	0.11
Open/Barren	172.46	79.23	45.94	93.24	54.06	0.00	0.00
Perennial Crop	25,493.30	16,124.65	63.25	7,359.16	28.86	2,009.49	7.88
Shrubs	2,075.11	326.14	15.71	1,748.97	84.28	0.00	0.00
Wooded Grassland	749.43	394.48	52.63	354.95	47.36	0.00	0.00
Total	**56,443.72**	**27,642.54**	**48.97**	**22,857.54**	**40.49**	**5,943.65**	**10.53**

Figure 13. Extent of Land Cover Exposed to Floods

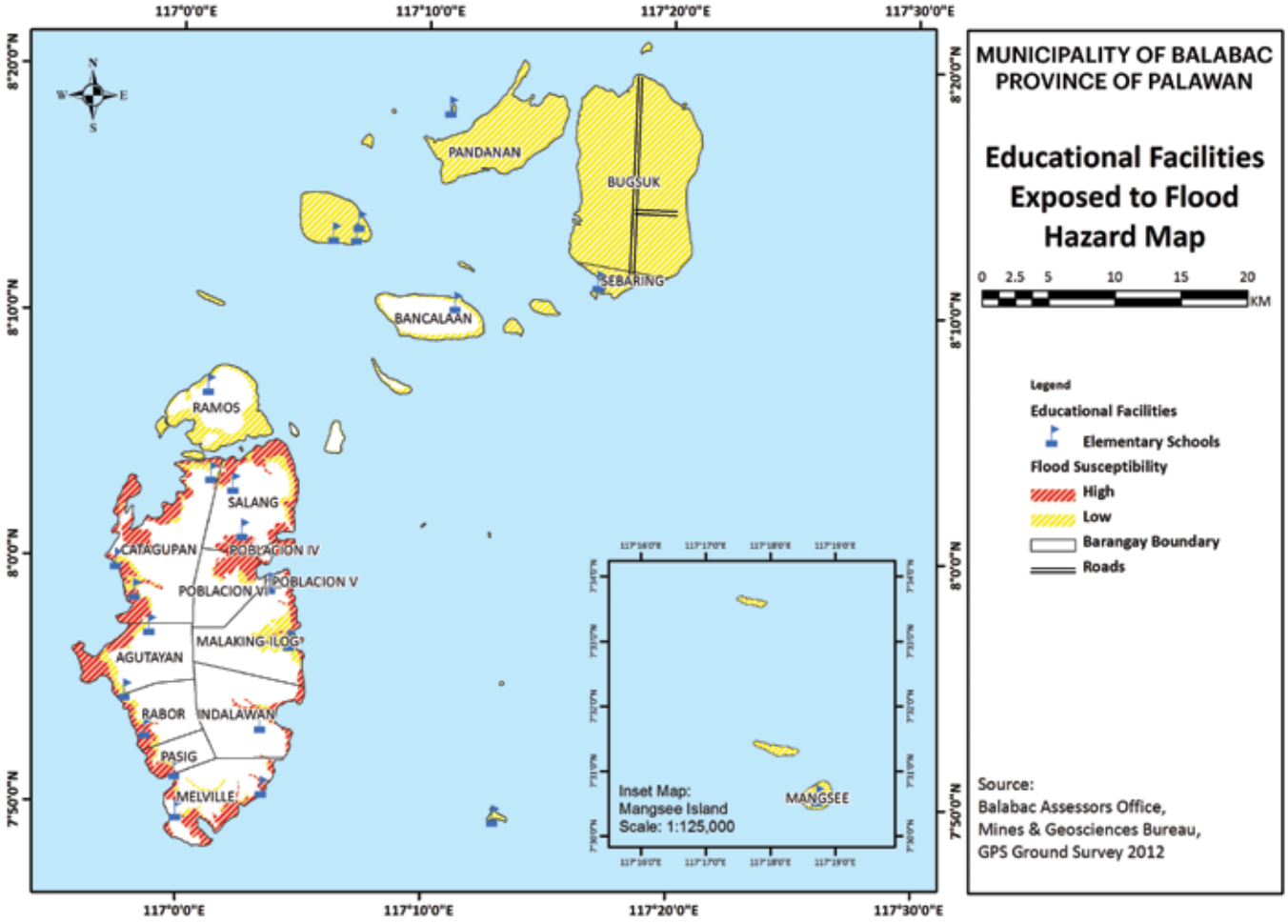


Education Facilities Exposed to Floods. Eight schools are exposed to high susceptibility flooding. They are located in Agutayan (1), Catagupan (1), Indalawan (1), Melville (2), Poblacion II (1), Poblacion VI (1), and Rabor (1) (Table 12; Figure 14). Six schools are exposed to low susceptibility flooding. These are located in Bancalaan (3), Malaking Ilog (1), Pandanan (1), and Sebaring (1). Seven were mapped as not exposed to floods; they are located in Agutayan (1), Bancalaan (1), Mangsee (1), Poblacion I (1), Ramos (1), and Salang (2). If these schools are validated as not affected by floods, they can serve as temporary evacuation centers until the *barangays* have established dedicated evacuation centers.

Table 12. Number of Educational Facilities Exposed to Floods

Land Cover	Exposure to Flood (ha)		
	Flood Susceptibility Level		
	None	Low	High
Agutayan	1		1
Bancalaan	1	3	
Bugsuk			
Catagupan			1
Indalawan			1
Malaking Ilog		1	
Mangsee	1		
Melville			2
Pandanan		1	
Pasig			
Poblacion I	1		
Poblacion II			1
Poblacion III			
Poblacion IV			
Poblacion V			
Poblacion VI			1
Rabor			1
Ramos	1		
Salang	2		
Sebaring		1	
Total	**7**	**6**	**8**

Figure 14. Educational Facilities Exposed to Floods



2. Exposure to Landslides

Less than 1% of the total population of the municipality is exposed to high-risk landslides, 8% to moderate-risk landslides, 30% to low-risk landslides, and 61% is not exposed to any risk. Therefore, it can be deduced that only a small portion of the municipality's population is exposed to landslide risk because a substantial part of the sloping areas is still covered with vegetation (Table 13; Figures 15 and 16).

Table 13. Population Exposed to Landslides

Land Cover	Population	Population Exposed to Landslides							
		No Risk	% of Total	Low	% of Total	Moderate	% of Total	High	% of Total
Agutayan	711	202.54	28.49	391.92	55.12	115.89	16.30	0.65	0.09
Bancalaan	10,427	6,373.17	61.12	4,053.83	38.88	0.00	0.00	0.00	0.00
Bugsuk	816	816.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Catagupan	1,954	613.19	31.38	1,340.81	68.62	0.00	0.00	0.00	0.00
Indalawan	1,270	140.65	11.08	515.65	40.60	515.31	40.58	98.39	7.75
Malaking Ilog	882	214.76	24.35	147.29	16.70	319.06	36.17	200.89	22.78
Mangsee	8,433	8,433.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Melville	1,129	324.92	28.78	484.34	42.90	319.74	28.32	0.00	0.00
Pandanan	972	972.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Pasig	340	92.66	27.25	106.09	31.20	141.25	41.54	0.00	0.00
Poblacion I	233	0.00	0.00	0.00	0.00	233.00	100.00	0.00	0.00
Poblacion II	294	0.00	0.00	0.00	0.00	294.00	100.00	0.00	0.00
Poblacion III	420	0.00	0.00	0.00	0.00	420.00	100.00	0.00	0.00
Poblacion IV	427	310.03	72.61	110.83	25.96	6.15	1.44	0.00	0.00
Poblacion V	530	153.00	28.87	0.00	0.00	377.00	71.13	0.00	0.00
Poblacion VI	1,211	293.76	24.26	787.90	65.06	129.34	10.68	0.00	0.00
Rabor	312	63.19	20.25	206.15	66.07	38.13	12.22	4.53	1.45
Ramos	1,963	914.59	46.59	1,048.41	53.41	0.00	0.00	0.00	0.00
Salang	2,533	887.49	35.04	1,552.20	61.28	93.30	3.68	0.00	0.00
Sebaring	901	901.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**35,758.00**	**21,705.97**	**60.70**	**10,745.42**	**30.05**	**3,002.16**	**8.40**	**304.46**	**0.85**

Figure 15. Population Exposed to Landslides

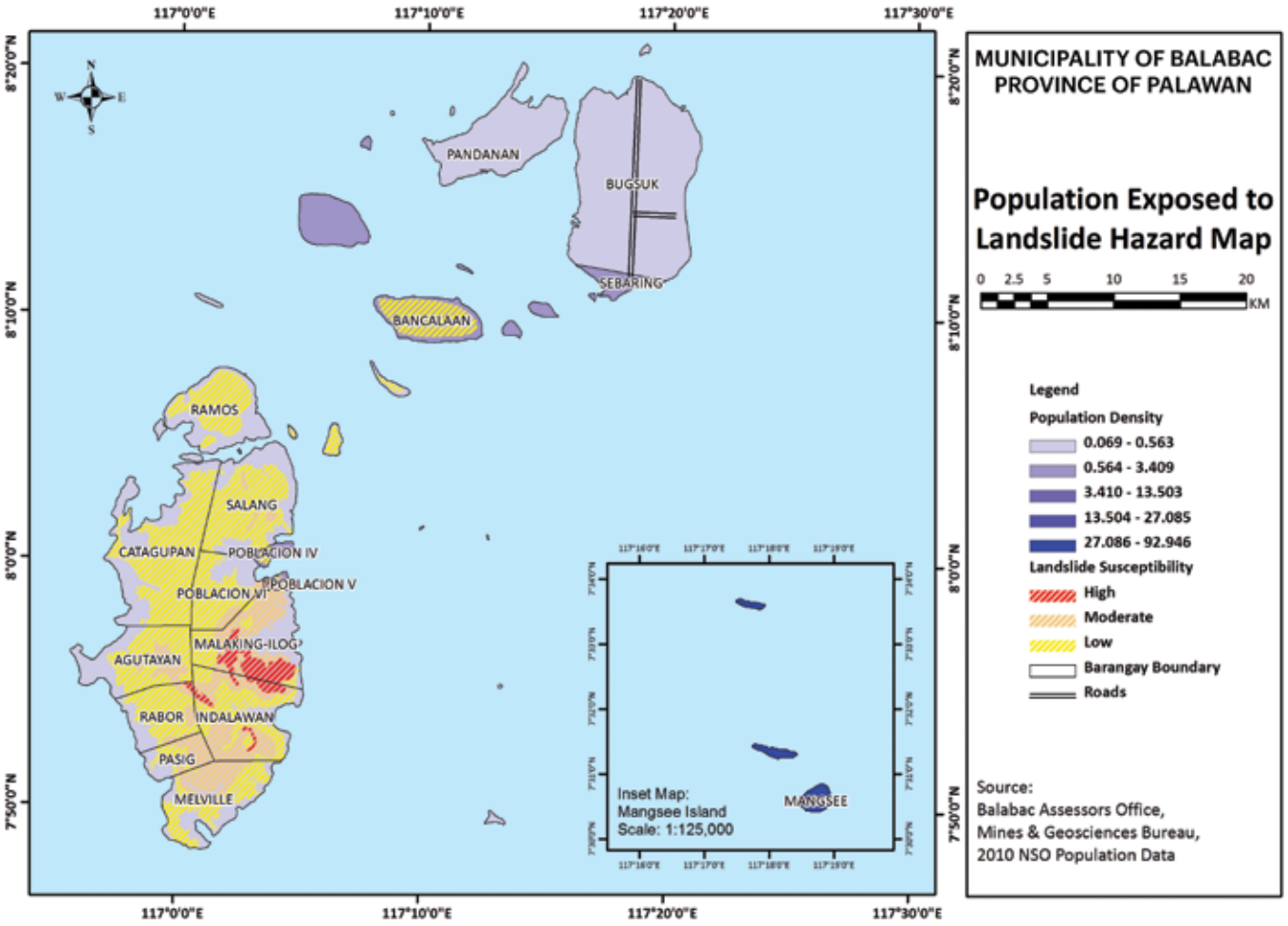
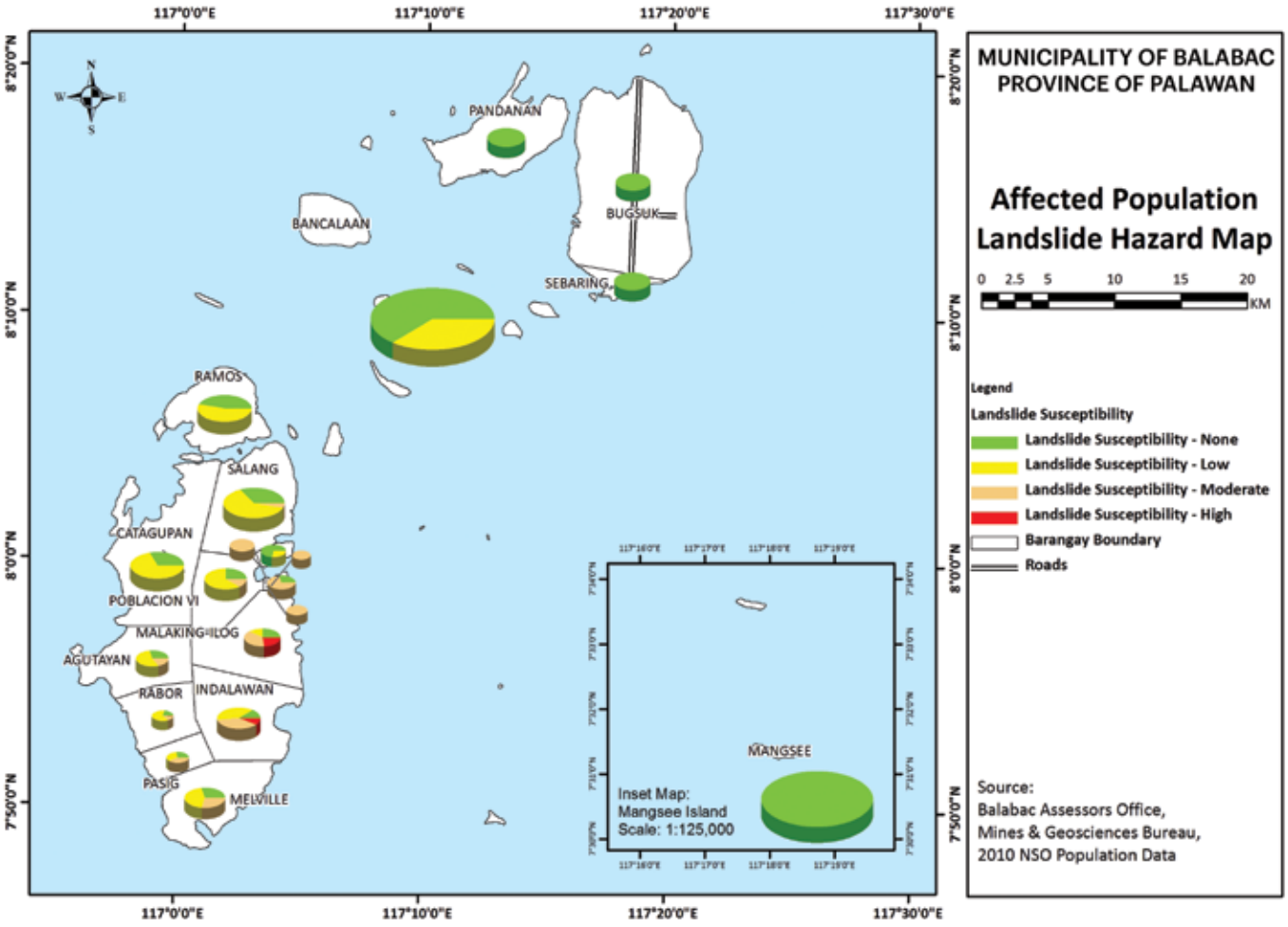


Figure 16. Extent of Population Exposed to Landslides



The population in almost all the *barangays* in the municipality are not exposed to high-risk landslides, except in *Barangay* Malaking Ilog, where about 23% of the total land area is highly susceptible to landslides. The population in Poblacions I, II, and III is exposed to moderate landslide susceptibility. Similarly, a large percentage (71%) of the population of Poblacion V is exposed to moderate-risk landslides.

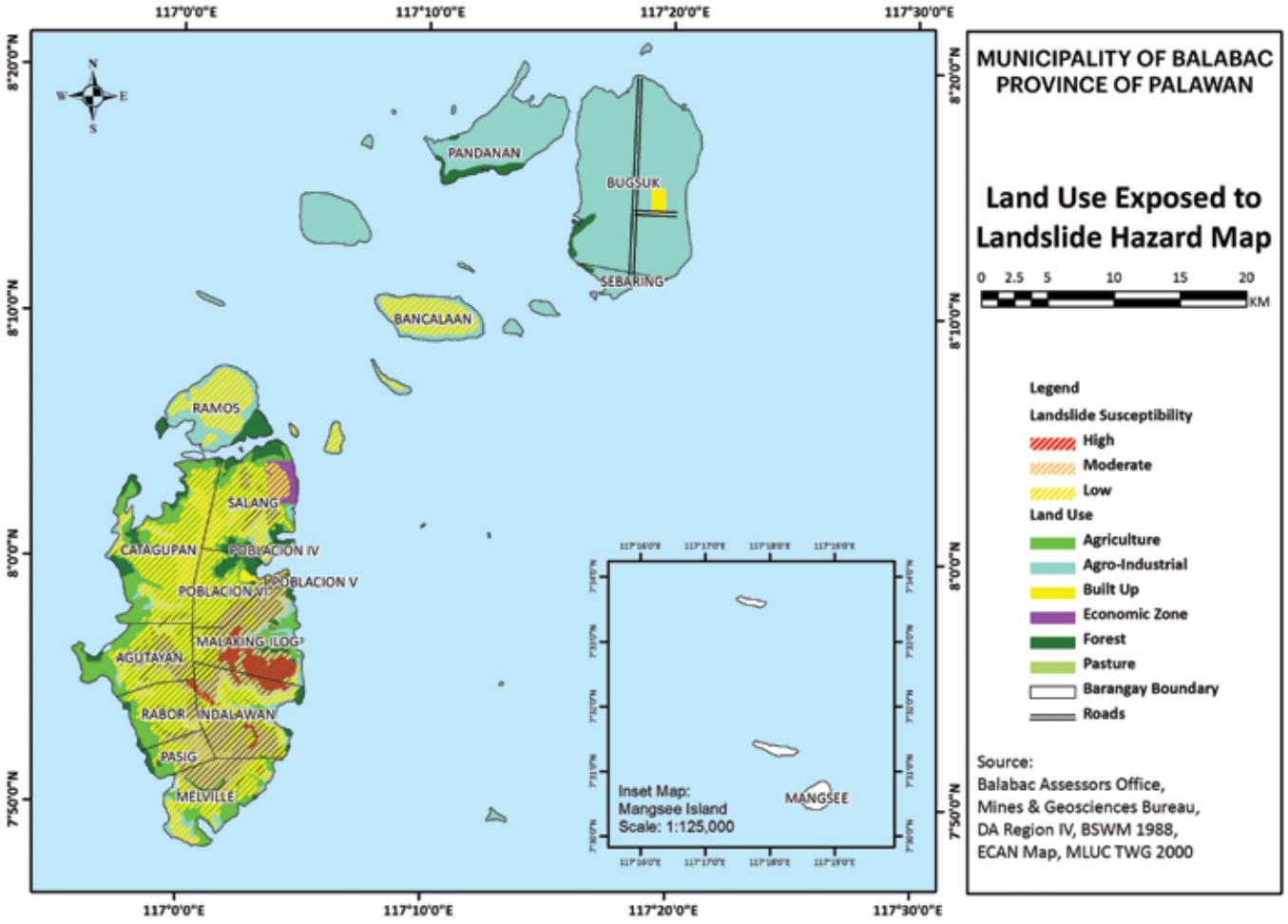
In *barangays* Catagupan (68%), Rabor (66%), Poblacion VI (65%), Salang (61%), Agutayan (55%), and Ramos (53%), more than 50% of the total population is exposed to low-risk landslides. The population of three *barangays* (Bugsuk, Sebaring, and Pandanan) is not exposed to landslides. The other *barangays* with more than 50% of their total population not exposed to landslide risk are Poblacion IV (73%) and Bancalaan (61%).

Land Uses Exposed to Landslides. All the land uses are not exposed to high-risk landslides, except for one, with 10% of the total land area of Forests exposed to high-risk landslides (Table 14; Figure 17). Moreover, about 39% of the total land area occupied by Forests is exposed to moderate-risk landslides. Lands used for Pasture (98%), Agriculture (61%), and Economic Zones (60%) are exposed to low-risk landslides. Large areas of land used for Built-up Areas (83%) and Agro-industrial Enterprises (75%) are not at risk from landslides.

Table 14. Extent of Land Uses Exposed to Landslides

Land Use	Area (ha)	Exposure to Landslides (ha)							
		No Risk	% of Total	Low	% of Total	Moderate	% of Total	High	% of Total
Agriculture	14,531.42	4,759.79	32.76	8,792.13	60.50	940.96	6.48	37.86	0.26
Agro-industrial	27,789.21	20,840.08	74.99	6,553.69	23.58	368.59	1.33	26.61	0.10
Built-up	367.68	305.33	83.04	0.00	0.00	62.17	16.91	0.00	0.00
Economic Zone	729.27	291.93	40.03	436.74	59.89	0.00	0.00	0.00	0.00
Forest	12,073.01	3,251.90	26.94	2,836.19	23.49	4,758.14	39.41	1,226.15	10.16
Pasture	1,385.56	24.59	1.77	1,359.99	98.15	0.00	0.00	0.00	0.00
No Category	286.81	286.81	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**57,162.95**	**29,760.43**	**52.06**	**19,978.74**	**34.95**	**6,129.87**	**10.72**	**1,290.62**	**0.00**

Figure 17. Extent of Land Uses Exposed to Landslides

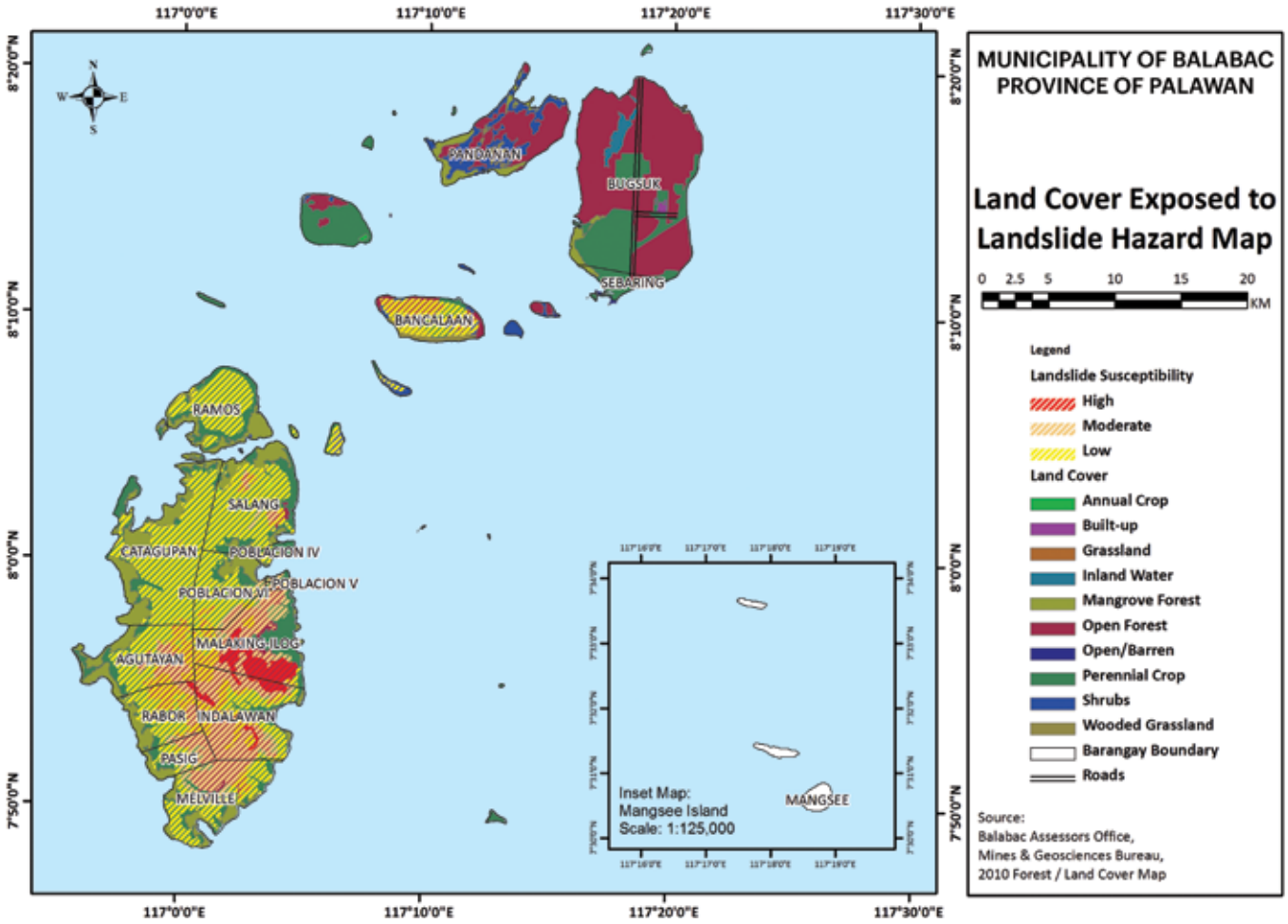


Land Cover Exposed to Landslides. All the types of land cover/vegetation are not exposed to high-risk landslides (Table 15; Figure 18). However, 23% of the total land area of Open Forests and 19% of Built-up Areas are exposed to moderate-risk landslides. The types of land/vegetation cover with more than 50% of their total land area exposed to low-risk landslides include Annual Crops (71%), Grasslands (71%), Perennial Crops (57%), and Wooded Grasslands (53%). Land cover/vegetation, such as Inland Water and Open/Barren Lands, are not exposed to landslides. Similarly, large portions of Built-up Areas (81%), Mangrove Forests (93%), and Shrubs (85%) are not exposed to landslides.

Table 15. Area of Land Cover Exposed to Landslides

Land Use	Area (ha)	Exposure to Landslides (ha)							
		No Risk	% of Total	Low	% of Total	Moderate	% of Total	High	% of Total
Annual Crops	139.62	39.89	28.57	99.61	71.34	0.12	0.00	0.00	0.00
Built-up Areas	83.09	67.58	81.33	0.00	0.00	15.52	18.67	0.00	0.00
Grasslands	28.03	8.14	29.04	19.89	70.95	0.00	0.00	0.00	0.00
Inland Water	352.38	352.38	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Mangrove Forests	6,556.35	6,089.21	92.80	463.68	7.07	3.45	0.00	0.00	0.00
Open Forests	20,793.95	10,830.96	52.08	3,934.97	18.92	4,753.67	22.86	1,274.35	6.12
Open/Barren Lands	172.46	171.50	99.44	0.97	0.56	0.00	0.00	0.00	0.00
Perennial Crops	25,493.30	9,436.38	37.01	14,688.91	57.61	1,351.74	5.30	16.27	0.00
Shrubs	2,075.11	1,763.23	84.97	311.88	15.02	0.00	0.00	0.00	0.00
Wooded Grasslands	749.43	355.86	47.48	393.57	52.51	0.00	0.00	0.00	0.00
Total	**56,443.72**	**29,115.14**	**51.58**	**19,913.48**	**35.28**	**6,124.49**	**10.85**	**1,290.62**	**2.28**

Figure 18. Extent of Land Cover Exposed to Landslides

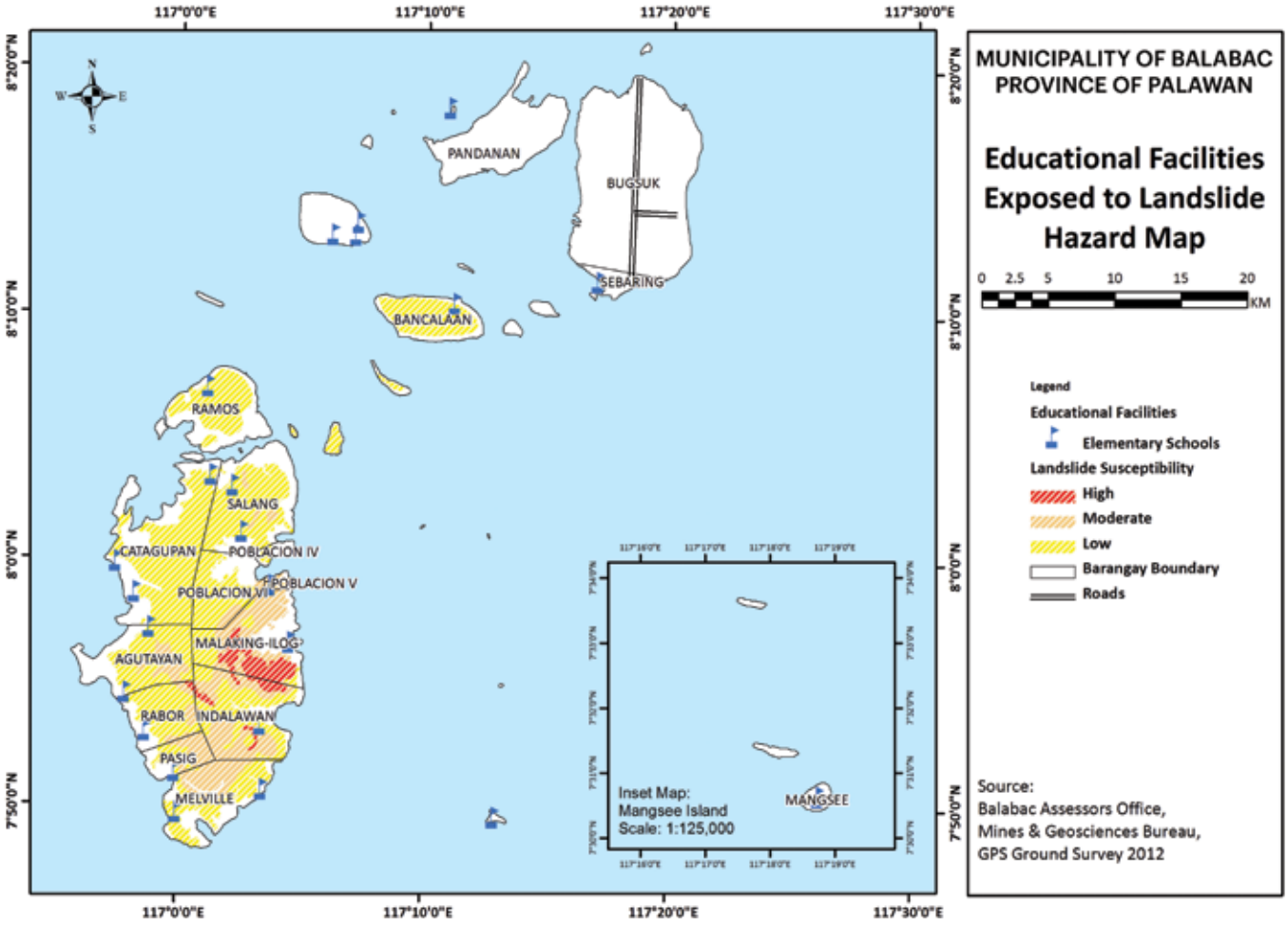


Education Facilities Exposed to Landslides. The map depicting the spatial distribution of schools in the *barangays* and the MGB landslide hazard map show that no school is exposed to high-risk landslides. Ten schools, located in *Barangays* Bancalaan (3), Catagupan (2), Mangsee (1), Pandanan (1), Poblacion I (1), Rabor (1), and Sebaring (1), are not exposed to landslides at all. Eight schools are exposed to low-risk landslides. They are located in Barangays Agutayan (1), Bancalaan (1), Melville (2), Poblacion II (1), Ramos (1), and Salang (2). Three schools are exposed to moderate-risk landslides; they are located in barangays Indalawan (1), Malaking Ilog (1), and Poblacion II (1) (Table 16; Figure 19).

Table 16. Number of Educational Facilities Exposed to Landslides

Land Cover	No. of Exposed Educational Facilities to Landslide			
	Landslide Susceptibility Level			
	None	Low	Moderate	High
Agutayan		1		
Bancalaan	3	1		
Bugsuk				
Catagupan	2			
Indalawan			1	
Malaking Ilog			1	
Mangsee	1			
Melville		2		
Pandanan	1			
Pasig				
Poblacion I	1			
Poblacion II		1		
Poblacion III				
Poblacion IV				
Poblacion V				
Poblacion VI			1	
Rabor	1			
Ramos		1		
Salang		2		
Sebaring	1			
Total	**10**	**8**	**3**	**0**

Figure 19. Educational Facilities Exposed to Landslides



3. Exposure to Tsunamis

The PHIVOLCS potential tsunami map show that if the Sulu Trench moves, tsunamis will be generated, which would affect the Palawan coastal areas, including Balabac and its islands. The estimated percentages of the total population of the municipality and its *barangays* that will be exposed to tsunamis is shown in Table 17 and Figures 20 and 21. About 57% of the total population of Balabac is exposed to tsunamis. The entire population of Barangays Mangsee and Poblacion III are exposed to tsunamis. The other *barangays* with large portions (>50%) of their total population exposed to tsunamis are Poblacion IV (82%), Sebaring (77%), Poblacion V (67%), and Bancalaan (56%). On the other hand, *barangays* with large portions (>50%) of their total population not at risk from tsunamis are Poblacion II (93%), Malaking Ilog (91%), Indalawan (90%), Poblacion VI (83%), Poblacion I (83%), Bugsuk (78%), Rabor (78%), Agutayan (73%), Pasig (73%), Melville (71%), Salang (65%), Pandanan (62%), Catagupan (59%), and Ramos (55%).

Table 17. Population Exposed to Tsunamis

Barangay	Population	Population Exposed to Tsunamis			
		No Risk	% of Total	Prone	% of Total
Agutayan	711	521.56	73.36	189.44	26.64
Bancalaan	10,427	4,554.82	43.68	5,872.18	56.32
Bugsuk	816	640.37	78.48	175.63	21.52
Catagupan	1,954	1,154.79	59.10	799.21	40.90
Indalawan	1,270	1,145.82	90.22	124.18	9.78
Malaking Ilog	882	806.85	91.48	75.15	8.52
Mangsee	8,433	0.00	0.00	8,433.00	100.00
Melville	1,129	801.52	70.99	327.48	29.01
Pandanan	972	602.94	62.03	369.06	37.97
Pasig	340	248.81	73.18	91.19	26.82
Poblacion I	233	193.63	83.10	39.37	16.90
Poblacion II	294	274.78	93.46	19.22	6.54
Poblacion III	420	0.00	0.00	420.00	100.00
Poblacion IV	427	76.82	17.99	350.18	82.01
Poblacion V	530	173.80	32.79	356.20	67.21
Poblacion VI	1,211	1,004.28	82.93	206.72	17.07
Rabor	312	244.45	78.35	67.55	21.65
Ramos	1,963	1,095.22	55.79	867.78	44.21
Salang	2,533	1,649.19	65.11	883.81	34.89
Sebaring	901	204.56	22.70	696.44	77.30
Total	**35,758.00**	**15,394.20**	**43.05**	**20,363.80**	**56.95**

Figure 20. Extent of Population Exposed to Tsunamis

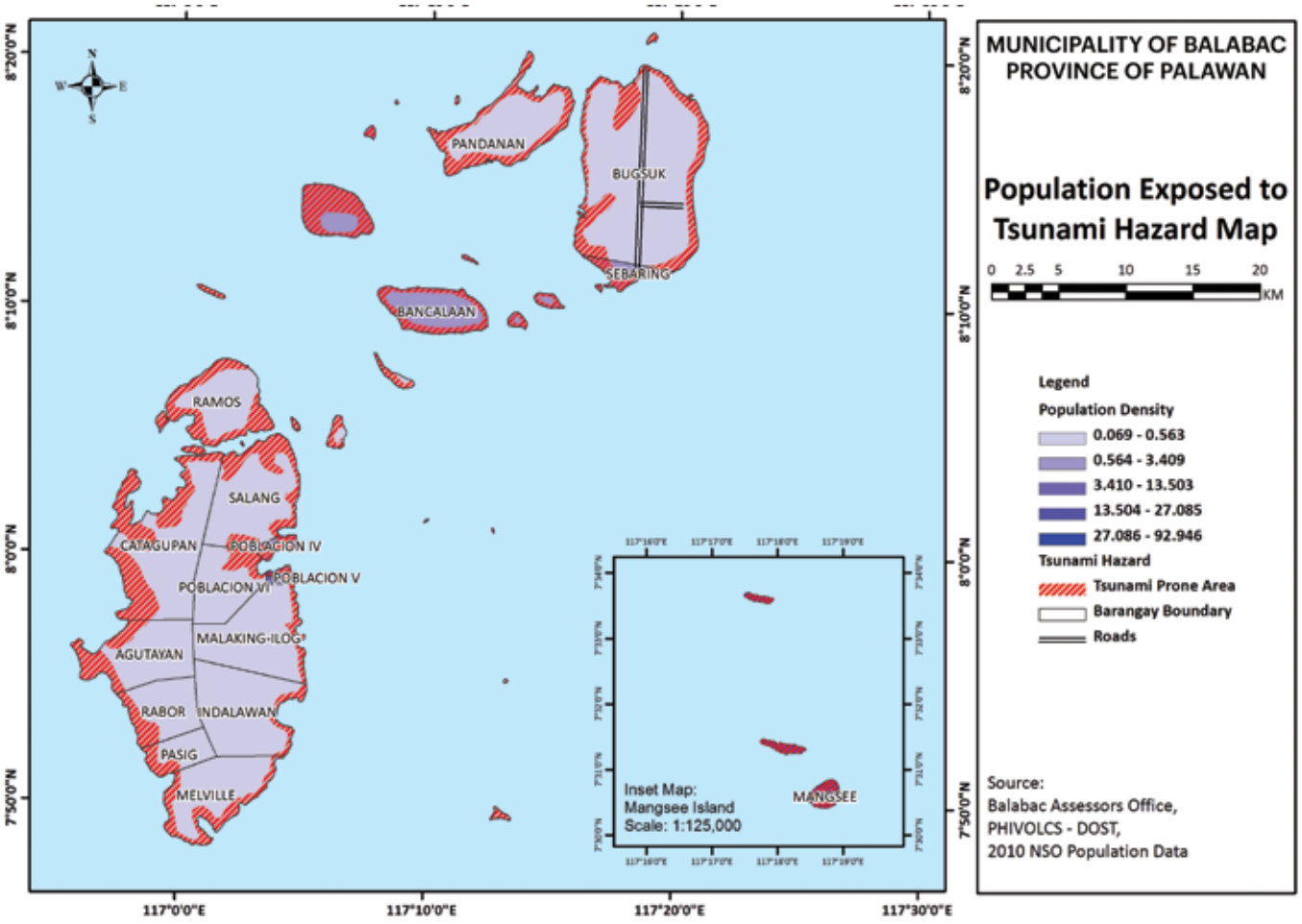
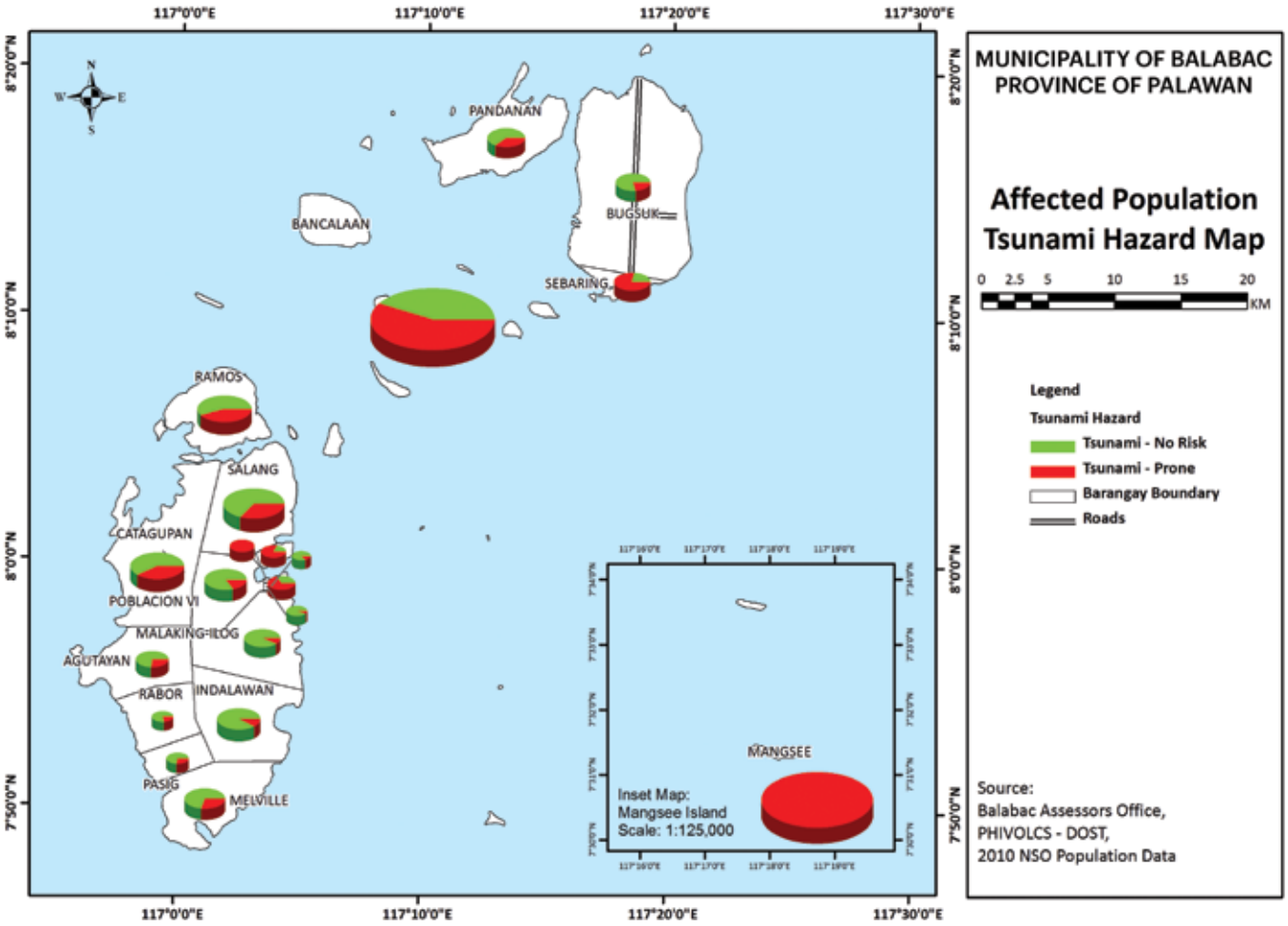


Figure 21. Extent of Population Exposed to Tsunamis

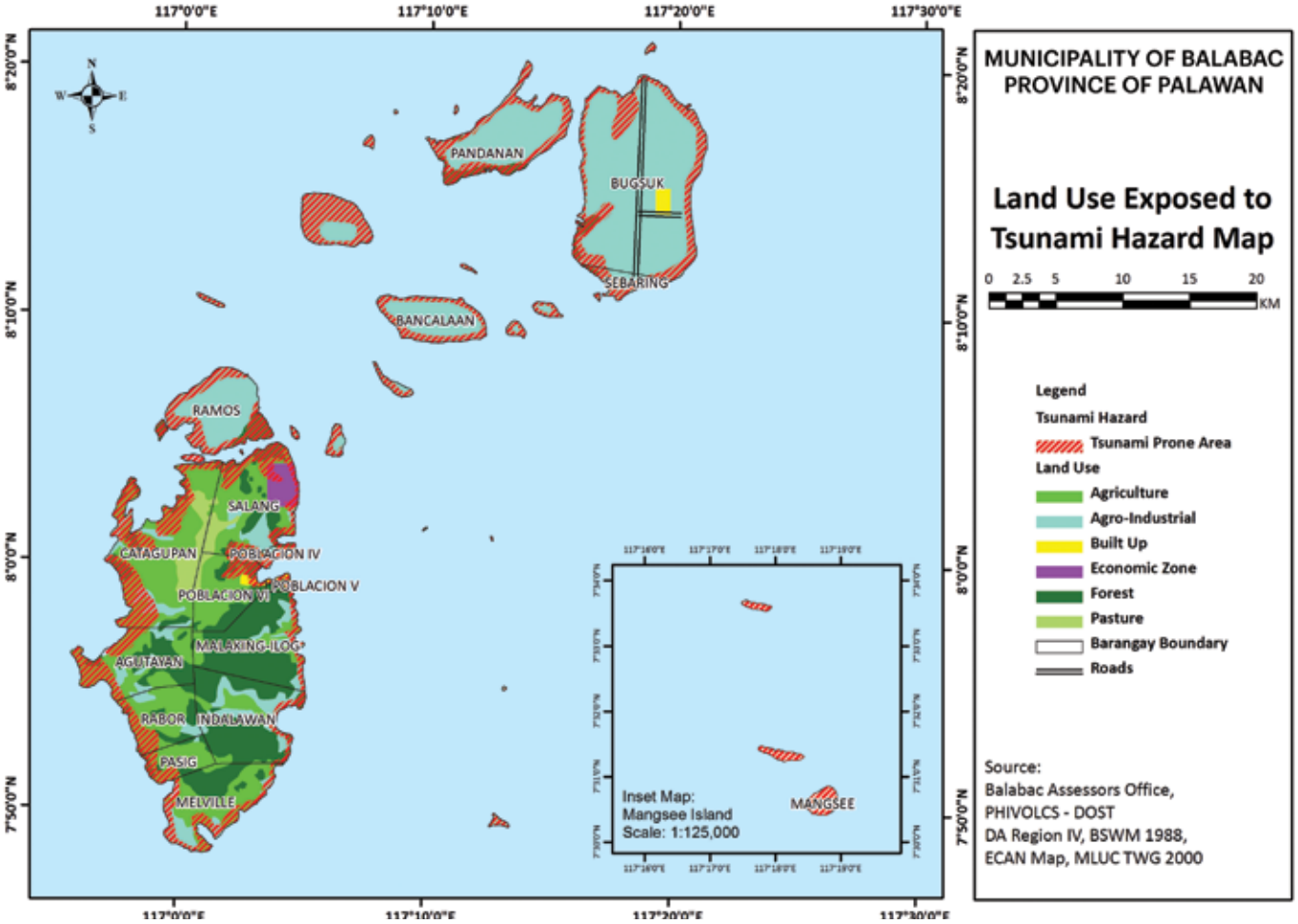


Land Uses Exposed to Tsunamis. Land uses with more than 20% of their total land area exposed to tsunamis include Agro-industrial (33%), Economic Zone (33%), Agriculture (30%), Built-up (29%), and Forest (25%). A large portion (60%) of the total land area of the following land uses are not exposed to tsunamis: Pasture (97%), Forest (75%), Built-up (71%), Agriculture (70%), Agro-industrial (67%), and Economic Zone (67%) (Table 18; Figure 22).

Table 18. Extent of Land Uses Exposed to Tsunamis

Land Use	Area (ha)	Exposure to Tsunamis (ha)			
		No Risk	% of Total	Prone	% of Total
Agriculture	14,531.42	10,173.51	70.01	4,357.91	29.99
Agro-industrial	27,789.21	18,606.42	66.96	9,182.79	33.04
Built-up	367.68	262.19	71.31	105.48	28.69
Economic Zone	729.27	485.73	66.60	243.54	33.40
Forest	12,073.01	9,035.66	74.84	3,037.34	25.16
Pasture	1,385.56	1,347.60	97.26	37.96	2.74
No Category	286.81	286.81	100.00	0.00	0.00
Total	**57,162.95**	**40,197.92**	**70.32**	**16,965.03**	**29.68**

Figure 22. Extent of Land Uses Exposed to Tsunamis

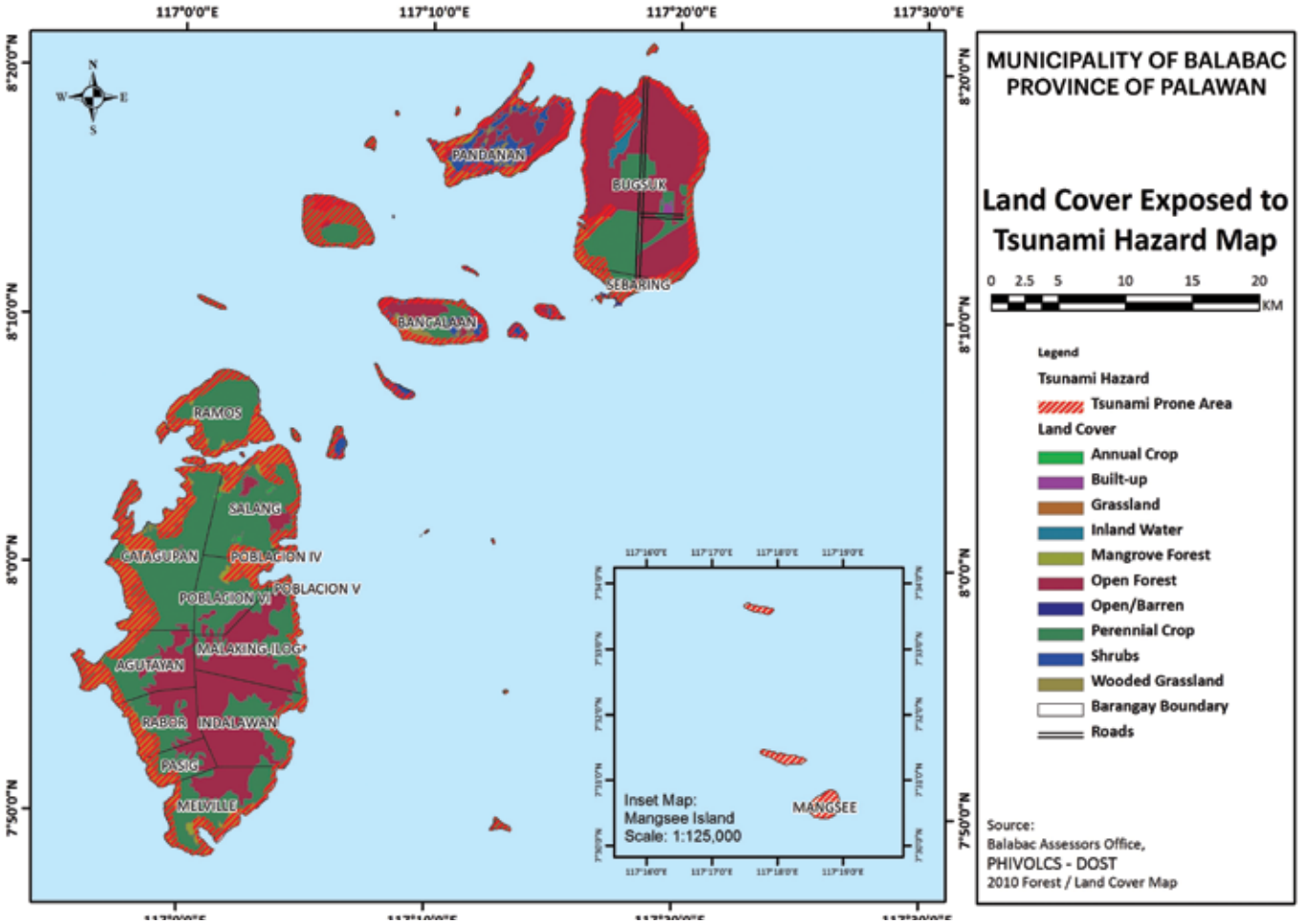


Land Cover Exposed to Tsunamis. The types of land cover/vegetation with more than 50% of their total land area exposed to tsunamis are Mangrove Forests (91%) and Open/Barren Lands (55%) (Table 19; Figure 23). Land cover/vegetation types with more than 50% of their total land area not exposed to tsunamis include Grasslands (100%), Open Forests (87%), Built-up Areas (82%), Annual Crops (81%), Perennial Crops (76%), Inland Water (63%), Shrubs (60%), and Wooded Grasslands (57%).

Table 19. Extent of Land Cover Exposed to Tsunamis

Land Cover	Area (ha)	Exposure to Tsunamis (ha)			
		No Risk	% of Total	Prone	% of Total
Annual Crops	139.62	112.66	80.69	26.97	19.31
Built-up Areas	83.09	67.96	81.79	15.13	18.20
Grasslands	28.03	28.03	100.00	0.00	0.00
Inland Water	352.38	222.23	63.06	130.15	36.93
Mangrove Forests	6,556.35	591.44	9.02	5,964.91	90.97
Open Forests	20,793.95	18,171.15	87.38	2,622.79	12.61
Open/Barren Lands	172.46	78.31	45.40	94.16	54.59
Perennial Crops	25,493.30	19,357.84	75.93	6,135.47	24.06
Shrubs	2,075.11	1,237.42	59.63	837.69	40.36
Wooded Grasslands	749.43	429.84	57.35	319.60	42.63
Total	**56,443.72**	**40,296.86**	**71.39**	**16,146.86**	**28.60**

Figure 23. Extent of Land Cover Exposed to Tsunamis

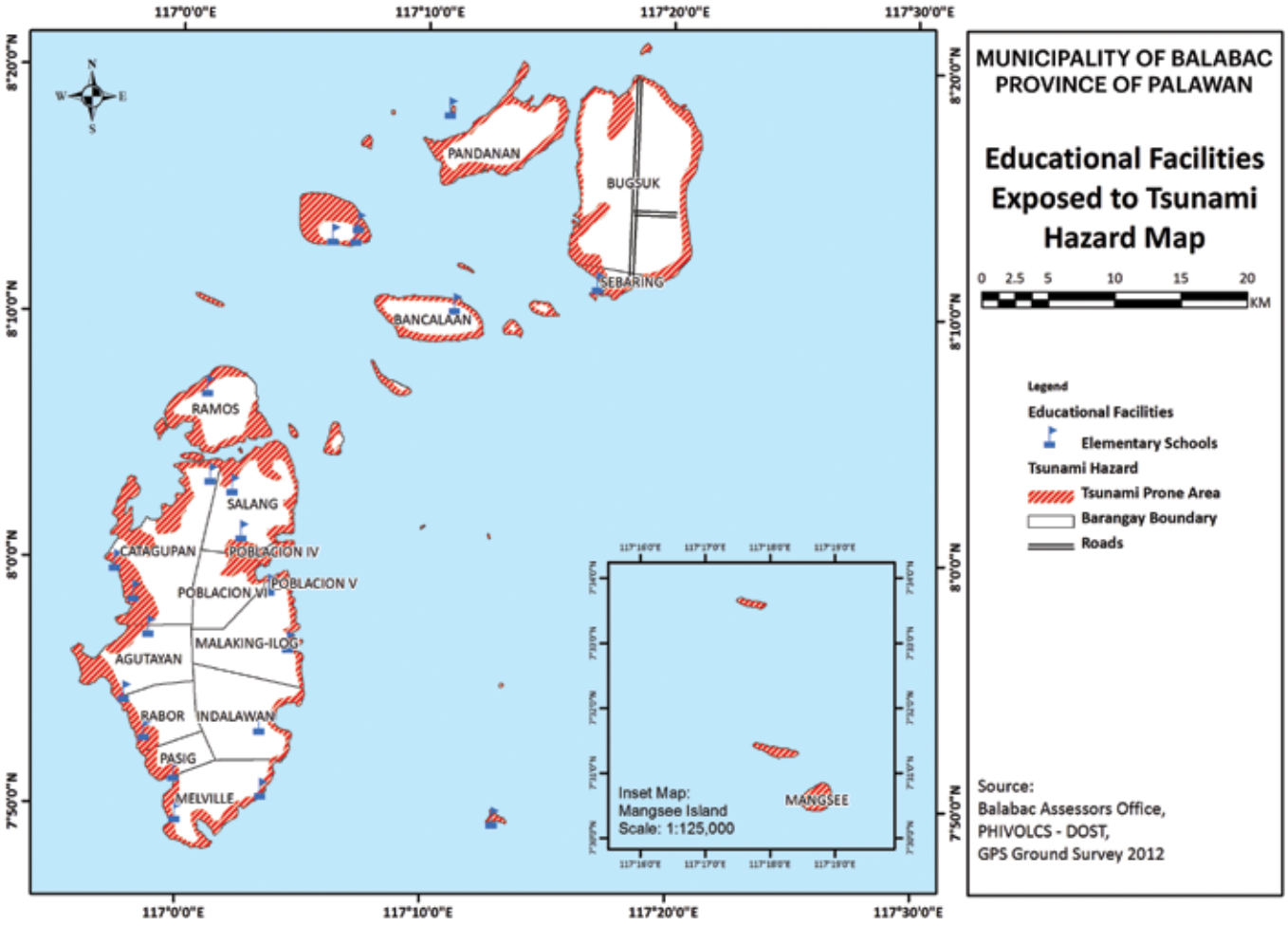


Educational Facilities Exposed to Tsunamis. Five schools are not exposed to tsunamis while 16 schools are prone to tsunamis (Table 20; Figure 24). The non-exposed schools are located in Bancalaan (1), Indalawan (1), Poblacion I (1), Ramos (1), and Salang (1). On the other hand, the schools exposed to tsunamis are in Agutayan (1), Bancalaan (3), Catagupan (2), Malaking Ilog (1), Mangsee (1), Melville (2), Pandanan (1), Poblacion II (1), Poblacion VI (1), Rabor (1), Salang (1), and Sebaring (1).

Table 20. Number of Educational Facilities Exposed to Tsunamis

Barangay	None	Low
Agutayan		1
Bancalaan	1	3
Bugsuk		
Catagupan		2
Indalawan	1	
Malaking Ilog		1
Mangsee		1
Melville		2
Pandanan		1
Pasig		
Poblacion I	1	
Poblacion II		1
Poblacion III		
Poblacion IV		
Poblacion V		
Poblacion VI		1
Rabor		1
Ramos	1	
Salang	1	1
Sebaring		1
Total	**5**	**16**

Figure 24. Educational Facilities Exposed to Tsunamis



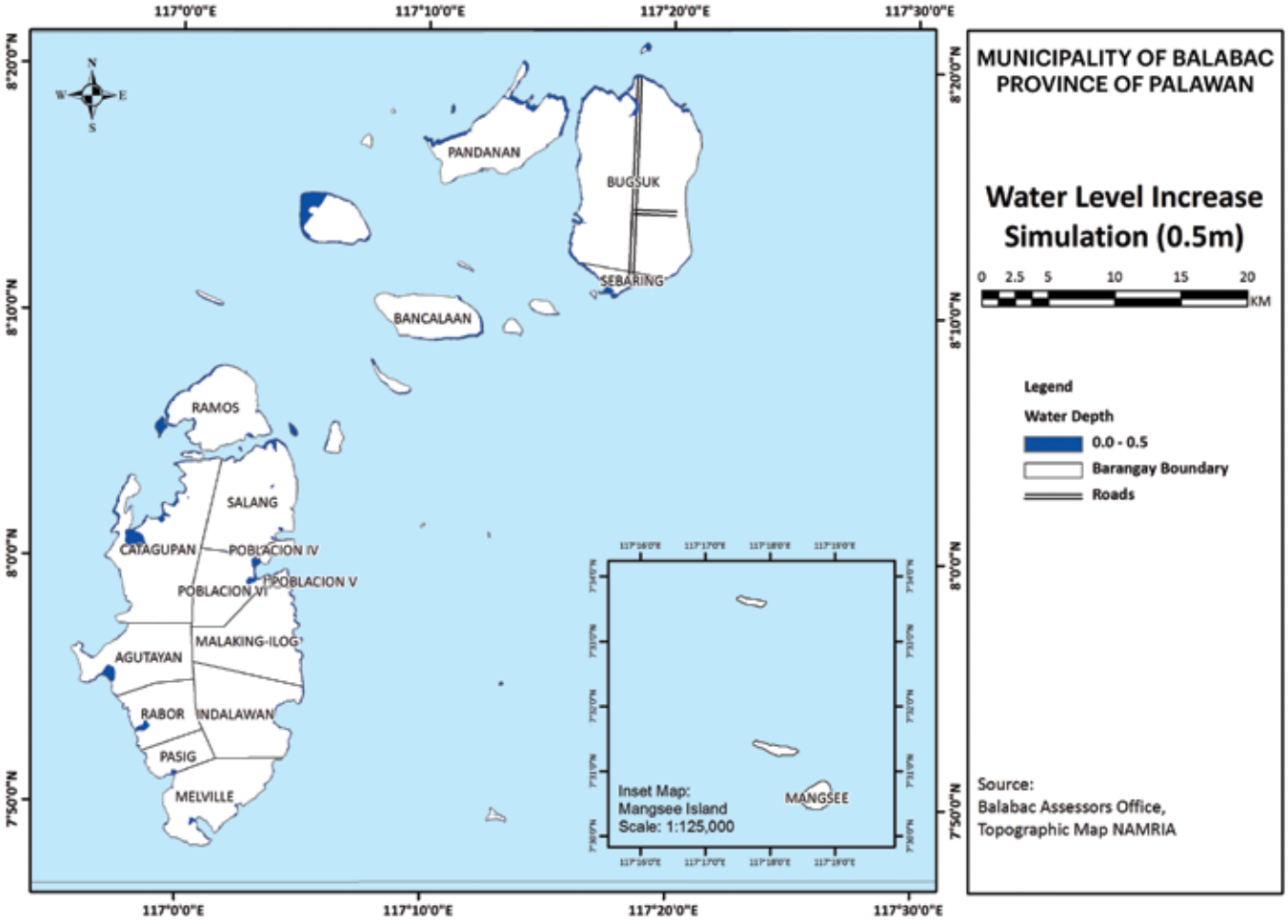
4. Exposure to Sea Level Rise

Population Exposed to SLR of 0.5 m. At an SLR simulation of 0.5 m, the following *barangays* and the corresponding percentage of their total population will be exposed to floods Poblacion III (20%), Bancalaan (14%), and Poblacion V (11%) (Table 21; Figure 25). More than 90% of the population of 15 *barangays* will not be affected by a 0.5-m SLR. These are: Poblacion I and II (100%), Poblacion VI (98%), Rabor (98%), Salang (98%), Indalawan (98%), Malaking Ilog (98%), Pasig (98%), Melville (97%), Agutayan (96%), Bugsuk (96%), Ramos (94%), Catagupan (93%), Poblacion IV (93%), and Pandanan (91%). About 7% of the total population of Balabac, or about 2,300 people, will be exposed to an SLR of 0.5 m.

Table 21. Populations Exposed to SLR Simulation of 0.5 m

Barangay	Population affected by an SLR of 0.5 m				
	Population	Unaffected	%	Affected	%
Agutayan	711	679.64	95.59	31.36	4.41
Bancalaan	10,427	8,990.87	86.23	1,436.13	13.77
Bugsuk	816	781.94	95.83	34.06	4.17
Catagupan	1,954	1,814.35	92.85	139.65	7.15
Indalawan	1,270	1,249.50	98.39	20.50	1.61
Malaking Ilog	882	866.45	98.24	15.55	1.76
Mangsee	8,433	8,433.00		0.00	
Melville	1,129	1,098.69	97.31	30.31	2.69
Pandanan	972	880.54	90.59	91.46	9.41
Pasig	340	332.64	97.83	7.36	2.17
Poblacion I	233	233.00	100.00	0.00	0.00
Poblacion II	294	294.00	100.00	0.00	0.00
Poblacion III	420	334.44	79.63	85.56	20.37
Poblacion IV	427	397.41	93.07	29.59	6.93
Poblacion V	530	473.31	89.30	56.69	10.70
Poblacion VI	1,211	1,185.38	97.88	25.62	2.12
Rabor	312	304.39	97.56	7.61	2.44
Ramos	1,963	1,840.10	93.74	122.90	6.26
Salang	2,533	2,493.21	98.43	39.79	1.57
Sebaring	901	680.94	75.58	220.06	24.42
Total	**35,758.00**	**33,363.80**	**93.30**	**2,394.20**	**6.70**

Figure 25. Barangays and Populations Exposed to SLR of 0.5 m



Population Exposed to SLR of 1.0 m. When the sea level rises by 1 m, the population of the following barangays will be flooded: Sebaring (30%), Poblacion III (23%), Bancalaan (17%), Pandanan (11%), and Poblacion V (11%). About 8% of the total population of the municipality (or about 2,800 people) will be exposed to an SLR of 1 m (Table 22; Figure 26).

Table 22. Populations Exposed to SLR of 1 m

Barangay	Population Affected by SLR of 1 m				
	Population	Unaffected	%	Affected	%
Agutayan	711	671.55	94.45	39.45	5.55
Bancalaan	10,427	8,706.53	83.50	1,720.47	16.50
Bugsuk	816	776.23	95.13	39.77	4.87
Catagupan	1,954	1,897.51	97.11	56.49	2.89
Indalawan	1,270	1,264.79	99.59	5.21	0.41
Malaking Ilog	882	864.30	97.99	17.70	2.01
Mangsee	8,433	8,433.00		0.00	
Melville	1,129	1,108.36	98.17	20.64	1.83
Pandanan	972	864.66	88.96	107.34	11.04
Pasig	340	328.35	96.57	11.65	3.43
Poblacion I	233	233.00	100.00	0.00	0.00
Poblacion II	294	294.00	100.00	0.00	0.00
Poblacion III	420	322.96	76.89	97.04	23.11
Poblacion IV	427	388.96	91.09	38.04	8.91
Poblacion V	530	469.28	88.54	60.72	11.46
Poblacion VI	1,211	1,171.78	96.76	39.22	3.24
Rabor	312	301.55	96.65	10.45	3.35
Ramos	1,963	1,766.90	90.01	196.10	9.99
Salang	2,533	2,413.73	95.29	119.27	4.71
Sebaring	901	633.45	70.31	267.55	29.69
Total	**35,758.00**	**32,910.90**	**92.04**	**2,847.10**	**7.96**

Population Exposed to SLR of 2 m. At a simulated SLR of 2 m, the population of the following *barangays* will be exposed to floods: Sebaring (39%), Poblacion III (28%), Bancalan (21%), Ramos (17%), Pandanan (15%), Poblacion IV (13%), Poblacion V (13%), and Catagupan (12%). About 12% of the total population of the municipality (or about 4,000 people), will be exposed to an SLR of 2 m (Table 24; Figure 27).

Figure 26. Barangays and Populations Exposed to SLR of 1 m

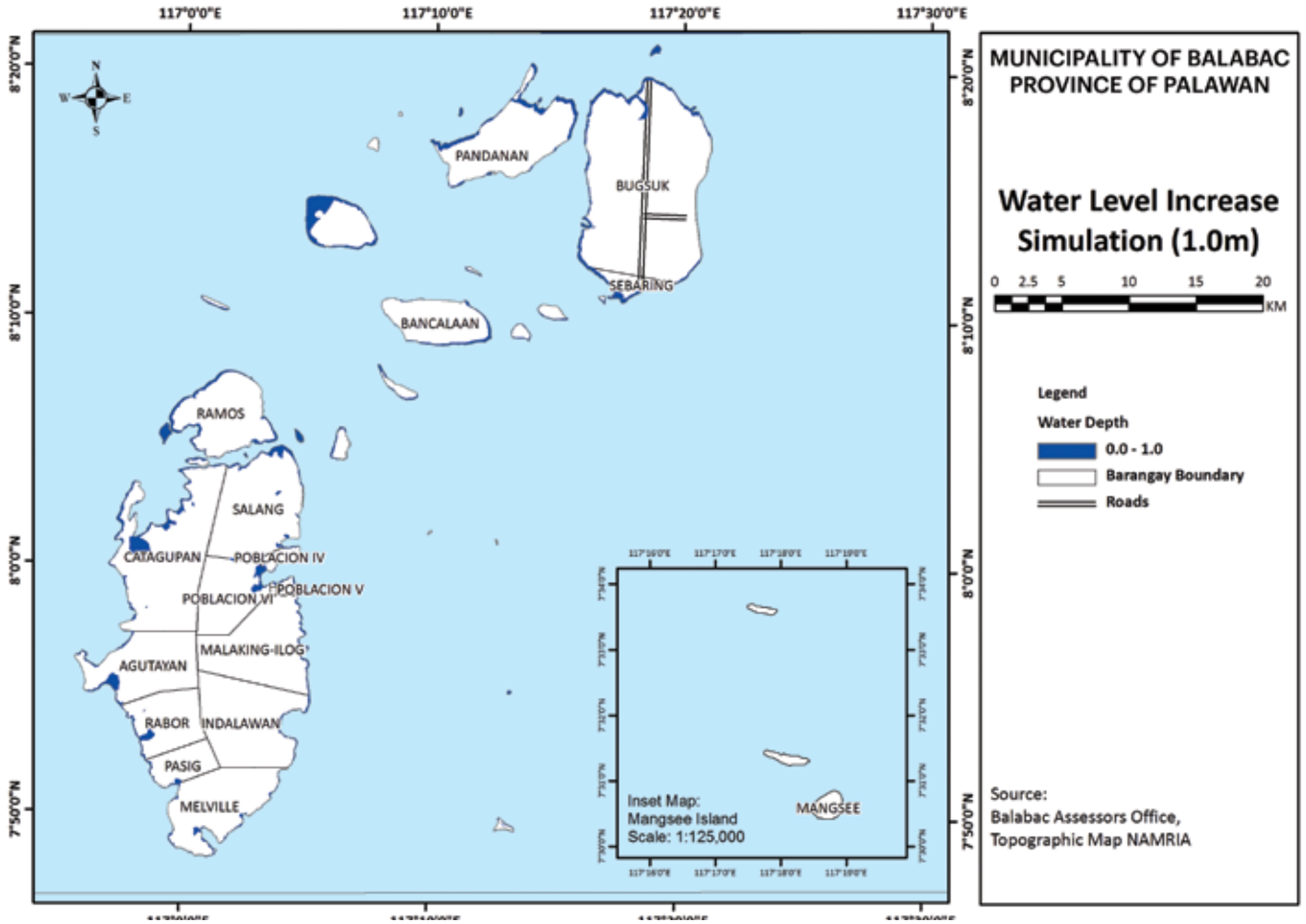
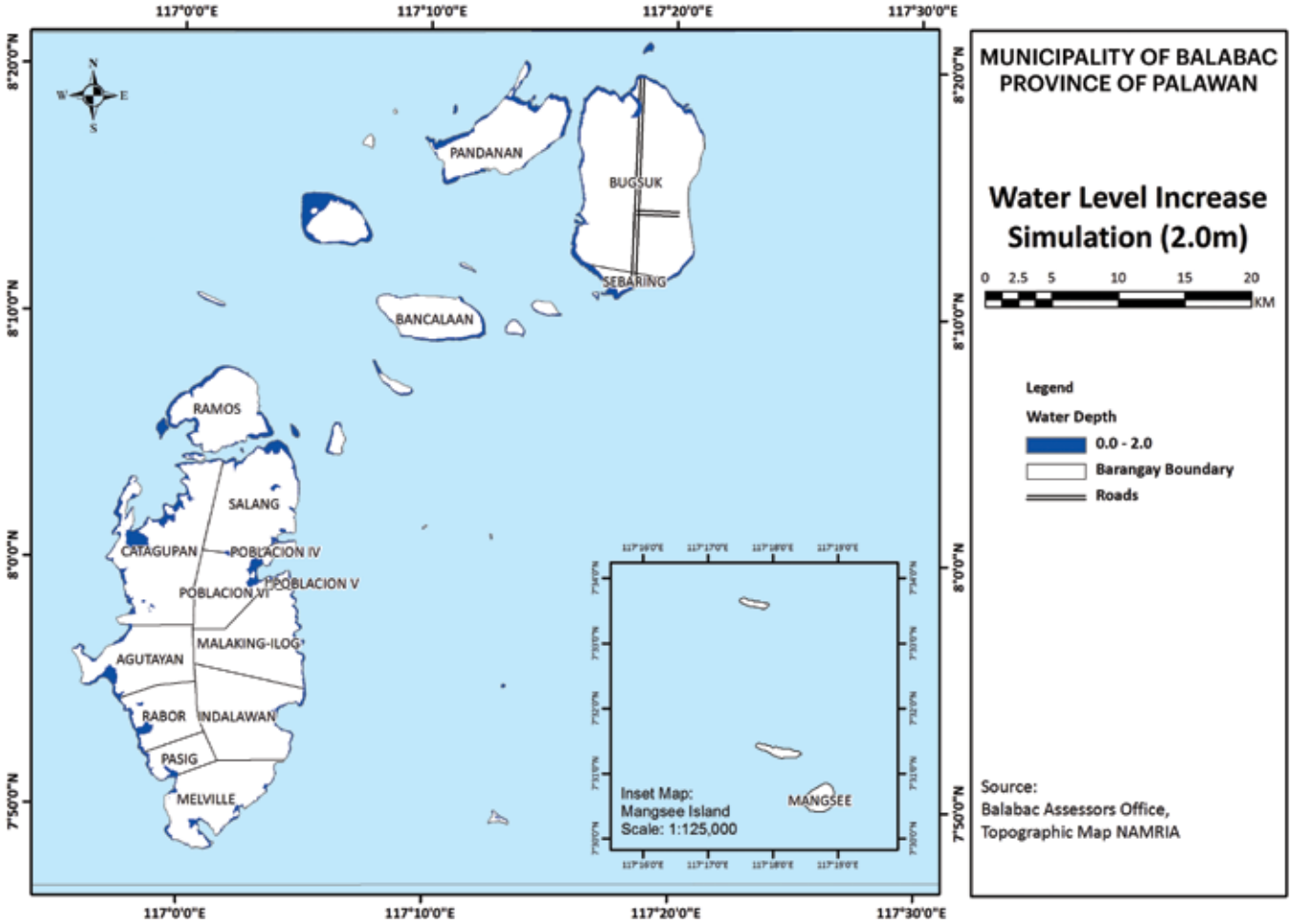


Table 23. Populations Exposed to SLR of 2 m

Barangay	Population affected by SLR of 2 m				
	Population	Unaffected	%	Affected	%
Agutayan	711	655.31	92.17	55.69	7.83
Bancalaan	10,427	8,192.85	78.57	2,234.15	21.43
Bugsuk	816	766.16	93.89	49.84	6.11
Catagupan	1,954	1,715.73	87.81	238.27	12.19
Indalawan	1,270	1,233.73	97.14	36.27	2.86
Malaking Ilog	882	860.44	97.56	21.56	2.44
Mangsee	8,433	8,433.00		0.00	
Melville	1,129	1,063.17	94.17	65.83	5.83
Pandanan	972	827.25	85.11	144.75	14.89
Pasig	340	316.33	93.04	23.67	6.96
Poblacion I	233	233.00	100.00	0.00	0.00
Poblacion II	294	294.00	100.00	0.00	0.00

Barangay	Population affected by SLR of 2 m				
	Population	Unaffected	%	Affected	%
Poblacion III	420	303.75	72.32	116.25	27.68
Poblacion IV	427	371.08	86.90	55.92	13.10
Poblacion V	530	462.88	87.34	67.12	12.66
Poblacion VI	1,211	1,140.99	94.22	70.01	5.78
Rabor	312	287.86	92.26	24.14	7.74
Ramos	1,963	1,623.47	82.70	339.53	17.30
Salang	2,533	2,297.54	90.70	235.46	9.30
Sebaring	901	549.60	61.00	351.40	39.00
Total	**35,758.00**	**31,628.14**	**88.45**	**4,129.86**	**11.55**

Figure 27. Barangays and Populations Exposed to SLR of 2 m



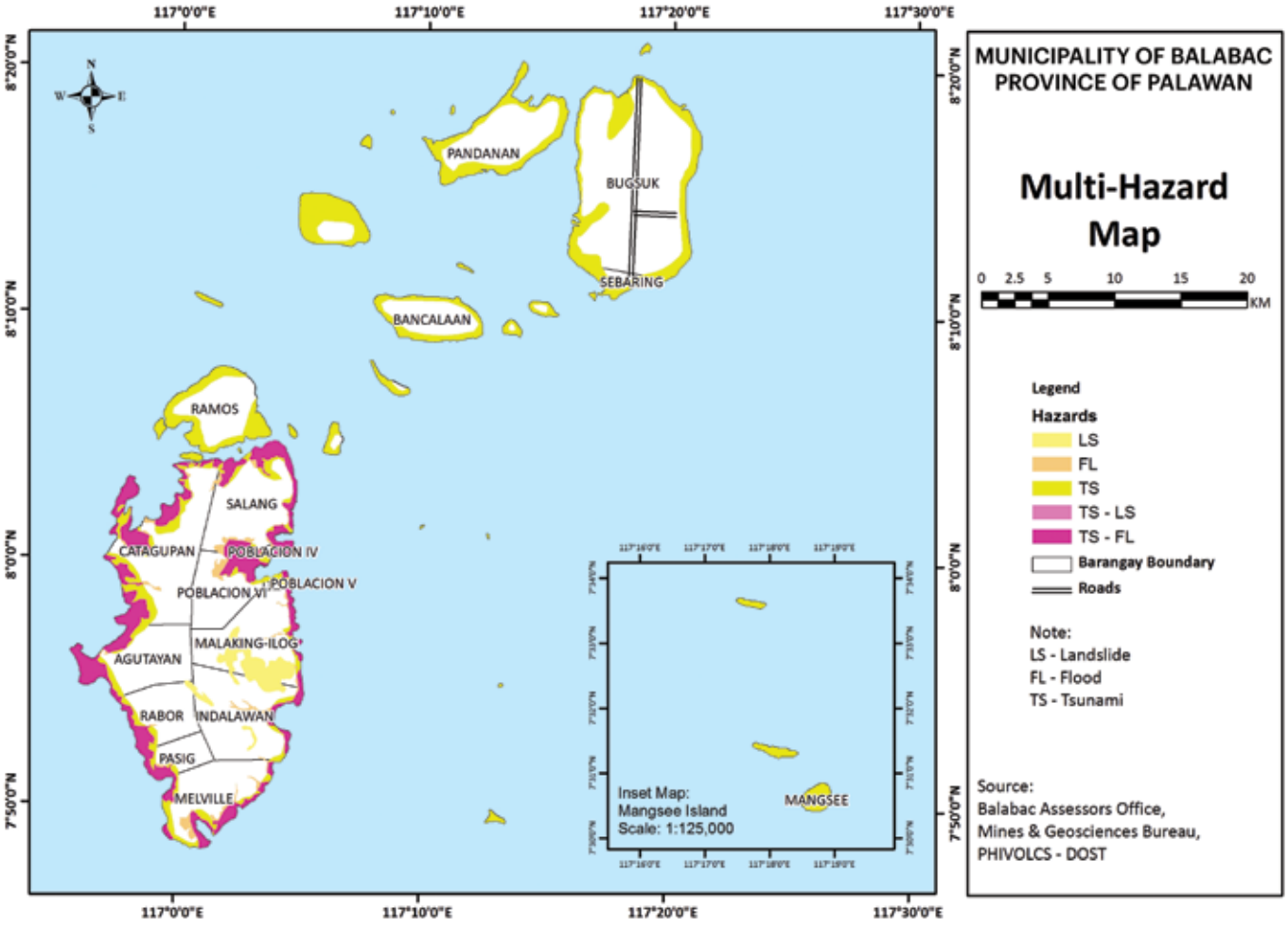
5. Exposure to Multi-hazards

The *barangays* that are exposed to both floods and tsunamis, and the extent of exposure of their total population are Poblacion IV (65%), Poblacion V (29%), Catagupan (25%), Salang (21%), Agutayan (20%), Pasig (19%), Melville (17%), Poblacion VI (14%), and Rabor (14%) (Table 25 and Figure 28). About 10% of the total population of Balabac is exposed to multi-hazards of floods and tsunamis.

Table 24. Extent of *Barangays* and Population to Multi-hazards

Barangay	Area	No Hazard	%	Landslides	%	Floods	%	Tsunamis	%	Landslides-Tsunamis	%	Floods-Tsunamis	%
Agutayan	3,350.264	2,441.184	72.87	3.041	0.09	13.39	0.40	217.889	6.50	0	0.00	674.76	20.14
Bancalaan	4,196.132	1,832.993	43.68	0	0.00	0	0.00	2,363.139	56.32	0	0.00	0	0.00
Bugsuk	11,808.669	9,267.091	78.48	0	0.00	0	0.00	2,541.578	21.52	0	0.00	0	0.00
Catagupan	6,321.809	3,431.64	54.28	0	0.00	131.298	2.08	1,153.772	18.25	0	0.00	1,605.099	25.39
Indalawan	4,332.334	3,473.47	80.18	335.646	7.75	99.616	2.30	206.423	4.76	0	0.00	217.179	5.01
Malaking Ilog	4,038.458	2,722.713	67.42	918.288	22.74	53.372	1.32	104.301	2.58	1.545	0.04	238.239	5.90
Mangsee	90.73	0	0.00	0	0.00	0	0.00	90.73	100.00	0	0.00	0	0.00
Melville	3,493.184	2,271.833	65.04	0	0.00	205.429	5.88	418.839	11.99	0	0.00	597.083	17.09
Pandanan	4,115.781	2,553.055	62.03	0	0.00	0	0.00	1,562.726	37.97	0	0.00	0	0.00
Pasig	1,175.451	830.905	70.69	0	0.00	29.266	2.49	90.239	7.68	0	0.00	225.041	19.15
Poblacion I	17.256	14.34	83.10	0	0.00	0	0.00	2.916	16.90	0	0.00	0	0.00
Poblacion II	26.582	24.844	93.46	0	0.00	0	0.00	1.738	6.54	0	0.00	0	0.00
Poblacion III	15.507	0	0.00	0	0.00	0	0.00	15.507	100.00	0	0.00	0	0.00
Poblacion IV	324.756	40.23	12.39	0	0.00	18.192	5.60	55.079	16.96	0	0.00	211.255	65.05
Poblacion V	155.474	50.985	32.79	0	0.00	0	0.00	59.765	38.44	0	0.00	44.724	28.77
Poblacion VI	2,388.792	1,852.708	77.56	0	0.00	128.302	5.37	56.48	2.36	0	0.00	351.302	14.71
Rabor	2,210.166	1,691.976	76.55	32.099	1.45	7.555	0.34	167.525	7.58	0	0.00	311.011	14.07
Ramos	3,485.597	1,944.727	55.79	0	0.00	0	0.00	1,540.87	44.21	0	0.00	0	0.00
Salang	4,946.517	3,047.913	61.62	0	0.00	172.664	3.49	689.071	13.93	0	0.00	1,036.869	20.96
Sebaring	650.065	147.589	22.70	0	0.00	0	0.00	502.476	77.30	0	0.00	0	0.00
Total	**57,143.524**	**37,640.196**	**65.87**	**1,289.074**	**2.256**	**859.084**	**1.5034**	**11,841.063**	**20.7216**	**1.545**	**0.002704**	**5,512.562**	**9.646871**

Figure 28. Extent of Barangays and Populations Exposed to Multi-hazards



6. Summary of Areas and Populations Exposed to Disaster Risks

The results of the hazard assessment revealed that 11 *barangays* are highly susceptible to **floods,** 4 are highly susceptible to landslides, and 20 are prone to tsunamis. Sixteen *barangays* are projected to be affected by a 0.5-m SLR, and 18 *barangays* by an SLR of 1 m and 2 m. The total area that is highly susceptible to floods is about 6,371 ha or 11% of the total land area of the municipality. About 2,533 people, or 7% of the municipality's total population, is exposed to conditions highly susceptible to flooding.

The total area highly susceptible to **landslides** is about 1,290 ha, or about 2% of the total land area of the municipality. About 304 people, or 1% of the municipality's total population, is exposed to conditions highly susceptible to landslides.

About 17,179 ha of land, or 30% of the total land area of the municipality, is prone to **tsunamis** in the event of a movement of the Sulu Trench. Such an event will affect 20,363 people or 57% of the total population in the municipality.

SLR simulations at 0.5 m revealed that 16 *barangays* in the coastal areas of Balabac will be flooded. At 1 m and 2 m SLR, 18 coastal *barangays* will be flooded. About 12,402.42 ha (or 22% of the municipality's

total land area) will be submerged at a 0.5 m SLR, 13,457.65 ha (or 24% of the municipality's total land area) at a 1 m SLR, and 15,192.45 ha, or 27% of the total municipal land area, will be submerged at a 2 m SLR. On the other hand, the existing population exposed to SLR was estimated at about 2,394, or 7% of the municipality's total population at 0.5 m, 2,847 or 8% at 1 m, and 4,129 or 17% at 2 m. The percentage values give an indication of the proportion of the future population (2020 and 2050) that could be affected by SLR.

A summary of the areas and populations exposed to floods, landslides, tsunamis, and simulated SLR of 0.5 m, 1 m, and 2 m, is provided in Table 25.

Table 25. Summary of Areas and Populations Exposed to Disaster Risks

Hazard Type	No. of Barangays Exposed		Total Area Exposed (ha)		Total No. of Exposed Population	
	No.	%	No.	%	No.	%
Flood						
High susceptibility	11	55	6,371	11	2,533	7
Low susceptibility	15	75	23,442	41	19,233	54
No susceptibility	16	80	27,328	48	14,000	39
Total	20	100	57,162.95	100.00	35,758	100
Landslide						
High susceptibility	4	20	1,290	2	304	1
Moderate susceptibility	13	65	6,124	11	3,002	8
Low susceptibility	12	60	20,106	35	10,745	30
No susceptibility	17	85	29,621	52	21,705	61
Total	20	100	57,162.95	100.00	35,759	100
Tsunami						
Prone	20	100	17,179	30	20,363	57
Not prone	18	90	39,964	70	15,394	43
Total	20	100	57,162.95	100.00	35,758	100
0.5-meter Sea Level Rise						
Affected	17	85	12,402.42	22	2,394	7
Not affected	3	15	44,760.52	78	33,363	93
Total	20	100	57,162.94	100.00	35,758	100
1-meter Sea Level Rise						
Affected	18	90	13,457.65	24	2,847	8
Not affected	2	10	43,705.29	76	32,910	92
Total	20	100	57,162.94	100.00	35,758	100
2-meter Sea Level Rise						
Affected	18	90	15,192.45	27	4,129	12
Not affected	2	10	41,970.48	73	31,628	88
Total	**20**	**100**	**57,162.93**	**100.00**	**35,758**	**100**

D. Climate Change Vulnerability Index Measurement

1. Method for Calculating Vulnerability Index

The vulnerability level of each *barangay* is represented by the **Vulnerability Index (VI)**, which is a composite value of the sub-indices on Susceptibility, Exposure, and Adaptive Capacity. The vulnerability index was calculated through the VI method using the formula below.

> ***VI = Susceptibility Sub-index + Exposure Sub-index - Adaptive Capacity Sub-index***

Susceptibility refers to the hazard susceptibility level characterizing the barangay (e.g., high, low, no flood susceptibility; high, moderate, low, no landslide susceptibility; prone/not prone to tsunami; prone/not prone to simulated sea level rise.

Rating of Areas with High Susceptibility to Hazards. The percentage of the total area of the barangay with a high hazard susceptibility is assigned an index value of 1–5 (Table 26). A rating of 5 is given to a barangay if more than 80% of its total area is given a high susceptibility assessment, 4 for 61–80%, 3 for 41–60%, 2 for 21–40%, and 1 for less than 20%. It should be noted that only those with high hazard susceptibility ratings are assessed for vulnerability using the index model, as this is the risk level that will be given priority in CCA and DRRM planning. The rating class applies to both flood and landslide susceptibility. For tsunami and SLR susceptibility, Table 27 is used.

Table 26. Rating Classes for Areas with High Hazard Susceptibility

Percentage of Total Area of Barangay with High Level of Susceptibility	Rating Index	Susceptibility Rating
>80%	5	Very High
61–80%	4	High
41–60%	3	Medium
20–40%	2	Low
<20%	1	Very Low

Table 27. Rating Classes for *Barangays* Prone to Tsunami and SLR

Percentage of Total Area of Barangay Prone to Hazard	Rating Index	Susceptibility Rating
>80%	5	Very High
61–80%	4	High
41–60%	3	Medium
20–40%	2	Low
<20%	1	Very Low

Rating of Population Exposed to High Level of Hazard Susceptibility. The percentage of the total population in a barangay that is exposed to high levels of susceptibility to floods and landslides is assigned an index value of 1–5 (Table 28). This is similar to the rating scheme adopted for areas of barangays with high levels of susceptibility. For populations exposed to tsunamis and SLR, the rating table in Table 29 is used.

Table 28. Rating Classes for Population Exposed to High Levels of Hazard Susceptibility

Percentage of Total Population of Barangay with High Level of Susceptibility	Rating Index	Exposure Rating
>80%	5	Very High
61–80%	4	High
41–60%	3	Medium
20–40%	2	Low
<20%	1	Very Low

Table 29. Rating Classes for Barangays Prone to Tsunami and SLR

Percentage of Total Population of Barangay Prone to Hazard	Rating Index	Susceptibility Rating
>80%	5	Very High
61–80%	4	High
41–60%	3	Medium
20–40%	2	Low
<20%	1	Very Low

Rating of Adaptive Capacity of Barangays. In the February 2014 workshop held with the barangay officials of Balabac, their adaptive capacities were roughly assessed considering certain parameters. The inputs provided by the barangay officials were then rated to derive the adaptive capacity sub-index. The procedure adopted is simple: one point is given for each of the capacity parameters present in the barangay. Hence, if the barangay meets all the adaptive capacity parameters, they will get a total score of 5.

Assignment of Importance Weight for the Sub-indices. The susceptibility, exposure, and adaptive capacity sub-indices were assigned their weight of importance given the following considerations:

- **Their level of impact on the population.** Population exposure was assigned a higher relative weight of importance of 50% to give a premium value to the lives of people.
- **Their level of impact on physical and natural assets.** Areas of barangays exposed to high levels of hazard susceptibility were given a moderate relative weight of importance of 30%.
- **The adaptive capacity level of barangays.** This was roughly determined, and the accuracy of inputs was not verified. Hence, adaptive capacity was given a lower weight of importance of 20%.

The weights are arbitrary, and the municipal planners can modify the weights as they deem fit. Nonetheless, the same range of vulnerability index values will more or less be derived. The vulnerability index was derived using the following formula:

Vulnerability Index = (Susceptibility Score at High Risk x Weight of 30%) + (Population Exposure Score at High Risk x Weight of 50%) – (Adaptive Capacity Score x Weight of 20%)

2. Results of Vulnerability Assessment

Flood Vulnerability. The results of the VI estimation showed that most of the barangays of Balabac municipality have low to very low vulnerability to high-risk flooding. The barangays with the highest VI include Poblacion IV (2.8), Poblacion V (1.6), Melville (1.6), and Catagupan (1.2) (Table 30).

Table 30. Flood Vulnerability Index of *Barangays* in Balabac

Barangay	Susceptibility Rating	Total Rating (Weight = 30%)	Population Exposure Rating	Total Rating (Weight = 50%)	Adaptive Capacity Rating	Total Rating (Weight = 20%)	Vulnerability Index (VI) at High Risk
Agutayan	1	0.3	1	0.5	2	0.4	0.4
Bancalaan	0	0	0	0	3	0.6	(0.6)
Bugsuk	0	0	0	0	ND	0	0
Catagupan	2	0.6	2	1.0	2	0.4	1.2
Indalawan	1	0.3	1	0.5	ND	0.4	0.4
Malaking Ilog	1	0.3	1	0.5	3	0.6	0.2
Mangsee	0	0	0	0	3	0.6	(0.6)
Melville	2	0.6	2	1.0	0	0	1.6
Pandanan	0	0	0	0	2	0.4	(0.4)
Pasig	2	0.6	1	0.5	3	0.6	0.5
Poblacion I	1	0.3	1	0.5	2	0.4	0.4
Poblacion II	1	0.3	1	0..5	1.1.1.1.1	ND	0
Poblacion III	0	0	0	0	3	0.6	(0.6)
Poblacion IV	4	1.2	4	2.0	2	0.4	2.8
Poblacion V	2	0.6	2	1.0	1.1.1.1.2	ND	0
Poblacion VI	0	0	0	0	3	0.6	(0.6)
Rabor	1	0.3	1	0.5	1.1.1.1.3	ND	0
Ramos	0	0	0	0	3	0.6	(0.6)
Salang	1	0.3	1	0.5	3	0.6	0.2
Sebaring	0	0	0	0	2	0.4	(0.4)

Landslide Vulnerability. Table 32 shows that only very few barangays are vulnerable to high-risk landslides. The resulting vulnerability indices of all the barangays in Balabac indicate zero to very low vulnerability. The barangays with a very low index include Malaking Ilog (1.0), Indalawan (0.8), and Agutayan (0.4); the rest of the barangays are not vulnerable to high-risk landslides.

Table 31. Landslide Vulnerability Index of *Barangays* in Balabac

Barangay	Susceptibility Rating	Total Rating (Weight = 30%)	Population Exposure Rating	Total Rating (Weight = 50%)	Adaptive Capacity Rating	Total Rating (Weight = 20%)	Vulnerability Index (VI) at High Risk
Agutayan	1	0.3	1	0.5	2	0.4	0.4
Bancalaan	0	0	0	0	3	0.6	(0.6)
Bugsuk	0	0	0	0	1.1	ND	0
Catagupan	0	0	0	0	2	0.4	(0.4)
Indalawan	1	0.3	1	0.5	1.2	ND	0.8
Malaking Ilog	2	0.6	2	1.0	3	0.6	1.0
Mangsee	0	0	0	0	3	0.6	(0.6)
Melville	0	0	0	0	0	0	0
Pandanan	0	0	0	0	2	0.4	(0.4)
Pasig	0	0	0	0	3	0.6	(0.6)
Poblacion I	0	0	0	0	2	0.4	(0.4)
Poblacion II	0	0	0	0	1.3	ND	0
Poblacion III	0	0	0	0	3	0.6	(0.6)
Poblacion IV	0	0	0	0	2	0.4	(0.4)
Poblacion V	0	0	0	0	1.4	ND	0
Poblacion VI	0	0	0	0	3	0.6	(0.6)
Rabor	1	0.3	1	0.5	1.5	ND	0.8
Ramos	0	0	0	0	3	0.6	(0.6)
Salang	0	0	0	0	3	0.6	(0.6)
Sebaring	0	0	0	0	2	0.4	(0.4)

Tsunami Vulnerability. The results of the VI assessment of barangays in Balabac revealed that six barangays have a high vulnerability index for tsunamis: Poblacion IV (3.6), Poblacion III (3.4), Mangsee (3.4), Poblacion V (3.2), Sebaring (2.8), and Catagupan (2). The other 14 barangays have a low VI.

Table 32. Tsunami Vulnerability Index of *Barangays* in Balabac

Barangay	Susceptibility Rating	Total Rating (Weight = 30%)	Population Exposure Rating	Total Rating (Weight = 50%)	Adaptive Capacity Rating	Total Rating (Weight = 20%)	Vulnerability Index (VI) at High Risk
Agutayan	2	0.6	2	1.0	2	0.4	1.2
Bancalaan	3	0.9	3	1.5	3	0.6	1.8
Bugsuk	1	0.3	1	0.5	1.1	ND	0.8
Catagupan	3	0.9	3	1.5	2	0.4	2.0
Indalawan	1	0.3	1	0.5	1.2	ND	0.8
Malaking Ilog	1	0.3	1	0.5	3	0.6	0.2
Mangsee	5	1.5	5	2.5	3	0.6	3.4
Melville	2	0.6	2	1.0	0	0	1.6
Pandanan	2	0.6	2	1.0	2	0.4	1.2
Pasig	2	0.6	2	1.0	3	0.6	1.0
Poblacion I	1	0.3	1	0.5	2	0.4	0.4
Poblacion II	1	0.3	1	0.5	1.3	ND	0.8
Poblacion III	5	1.5	5	2.5	3	0.6	3.4
Poblacion IV	5	1.5	5	2.5	2	0.4	3.6
Poblacion V	4	1.2	4	2.0	1.4	ND	3.2
Poblacion VI	0	0	0	0	3	0.6	(0.6)
Rabor	1	0.3	1	0.5	1.5	ND	0.8
Ramos	3	0.9	3	1.5	3	0.6	1.8
Salang	2	0.6	2	1.0	3	0.6	1.0
Sebaring	4	1.2	4	2.0	2	0.4	2.8

SLR Vulnerability. All the *barangays* in Balabac have a low vulnerability index for an SLR of 2 m. However, four barangays scored higher compared with the others. These are Bugsuk, Melville, Poblacion II, and Rabor (Table 33).

Table 33. Two-meter SLR Vulnerability Index of *Barangays* in Balabac

Barangay	Susceptibility Rating	Total Rating (Weight = 30%)	Population Exposure Rating	Total Rating (Weight = 50%)	Adaptive Capacity Rating	Total Rating (Weight = 20%)	Vulnerability Index (VI) at High Risk
Agutan	1	0.3	1	0.5	2	0.4	0.4
Bancalaan	1	0.3	1	0.5	3	0.6	0.2
Bugsuk	1	0.3	1	0.5	1.1	ND	0.8
Catagupan	1	0.3	1	0.5	2	0.4	0.4
Indalawan	1	0.3	1	0.5	1.2	ND	0.8
Malaking Ilog	1	0.3	1	0.5	3	0.6	0.2
Mangsee	0	0.0	0	0.0	3	0.6	(0.6)
Melville	1	0.3	1	0.5	0	0.0	0.8
Pandanan	1	0.3	1	0.5	2	0.4	0.4
Pasig	1	0.3	1	0.5	3	0.6	0.2
Poblacion I	1	0.3	1	0.5	2	0.4	0.4
Poblacion II	1	0.3	1	0.5	1.3	ND	0.8
Poblacion III	2	0.6	2	1.0	3	0.6	(0.6)
Poblacion IV	1	0.3	1	0.5	2	0.4	0.4
Poblacion V	0	0.0	0	0.0	1.4	ND	0.0
Poblacion VI	0	0.0	0	0.0	3	0.6	(0.6)
Rabor	1	0.3	1	0.5	1.5	ND	0.8
Ramos	1	0.3	1	0.5	3	0.6	0.2
Salang	1	0.3	1	0.5	3	0.6	0.2
Sebaring	2	0.6	2	1.0	2	0.4	0.4

IV. THE PROPOSED CCA/DRRM PLAN

A CCA/DRRM Framework Plan for Balabac Municipality was developed by *barangay* officials, with technical guidance provided RETA 7813 CCA Specialists, based on the issues and challenges identified in the course of implementing the Climate Vulnerability and Disaster Risk Assessment Study. Appropriate strategies, programs, and projects were then formulated to address the identified issues. The proposed Balabac Municipality CCA/DRRM Framework is presented below.

A. Hazard 1: Increase in Temperature and Rainfall Variability

Issue 1: Limited climate data and information for Balabac municipality

There is no weather station in Balabac municipality. Hence, there are no historical data on temperature and rainfall, which are needed for forecasting and planning for climate change and natural hazards management. This study used the climate data for the province of Palawan in the absence of local climate data for the municipality of Balabac. Thus, the results of the climate change projections and analysis for Balabac are less accurate.

Objective

- To establish a weather station in Balabac municipality

Strategies

- Request technical assistance from PAGASA in establishing a weather station in the municipality
- Mobilization of LGU resources for the establishment and maintenance of the weather station
- Training of designated responsible LGU personnel in the recording and reporting of weather data

Programs and Projects

- Institutionalized Weather Monitoring Program
- Weather Station Project
- Training on Weather Monitoring and Reporting

Issue 2: Increasing threats and impacts of climate change due to increasing temperature and rainfall

Based on PAGASA (2011) projections on climate for the medium-range greenhouse gas (GHG) emission scenario at the provincial level (indicative for the municipality of Balabac), temperatures are projected to increase up to an average of 1.1OC in 2020 and up to a maximum of 2.1°C in 2050. These levels of temperature may cause discomfort to the population and can be further worsened by the periodic occurrence of El Niño. An increase in temperature by >2°C is projected to have severe adverse impacts on agriculture, water resources, coastal habitats and fisheries, and human health. The dry season will be drier and the wet season will be wetter, which could affect agricultural crop production in the province, including Balabac municipality.

Objectives

- To put in place CCA measures that will minimize the impacts of increasing temperature and extreme rainfall variability on agriculture, fisheries, water resources, health, and other livelihood projects of the communities
- To mobilize support and participation of local communities in implementing disaster risk reduction management and climate change adaptation measures.

Strategies

- Identification and study of the feasibility of selected CCA measures to minimize the immediate and long-term impacts of climate change on various development sectors
- Prioritization of CCA measures based on effectiveness, cost efficiency, and affordability by the LGU
- Mobilization of technical and financial assistance programs for CCA/DRRM from national government agencies (NGAs), People's Survival Fund (PSF) accounts, international donor organizations, and local and international non-government organizations (NGOs)
- Strict enforcement and provision of adequate investments on environment and natural resources conservation to sustain natural defenses against natural disasters and climate change impacts
- Increased awareness and education of local communities on natural hazards and climate change impacts and the importance of disaster preparedness and their support and participation in implementing CCA/DRRM measures

Programs and Projects

- CCA/DRRM mainstreaming in the CLUP and Comprehensive Development Plan (CDP)
- Feasibility study and packaging of identified CCA/DRRM projects
- Natural resources protection and conservation programs and projects
- CCA/DRRM information, education, and communication (IEC) program
- Issuance of local ordinances supporting national environment and natural resource laws and regulations

Issue 3: Increasing rainfall volume and shorter return period of worst flooding

In the case of Palawan, of which Balabac islands are part, the return period of the highest recorded volume of rainfall (281.1 mm) is every 100 years. However, according to a recent bulletin of the Department of Science and Technology (DOST) (The *Philippine Daily Inquirer,* 3 February 2014), 240 mm of rainfall in 24 hours will cause serious flooding. The record for Palawan shows that the return period for a one-day rainfall of 244 mm is 50 years. Moderate flooding, on the other hand, can be triggered by a rainfall volume of about 190 mm. For Palawan, this rainfall volume occurs every 20 years. Climate change is, thus, projected to shorten the frequency or return period of rainfall that will trigger serious flooding. The rainfall volume of about 240 mm, which could trigger serious flooding, is projected to occur in 40 years based on 2006–2035 data and projections. Hence, the frequency or return period of serious flooding in Palawan and neighboring islands will be 10 years shorter than the current estimate.

Objectives

- To establish early warning systems (EWSs) for flooding
- To improve natural drainage systems to minimize floods
- To prepare contingency plans and measures in the event of serious flooding

Strategies

- Identification of areas highly susceptible to, or at great risk from, floods
- Formulation and implementation of emergency measures in the event of serious flooding
- Establishment of flood gauging stations and early warning communication systems
- Adoption and implementation of measures to minimize floods

Programs and Projects

- Detailed survey, assessment, and mapping of areas at high risk from flash floods
- Establishment of flood gauging stations and early warning communication systems
- Contingency and emergency operations plan and measures project
- Watershed reforestation, solid waste disposal, and drainage improvement projects
- Relocation and resettlement of households highly exposed to serious flooding

Issue 4: Negative impacts of climate change on livelihood and agriculture

About 30% of the total number of survey respondents reported that their work is disrupted by extreme heat or frequent rains, while 55% claimed that the yield of their agricultural produce is declining due to less rain or more drought conditions. Some 39% reported that their crops were destroyed during frequent and heavy rains, and 31% experienced increased animal mortality and morbidity due to increased heat and rains.

Objective

- To anticipate and minimize the adverse impacts of increasing temperature and extreme rainfall variability on agriculture

Strategies

- Integration of CCA/DRRM measures in the local agriculture sector plan
- Training of Municipal Agriculture Office (MAO) staff on the establishment of CCA/DRRM measures
- Provision of information to farmers on how to access crop insurance
- Extension of technical assistance to farmers on the adjustment of their cropping calendar based on agro-meteorological forecast information from PAGASA
- Construction of small-scale irrigation projects to improve and sustain the production of rice and other crops in the municipality
- Promotion of appropriate agriculture practices to improve the water holding capacity of soil and reduce runoff and erosion, including the following:
  - Restriction on slash and burn methods
  - Reforestation on steep to very steep slopes
  - Use of organic fertilizers to improve the water holding capacity of the soil
  - Adoption of soil conservation measures, including both mechanical and vegetative cover
  - Strip cropping to reduce runoff
  - Minimum cultivation to minimize erosion
  - Practice of multi-functionality and maximum biodiversity
  - Maintenance of existing tree cover
  - Possible use of steeper slopes (<50%) for agro-forestry
  - Cross-slope farming (plowing and cultivating fields up and down the slope, creating channels where surface runoff can concentrate)

Programs and Projects

- Irrigation projects (small water impounding and/or communal irrigation)
- Access to agro-meteorological forecasting information
- Crop insurance program
- Training on soil moisture conservation and water conservation

Issue 5: Negative impacts of climate change on the health of local residents

The respondents also perceived that the changing climate aggravated certain types of diseases commonly acquired by their family members. About 24% reported that some members of their families suffered from diarrhea and vomiting, 17% from influenza and fever, 12% from malaria, and 1% from measles and skin diseases.

Objectives

- To prevent or minimize the impacts of climate change on the health of local communities
- To inform and educate the local communities on the health hazards of climate change, such as waterborne and vector-borne diseases

Strategies

- Survey, assessment, and mapping of areas highly exposed to waterborne and vector-borne diseases
- Conduct of information dissemination and education on prevention of waterborne and vector-borne diseases to households at high risk
- Expansion of coverage of water and sanitation programs to communities highly vulnerable to waterborne and vector-borne diseases
- Prevention and control of waterborne and vector-borne diseases, which are made prevalent by climate change impacts, such as stagnation of flood waters, in coordination with the Provincial Health Office (PHO)

Programs and Projects

- Water and sanitation program
- Malaria control program
- Waterborne and vector-borne (dengue, gastrointestinal diseases, leptospirosis, schistosomiasis) disease control program
- IEC program on climate change impacts on health, their prevention and prevalence reduction
- Solid waste disposal and drainage improvement program

B. Hazard 2: Increasing Frequency of Typhoons

Issue 1: Increasing frequency of super typhoon landings in Palawan Province

The frequency of tropical cyclones crossing Palawan 50 km from its boundary is 1.6 per year based on the PAGASA historical records from 1948–2009. The province is affected by tropical depressions once every three years, by tropical storms once every two years, and by typhoons once every two years. It has not been hit by a super typhoon in the last 61 years. However, in 2013, Coron in northern Palawan was hit by super typhoon Yolanda, reportedly killing about 20 persons and damaging close to 100 houses. With this recent incident, the record of the province will change to a frequency estimate of one super typhoon to hit the province every 65 years.

Objectives

- To integrate typhoon frequency and disaster preparedness in the CCA/DRRM Plan
- To identify typhoon track-prone areas and institute early warning and evacuation systems

Strategies

- Documentation and compilation of frequencies, intensities, and consequences of tropical cyclones hitting the municipality and its islands
- Identification and mapping of areas directly and frequently hit by typhoons
- Institution of early warning systems in highly prone typhoon path areas
- Preparation of typhoon contingency plans and evacuation procedures at the *barangay* level

Programs and Projects

- Documentation of historical typhoon events, including areas affected and consequences
- Evaluation and mapping of areas directly and frequently hit by typhoons
- Establishment of early warning systems
- Creation of *barangay* typhoon contingency plans
- Establishment of emergency evacuation procedures

Issue 2: Damages frequently caused by typhoons and strong winds

Respondents reported that typhoons and strong winds destroyed agricultural crops, such as bananas, rice, and coconuts; wrecked fishing boats and aquaculture; and toppled down houses. Floods damaged houses and a few schools and destroyed bridges and road segments.

Objectives

- To anticipate and minimize the damages caused by typhoons on agriculture, fisheries, houses, and infrastructure
- To improve typhoon-coping mechanisms of communities

Strategies

- Improvement of typhoon alert system of communication with all residents
- Provision of information on crop insurance systems
- Retrofitting of vulnerable infrastructure and houses for typhoon resiliency
- Strengthening of typhoon-coping mechanisms by *barangays*
- Provision of hazard-safe evacuation facilities at the *barangay* level
- Adjustment of cropping patterns and calendars to maximize seasonal advantages

Programs and Projects

- Typhoon alert system communication program
- Coping mechanism strengthening program
- Crop insurance program
- Retrofitting program for houses and infrastructure (resilient design and lending program)
- Evacuation system and facility project
- Cropping calendar advisory support for farmers

Issue 3: Wide extent of area devastated by typhoons and strong winds

Typhoons and strong winds affect the whole municipality and its *barangays.* Floods affect about 25–50% of the total area of the *barangays,* while storm surges flood about 5–10%. The areas affected by landslides are undetermined.

Objectives

- To prepare CCA/DRRM plans
- To integrate CCA/DRRM in the CLUP, CDP, and Annual Investment Plan (AIP)

Strategies

- Assessment and mapping on the ground at the *barangay* level of areas, populations, and physical and natural assets at high risk from natural disasters such as floods and landslides
- Preparation of CCA/DRRM plans to address the threats and impacts of climate change and natural disasters
- Prioritization of highly vulnerable areas, populations, and physical and natural assets that are highly exposed to floods and landslides
- Improvement of hazard monitoring systems

Programs and Projects

- Ground verification of floods and landslides at the *barangay l*evel
- Integration of flood control and landslide mitigation measures (infrastructure and non-infrastructure programs) in the CLUP, CDP, and AIP
- Establishment of hazard monitoring systems

C. Hazard 3: Rise in Sea Level and Sea Surface Temperature

Issue 1: Exposure of coastal areas of Balabac to flooding due to SLR

Simulations of SLR at 0.5 m revealed that 16 *barangays* located in the coastal areas of Balabac municipality will be flooded, while simulations at 1 m and 2 m showed that 18 *barangays* will be inundated. Of the municipality's total land area, 22% (or 12,402.42 ha) will be submerged at an SLR of 0.5 m, 24% (or 13,457.65 ha) at 1 m, and 27% (or 15,192.45 ha) at 2 m. On the other hand, 4,610 people or 13% of the municipality's total population will be affected when sea level rises by 0.5 m; 5,193 people or 15% of the total population by a rise of 1 m; and 6,020 people or 17% of the total population by a rise of 2 m. The percentage values give an indication of the proportion of the population in the future (2020 and 2050) that would be affected by SLR.

Objective

- To prepare for and mitigate the impacts of SLR on coastal communities, habitats, and fisheries

Strategies

- Ground verification and mapping of SLR and its affected populations and physical and natural assets
- Establishment of monitoring stations to measure the rate of SLR
- Planning and program implementation of adaptation and mitigation measures to address the impacts of SLR

Programs and Projects

- SLR survey, assessment, and mapping project
- Establishment of a monitoring and reporting system for SLR
- Relocation and resettlement of highly exposed communities
- Water resources development project for coastal communities

- SLR-adaptive housing design and engineering
- Seawall development project

Issue 2: Impacts on coral reefs and fishery production of increasing sea temperature in the coastal waters of Balabac islands

From the months of January to March and December during the period, 1982–2009, SST in the sea surrounding Balabac islands was reported by US-NOAA to be about 27-28°C. From August to November and December, SST was higher at 30°C. The highest SST was recorded in the months of May and June at 31°C. The increase in SST will trigger coral bleaching, thereby affecting reef fish production in the coastal waters of Balabac islands. SST increase is believed by some fishermen to have caused the decrease in their fish catch.

Objectives

- To reduce the negative impacts of increasing coastal SST on fishery production
- To conserve and protect fisheries and critical habitats
- To provide alternative livelihood support to small fishermen

Strategies

- Monitoring of SST using satellite data from foreign sources (e.g., US-NOAA) or from local studies
- Establishment of marine sanctuaries
- Provision of alternative livelihood (inland or coastal water-based) to small fishermen

Programs and Projects

- Alternative livelihood programs for small fishermen, such as small-scale processing of agriculture and fishery products, poultry and livestock raising, aquaculture and mariculture, and others
- Establishment of marine sanctuaries for sustainable fishery production
- Strengthening of the enforcement of fishery laws

Issue 3: Institutional weaknesses of the municipality of Balabac in implementing DRRM

The Balabac LGU needs to improve in the following aspects of DRRM: provision of incentives for homeowners, businesses, and the private sector to invest in DRRM efforts; investment in critical infrastructure to reduce risks; assessment and retrofitting of schools and health facilities; application of risk-resilient building regulations and land use planning principles; and capacity for reconstruction.

Objectives

- To strengthen the institutional capacity of the Balabac LGU in CCA/DRRM governance
- To mobilize local communities, NGOs, and the private sector in the implementation of CCA/DRRM measures

Strategies

- Mobilization of local residents, civil society organizations, and the private sector in disaster preparedness and implementation of mitigation measures
- Improvement of natural drainage systems for flood control
- Retrofitting of schools and health facilities that are exposed to serious flooding
- Construction of new schools and health facilities, as well as roads, in low- or non-risk areas from flooding, landslides, storm surges, earthquakes, and tsunamis
- Integration of CCA/DRRM in land use plans and zoning ordinances

Programs and Projects

- Social advocacy on DRRM and community mobilization
- Drainage improvement project
- Retrofitting of houses, schools, and health facilities
- Mapping and zoning of development-constrained areas
- Preparation of risk-sensitive local development plans (CLUP, CDP)

Issue 4: Lack of budget and information for implementing DRRM

The budget of the DRRM Office (DRRMO) for its operations is inadequate. As of the 2014 Workshop, the municipality still had no DRRM Plan. Its CLUP had not integrated disaster risk and climate change concerns in its objectives, strategies, and programs and projects. Also, the municipality has no maps on storm surges, landslides, and soil liquefaction hazards, which may potentially affect its population, and physical and natural assets.

Objectives

- To strengthen the capacity of the DRRMO to plan and implement CCA/DRRM programs and projects
- To mobilize and allocate adequate funds for CCA/DRRM implementation

Strategies

- Mobilization of CCA/DRRM funds from PSF, NGA partners, international donor agencies and NGOs, the private sector, and philanthropic foundations
- Mainstreaming of CCA/DRRM in the CLUP and CDP
- Improvement of database, including maps on natural hazards and climate change-vulnerable development sectors, *barangays,* and populations

Programs and Projects

- Financial assistance mobilization program for CCA/DRRM
- Preparation of risk-sensitive CLUP, CDP, and AIP
- Database development, including the collection and processing of geo-referenced maps on climate change vulnerability and disaster risk

Issue 5: Poor adaptive capacity of barangays for disaster preparedness and mitigation measures

Of the 19 *barangays* represented in the workshop, only one has a rain gauge. All the *barangays* have no early warning system in place, nine have no designated evacuation center, and five have no Barangay DRRM (BDRRM) committees. Only two of the *barangays* have disaster contingency plans, and only ten had undertaken some form of training on DRRM and disaster preparedness. Furthermore, only seven barangays have basic life-saving equipment, and *barangay l*eaders are not undertaking any mitigation and adaptation measures on climate change. It was also reported that the *barangays,* in particular, and the municipality, in general, have no mitigation and adaptation policies, programs, and projects.

Objectives

- To strengthen the adaptive capacity or coping mechanism of *barangays*
- To institute CCA/DRRM measures at the municipal and *barangay* levels

Strategies

- Establishment of an early warning system in each *barangay*
- Designation/construction of evacuation centers in safe areas for every *barangay*
- Strengthening the capacity of the BDRRM organization in disaster preparedness and mitigation measures
- Preparation of *barangay* contingency and emergency operations plans
- Acquisition of adequate life-saving equipment such as rubber boats through procurement or donations

Programs and Projects

- Establishment of an early warning system in every *barangay*
- Establishment of safe evacuation centers
- Training of the BDRRM organization on CCA/DRRM
- Preparation of the *barangay* contingency and emergency operations plans
- Acquisition of life-saving equipment

Issue 6: Need for thorough site assessment of areas for socialized housing

The municipality has identified safe land for low-income citizens and has developed an upgrading program for informal settlements. The Housing Development section of the CLUP identified the area for socialized housing in *Barangay* Catagupan. The proposed five-ha area needs to be carefully assessed for safety from flooding, landslides, and earthquakes.

Objectives

- To study the feasibility of socialized housing developments in selected sites
- To assess the safety of the proposed site from natural hazards and disasters

Strategies

- Conduct of a feasibility study that includes disaster risk and climate vulnerability assessment of the site selected for socialized housing
- Determination of the appropriate housing design and its resiliency to natural hazards and climate change impacts

Programs and Projects

- Feasibility study of the proposed site and socialized housing development
- Development of a resilient architectural design for socialized housing developments

D. Hazard 4: Earthquakes

Issue 1: Location of several *barangays* along the thrust fault found in the municipality

About eight *barangays* (Malaking Ilog, Catagupan, and Poblacions I to VI) are located along the thrust fault identified by MGB in the municipality. Thus, these *barangays* are highly prone to ground movements or earthquakes resulting from the movement of the thrust fault.

Objectives

- To inculcate preparedness among communities that are highly exposed to ground movement
- To relocate houses sitting on the thrust fault

Strategies

- Conduct of regular earthquake drills and exercises
- Identification of highly vulnerable households to strong ground shaking
- Designation of routes and open grounds as emergency staging areas prior to full evacuation
- Retrofitting of exposed houses to increase their resilience to earthquakes
- Relocation of houses sitting on fault lines
- Regulation of future development of settlements in earthquake-prone areas
- Evaluation of building safety and retrofitting of schools, health centers, and public facilities exposed to earthquakes

Programs and Projects

- Earthquake preparedness drills and exercises
- Relocation and resettlement of households located along fault lines
- Retrofitting of houses and lifeline facilities located close to fault lines

E. Hazard 5: Floods

Issue: Exposure of several barangays and populations to serious flooding

The *barangays* with more than 20% of their population exposed to high levels of flood susceptibility are: Poblacion IV (71%), Poblacion V (29%), Catagupan (27%), Salang (25%), Melville (23%), Pasig (22%), Agutayan (21%), and Poblacion VI (20%). Those with 100% of their population exposed to low-level flooding are: Bugsuk, Mangsee, Pandanan, and Sebaring. In contrast, the entire populations in barangays Poblacion I, II, and III are not exposed to floods.

Objectives

- To establish an early warning system for flooding
- To improve natural drainage systems to minimize floods
- To prepare contingency plans and measures in the event of serious flooding

Strategies

- Identification of areas that are highly susceptible to, or at great risk from, floods
- Formulation and implementation of emergency measures in the event of serious flooding
- Establishment of flood-gauging stations and early warning communication systems
- Adoption and implementation of measures to minimize floods

Programs and Projects

- Detailed survey, assessment, and mapping of areas at high risk from flash floods
- Flood gauging station and early warning communication project
- Contingency and emergency operations plan and measures project
- Watershed reforestation, solid waste disposal, and drainage improvement projects
- Relocation and resettlement of households highly exposed to serious flooding

F. Hazard 6: Tsunamis

Issue: Susceptibility of many coastal barangays to tsunamis

Only one *barangay* of the Balabac islands is not exposed to tsunamis. The PHIVOLCS REDAS Study projects that the movement of the Sulu Trench may possibly trigger an earthquake with a magnitude ranging from 7.9–8.2 on the Richter scale. This will create a tsunami with a height of 3 m or more, which will inundate the western coastal areas of the Balabac islands, affecting Salang, Agutayan, Rabor, Pasig, Poblacions I–VI, Melville, Bancalaan, Matanggule, Pandanan, and Bugsuk islands. The other barangays in the municipality will also be affected, but not as hard as those on the western coast. Hard hit will be the small islands such as Bancalaan and Matanggule. About 17, 206.27 ha of land, or 30% of the total land area of the municipality, are prone to tsunamis resulting from the movement of the Sulu Trench and about 19,163 or 54% of the total population of the municipality will be affected.

Objectives

- To safeguard coastal communities from the potential impacts of tsunamis
- To establish measures to mitigate the potential impacts of tsunamis

Strategies

- Institution of a tsunami warning system, evacuation drills, and IEC campaigns
- Establishment of a direct communication facility with PHIVOLCS
- Construction of access roads in coastal *barangays* to the nearest higher ground
- Maintenance of coastal vegetation, such as mangroves and beach forests

Programs and Projects

- Tsunami alert and warning system program
- Tsunami emergency measures program
- Tsunami IEC project
- Coastal vegetation reforestation and afforestation project

G. Hazard 7: Storm Surges

Issue: High susceptibility of some *barangays* to storm surges

A quarter of the respondents mentioned that they were affected by storm surges every year. *Barangays* Bancalaan and Matanggule often affected by storm surges every year because they are not protected by mangroves along their coastlines. The other affected *barangays* are Catagupan and Rabor. In Bancalaan and Matanggule, the height of the most recent storm surge was about 2.1–2.7 m (Matanggule), while Catagupan and Rabor experienced storm surges 1.2–1.8 m high. Only less than 20% of the families living in these *barangays* were believed to have been affected. On the other hand, storm surges caused damages to crops, small boats, fish cages, and fish corrals in Catagupan, Pasig, Rabor, and Matanggule.

Objectives

- To document the occurrence and impacts of storm surges in the municipality
- To protect coastal communities from storm surges

Strategies

- Conduct of surveys and mapping of areas affected by storm surges
- Implementation of measures to mitigate the impacts of storm surges

- Establishment of storm surge warning and advisory/alert systems
- Conservation of forest vegetation in coastal areas

Programs and Projects

- Documentation of storm surge occurrence and impacts
- Mangrove and beach vegetation reforestation and afforestation
- Relocation and resettlement of households at high risk exposure
- Establishment of storm surge warning and advisory systems
- Coastal flooding mitigation

H. Hazard 8: Landslides

Issue: Exposure of some *barangays* and their populations to high- and moderate-risk landslides

Only *Barangay* Malaking Ilog has a substantial portion (about 25%) of its total land area highly prone to landslides. The barangays with more than 20% of their total land area moderately prone to landslides are: Poblacion I (77%), Poblacion III (52%), Pasig (48%), Indalawan (40%), and Malaking Ilog (36%). The total area of the municipality exposed at high susceptibility to landslides is 1,290.62 ha or about 2% of its total land area. About 291 people, or about 0.8% of the municipality's total population, are exposed to landslides at high susceptibility.

Objectives

- To verify on the ground the areas and populations exposed to landslides
- To implement measures to prevent and avoid landslides

Strategies

- Conduct of ground-level validation of landslide-prone areas and threatened populations
- Construction of landslide-control structures and establish vegetation control
- Relocation and resettlement of households at high risk from landslides

Programs and Projects

- Ground validation of landslide-prone areas
- Establishment of landslide control structures
- Cultivation of landslide control vegetation
- Relocation and resettlement of households at high risk from landslides

CCA/DRRM Plan

A summary matrix of the CCA and DRRM Plan is presented in Appendix 2. Aside from the issues and challenges, objectives, strategies, and programs and projects, the matrix also provides the implementing organizations and the timeline for program and project implementation.

Criteria for Prioritizing CCA and DRRM Programs and Projects

LGUs should be guided by the criteria provided here when prioritizing their proposed programs and projects. Through sound prioritization, the proposed projects are ranked according to their urgency and importance. This process helps the LGU in allotting its limited resources and in mobilizing external support. The schedule of project implementation may be undertaken in phases based on the results of the prioritization.
Two sets of prioritization criteria are recommended: (i) level of exposure of areas and populations; and (ii) project impacts. The municipality may also employ their own prioritization criteria that they deem fit.

Prioritization criteria based on the level of exposure of areas and populations include the following:

- Level of vulnerability. The areas and populations with high risk or high susceptibility to hazards are given high priority rating. The scoring can be based on the percentage of the area of the barangay affected or the percentage of the population affected.
- Areas and populations frequently affected by disaster events are given high priority rating.
- Extent or magnitude of possible damages and level of past and potential damages of the hazard. The scoring can be based on percentage of the residential, commercial, industrial, agriculture, and fisheries land use that were or will be affected, including the elements at risk under high and moderate level of exposure.
- Priority adaptive capacity of the LGU in place, such as the following:
  - Disaster preparedness (hazard monitoring, alert, warning, and evacuation systems in place);
  - With basic rescue and relief equipment;
  - With evacuation centers with basic facilities; and
  - With mitigation measures already in place (flood control and drainage, slope stabilization, etc.

Barangays with less of these adaptive capacity measures in place will be given higher priority.

Rating of priority: 1—highest priority; 5—lowest priority. Sum up the scores and get the average.

Prioritization criteria for issues and programs and projects include the following:

- Those that refer to or address disaster events that frequently affect the municipality are given higher rating.
- Those that refer to or address the most serious apparent deficiencies in adaptive capacity measures of the municipality are given higher rating.
- Those that refer to or address hazards that will affect the largest area and number of population in the municipality are given higher rating.

Rating of priority: 1—highest priority; 5—lowest priority. Sum up the scores and get the average.

REFERENCES

Asian Disaster Preparedness Centre (APDC). 2010. Mainstreaming Disaster Risk Reduction. Book 4. Manila: Urban Governance and Community Resilience, USAID, and APDC.

Cabrido, Candido A., Jr. 2013. *Mainstreaming of Local Climate Change Action Plan (LCCAP) in the CLUP of Three Cities: Santa Rosa, Dagupan, and General Santos.* Green and Sustainable Urban Planning Project. Manila: ICF-GHK and French Agency for International Development.

_____. 2013. *Risk and Vulnerability Assessment.* Revised version 1 of Training Design and Survey Materials. Manila: CTI SEA Project and PRIMEX.

_____. 2012. *Method for Mainstreaming Disaster Risk Reduction Management and Climate Change Adaptation into Land Use Planning: City to City Sharing Initiatives.* Global Facility for Disaster Reduction and Recovery (GFDRR) for the Cities of Quito, Ecuador, Kathmandu, Nepal, and Makati City, Philippines. Manila.

_____. *Training Modules and Manual on Mainstreaming Climate Change and Disaster Risk Reduction and Management in the Provincial Development and Physical Framework Plan.* NEDA MDG-F 1656 Project. Manila: NEDA.

_____. *Sectoral Vulnerability Assessment Tool for Climate Change.* MDGF 1656 Project. Manila: NEDA, UNDP, and AUSAID, 2011.

_____. *2008. National Assessment of the State of Disaster Risk Management in the Philippines.* Manila: UNDP, ADB, Office of Civil Defense, and National Disaster Coordinating Council.

Department of Environment and Natural Resources-Mines and Geosciences Bureau (DENR-MGB). Geological Database Information System. http://gdis.denr.gov.ph/mgbviewer.

ICF-GHK. 2013. *Mainstreaming Local Climate Change Action Plan into the CLUP of Sta. Rosa City.* Green and Sustainable Urban Planning Project. Manila: French Agency for International Development.

Municipal Government of Balabac. 2000. *Municipality of Balabac Socioeconomic Profile.* Balabac: Municipality of Balabac.

National Oceanic and Atmospheric Administration (NOAA). NOAA Laboratory for Satellite Altimetry. http://ibis.grdl.noaa.gov/SAT/SeaLevelRise/.

Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA). 2011. *Climate Change in the Philippines.* Manila: PAGASA, 2011.

Philippine Atmospheric, Geophysical, and Astronomical Services Administration-Department of Science and Technology (PAGASA-DOST). *Current Climate Trends in the Philippines.* http://www.climateadapt.asia/upload/events/files/4f7565E804fdc2_PAGASA.pdf.

Philippine Institute of Volcanology and Seismology (PHIVOLCS). http://www.phivolcs.dost.gov.ph.

APPENDIX 1

HAZARD CHARACTERIZATION OF BARANGAYS IN BALABAC MUNICIPALITY*

Barangay	Resource Person	Types of Hazards and Frequency	Consequences	% of Barangay Affected	With Early Warning System	With Evacuation Center	With BDRRM Committee	With Contingency Plan	Training and Equipment Needed
Salang	Bgy. Chair Lorena Halili	Typhoons Strong winds every yr El Niño and drought - every 10-15 yr Earthquakes - every 20 yrs	Palay, bananas, and coconuts destroyed Bancas destroyed and seaweed farms washed out Houses destroyed due to strong winds No road destroyed Bridge destroyed by floods	Whole barangay affected by typhoons	None	Yes	Yes	No	Life jackets Pump boats Radios Satellite phones
Agutayan	Bgy. Chair Carman Condes	El Niño and drought - every yr Floods - every yr (1.2 m deep and 3 hrslong) Strong winds and typhoons - every yr Earthquakes - every 10-20 yrs	No deaths, no injuries Coconuts, bananas, and palay destroyed by strong winds Fish corrals and seaweeds destroyed Bancas carried by floods Houses destroyed Roads destroyed by floods	Whole barangay affected by typhoons	None	Yes	Yes	No	Training
Mangsee		Strong winds - annually Storm surges 4 m deep - 1970-1998	Houses destroyed due to strong winds	10% of barangay affected by storm surges	No answer	Designated school	Yes	No	Incident Command System (ICS), Barangay Incident Command System (BICS), Private Sector Partnership (PSP) support
Sebaring	Bgy. Chair Edward Malinawag	Floods - yearly from 1992 - 2012, 0.3–0.9 m deep for one day El Niño and drought - 2010-2012 drought—2010–2012	Seaweeds washed out due to storm surges	25% of barangay affected by flood	None	With evacuation center	None	No	ICS, BCS

* Based on the Workshop on Hazard Characterization of Barangays in Balabac Municipality, Puerto Princesa City, Palawan, 14 February 2014

Pandanan	Bgy. Chair Violeta Gabinete	Strong winds - every yr Earthquakes - every 20 yrs Super typhoons - every 65 yrs El Niño and drought - every 10-15 yrs Storm surges - every 20 yrs	Two persons died-drowned due to sinking of boat Coconuts destroyed Seaweeds washed out Six houses destroyed	Whole barangay affected by strong winds and storm surges	None	None	Yes	None	Life jackets Flashlights Radios Satellite phones TV
Poblacion 6	Bgy. Chair Rabbana Ami	Landslide every yr Floods - 2011-2012, 9 m deep for 3 hrs	Coconuts destroyed Bridge destroyed by flood Road destroyed by rains	50% of barangay affected by floods	None	Yes	Yes	None	ICS, BCS
Poblacion 1	Bgy. Chair Joseph Calopez	Floods - 0.6 m deep every typhoon due to overflowing of rivers Earthquakes Landslides - one in the last 3 yrs Strong winds Typhoons - every yr	Fruit trees - jack fruit, mango, and coconut - destroyed	25% of barangay affected by floods	No	No	Yes	No	Early warning system training
Catagupan	Bgy. Chair Kamaria Ami	Floods - 1.5-2.1 m deep for 2-3 days Strong winds - every yr Earthquakes - every 20 yrs	Flood - one dead, three seriously injured Coconuts and bananas destroyed Cows and carabaos killed Seaweeds washed out Boats destroyed Houses destroyed Road damaged by flood	Whole barangay affected by flood	No	No	Yes	No	ICS Rubber boat
Poblacion 6	Lorna Gapilango, MSWDO	Strong winds and typhoons - every yr Earthquakes - every 10 yrs Floods - 0.6- 0.9 m deep for 1–2 hrs/yr due to heavy rains El Niño and drought - every 8 years	Palay, bananas, and coconuts destroyed High school building damaged due to strong winds and *habagat* Road and bridge damaged	Whole barangay affected by all hazards identified	Yes - rain gauge	Yes - designated covered court	No	No	Disaster risk management training People survival training Budgeting of calamity funds
Poblacion 3	Bgy. Chair Adamson Salleh	Floods - 0.3–0.6 m deep every yr Landslides - 5–100 m deep every yr Earthquakes - every 10 yrs	Houses damaged due to typhoon Road damaged due to landslide	20% of barangay affected by flood 10% of barangay affected by landslide	No	Yes	Yes	No	Disaster risk management training

Poblacion 2	Bgy. Chair Kenneth Batalla	Earthquakes - every 10 yrs Landslides - every 10 yrs	School damaged by landslide	5% of barangay affected	No	No	No	No	Early warning training
Poblacion 3	Romeo Ong, Municipal Engineer and Municipal Planning and Development Coordinator	Strong winds and typhoons - 60-80 kph every yr Earthquakes - 10 seconds long every 10 yrs El Niño and drought - every 15 yrs Tsunamis - no historical record Landslides - 5 m x 100 m	Two houses damaged by landslide Road damaged by landslide	10% of barangay affected by landslide	No	No	No answer	No answer	Disaster preparedness training
Merville	Bgy. Chair Julasan Setturan	Typhoons - every yr Earthquakes - every 10 yr Floods due to absence of drainage system in roads	Residents evacuate to higher grounds during floods Bridge rendered impassable by flooding	2% of barangay affected by floods	No	No	No	No	Health center and multipurpose hall
Ramos	Bgy. Chair Roning Abducani	Storm surges Habagat SLR Strong winds - every yr Floods - lasts for 1 day	Coconuts destroyed by storm surges Fish cages destroyed by storm surges Seaweeds washed out Bancas destroyed	5% of barangay affected by storm surge	No	Elementary school	Yes	No	Disaster risk management training for barangay officials
Bancalaan	Bgy. Chair Hji Mad-Yusop Janabbil	Strong winds and typhoons -every yr Earthquakes - every 10 yrs Storm surges 0.6 m high	Fish cages damaged Bancas washed out Houses damaged by *habagat*	Whole barangay affected by *habagat*	No	Yes	Yes	No	Disaster risk management training for barangay officials
Malaking Ilog	Bgy. Chair Jahedol Saynol	Landslides - 2 ha Earthquakes - every 5 yrs Floods	Coconuts destroyed Road and bridge damaged by floods	80% of barangay affected by flood	No	No	Yes	Yes	Training on the construction of evacuation buildings
Pasig	Bgy. Chair Eduardo Acpao	Strong winds Earthquakes El Niño	Road damaged by floods	1% of barangay affected by flood	Yes	Yes	Yes	Yes	
Poblacion 4	Bgy. Chair Emil Balahim	Strong winds and typhoons - every yr Floods - 1 m deep 3-4 times a yr Earthquakes - every 10–15 yr SLR Storm surges-0.5 meter high every yr El Niño and drought - every 10–15 yr	Crops damaged Fisheries damaged Houses and schools damaged Road damaged by floods	50% of barangay was affected by flood 95% of barangay was affected by sea level rise	No	No	Yes	No	Vulnerability and disaster risk assessment training and survey Information, education, and communication on CCA and DRRM

APPENDIX 2

PROPOSED CCA/DRRM PLAN FOR BALABAC MUNICIPALITY

Issues/Challenges	Objectives	Strategies	Proposed Programs & Projects	Implementing Organization/s	Timeline
Climate data and information for Balabac municipality are scanty	To establish a weather station in Balabac municipality	Request technical assistance from PAGASA in establishing a weather station in the municipality Mobilization of resources for the establishment and maintenance of the weather station Training of designated responsible LGU personnel in the recording and reporting of weather data	Institutionalized weather monitoring program Weather station project Training on weather monitoring and reporting	LGU, PAGASA	Short term
Increasing threats and impacts of climate change due to increasing temperature and rainfall	To put in place climate change adaptation measures that will minimize the impacts of increasing temperature and extreme rainfall variability on agriculture, fisheries, water resources, health, and other livelihood projects of the communities To mobilize support and participation of local communities in implementing DRRM and CCA measures	Integration of DRRM and CCA measures in local agriculture sector plans Training of MAO and staff on the establishment of DRRM and CCA measures Provision of information to farmers on how to access crop insurance Extension of technical assistance to farmers on the adjustment of their cropping calendar based on agrometeorological forecast information from PAGASA Construction of small-scale irrigation projects to improve and sustain production of rice and other crops in the municipality Promotion of appropriate agriculture practices to improve water-holding capacity of soil, and reduce run-off and erosion	Irrigation projects (small water impounding and/or communal irrigation) Access to agro-meteorological forecasting information Crop insurance program Training on soil moisture conservation and water conservation	LGU, PAGASA, DENR, DA, TESDA	

Negative impacts of climate change on the health of local residents	To prevent or minimize the impacts of climate change on the health of local communities To inform and educate the local communities on the health hazards of climate change such as water-borne and vector-borne diseases	Survey, assessment, and mapping of areas highly exposed to waterborne and vector-borne diseases Conduct of information and education on prevention of waterborne and vector-borne diseases to households at high-risk exposure Expansion of coverage of water and sanitation program to communities highly vulnerable to waterborne and vector-borne diseases Prevention and control of waterborne and vector-borne diseases that are made prevalent by climate change impacts, such as stagnation of flood waters, in coordination with the PHO	Water and sanitation program. Malaria control program Waterborne and vectorborne (dengue, gastrointestinal diseases, leptospirosis, schistosomiasis) disease control program on climate change impacts on health; their prevention; and prevalence reduction Solid waste disposal and drainage improvement program	LGU, DOH	Medium term
Frequency of super typhoon landings in Palawan province	To integrate typhoon frequency and disaster preparedness in the DRRM and CCA plan To identify typhoon track-prone areas and institute early warning and evacuation systems	Documentation and compilation of frequencies, intensities, and consequences of tropical cyclones hitting the municipality and its islands Identification and mapping of areas directly and frequently hit by typhoons Institution of early warning systems in highly prone typhoon path areas Preparation of typhoon contingency plans and evacuation procedures at the barangay level	Documentation of historical typhoon events, including areas affected and consequences Evaluation and mapping of areas directly and frequently hit by typhoons Establishment of early warning systems Formulation of barangay typhoon contingency plans Emergency evacuation procedures	LGU, PAGASA	Medium term
Damages frequently caused by typhoons and strong winds	To anticipate and minimize the damages caused by typhoons on agriculture, fisheries, houses, and infrastructure To improve typhoon coping mechanisms of communities	Improvement of typhoon alert system communication with all residents Provision of information on crop insurance systems Retrofitting of vulnerable infrastructure and houses for typhoon resiliency Strengthening of typhoon-coping mechanisms by barangays Provision of hazard-safe evacuation facilities at the barangay level Adjustment of cropping patterns and calendars to maximize seasonal advantages	Typhoon alert system communication program Coping-mechanism-strengthening program Crop insurance program Retrofitting program for houses and infrastructure (resilient design and lending program) Evacuation system and facility project Cropping calendar advisory support for farmers	LGU, DA, PCIC, DepEd	Short term

Wide extent of area devastated by typhoons and strong winds	To prepare DRRM and CCA plans To integrate DRRM and CCA plans in CLUP, CDP, and AIP	Assessment and mapping on the ground at the barangay level of areas, populations, and physical and natural assets at high risk from natural disasters such as floods and landslides Preparation of DRRM and CCA plans to address the threats and impacts of natural disasters and climate change Prioritization of highly vulnerable areas, populations, and physical and natural assets highly exposed to floods and landslides Improvement of hazard monitoring systems	Ground verification of flood and landslide at the barangay level Integration of flood control and landslide mitigation measures (infrastructure and noninfrastructure programs) in the CLUP, CDP, and AIP Hazard monitoring system program	LGU, DPWH	Short term
Increased exposure of coastal areas and population to inundation as a result of SLR	To prepare for and mitigate the impacts of SLR on coastal communities, habitats, and fisheries	Ground verification and mapping of SLR and its affected populations, and physical and natural assets Establishment of monitoring stations to measure the rate of SLR Planning and program implementation of adaptation and mitigation measures to address the impacts of SLR	SLR survey, assessment, and mapping project Monitoring and reporting systems for SLR Relocation and resettlement of highly exposed communities Water resources development project for coastal communities SLR adaptive housing design and engineering Seawall development project	LGU, DPWH	Long term
Impacts on coral reefs and fishery production of increasing SST in the coastal waters of Balabac islands	To reduce the negative impacts of increasing coastal SST to fishery production To conserve and protect fisheries and critical habitats To provide alternative livelihood support to small fishermen	Monitoring of sea surface temperature using satellite data from foreign sources (e.g., US NOAA) or from local studies Establishment of marine sanctuaries Provision of alternative livelihood (inland or coastal water-based) to small fishermen Implementation of measures to conserve fisheries and protect critical fishery habitats (mangroves, corals, and seagrass) Strict enforcement of laws and regulations on illegal fishing and catching of endangered marine mammals and other animals Training of small fishermen and family members, including women, in alternative livelihood projects	Alternative livelihood programs for small fishermen, such as small-scale processing of agriculture and fishery products, poultry and livestock raising, aquaculture and mariculture, and others Establishment of marine sanctuaries for sustainable fishery production Strengthening the enforcement of fishery laws	LGU, DENR, TESDA, DA	Long term

Institutional weaknesses of the municipality of Balabac in implementing DRRM	To strengthen the institutional capacity of Balabac municipality in CCA and DRRM governance To mobilize local communities, NGOs, and the private sector in the implementation of DRRM and CCA measures	Mobilization of local residents, CSOs, and the private sector in disaster preparedness and implementation of mitigation measures Improvement of natural drainage systems for flood control Retrofitting of schools and health facilities that are exposed to serious flooding Construction of new schools and health facilities as well as roads in low-risk or non-risk areas from flooding, landslides, storm surges, earthquakes, and tsunamis Integration of CCA and DRRM in land use plans and zoning ordinances	Social advocacy on DRRM and mobilization program Drainage improvement project Retrofitting of houses, schools, and health facilities program Mapping and zoning of development-constrained areas Preparation of risk-sensitive local development plans (CLUP, CDP)	LGU	Medium term
Lack of budget and information for implementing DRRM	To strengthen the capacity of the DRRMO to plan and implement CCA and the DRRMO programs and projects To mobilize and allocate adequate funds for DRRM and CCA implementation	Mobilization of CCA and DRRM funds from PSF, national government agency partners, international donor agencies and NGOs, private sector, and philanthropic foundations Mainstreaming of CCA and DRRM in CLUP and CDP Improvement of database, including maps on natural hazards and climate change-vulnerable development sectors, barangays, and populations	Financial assistance mobilization program for CCA and DRRM preparation of risk-sensitive CLUP, CDP, and AIP Database development, including the collection and processing of geo-referenced maps on CC vulnerability and disaster risk	LGU	Short term and continuing
Poor adaptive capacity of barangays on disaster preparedness and mitigation measures	To strengthen the adaptive capacity or coping mechanism of barangays To institute CCA and DRRM measures at the municipal and barangay levels	Establishment of an early warning system in each barangay Designation/construction of evacuation centers in safe areas for every barangay Strengthening the capacity of the BDRRMO in disaster preparedness and mitigation measures Preparation of barangay contingency and emergency operations plans	Establishment of early warning systems in every barangay Establishment of safe evacuation centers Training of the BDRRMO on CCA and DRRM Preparation of barangay contingency and emergency operations plans	LGU, OCD, PAGASA	Medium term
Short term: 1–3 years; Medium term: 4–6 years; Long term: More than 6 years					

Legend: AIP – Annual Investment Program; BDRRMO – barangay disaster risk reduction and management office; CC – climate change; CCA – climate change adaptation; CDP – Comprehensive Development Plan; CLUP – Comprehensive Land Use Plan; CSO – civil society organizations; DA – Department of Agriculture; DENR – Department of Environment and Natural Resources; DepEd – Department of Education; DOH – Department of Health; DPWH – Department of Public Works and Highways; DRRMO – Disaster Risk Reduction and Management Office; IEC – Information, Education, and Communication; LGU – local government unit; MAO – Municipal Agriculture Office; PAGASA – Philippine Atmospheric Geophysical and Astronomical Services Administration; PCIC – Philippine Crop Insurance Corporation; PSF – People's Survival Fund; SLR – sea level rise; SST – sea surface temperature; TESDA – Technical Education and Skills Development Authority

CLIMATE CHANGE VULNERABILITY AND DISASTER RISK ASSESSMENT STUDY OF BALABAC MUNICIPALITY, PALAWAN

This study recommends appropriate climate change adaptation and risk reduction measures to help address present and potential climate-related problems in the municipality. This includes floods, storm, surges, landslides, and sea level rise. The study covered six villages in Balabac (Agutayan, Bancalaan/Matanggule, Catagupan, Pasig, Rabor, and Salang), which are usually affected by floods.