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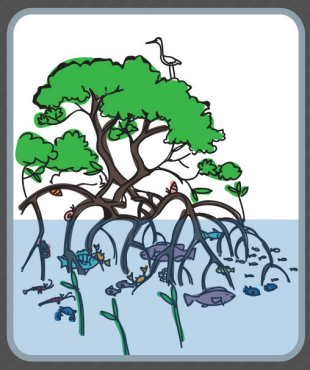
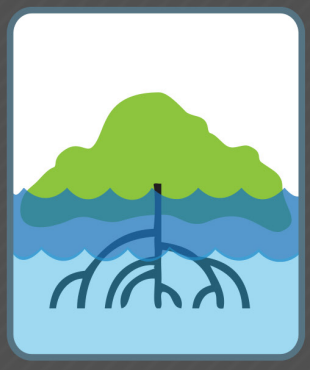
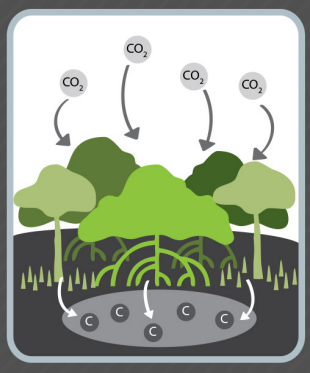
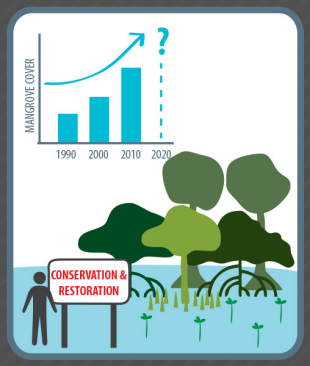
STATE OF THE MANGROVE SUMMIT:

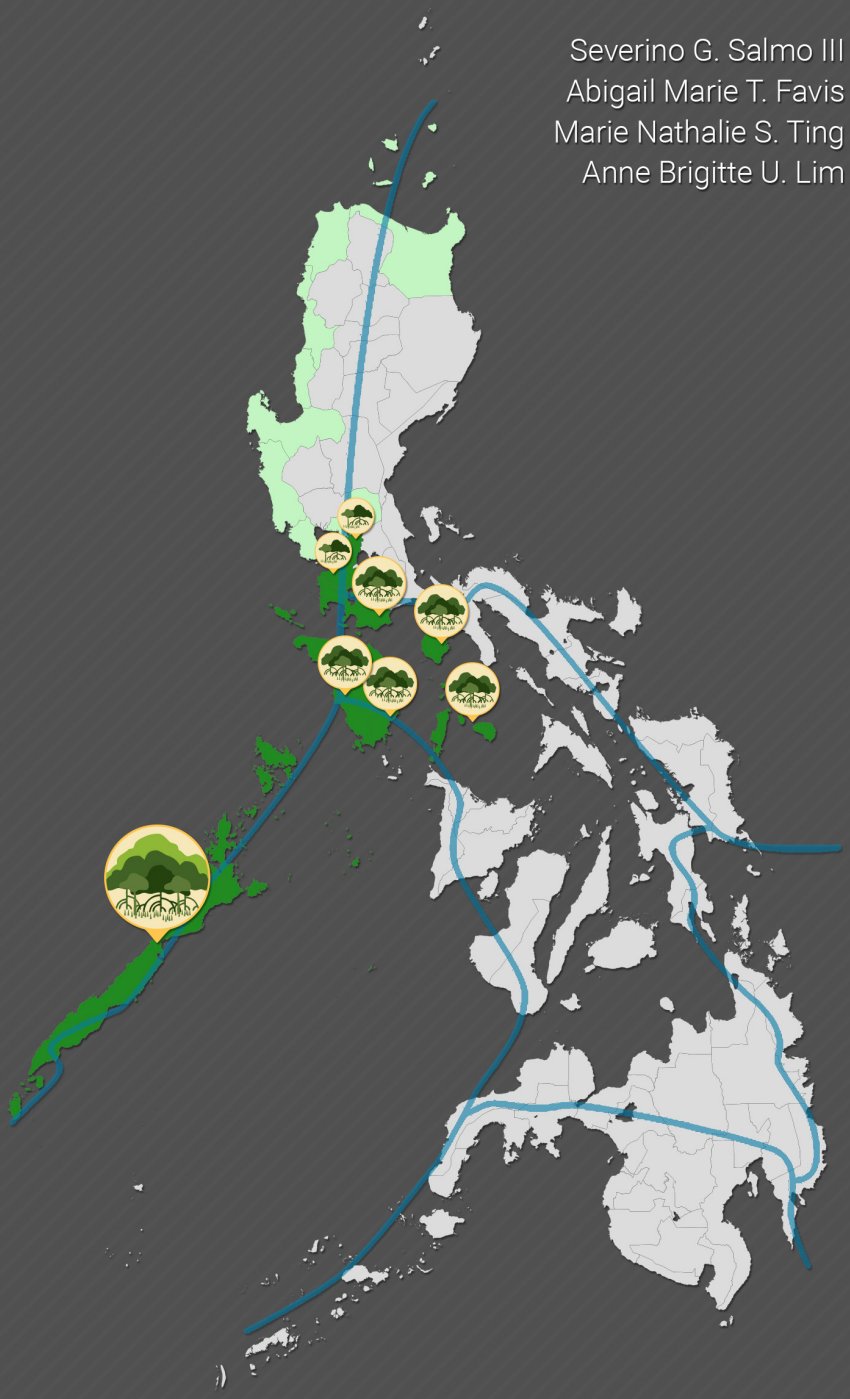
Southern Luzon Proceedings | 1–2 October 2015











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CONSERVATION INTERNATIONAL Philippines
Turing Foundation
FOUNDATION FOR THE PHILIPPINE ENVIRONMENT
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About the cover: With climate change upon us, stronger and more frequent typhoons and sea level rise threaten the survival of both mangroves and communities along the Philippine coasts. Mangroves are special trees that help buffer our coasts and efficiently absorb excess carbon dioxide from the air. However, mangrove forests have been decimated through decades of clearing and unsustainable human activities. Looking past the short-sighted gains, coastal communities and local governments now know that they need the living fortresses, sustainable food, and valuable products and services that mangrove ecosystems provide. Good governance is key to restoring the resilience of mangrove habitats and improving the plight of communities that depend on them.

Highlighted (in dark green) on the Philippine map are the eight provinces of Southern Luzon that are featured in the following Proceedings. The icons show the relative status of the mangrove forests per province–from healthy to degraded. Also highlighted (in light green) are Northwestern Luzon provinces that were featured in the 1st Mangrove Summit Proceedings.

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List of acronyms

ACT NOW – Accelerate management effectiveness, Connectivity complementarity continued, Threat and disaster risk reduction, Networks sustained and institutionalized, Organizations strengthened and capacitated, Win-win combinations tradeoffs options for adaptive management
AIMS – Adaptive Integrated Management System
ASLR – Accelerated sea level rise

BIL – Band-Interleave-By-Line
BBR – Batangas Bay Region
BLGU – Barangay Local Government Unit
BMB – Biodiversity Management Bureau
BFAR – Bureau of Fisheries and Aquatic Resources
BFARMC - Barangay Fisheries and Aquatic Resources Management Council

CALABARZON – Cavite, Laguna, Batangas, Rizal, and Quezon
CAR – Cordillera Administrative Region
CBD – Convention on Biological Diversity
CBFMA – Community-Based Forest Management Agreement
CFMA – Community Forest Management Agreement
CENRO – Community Environment and Natural Resources Office
CEP – Coastal Environment Program
CGDNCR-CL – Coast Guard District National Capital Region-Central Luzon
CGS – Coast Guard Station
CHED – Commission on Higher Education
CI-P - Conservation International-Philippines
CMFCP – Calatagan Mangrove Forest Conservation Park
CoRVA – Coral Reef Visualization and Assessment
CRM – Coastal Resources Management
CRMP – Coastal Resources Management Program
CSO – Civil Society Organization
CSR – Corporate Social Responsibility
CTI – Coral Triangle Initiative
CTSP – Coral Triangle Support Program
CvSU – Cavite State University

DA – Department of Agriculture
DAO – Department Administrative Order
DBH – Diameter at Breast Height
DBP – Development Bank of the Philippines
DENR – Department of Environment and Natural Resources
DMT – Dry Metric Tons
DOST – Department of Science and Technology
DRR – Disaster Risk Reduction

EbA – Ecosystems-based Adaptation
ENRO – Environment and Natural Resources Office
EO – Executive Order
ERDB – Ecosystems Research and Development Bureau

FAO – Food and Agriculture Organization
FARMC – Fisheries and Aquatic Resources Management Council
FLA – Fishpond Lease Agreement
FLAASH – Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes
FMB – Forest Management Bureau
FORI – Forest Research Institute

GSIS – Governance Socio-ecological Integrated System

IA – International Agencies
ICAMP – Integrated Coastal Area Management Programs
ICM – Integrated Coastal Management
ICRMP – Integrated Coastal and Resource Management Program
ICSEACC – Integrated Coastal Sensitivity, Exposure, and Adaptive Capacity for Climate Change
IGEBC – International Group of Experts on Blue Carbon
IEC – Information, Education, and Communication
IRR – Implementing Rules and Regulations
ISI – Institute for Scientific Information
ISODATA – Iterative Self-Organizing Data Analysis Techniques

LANDSAT – Land Remote-Sensing Satellite
LGU – Local Government Unit
LiDAR – Light Detection and Ranging
LPPCHEA – Las Piñas-Parañaque Critical Habitat and Ecotourism Area

M/BFARMC – Municipal/Barangay Fisheries and Aquatic Resources Management Council
MAO - Municipal Agriculture Office
MBFDP – Mangrove and Beach Forest Development Project
MEAT – Management Effectiveness Assessment Tool
MENRO – Municipal Environment and Natural Resources Office
MFO – Municipal Fisheries Ordinance
MFRC – Mangrove Forest Research Center
MIMAROPA – Mindoro, Marinduque, Romblon, and Palawan
MLGU – Municipal Local Government Unit
MOA – Memorandum of Agreement
MPA - Marine Protected Area
MSA - Mangrove Stewardship Agreement

NCR – National Capital Region
NGA – National Government Agency
NGO – Non-Government Organization
NGP – National Greening Program
NMC – National Mangrove Committee
NRMC – National Resources Management Center

OPA – Office of the Provincial Administrator
OPAg – Office of the Provincial Agriculturist

PCG – Philippine Coast Guard
PCSD – Palawan Council for Sustainable Development
PD – Presidential Decree
PDPFP – Provincial Development and Physical Framework Plan
PENRO – Provincial Environment and Natural Resources Office
PEZA – Processing Export Zone Authority
PFO – Provincial Fisheries Office
PGB – Provincial Government of Batangas
PGM – Provincial Government of Marinduque
PhilMarSaSt – Philippine Marine Sanctuary Strategy
PNP – Philippine National Police
PO – People's Organization

RA – Republic Act
REA – Resource and Ecological Assessment
ROI – Regions of Interest

SLR – Sea Level Rise
SSS – Suitability, Sensitivity, Susceptibility
SST – Sea Surface Temperature
SVM – Support Vector Machine

TAB – Tayabas and Adjacent Bays
TABR – Tayabas and Adjacent Bays Region
TIRS – Thermal Infrared Sensors

UNEP – United Nations Environment Programme
UNESCO – United Nations Educational, Scientific, and Cultural Organization
UP-MSI – University of the Philippines-Marine Science Institute
USGS – United States Geological Survey

VA – Vulnerability Assessment
VIP – Verde Island Passage
VIPMC – Verde Island Passage Marine Corridor

Messages

On behalf of Fr. Jose Ramon T. Villarin, President of the Ateneo de Manila University, it gives me great pleasure to extend a warm welcome to you all.

Climate change and disaster risk reduction have always been part of the Ateneo's priority areas. As a Filipino, Catholic, and Jesuit University, these issues have always figured prominently in our education, research, and advocacy.

In recent years, the significance of mangroves in disaster risk reduction and management has been highlighted. As both a carbon sink and a physical buffer against storm surges, mangrove ecosystems protect coastal areas, where the majority of our population resides. Thus, in line with the Ateneo de Manila University's goals towards mainstreaming environment and development and reducing disaster risk from climate change, we are happy to host this gathering of mangrove experts and managers!

We also acknowledge the issues in mangrove management are not easily solved, and that we need to work together if we wish to properly address these. In Pope Francis' encyclical letter *Laudato Si*, our Holy Father writes about the need for humility to recognize the "human roots of our ecological crisis." He talks about the need for a multi-disciplinary and multi-sectoral approach to achieve a unified strategy to tackle such a wicked problem. Thus, we recognize the importance of coming together to share data, insights, and best practices and how this contributes to the enhancement of mangrove management plans for the Philippines.

I thank all the resource persons and participants who generously share their knowledge and expertise. I also thank the Department of Environmental Science for making this gathering possible.

I hope that this summit will result in fruitful collaboration between and among all the provinces and I hope that everyone will be inspired to continue to protect and manage such an important ecosystem.

EVANGELINE P. BAUTISTA, PhD
Dean, School of Science and Engineering
Ateneo de Manila University

Messages

Over the years, there has been a dramatic decline in our mangrove resources. This condition is further aggravated by the occurrence of strong typhoons and other anthropogenic activities. Consequently, the values and importance of mangroves against these disturbances are increasingly appreciated by policy makers and managers.

The Ecosystems Research and Development Bureau (ERDB), as the principal research arm of the Department of Environment and Natural Resources (DENR) is tasked to implement and supervise the Mangrove and Beach Forest Development Project under the Rehabilitation and Reconstruction Program. Notwithstanding the constraints associated with limited period of implementation, the ERDB is carefully implementing the project through a more stringent site validation and assessment in order to ensure successful implementation of the project and to meet the intended objectives. Implementation is guided by its Technical Bulletins issued by the office to ensure the success.

The ERDB joins in the endeavor and goals of the 2nd State of the Mangroves Summit: Southern Luzon. This is consistent with our mission to provide relevant technology and information through research and development of our natural resources particularly mangrove ecosystems. The summit marks the continuous efforts of multipartite collaboration among non-government organizations (NGOs), government agencies, local government units and academic institutions to battle the dwindling condition of mangrove resources in the light of climate change, human-induced degradation and other developments. It is imperative to review the status, what has been done, and what is needed to be done in managing the mangroves to map a clear direction towards sustainable development of this complex ecosystem.

It is our hope that the Summit will continually bring about awareness and active participation of different stakeholders in mangrove conservation and management. Along this line, the ERDB is deeply committed in generating science-based approaches in mangrove rehabilitation and conservation.

Thank you.

HENRY A. ADORNADO, PhD
Director, Ecosystems Research and Development Bureau
Department of Environment and Natural Resources

Messages

CONSERVATION INTERNATIONAL Philippines

Turing Foundation

For more than 25 years, Conservation International (CI) has been working to protect nature. We involve communities, civil society, policy makers, business organizations in these efforts. Our mission is to improve human well-being, particularly in ways that are most dependent on the essential services that nature provides: fresh water, food, health, livelihoods, and climate resilience.

Our mangrove forests, seagrass meadows, and tropical coral reefs are among the richest marine habitats in the world. These habitats provide livelihoods and bolster food security. They also help protect coastlines from typhoons and other natural disasters. These natural buffers are even more important now considering how the super typhoon Haiyan wreaked havoc, claiming over 6,000 lives in the Philippines. Haiyan will always serve important lessons on our climate change adaptation and mitigation strategies. We need to protect and rehabilitate our mangrove ecosystems. We need to share lessons, knowledge, and practices related to these.

We at CI-Philippines believe that the 2nd State of the Mangroves Summit is an important gathering among partners. As the threats of climate change increases, so does the recognition of the value of mangrove greenbelts. Mangroves sequester and store large amounts of carbon and can contribute to climate change mitigation. However, these ecosystems and the livelihoods they support are under intense pressure from rapid population growth, detrimental development, and the increasing threats associated with the impacts of climate change.

For several years now, CI-Philippines has been supporting ecosystems-based adaptation (EbA) to climate change alongside its biodiversity conservation initiatives. We support EbA initiatives in vulnerable coastal areas in the Verde Island Passage (VIP). These, in turn, support fisheries management, MPAs, and MPA networks in the VIP. Together with the Turing Foundation and other partner organizations, we also support the mangrove rehabilitation and conservation initiatives of our local partners in the provinces of Oriental Mindoro and Marinduque.

We all know that the VIP is an important area for biodiversity in the world. However, from our vulnerability assessment studies, we also know that it is highly vulnerable to climate change. Thus, we continue to research on new approaches to promote nature-based adaptation measures. With our experience in implementing coastal conservation in key biodiversity areas, we have identified a suite of options that include innovative adaptation solutions which will strengthen coastal resilience and reduce disaster risks. Mangrove conservation and rehabilitation remain to be a key piece of this work.

CI-Philippines and the Turing Foundation support the *State of the Mangrove Summit series*. The Summit gathers experts, community leaders, and representatives from the civil society and government agencies. The present and future summits (culminating to a nationwide conference) will produce a comprehensive action plan to protect our coastal ecosystem and communities in response to the growing threat of climate change. The current status of mangroves is impressive in some areas in the country while depressing in many others. We have a little over 250,000 hectares of mangrove areas remaining. The Summit is an opportunity to clear the way forward for the conservation and rehabilitation of our mangrove areas.

CI–Philippines and the Turing Foundation would like to recognize the valuable role of the Ateneo de Manila University in organizing this Summit. We are pleased that one of the outputs is the publication of the proceedings. The proceedings will help communities and partners in Southern Luzon and MIMAROPA develop long-term plans and projects on mangrove conservation. These, in turn, will improve community and ecosystem resilience to climate change. The information in the proceedings will also help policy makers, civil society, and community workers in promoting mangrove conservation in the country.

ENRIQUE A. NUÑEZ JR.
Country Executive Director
Conservation International Philippines Foundation

Introduction and Overview

The existence and ecosystem health of mangrove forests are vital to the long-term productivity and stability of coastal environments in the Philippines (Salmo et al. 2007). Mangroves contribute to fisheries production, which provide food and livelihood to millions of coastal residents. They also buffer the shoreline against natural disasters such as typhoons, storm surges, coastal erosion, and rising sea level. Their performance of ecological functions, however, depends on the extent and ecosystem health of the forest (Duke et al. 2007).

Mangroves in the Philippines have long been 'ecologically disturbed' by rampant cutting for timber products and massive conversion of forests into aquaculture ponds (Primavera 2000). Sea level rise (SLR) is another threat that will aggravate the situation by causing widespread tree mortalities due to drowning (Lovelock et al. 2015).

Aside from declaring mangrove conservation sites, the primary mode of mangrove management in the country is through planting programs (Walters 2004). An effectively designed and implemented mangrove restoration program helps increase mangrove forest cover and abate the impacts of SLR. However, evidence of success is lacking despite the widespread implementation of mangrove planting programs in the country since late 1980s. Most of these programs have selected unsuitable sites and used inappropriate species, thus, resulted to poor survival and stunted growth of mangroves, at best (Salmo et al. 2007).

Monitoring data and reports on the status of natural mangrove stands and the growth and survival rate of the planted mangrove stands have rarely been provided. Such information is critical in crafting science-based management strategies for conservation and restoration programs. In addition, sharing information on mangrove ecosystem status and best practices for mangrove management and planting can enhance current management efforts that will lead to more effective programs. Thus, the State of the Mangrove Summit aimed to gather and consolidate nationwide information on mangrove status and management. The first part of the series is the Northwestern Luzon Summit in October 2014. This second part covers selected areas in Southern Luzon.

The Need for a Mangrove Summit

The summit envisions institutionalizing a national State of the Mangroves biannual workshop that consolidates monitoring data (e.g. growth and biodiversity). The information, collated in an accessible online database, will also be useful in estimating the carbon sequestration of mangroves and in assessing the vulnerability or resiliency of mangroves against sea level rise.

This summit covers three administrative regions (NCR, Regions 4A, and 4B), and eight provinces (Romblon, Marinduque, Palawan, Oriental Mindoro, Occidental Mindoro, Batangas, Cavite, and NCR). These areas boast a diversity of mangrove settings–from heavily disturbed (NCR and Cavite) to the most intact and largest extent of mangroves in the country (Palawan and Mindoro).

Although Southern Luzon has the most extensive mangrove areas in the country, it is highly vulnerable against anthropogenic impact and natural disasters. In all its provinces, mangrove planting is a regular activity. Planting sites are usually along the shoreline using species from the genus *Rhizophora* (Salmo & Duke 2010). The survival rate is low and usually attributed to wrong species-substrate matching, and the inappropriate location and timing of planting. Similar to most mangrove rehabilitation programs in the country, most mangrove planting activities in the region are more of 'afforestation' (which affects the existing nearby habitats like seagrass beds and mudflats) rather than reforestation of denuded mangrove areas. The planted stands are usually mono-specific (Walters 2004, Primavera & Esteban 2008, Salmo et al. 2013) with stunted growth and poor survival (Samson & Rollon 2008).

Summit Objectives

The **2nd State of the Mangroves Summit** provided an opportunity for mangrove managers to discuss the status of mangrove forests in their regions. The summit also aimed to complement the State of the Coast Reports of the UP Marine Science Institute in providing a more comprehensive overview of the status of coastal ecosystems in the Philippines. The specific objectives of the summit were to:

- Provide a venue for provincial representatives to share and discuss the status of mangrove forests in the Philippines, especially in the light of climate change vulnerability;
- Involve experts in the field of mangrove ecology and management, climate change vulnerability, and carbon sequestration;
- Consolidate more accurate data from each province; and
- Come up with a plan of action to enhance mangrove management.

Content and Structure of the Proceedings

The first part of the Proceedings came from individual provincial reports. Prior to the summit, a survey form was sent to the eight provinces. This survey was implemented through the Philippine Higher Education Research Network (PHERNet) project funded by the Commission on Higher Education, entitled "Assessing the Success of Mangrove Rehabilitation Projects: Comparative Rates of Carbon Deposition in Natural versus Planted Mangrove Stands".

The survey yielded information on:

1. Province/area geographic and socioeconomic profile (e.g. population in coastal areas, barangays, and threats);
2. Mangrove assessment status (including areas of old-growth and planted stands, presence of a mangrove protected area, importance of mangroves to the community, mangrove products utilized, mangrove managers, causes of decline, effects of decline, steps taken to address decline, and presence of mangrove protection/planting/rehabilitation efforts); and
3. Provincial mangrove projects/programs (specifying the type of project, objectives, funding groups, implementing groups, partners, budget, area replanted/rehabilitated, growth and survival rate, presence of monitoring programs, community engagement, and community benefits).

Information gathered from the survey was organized into a matrix and formatted into a comprehensive, accessible online database to supplement existing mangrove information. An outline was prescribed for both oral and written reports. Each partner institution was then requested to submit an oral presentation and written report. Oral presentations were delivered during the Mangrove Summit while the written reports were submitted and completed in June 2016. The Secretariat reviewed the submitted documents for formatting and copyediting to achieve consistency (while retaining the original contents and context) throughout the Proceedings. In cases where the reporters did not provide data, the Secretariat labeled it as "no data provided." Although some reports were submitted in November 2015, there were some provinces that were not able to submit. In this case, the Secretariat prepared for the report and used the PowerPoint and survey files as bases for the report. These individual reports constitute the bulk of the Proceedings, which is available at **http://mangroveecology.com.**

The second part is composed of six technical reports covering topics on:

(1) **Status of Mangroves and Mangrove Management in the Philippines (Dr. Villamor, DENR-ERDB).** The document discusses the status of mangroves along with the historical trend in changes in mangrove forest cover. The national government agencies that were tasked to manage mangroves, their respective mandates and policies from 1970s to current period were discussed. This includes the priority government programs on mangrove rehabilitation and post-Yolanda rehabilitation programs. There was also a recognition of the constraints and "failures" of previous mangrove planting practices. While there are various programs on mangrove conservation and management, the report emphasizes the need to harmonize all programs, and it can start more particularly on government-sponsored programs.

(2) **Mangrove Forest Extent Mapping in Southwestern Luzon Using 2015 Landsat Imagery (Al Jayson Songcuan, Department of Geodetic Engineering and Marine Science Institute, UP Diliman).** This report presents the spatial distribution and estimate of coverage of mangrove forests in Southwestern Luzon (including the province of Quezon). The data on mangrove extent and cover, similar to the Northern Luzon Summit, is quite different from the provincial reports as well as with the data of Long and Giri (2013). Nonetheless, the study documented some areas with a decreasing forest cover while some areas had a significant increase. The increase in mangrove areas is attributed to the enhanced methods in areal estimation (through remote sensing and GIS) and likely with the conservation and restoration programs as well.

(3) **Resiliency and Vulnerability of the Coastal Zone Against Sea Level Rise (Dr. Samuel S. Mamauag, Marine Environment and Resources Foundation, Inc./Marine Science Institute, UP Diliman).** The document discusses the analyses on the vulnerability and/or resiliency of mangroves against SLR.

(4) **Integrating Mangrove Ecosystems Approaches to Integrated Coastal Management (Dr. Porfirio M. Aliño, Marine Science Institute, UP Diliman).** The document discusses frameworks and strategies that incorporate mangrove ecosystem in Integrated Coastal Management.

(5) **Blue Carbon (Ms. Ma. Josella Pangilinan, Conservation International-Philippines).** The document presents the initiatives and activities of Blue Carbon International Working Group, as well as early attempts to establish Blue Carbon Philippines. The Philippines is one of the original members of the International Technical Working Group. However, there has not been much development in the country since its inception. This Blue Carbon Initiative offers a great opportunity to provide value-adding services (through Carbon Accounting and Payment for Ecosystem Services, among others) that would contribute in enhancing mangrove conservation and management.

(6) **Status of Mangroves and Mangrove Research in the Philippines (Dr. Miguel D. Fortes, Marine Science Institute, UP Diliman and Dr. Severino G. Salmo III, Department of Environmental Science, Ateneo de Manila University).** The document provides a comprehensive review of studies done on Philippine mangroves since the 1600s. This include historical accounts of research

according to timeline, theme (ecology, conservation, biodiversity, etc.), geographic regions (comparing number of publications), and management. The study emphasized that research priorities differed across time and that most of the research works were in response to environmental issues at the time.

The third part is the summary of workshop-planning outputs drawn from the summit. There were three groups formed to do the workshop. Each group was asked to come up with a Problem Tree Analysis to identify data gaps and prioritize issues and problems. The activities to address the identified problems were elaborated.

The last part is a synthesis of the 2nd State of the Mangrove Summit. Information from all reports, technical presentations, and workshop outputs were consolidated. Statistics on mangrove forest cover for the Southern Luzon in terms of species composition, distribution, and extent of old and planted stands were reported. Current and emerging issues that pose threats to the existence of mangroves (e.g. coastal poverty, habitat conversion, and sea level rise) were discussed. Management approaches across sites were summarized to identify common strategies that will help improve mangrove management in the region. In this section, we incorporated our insights and perspectives based on the identified data gaps and the needed research to complement the current management strategies.

Summary and Challenges

Around 41 participants from academic institutions, NGOs, NGAs, and local government units attended the 2nd State of the Mangrove Summit. There were eight case study presentations from mangrove managers and five technical presentations from resource persons. The sharing sessions were valuable and covered mangrove statistics, perceived threats, management responses, as well as the difficulties and lessons learned in mangrove management. The concerns mentioned in the workshop and planning sessions will serve as inputs in crafting national mangrove management plan. This document will be available online for public access.

Like the first summit, the second summit has accomplished its objectives and paved the way for future mangrove summits at the regional and national levels. Organizing this summit was rife with challenges. Matters of funding, coordination, participation, and publication of proceedings were nonetheless overcome. For our success at each stage, we are grateful to all the participants and resource persons, as well as the members of the Secretariat, the Department of Environmental Science and the administrators of the Ateneo de Manila University, and the sponsors (Foundation for the Philippine Environment, Conservation International-Philippines, USAID Protect Wildlife Project, and CHED). As we present this collection of status reports and knowing the formidable challenges ahead, we enjoin all mangrove stakeholders to participate in the continuing efforts and contribute to the improvement of mangrove management in the country.

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State of the Mangroves in

MARINDUQUE

The Editors, based on inputs from Marinduque participants

I. INTRODUCTION

The province of Marinduque is located about 170 km south of Metro Manila. It is bounded on the north by the Tayabas Bay, on the east by the Bondoc Peninsula, on the west by Oriental Mindoro, and on the south by the Sibuyan Sea. The total land area of the province is 95,925 ha. It has a lone congressional district composed of six municipalities, namely Boac (the capital town), Buenavista, Gasan, Mogpog, Torrijos, and Sta. Cruz. These municipalities are comprised of 218 barangays, 86 of which are coastal barangays. The coastal area of Marinduque takes up about 241,500 ha with a shoreline length of 161 km.

Out of the provincial population of 227,828 (NSO/PSA 2010), 115,738 or 50.8% live in coastal barangays. The primary sources of income of these coastal communities are fishing and agriculture. These sources of livelihood are threatened by illegal or unregulated fishing, coastal siltation, and extreme weather conditions. Given their limited income, marginal fisher folks are further made more vulnerable by their lack of alternative livelihood. These make it difficult for them to sustain their family's daily needs. Coastal residents also experience social problems related to low family values and their own vices, which have led to crimes in the community. Unregulated coastal settlement, substandard roads, lack of drainage and sewage facilities, and poor waste management exposes the community to health hazards and disasters. Many also have poor health and sanitation due to the limited supply of safe drinking water. Most coastal communities depend on deep wells, which are vulnerable to saline intrusion when sea level rises. Lastly, these communities are exposed to typhoons, storm surges, coastal erosion, and flooding.

Table 1. Estimated areal extent of mangroves in Marinduque (ha).

Old stand	Secondary growth	Plantation
2,000	747.78	450

Importance of Mangroves

Mangroves are important for the province as sources of food and other marketable products such as wood, fish, clams, and shellfish. They also provide opportunities for ecotourism and recreation. Most of the people who earn from mangrove resources–from products to aesthetic services–live in the municipalities of Sta. Cruz, Torrijos, and Mogpog, which may be found in the eastern and northern coasts of Marinduque. Mangroves provide invaluable ecological services such as wildlife habitat and shoreline protection from tsunami, storm surges, and erosion.

II. STATUS OF MANGROVES IN MARINDUQUE

The province of Marinduque has a total mangrove area of 3,197.58 ha located along the coastal areas of Sta. Cruz (2,474.32 ha), Torrijos (604.48 ha), and Mogpog (118.78 ha). Over 2,000 ha of these are considered old stands, whereas 450 ha are newly planted (within the last 10 years), and 747.78 ha are secondary growth (**Table 1)**. The most common species thriving in the province are *Rhizophora* sp. and *Api-api* (*Avicennia marina*).

Mangrove species in Marinduque include *Aegiceras floridum* (Tindok-tindok), *Avicennia marina* (Pipisik), *Bruguiera cylindrica* (Pototan), *Bruguiera gymnorrhiza* (Pototan or Busain), *Bruguiera parviflora* (Larangay), *Ceriops decandra* (Lapis-lapis), C*eriops tagal* (Tangal), *Excoecaria agallocha* (Buta-buta), *Heritiera littoralis* (Dungon lati), *Nypa fruticans* (Sasa), *Pemphis acidula* (Bantigue), *Rhizophora apiculata* (Bakawan lalake), *Rhizophora mucronata* (Bakawan babae), *Rhizophora stylosa* (Bakawan bato), *Sonneratia alba* (Pagatpat), *Sonneratia caseolaris* (Pagatpat), and *Xylocarpus granatum* (Tabigi).

Degradation of Mangrove Forests

The total forestland of the Marinduque remains at 7,105 ha, which is subdivided into upland forest, mangrove forest, and mossy forest. This places Marinduque as the

3rd most denuded province in the country. It is also ranked as the 7th most geohazard-prone province. The decline of mangroves is mostly due the following reasons: (1) conversion of mangrove areas into fishponds; (2) cutting of mangrove stands for construction materials, firewood, and charcoal; and (3) encroachment or illegal settlement along and on mangrove areas.

The degradation of mangrove forests has resulted in the decline of wildlife biodiversity. Declines in fish and shellfish catch, a primary source of livelihood, have been experienced in the province. Coastal-dwellers have also been more exposed to strong winds, tidal waves, storm surges, and coastal erosion.

Threats to Mangrove Forests

The biggest threat to mangroves in the province is the dumping of mine wastes along its coastal areas. From 1975 to 1988, almost 300 million dry metric tons (DMT) of mine tailings were directly dumped in Calancang Bay by the Marcopper Mining Corporation. In 1997 to 1979, the Consolidated Mines Incorporated directly dumped their mine tailings in Ulong Bay, Mogpog. This dumping killed coral reefs and rich fishing grounds, affecting the livelihood of fisher folks. On December 6, 1993, the Maguilaguila Dam of Marcopper mining collapsed. Toxic silt and water contaminated with mine wastes flowed down the river. This caused massive flooding in downstream agricultural areas, and residential and business districts. It also damaged coastal habitats. Once again, in 1994, more than 1.6 million cubic meters of mine tailings spilled into the Makalupnit and Boac rivers and coastal areas. These bouts of mine waste dumping or accidents have affected both the natural and human capitals of the province.

III. MANGROVE PROTECTION AND MANAGEMENT

Mangrove protection and management involve various stakeholders in the province. The DENR plays a role in the issuance of legal, institutional, and partnership arrangements, which are formalized through a memorandum of agreement (MOA). The DENR also provides technical guidance to other stakeholders. The Provincial Government, on the other hand, is responsible for the proper implementation of projects. This involves close coordination with other stakeholders, information, education, and communication (IEC) campaigns, provision of personnel and livelihoods, as well as the management and administration of financial resources of projects. Stakeholders, which include the municipal governments of Sta. Cruz, Torrijos, and Mogpog, provide personnel and funding supports. Municipal local government units (LGUs) also assist in IECs and lead community mobilization for the protection of resources. At the fourth tier are the barangay LGUs, which assist in community mobilization and resource protection. The Barangay Fisheries and Aquatic Resources Management Councils (BFARMCs), cooperatives, and civil society organizations (CSOs) also assist in the implementation and resource protection at the local level. Lastly, the Marinduque State College provides technical assistance and community organizing.

Table 2. DBP/PGM Forest Project

Area (Municipality/ Barangay)	Area (ha)	Propagules planted
STA. CRUZ:		
Botilao	3	7,500
Ipil	7	17,500
Kamandugan	3	7,500
Kalangkang	5	12,500
Kasily	3	7,500
Hupi	2	5,000
Balogo	4	10,000
Lapu-lapu	2	5,000
Polo	5	12,500
Buyabod	5	12,500
Biga	5	12,500
Tamayo	5	12,500
Tawiran	5	12,500
Alobo	5	12,500
Morales	1	2,500
Matalaba	2	5,000
Tagum	3	7,500
Taytay	5	12,500
Masaguisi	5	12,500
TORIIJOS:		
Mabuhay	3	7,500
Suha	4	10,000
Malinao	4	10,000
Bonliw	4	10,000
Kayduke	10	25,000
TOTAL	**100**	**250,000**

One of the mangrove management projects of the province is the Forest Project, which focuses on coastal rehabilitation by replanting in existing mangrove areas. This project ran from 2007 to 2015 and covered around 19 coastal barangays in the municipality of Sta. Cruz and five coastal barangays in the municipality of Torrijos. This project was funded by the Development Bank of the Philippines (DBP) in partnership with the Provincial Government of Marinduque (PGM) with funding of approximately Php 734,250 and Php 500,000, respectively.

It was mainly implemented by PGM together with the DENR and the LGUs of Sta. Cruz and Torrijos. The project has four main objectives: (1) to develop, rehabilitate, stabilize, and arrest the degradation of coastal resources through reforestation and rehabilitation of mangrove swamp; (2) to increase public awareness and education about the benefits of mangrove forests; (3) to promote sustainable management of mangrove forests; and (4) to respond to climate change and to mitigate its impacts.

The DBM/PGM Forest Project rehabilitated about 100 ha by replanting 250,000 mangrove propagules (**Table 2**). The survival rate for this project is at 88%. Mortality of the seedlings is attributed mostly due to typhoons, flooding, and pests (e.g. barnacles, parasites, tussock, and moth). Other problems encountered with the project are the following: (1) lack of community participation; (2) inadequate budget; (3) weak support from some implementing partners; (4) occurrences of typhoons; and (5) change in political leadership.

Aside from its main goal of replanting in mangrove areas, the project also had sub-programs. These include IECs on the DBP Forest project, management trainings for FARMCs and barangays, and livelihood training for the communities. The project and its sub-programs were beneficial for the community. The community became more aware of the importance of mangrove forests, particularly their contribution to fish and shellfish production, farming, livelihood programs, and protection from natural disasters. Realizing the value of mangroves, the community has eventually reduced the cutting and illegal fishing in mangrove forests.

IV. SUMMARY AND RECOMMENDATIONS

Although the DBP Forest project has been successful, the following measures can help improve the project and other mangrove programs in the province:

1. Develop a legal framework for mangrove ecosystem management, which encourages community-based participation;
2. Institutionalize community-based mangrove rehabilitation;
3. Enhance administrative capacity for the management of mangrove forest; and
4. Include coastal ecosystem and wildlife biodiversity conservation, protection, and sustainable management.

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State of the Mangroves in

ROMBLON

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I. INTRODUCTION

Romblon is an archipelagic province strategically situated at the center of the Philippines. It has a lone congressional district with two legislative districts, seventeen municipalities and 219 barangays (**Appendix A**). The capital of the province is the island-municipality of Romblon. It is classified as a third-class province and belongs to Region IV-B (MIMAROPA).

The province lies within 12° 13' latitude and 121° 45' longitude, approximately 300 km south of Manila. It is surrounded by deep waters, bounded by Masbate Island in the east, Mindoro Island in the west, Marinduque Island in the north, and Panay Island in the south.

The total land area of Romblon is 135,590 ha representing 0.46% of the Philippines and 4.6% of the land area of Region IV-B (MIMAROPA). It has the second smallest area in MIMAROPA. About 72.98% of the total land area is classified as alienable and disposable while the remaining 27.98% is classified as forest land.

The province is known as the "marble capital" of the Philippines for its lucrative marble industry. The islands are geographically dispersed and accessible to and from Metro Manila and other provinces only through sea transportation. Tablas Island has a domestic airport located in Barangay Tugdan, Alcantara.

The province's large coastal area and municipal waters abound in marine resources. The fishing grounds of Romblon include migratory paths of fishes from the Sulu and the Visayan Seas via the Tablas Strait, the Sibuyan Sea, and the Romblon Pass. The sea of the island-municipalities of Concepcion, Banton, and Corcuera at the northwestern portion of the province is part of the Verde Island Passage-Marine Corridor (VIP-MC). This area is recognized as the center of the center of marine shore fish biodiversity in the world.

Out of 219 barangays, there are 168 coastal barangays in 17 municipalities (**Appendix B**). The shoreline length is 478.74 km with a coastal area of 53,258 ha. As of the 2010 census, Romblon has a total population of 283,930 while its coastal population is estimated at 251,931. The primary sources of income in the coastal communities are fishing, fish trading, farming (e.g. vegetables, root crops, and rice), copra production, livestock and poultry raising, seaweed farming, carpentry, charcoal and nipa shingles-making, and other local employment.

Social problems besetting the coastal areas are (1) the lack of sustainable/alternative livelihood; (2) the lack of health services; (3) inadequate solid waste management systems; (4) the lack of potable water system; (5) low compliance in fishery and other related environmental laws/policies; (6) resource-use conflicts in fishing, reclamation, tourism, and settlement; (7) lack of social and environmental awareness; and (8) limited government and other institutional support systems.

Importance of Mangroves

Mangroves provide nursery grounds, shelter and food for fish and other sea creatures; protect the coastal communities from storm surges; act as carbon sinks; serve as recreational grounds for wildlife enthusiasts; stabilize the coastline by reducing erosion; and regulate groundwater recharge/discharge.

Mangroves have significant socio-economic importance in the province. Coastal communities benefit from mangroves as their source of charcoal, timber, honey, traditional medicines, and housing materials. Mangroves also support fisheries and aquaculture production, and develop or enhance ecotourism, spiritual and cultural values (**Fig. 1**). Most of the coastal residents in the province earn income from various mangrove products, particularly wood, fishes, prawns, crabs, shellfish, and honey.

II. STATUS OF MANGROVES IN ROMBLON

Based on the data gathered from DENR, the mangrove area is about 1,263.29 ha in which 230.22 ha is considered as old stand located in Cajidiocan, Romblon, San Agustin, and Calatrava (**Table 3**).

Table 3. Estimated areal extent of mangroves in Romblon (ha).

Old Stand	Secondary Growth	Plantation
230.22	539.77	493.30

From 2009, various national and local government agencies resorted to massive Mangrove Planting Program of about 493.30 ha. **Fig. 2** shows some planted mangroves for mangrove rehabilitation programs from both national and local initiatives.

Table 4 shows the list of areas planted from year 2009 up to 2015. The total mangrove plantation area is 390.3 ha. **Fig. 3** shows the provincial mangrove profile map.

The dominant mangrove species found in the province are from the genera *Avicennia*, *Nypa*, *Rhizophora*, and *Sonneratia*. About 14 mangrove species are reported. Species planted are from the genera *Avicennia* (Piapi and Bungalon); *Rhizophora* (Bakawan babae, Bakawan lalaki); *Sonneratia* (Pagatpat); and other mangrove species such as nipa.

Table 4. Planted mangrove area profile of Romblon.

Date	Municipality/Barangays	Area Planted (ha)
2015	Odiongan; Ferrol; Looc; Sta. Fe; Calatrava; Romblon; Magdiwang, Cajidiocan	11
2012–2014	Balogo, Calatrava	25
2000–2014	Sugod, Carmen, Cabolutan, Cagboaya, Dubduban, Doña Juana, and Bachawan in San Agustin	11
2013	Magdiwang, Cajidiocan, Romblon, San Agustin, Looc, Sta. Fe, and Alcantara	7
2011–2013	Ginablan, Li-o, Agnay, Mapula, Logbon, Lanas in Romblon, Romblon	4.3
2013	Ferrol, Alcantara, Corcuera, Sta. Fe, Cajidiocan, Magdiwang, Odiongan, and Ferrol	322
2009	Suba Bay, Corcuera	10

Figure 1. Socio-economic activities in the mangrove areas of Romblon.

Figure 2. National and local initiatives on mangrove rehabilitation in Romblon.

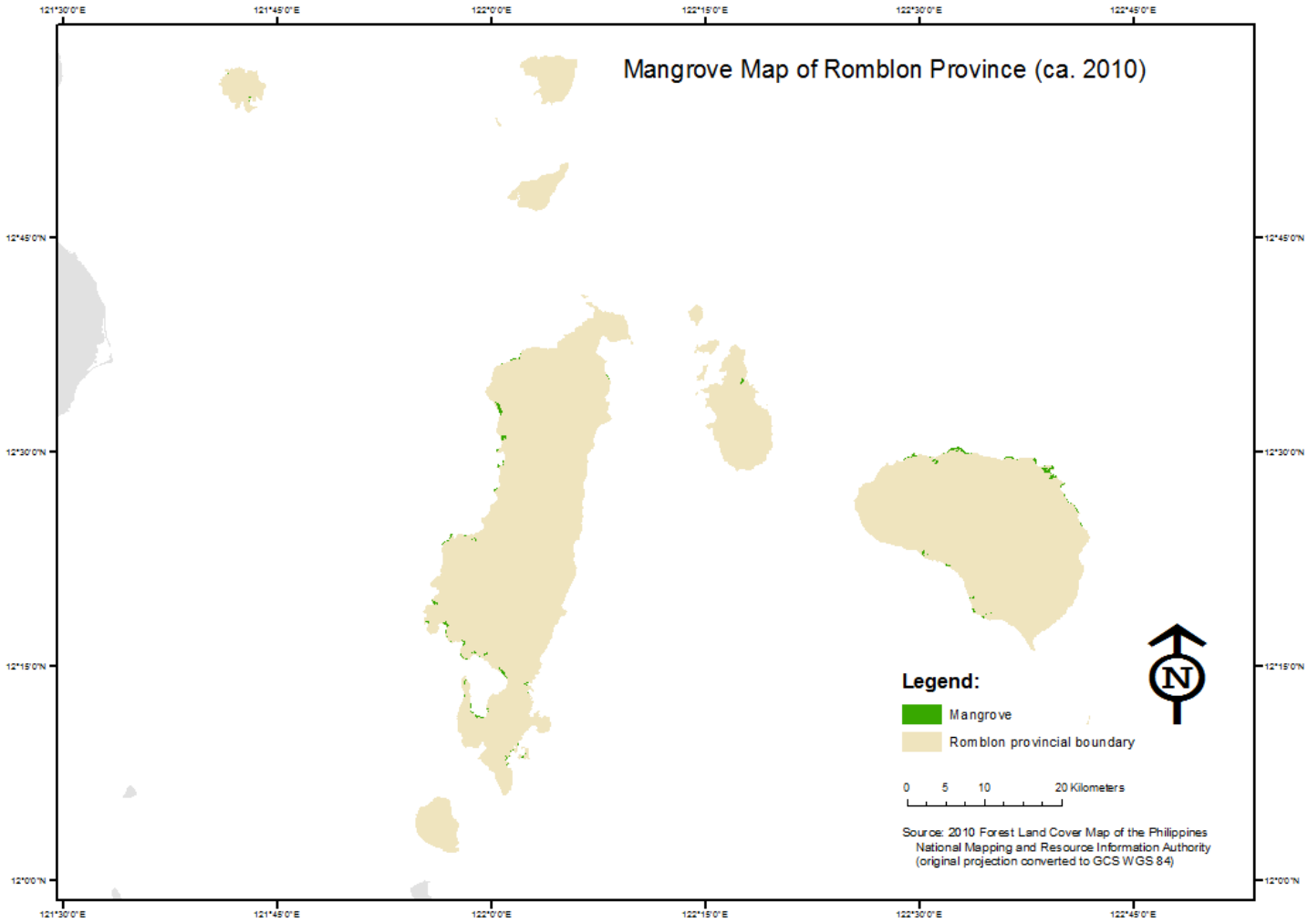

Figure 3. Provincial mangrove profile map of Romblon

Degradation of Mangrove Forests

Threats both from anthropogenic and natural causes greatly contribute to the degradation of the mangrove forests in the province. However, the massive mangrove rehabilitation efforts of the national and local governments (**Fig. 4**) may reverse this trend.

Threats to Mangrove Forests

Some of the identified natural hazards and human disturbances in Romblon are (1) global warming and sea level rise; (2) cutting of mangrove forests and grazing of goats; (3) illegal construction of fishponds; (4) human settlements/reclamation; (5) unregulated tourism development; (6) presence of plastic trashes and other wastes; (7) illegal beach quarrying; (8) weak institutional support systems; and (8) the absence of well-organized coastal law enforcement team (**Fig. 5**).

III. MANGROVE PROTECTION AND MANAGEMENT

Table 5 shows the list of protected mangrove areas (total: 1,114.98 ha) that have existed since 1980s.

Table 5. List of mangrove protected areas in Romblon.

Municipality	Size (ha)
Looc (Tablas Island)	253.5
Magdiwang (Sibuyan Island)	233.19
Sta. Fe (Tablas Island)	199.6
Cajidiocan (Sibuyan Island)	197.39
Ferrol (Tablas Island)	138
Odiongan (Tablas Island)	47.8
Corcuera	24
Romblon	21.5
TOTAL	**1,114.98**

The policies related to mangrove protection and management are found in Proclamation 2152 (dated December 29, 1981 for Sibuyan Island as Mangrove Swamp Forest Reserve), Republic Act (RA) 7161 (prohibition on cutting of mangroves), RA 8550 (Philippine Fisheries Code), PD 705 (Revised Forestry Code); Provincial Development and Physical Framework Plan (PDPFP; 2010-2040),

Environment and Natural Resources Office (ENRO) Code, Municipal Fishery Ordinance and Resolutions, and Integrated Coastal Management (ICM)/MPA Plans. Agencies who exerted efforts in the mangrove protection are Department of Environment and Natural Resources - Provincial Environment and Natural Resources Office (DENR-PENRO), Department of Agriculture - Bureau of Fisheries and Aquatic Resources - Provincial Fisheries Office (DA-BFAR-PFO), Provincial Government-ENRO and Office of the Provincial Agriculturist (OPAg), Municipal Local Government Units - Municipal Agriculture Office (MLGUs-MAO), Barangay Local Government Units (BLGUs), and People's Organizations (POs).

Mangrove Rehabilitation

Table 6 shows the continued efforts of various stakeholders in the protection, rehabilitation or planting of mangroves in the province.

Monitoring and Evaluation

Based on field observation (**Fig. 6**), the overall status of planted mangroves in the province is in good condition with an average survival rate of 70%.

Impacts of Mangrove Rehabilitation

Positive impacts of rehabilitating degraded mangrove areas include: (1) improved supply of fish and other marine products; (2) decrease in coastal hazards; (3) improved aesthetic quality; (4) enhanced ecotourism attraction; (5) enhanced biodiversity; (6) improved social and environmental awareness; and (7) establishment of institutional support systems.

Table 6. List of active projects/programs on mangrove protection and management in Romblon.

Projects/ Programs
1. Mangrove Restoration through Food for Work/ Cash for Work
2. Provincial Mangrove Nursery
3. Coastal Resources Management Program – Mangrove Rehabilitation
4. National Greening Program – Mangrove Rehabilitation
5. Integrated Coastal Resources Management Project

Figure 4. Mangrove rehabilitation efforts of national and local government in Romblon.

Figure 5. Common threats to mangrove forests in Romblon.

Figure 6. Field observation, monitoring, and evaluation of mangroves in Romblon.

IV. Summary & Recommendations

There are significant increases in mangrove cover in the province. With these progress, we recommend the following actions to be undertaken by concerned stakeholders:

1. Develop sustainable livelihoods for coastal communities;
2. Sustain and strengthen initiatives on mangrove rehabilitation, protection, and management;
3. Institutionalized social mobilization; and
4. Strengthen linkages and network with other institutions for funding, research or extension support.

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State of the Mangroves in

PALAWAN

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I. INTRODUCTION

Palawan is a narrow archipelago with 1,959 km of shoreline and 4,940,800 ha of marine area. It has 58,400 ha of mangrove forests and 980,000 ha of coral reefs. The province has 426 barangays, 354 of which are coastal (**Appendix C**). The province has a total population of 994,340 (NSO 2010). For the 15-year period, the average annual population growth rate was 2.66% for the entire province, and 3.24% for Puerto Princesa City, both of which are higher than the 1.9% national growth rate.

The coastal and marine areas of Palawan not only support a rich biodiversity and ecosystems, but also are the bases of the main economy of its residents. Fishing, seaweed farming, and motorboat operation for tourists are the primary sources of income among coastal residents. The marine area generates an estimated Php 1.2 billion per year of fisheries, which is twice that of land-based agriculture products. Its fishing grounds are among the top fisheries producers in the country and contribute 65% of fish consumed by Metro Manila residents. In addition, Palawan's mangroves are among the most biologically productive ecosystems and provide additional sources of income (e.g. from selling of fishes, prawns, crabs, and shellfish found thereat) for coastal residents. Despite the abundance of the resources, the coastal residents are still in need of livelihood support.

II. STATUS OF MANGROVES IN PALAWAN

The mangrove forests of Palawan accounts for 4.4% or 63,532 ha of its land cover (**Table 7**). Mangrove areas of the province have increased over the years: from 3.34% cover in 1992 (JAFTA 1992), 3.35% in 1998 (NAMRIA 1998), 4.0% in 2005 (PCSDS 2005), to 4.4% in 2010. Despite these, mangrove forests are still threatened by human activities. The "open access" mangrove forests in some areas are still exploited for construction materials, firewood, tanbark, charcoal, and for conversion into fishponds.

The baseline assessments and monitoring of mangrove forests in 20 municipalities of Palawan recorded a total of 24 mangrove species from 11 families. Species include *Acrostichum aureum*, *Aegiceras corniculatum*, *Aegiceras floridum*, *Avicennia alba*, *Avicennia marina*, *Bruguiera cylindrica*, *Bruguiera gymnorrhiza*, *Bruguiera parviflora*, *Bruguiera sexangula*, *Camptostemon philippinense*, *Ceriops decandra*, *Ceriops tagal*, *Excoecaria agallocha*, *Heritiera littoralis*, *Lumnitzera littorea*, *Lumnitzera racemosa*, *Nypa fruticans*, *Osbornia octodonta*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Rhizophora stylosa*, *Scyphiphora hydrophylacea*, *Sonneratia alba*, and *Xylocarpus moluccensis*.

Table 7. Palawan State of the Environment Report 2015

Land cover	Area (ha)				% Land area	
	2005 (PCSD)	2010 (NAMRIA)	Change (ha)	Rate loss (ha/year)	2005	2010
Forest area	666,336	625,629	(40,707)	(8,141)	46.1	43.4
Mangrove forest	58,400	63,532	5,132	1,026	4.0	4.4
Grassland	55,727	36,023	(19,704)	(3,941)	3.9	2.5
Built-up	10,080	13,575	3,495	699	0.7	0.9
Agricultural land	194,066	275,037	80,971	16,194	13.4	19.1

References: PCSD-GIS (2005), NAMRIA (2010)

III. MANGROVE PROTECTION AND MANAGEMENT

The entire island of Palawan has been declared as a Mangrove Swamp Forest Reserve through PD No. 2152 on December 29, 1981. These mangrove areas contribute to coastal stability and security by reducing erosion, buffering wave action, and mitigating the effects of floods and tidal waves. In addition, Palawan also has 155 marine protected areas (MPAs) with a total reef area of 82,000 ha declared through municipal and barangay ordinances. These protected areas were established to conserve marine biodiversity and mitigate the threats to the coastal and marine ecosystems.

Created through Executive Order No. 15 series of 1994, the "*Pista ng Kalikasan sa Palawan*" Program was launched on June 19, 1994 to meet the required forest cover for the province and contribute to climate change mitigation. Municipal governments were mandated to conduct their own program/activities, particularly a yearly planting of endemic and exotic forest trees, mangroves, and other kinds of trees. The program initially concentrated in upland areas, but later shifted to mangroves. Mangroves were planted in Brgy. Tabon, Quezon (2013), Brgy. Magsaysay, Aborlan (2014), and Brgy. Minara, Roxas and Brgy. Punang in Sofronio Española (2015).

The average mangrove density in Palawan improved from 1,428 to 2,779 trees per hectare from 2004 to 2014 (**Fig. 7**); thus, from inadequate to adequate stocks. Notably, forest cover remained adequate in the municipalities of Araceli, Cuyo, Dumaran, Quezon, and Roxas and improved from inadequate to adequate in Bataraza, Magsaysay, and Narra. However, forest cover remained at inadequate densities or logged-over in all other municipalities during the same period.

IV. SUMMARY AND RECOMMENDATIONS

1. Laws related to mangrove forest conservation must be strictly enforced.
2. Coastal residents should be given alternative livelihoods that do not rely on mangroves.
3. Continuous mangrove reforestation should be done to increase the mangrove forest cover of Palawan.

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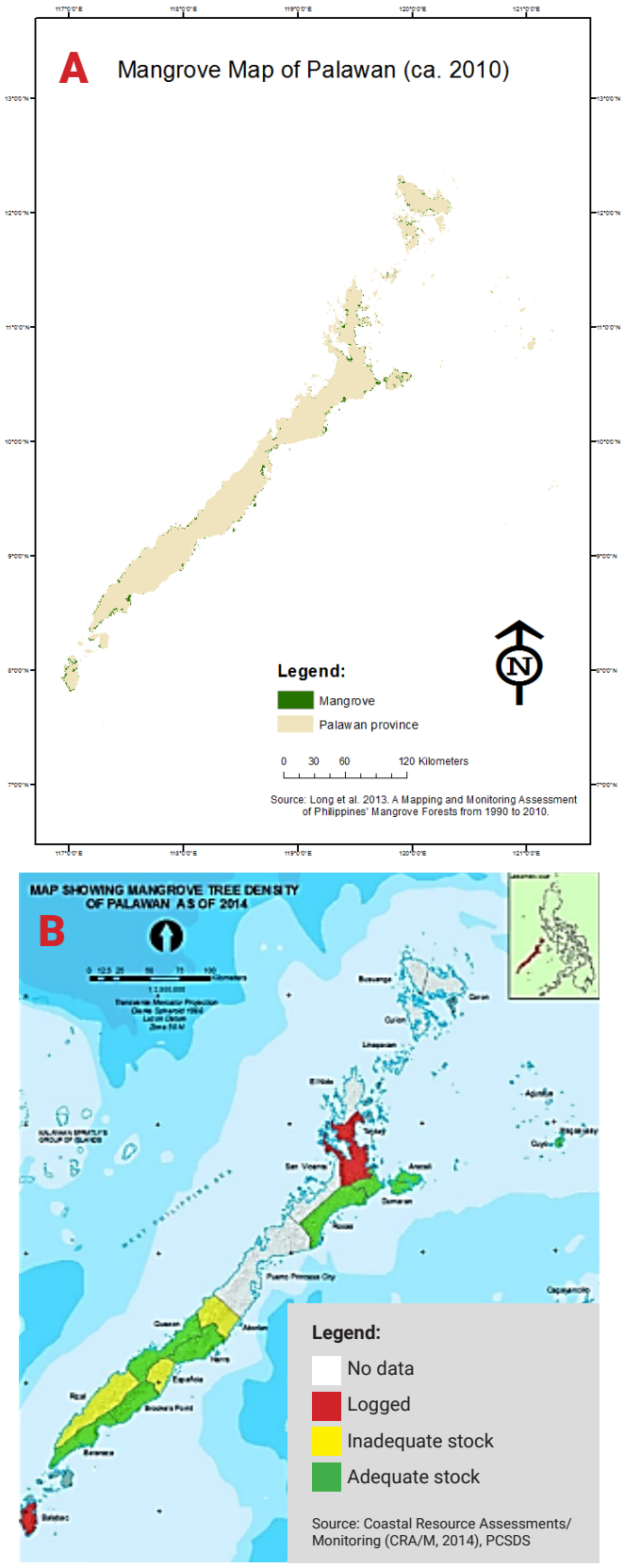

Figure 7. Maps of (A) mangrove distribution and (B) mangrove tree densities and conditions in Palawan.

State of the Mangroves in

OCCIDENTAL MINDORO

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I. INTRODUCTION

The province of Occidental Mindoro lies off the southern coast of the Luzon mainland. It is the western part of Mindoro Island and is under the administrative region of MIMAROPA (Region IV-B). It has a land area of 587,990 ha, a coastal area of 17,000 ha, and a shoreline length of 334.8 km. The province has 11 municipalities, namely, Abra de Ilog, Calintaan, Looc, Lubang, Magsaysay, Mamburao, Paluan, Rizal, Sablayan, San Jose, and Santa Cruz. These municipalities have 82 coastal barangays (**Appendix D**).

The province has a total population of 452,972, of which 234,509 are male and 218,463 are female (NSO 2010). The primary sources of income of coastal residents are from capture fisheries and aquaculture. The average annual household income is approximately Php 166,109 (NCSB 2009). Common problems of coastal residents are poverty (in which basic needs are unmet), poor hygiene and sanitation (resulting in illnesses), and limited assistance and intervention from the government.

The coastal areas of Occidental Mindoro are home to a large and growing population. This growth along its coasts have produced many economic benefits, including improved transportation links, industrial and urban development, revenue from tourism, and food production. However, the burgeoning population combined with the effects of economic and technological developments have led to environmental decline and continues to threaten the ecosystem integrity of coral reefs, seagrass beds, and mangrove forests.

Importance of Mangroves

In the province, mangroves are known to provide shoreline protection (e.g. erosion control), habitat and breeding areas of various marine organisms, and good sources of food. Mangroves are also sources of products such as wood, fish, and clams, particularly for the residents of the municipalities of Magsaysay, San Jose, Abra de Ilog, Looc, and Lubang.

II. STATUS OF MANGROVES IN OCCIDENTAL MINDORO

Based on the Landsat imagery study of Long and Giri (2011), Occidental Mindoro has a total of 1,842.93 ha of mangroves. In contrast, the present estimates by the DENR is 2,500 ha, including secondary growth and new plantation. Old stands account for 420 ha, most of which are in the municipality of San Jose. **Table 8** shows the old stand, secondary growth and new plantations of mangroves in the province. Mangrove planting program started in 2005.

Table 8. Estimated areal extent of mangroves in Occidental Mindoro (ha).

Old stand	Secondary growth and plantation
420	2,080

Occidental Mindoro has 16 species of mangroves namely, *Aegiceras corniculatum*, *Avicennia marina*, *Avicennia officinalis*, *Bruguiera gymnorrhiza*, *Ceriops decandra*, *Ceriops tagal*, *Excoecaria agallocha*, *Heritiera littoralis*, *Lumnitzera racemosa*, *Nypa fruticans*, *Pemphis acidula*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Rhizophora stylosa*, *Sonneratia alba*, and *Xylocarpus moluccensis* (Samson, 2012)

Degradation of Mangrove Forests

The decline of mangrove stands in the province are due to the (1) conversion of mangrove areas into aquaculture areas; (2) reclamation and conversion for agriculture and settlements; (3) cutting of mangroves for firewood and housing materials; and (4) flooding, soil erosion, and sedimentation. The decline in mangrove stands has exposed communities to greater risks from coastal hazards (e.g. storm surge, tidal flooding, and sea level rise) and decreased the feeding and nursery grounds for fishes which, in turn, has decreased the fish catch.

Threats to Mangrove Forests

In the past, mangroves have been viewed as wastelands by local communities and even by the government. Thus, significant portions of mangrove areas in the province were cleared to make room for settlements, agriculture, other industries, and infrastructure (e.g. ports and harbors). More recently, such clearings have been done for tourism developments.

III. MANGROVE PROTECTION AND MANAGEMENT

To protect and rehabilitate mangrove areas, the following activities have been carried out in the province since the early 1990s: (1) implementation of Municipal Fisheries Ordinance (MFO); (2) mangrove-planting led by the BFAR and DENR and implemented by the LGU through its Municipal and Barangay Fisheries and Aquatic Resource Management Council (M/BFARMC) or people's organizations; and (3) tree planting in upland areas to prevent soil erosion.

One of the most recent and notable projects in the province is the Mangrove and Beach Forest Development Project (MBFDP), which is a component of the National Greening Program (NGP) aimed at stabilizing the coastal areas of the country. The project hopes to help (1) reduce poverty among coastal residents; (2) mitigate climate change; (3) manage and sustain fisheries production; and (4) lessen dependence on fishing. The project was carried out by the DENR and LGUs through the M/BFARMCs from February to December 2015, covering approximately 767.1 ha in six municipalities. Although the project still needs to be evaluated, the growth and survival of mangrove seedlings were observed to have been negatively affected by wave and wind action, boat parking, and other human activities. There were other mangrove rehabilitation projects implemented at the barangay level, but no information is available yet as to the coverage of mangroves and the progress of these projects. **Table 9** summarizes the other mangrove rehabilitation projects in the province.

Table 9. Mangrove rehabilitation programs in Occidental Mindoro

Name of Project	Year	Area (ha)
Mangrove and Beach Forest Development Project (MBFDP)	2015	767
DENR Initiative Planting (DENR-CENRO, San Jose)	2014	2
	2012	29

IV. SUMMARY AND RECOMMENDATIONS

There is a need to continue raising the awareness of communities on the importance of coastal habitats, particularly mangrove forests. This will help in encouraging communities to support and take part in CRM efforts. Organizing and strengthening the fisherfolk and other community groups will help in sustaining CRM efforts at the local level. There is also a need to provide alternative non-fisheries livelihoods in coastal communities to reduce fishing pressure.

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State of the Mangroves in

ORIENTAL MINDORO

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I. INTRODUCTION

Oriental Mindoro is located 120 km south of Metro Manila and 45 km south of Batangas. It comprises 16% of Region IV-B (or MIMAROPA Region) with a land area of 588,350 ha. It is bounded by Verde Island Passage in the north, Maestro del Campo Island and Tablas Strait in the east, Semirara Island in the south, and Occidental Mindoro in the west. It has a total land area of 436,472 ha, comprising 1.5% of the country's total landmass.

It is divided into two congressional districts i.e., District I and District II, with Calapan City as its capital. It is comprised of 14 municipalities and 426 barangays. Naujan is the biggest municipality, covering an area of 52,800 ha and accounting for 12% of the province's land area. The smallest is the municipality of Roxas comprising only 1.99% with an area of 8,710 ha. Naujan has the most number of barangays while San Teodoro has the least number with 70 and 8 barangays, respectively. Twelve municipalities and one city are located along the coast of Oriental Mindoro, namely: Puerto Galera, San Teodoro, Naujan, Pola, Socorro, Pinamalayan, Gloria, Bansud, Bongabong, Roxas, Mansalay, Bulalacao, and Calapan City. **Appendix E** shows the list of coastal barangays in the 13 coastal municipalities.

The total coastline length of the province is about 342.45 km. The coastal population is approximately 237,023 with 12,523 fishing families as of 2015. The total area of the municipal waters of Oriental Mindoro is about 320,789 ha. There are 33 marine protected areas with a total area of ca. 6,000 ha that were established and being managed by the community. The coastal and marine waters in the province of Oriental Mindoro are used for transportation, navigation, fish culture, recreation, and tourism.

The northern portion of the shores of the province is situated along the Verde Island Passage that is recognized as the "center of the center of marine shorefish biodiversity." This area is part of the Coral Triangle and is considered a rich spawning ground of diverse fish species.

The fisherfolk in the province have an average age of 40 years old, and age range of 16–80 years. Ninety-three percent (93%) are married with an average of four children per household. Daily household expenses are less than Php 200 for food, water, electricity and other expenses such as daily allowances of school kids. Generally, fishers in Oriental Mindoro have very low educational attainment. Only about 4% have reached college level and only 1% would graduate. About 68% did not finish high school, 59% did not reach high school, while 10% did not attend school at all. The number of fishers with no formal education was highest in Mansalay (29%), followed by Pinamalayan (21%), Baco (17%), San Teodoro (15%), and Puerto Galera (11%). In Calapan, all residents had at least elementary level education (Romero, et al 2015).

The main sources of income for Oriental Mindoro are agriculture and fishing, except for Puerto Galera, which relies on tourism. Rice farming is highest in Naujan followed by Calapan, with irrigated areas covering 11,348 ha and 7,043 ha, respectively. Mansalay has the highest number of families (1,200) engaged in fishing. However, in terms of total number of registered fisherfolk, Bulalacao is highest with 2,100, followed by Pola, Calapan City, and Mansalay.

Among the main socio-economic problems of coastal residents in the province are low income and limited alternative livelihood. Like most coastal communities, the coastal residents heavily depend on fishing for their income, have little or no savings, and lack access to capital.

Table 10. Mangrove areas in the municipalities of Oriental Mindoro, 2010

Municipality	Exact image date (circa 1990)	Exact image date (circa 2010)	No. of years	CA. 1990 Areas (ha)		CA. 2010 Areas (ha)	
				Mangrove	Fishpond	Mangrove	Fishpond
Puerto Galera	18-Jun-1989	17-Sep-2009	20	5.4	2.25	5.55	2.17
San Teodoro	18-Jun-1989	17-Sep-2009	20	154.03	10.98	174.95	13.88
Baco	18-Jun-1989	17-Sep-2009 and 18-Apr-2010	20	185.1	30.57	210.29	53.39
Calapan City	18-Jun-1989 and 18-Mar-1993	18-Apr-2010	17	522.69	557.31	618.13	622.32
Naujan	18-Jun-1989 and 18-Mar-1993	18-Apr-2010	17	405.98	204.84	298.36	179.15
Pola	18-Mar-1993	18-Apr-2010	17	291.33	158.58	405.28	279.09
Pinamalayan	18-Mar-1993	18-Apr-2010	17	31.19	49.2	38.12	61.7
Gloria	18-Mar-1993	18-Apr-2010	17	14.47	3.36	20.72	5.92
Bansud	18-Mar-1993	18-Apr-2010	17	31.44	0	67.83	0.15
Bongabong	18-Mar-1993	18-Apr-2010	17	286.14	498.21	344.67	461.9
Roxas	18-Mar-1993	18-Apr-2010	17	52.86	232.41	33.76	232.06
Mansalay	18-Mar-1993	18-Apr-2010	17	52.2	186.57	20.34	238.09
Bulalacao	18-Mar-1993	18-Apr-2010	17	178.11	182.97	153.7	269.71

Importance of Mangroves

The most important role of mangroves in the province is in protecting vulnerable coastlines from wave action. Mangroves shield inland areas during storms, minimizing its damage, and regularly break down pollutants, filter sediments, and protect the ocean from siltation. Ecologically, mangrove forests provide habitats for aquatic species, especially as nursery areas and safe havens for juvenile fish, shrimp and crab. Mangroves also contribute significantly to the fishing industry and fisheries resources of coastal residents. Some fishers earn additional income from mangroves through charcoal-making and aquaculture activities.

II. STATUS OF MANGROVES IN ORIENTAL MINDORO

Mangrove area in the province covers approximately 2,392 ha. These are mostly located in the coastal municipalities of Puerto Galera, San Teodoro, Baco, Calapan City, Naujan, Pola, Pinamalayan, Gloria, Bansud, Bongabong, Roxas, Mansalay, and Bulalacao (**Table 10**; CI-Philippines 2010;). **Table 11** provides a summary of the old growth, secondary growth and mangrove plantations in the province.

Cayabyab (2014) assessed the mangrove areas in Oriental Mindoro. Forty (40) plots were surveyed in 11 out of 13 coastal municipalities and in the city of Oriental Mindoro. From these plots, 26 mangrove species were identified along its coasts. Mangrove areas in Silonay in Calapan City, Tambong, Proper Bansud in Bansud, and Crutinda II, Masaguisi in Bongabong had the highest species richness while Tuhod, Naujan and Budburan, Mansalay had the lowest species richness. The rest of the surveyed municipalities have 6 to 12 mangrove species. The genera *Rhizophora* and *Sonneratia* are widely distributed in the province.

Table 11. Estimated areal extent of mangroves in Mindoro Oriental (ha).

Old stand	Secondary growth	Plantation
2,210.95	0	181.05

"Regeneration" is a measure of the capacity of the mangrove forest to replenish itself. This is estimated from the number of saplings that measure 5 cm DBH and 2 m in height, and seedlings whose height is lower than 2 m. In Roxas, planted saplings of *Rhizophora apiculata* and seedlings of *Avicennia* spp. contributed significantly to the regeneration of the area. In Mansalay, seedlings of *Avicennia marina* (in the landward side) and saplings of *Sonneratia alba* (in the seaward side) also contributed to the regeneration. In Bulalacao, regeneration was relatively high because of the presence of *Rhizophora mucronata* seedlings at the seafront. Regeneration ranged from 200 (Tuhod, Naujan) to ~8000 ha^{-1} (Silonay, Calapan City) as shown by the number of seedling and saplings/ha (**Figs. 8 and 9**). The species *Avicennia marina*, *Avicennia rumphiana* and *Sonneratia alba* have high basal area (**Fig. 10**).

The canopy is the upper layer or habitat zone formed by mature tree crowns including other organisms. This refers to the extent of the outer layer of leaves of an individual tree or a group of trees. San Teodoro has the highest canopy cover with *Sonneratia alba* as the dominant species followed by Pola which is dominated by *Rhizophora apiculata* (**Fig. 11**). The next municipality with high canopy cover is Pola but it is primarily composed of *Avicennia* spp.

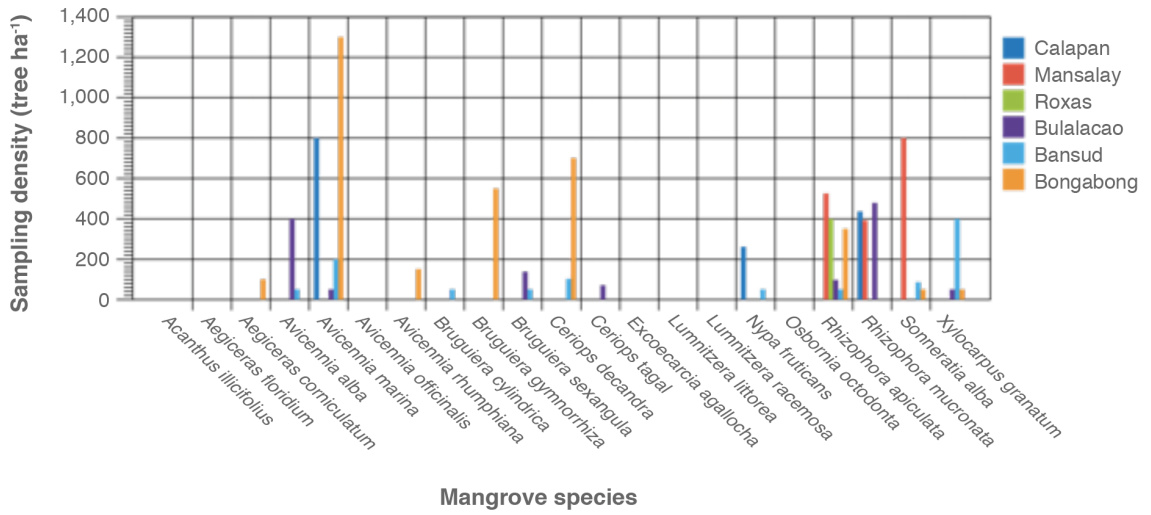

Figure 8. Sapling density in six coastal municipalities of Oriental Mindoro.

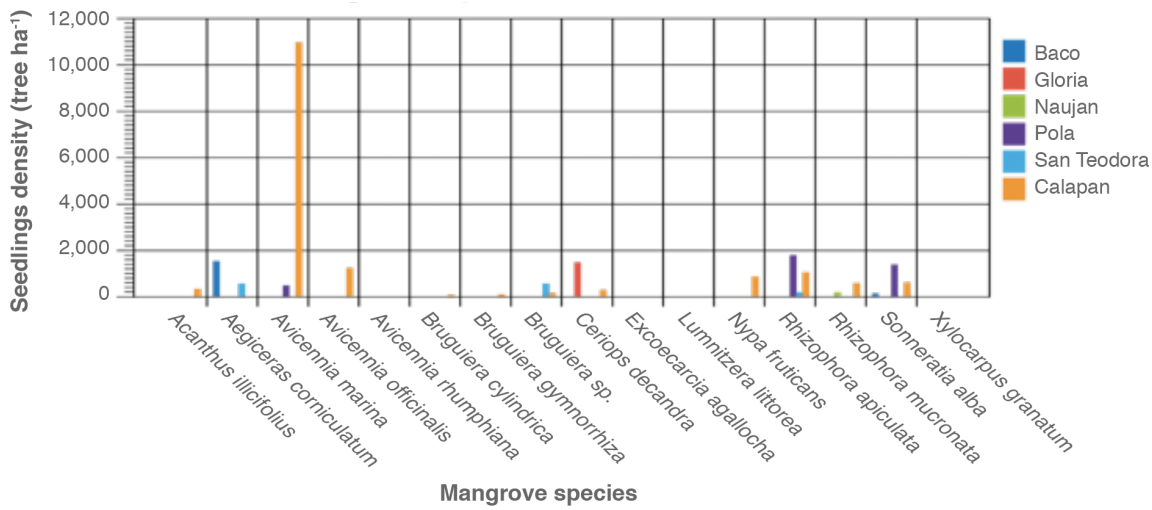

Figure 9. Seedling density of mangrove species in six sites in Oriental Mindoro.

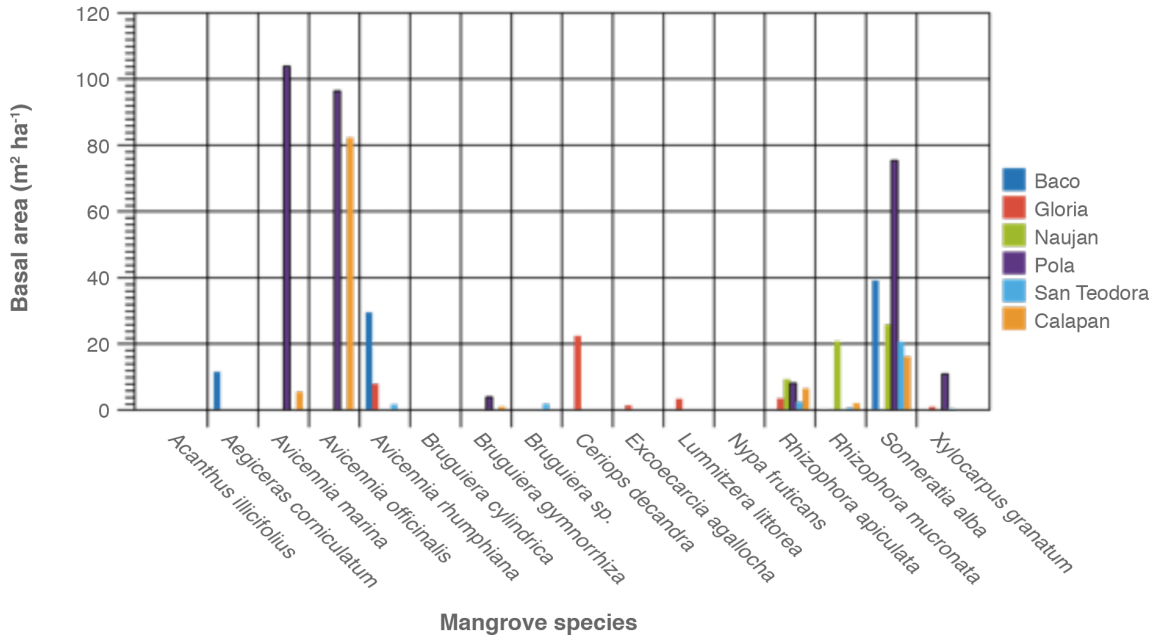

Figure 10. Basal area of mangrove species in six sites in Oriental Mindoro.

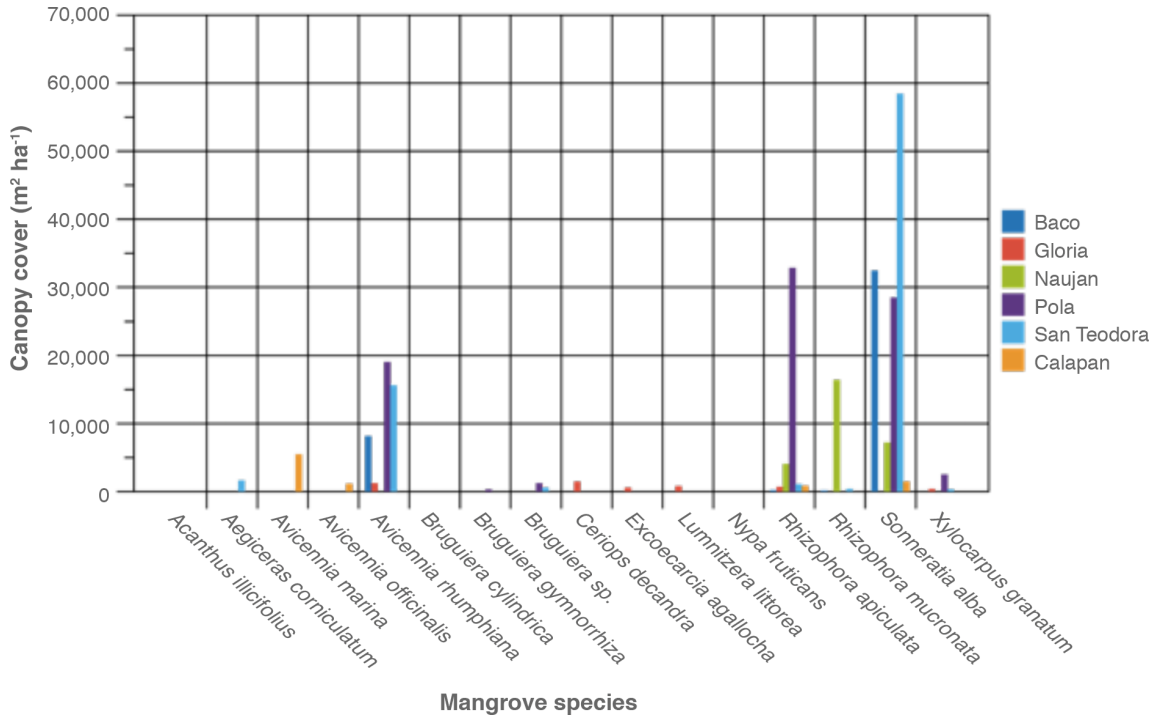

Figure 11. Canopy cover of six municipalities in Oriental Mindoro in 2014.

The overall condition of mangrove areas in Oriental Mindoro is classified as 40% fair, 30% good, 20% poor, and 10% excellent. Most of these mangrove areas are of the riverine and fringing types dominated by species from the genera *Rhizophora* and *Avicennia*. The dominant substrates are sandy, clay loam, and muddy. In Calapan City, the forest cover is 332 ha, Naujan with 165 ha, Baco with 134 ha, and Pola with 147 ha. However, most of these mangrove areas are near coastal communities and are being affected by anthropogenic activities such as conversion to fishponds, resort and port establishment, and illegal cutting.

Degradation of Mangrove Forests

Generally, mangrove stands in the province is increasing. This could be due to the mangrove rehabilitation programs being implemented in the province by various groups like national government agencies (DENR and BFAR), NGOs, academic institutions, people's organizations (POs) and other civil groups. The decline in mangrove stands in some areas is attributed to cutting, conversion into residential areas, and influx of coastal residents from other municipalities or provinces. These issues are being addressed through the effective implementation of the Coastal Resource Management Program (CRMP). The CRMP aims to conserve and protect marine ecosystems such as mangrove, seagrass and coral reef. One of the major projects in CRMP is the establishment of marine protected areas (MPAs).

Threats to Mangrove Forests

Many coastal residents still cut mangrove trees for house construction and charcoal-making. There are few alternative sources of livelihood available to them. While there are mangrove rehabilitation activities, the technology on mangrove reforestation is not properly observed. In many cases, planting of the wrong species in wrong substrate areas like the planting of *Rhizophora* spp. in seagrass beds have been practiced. There are so many abandoned fishponds which used to be mangrove forests, but since these are still covered by Fishpond Lease Agreements (FLA) and they remain abandoned because leaseholders lack the capital to rehabilitate the ponds or to reforest these. Updating of FLA status is a national agency concern. This should be prioritized by BFAR to validate non-productive areas and convert these into mangrove forests.

III. MANGROVE PROTECTION AND MANAGEMENT

The major activity under the Integrated Coastal Area Management Programs (ICAMP) is the establishment of Marine Protected Areas. Mangrove forest is among the ecosystems being protected under local ordinance. The following are the locally managed MPAs in the province:

- Silonay Mangrove Conservation Area and Eco Park with a total area of 42 ha;
- Baco Marine Protected Area located at Barangays Pulang Tubig and San Andres with total area of 120 ha (mangroves, seagrass, and coral reef); and
- Puerto Galera Mangrove and Ecotourism Area located at Barangays Tabinay and Dulangan with a total area of 18 ha (mangroves, seagrass, and coral reef).

Mangrove rehabilitation is part of the ICAMP. Mangrove seedlings are being planted along the different sections of coastlines and rivers. Another program is the mapping of mangroves using GIS tools in conjunction with the establishment of a monitoring and reporting process.

On the policy and regulatory side, mangrove protection is now considered in the Municipal Fishery Ordinance and other ordinances related to conservation and protection of natural resources formulated by the Local Government Unit that are adopted at the legislative level.

Monitoring and Evaluation

The Provincial Agriculture Office (PAO) established the Oriental Mindoro Resource Monitoring Team, composed of trained technical personnel who are capable of conducting a baseline assessment and monitoring surveys and writing reports. The team does resource assessment on a yearly basis, particularly in protected areas. The data gathered are analyzed to determine the impact of protecting and conserving marine habitat. A monitoring and evaluation system is freely available in the state of the Coasts of the Oriental Mindoro guidebook; a chapter was dedicated to emphasize its importance.

IV. SUMMARY AND RECOMMENDATIONS

Mangrove rehabilitation and reforestation of patches where mangroves used to grow is the most recommended action. This can be done through massive planting of appropriate species along the coastal zone and the planting of different species to maintain the integrity and ecological services that mangroves provide. The indicator for this would be a 50% increase in mangrove areas by 2020. Towards this end, the establishment of ten operational mangrove nurseries for various mangrove species and beach forest nurseries within the province must be the target in the next five years. At least 50% of the Fish Pond Lease Agreement should be reverted and converted into mangrove rehabilitation sites.

As a management measure, mangrove MPAs should be established per municipality and four mangrove protected areas and ecotourism and conservation areas shall be established by 2020. These should be properly gazetted and maintained. Regular mangrove clean-up shall be sustained and a solid waste management program shall be functional so that garbage-free mangrove areas may be attained. In lieu of fishponds, five mangrove aquasilviculture projects shall be implemented as an alternative livelihood for communities dependent on mangrove resources with support from BFAR. Municipal ordinances shall likewise be reviewed to include management and conservation of mangrove forests with stiffer penalties for violations.

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State of the Mangroves in

BATANGAS

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I. INTRODUCTION

The province of Batangas is located along the southwestern edge of Luzon. It is part of the Southern Tagalog Region (Region 4A) and is bordered by the provinces of Cavite in the north, and Laguna and Quezon in the east. The province has a land area of approximately 316,581 ha and consists of 31 municipalities and three cities. There are three major bays in the province, namely Batangas Bay, Balayan and adjacent bays, and Tayabas and adjacent bays.

Batangas Bay forms a semi-enclosed body of water, with an average depth of about 60 meters and a total area of about 220 ha. The Batangas Bay Region (BBR), has a total land area of 146,100 ha and a coastline of 92 km. Within this region lies 14 coastal and inland cities and municipalities. The BBR is bordered by the coasts of Batangas City, San Pascual, and parts of Lobo, Tingloy, Mabini, and Bauan. The inland towns include Lipa City, San Jose, Ibaan, Cuenca, Alitagtag, Padre Garcia, Rosario, and Taysan.

Balayan Bay is comprised of 12 municipalities with a total land area of 108,900 ha, and a coastline of around 300 km. It is bordered by the coasts of Nasugbu, Lian, Calatagan, Calaca, Balayan, Lemery, Taal, and San Luis, and parts of Tingloy, Bauan, Mabini and Tuy. Taal Lake is the major freshwater body in the province, which flows out into the Balayan Bay via Pansipit River.

Tayabas and Adjacent Bays (TAB) are shared by the provinces of Batangas and Quezon. Sigayan Bay and Coloconto Bay are minor enclaves within Tayabas Bay. The Tayabas and Adjacent Bays Region (TABR), comprises the coastal municipalities of San Juan and parts of Lobo and the inland municipalities of Rosario and Padre Garcia and the City of Lipa. The total land area of TABR is 95,865 ha, while its coastline is around 100 km (SEMP, 2005–2020).

Batangas Province has 152 coastal barangays with a total shoreline length of 492 km and a coastal area of 350,891 ha. As of 2015, there are 2,540,618 people living in Batangas. Of which, 366,850 are living in the coastal areas. The province has a population growth rate of 2.24%.

The primary sources of income of coastal communities are fishing and agriculture. Some are employed by industrial locators. Mangrove products like fish, prawns, crabs, and shellfish also provide livelihood to coastal residents in the western (Nasugbu, Calatagan and Lian) and eastern (Lobo and San Juan) parts of Batangas. Socio-economic problems in the coastal communities include poverty, underemployment (caused by underdeveloped tourism), decline of fish harvest due to overfishing from both municipal fisheries and commercial fisheries; and poor sanitation due to over population along the coastal area.

The prevalence of illegal fishing, destructive fishing and overfishing are among the major threats and problems on coastal environment that the province faces. Municipal waters have not been delineated, thus hampering enforcement of fishery laws. Other threats include habitat destruction, mangrove destruction (e.g. illegal cutting), siltation (from illegal quarrying upstream and upland deforestation), pollution (from inefficient drainage and sewage system and improper waste disposal); and unregulated human settlement (e.g. prevalent squatting on critical areas and danger zones).

Importance of Mangroves

Mangroves provide numerous tangible and intangible benefits, and are of prime importance in view of their productive, protective, and tourism values. Mangrove ecosystems are important in Batangas because it is a source of food and products for selling such as wood, fish, and clams. Ecologically, these ecosystems serve as a nursery ground for small fish and marine life. Mangrove structures also protect the shoreline from erosion and may buffer the effects of wind and waves (perhaps even extreme events such as typhoons and tsunami) on coastal areas. Lush mangrove forest areas also serve as tourist destinations.

Although clearing of mangrove forests for shrimp farming creates short-term profits for a few businessmen and farmers, the net benefits are not economically viable and are even disadvantageous for the entire community considering the consequences of mangrove destruction and ensuing water pollution.

II. STATUS OF MANGROVES IN BATANGAS

As of 2010, Batangas has an estimated total mangrove area of 610.94 ha. Around 517.27 hectares are old stands while 93.67 ha have been planted during the last ten years (**Table 12)**.

Fig. 12 shows a map of the province indicating mangrove forest areas. The municipalities of Tingloy, Taal, San Luis, Lemery, and Lobo have 2.03 ha, 1.50 ha, 2.77 ha, 47.00 ha and 76.09 ha of mangroves, respectively. On the other hand, the municipalities of Lian, Nasugbu, San Juan and Calatagan have mangrove areas of 108.92 ha, 256.54 ha, 276.97 ha, and 506.76 ha, respectively.

Batangas has 12 mangrove species and 8 associate species. Mangrove species include *Avicennia alba*, *Avicennia marina*, *Avicennia officinalis*, *Bruguiera gymnorrhiza*, *Bruguiera sexangula*, *Ceriops decandra*, *Ceriops tagal*, *Excoecaria agallocha, Rhizophora apiculata*, *Rhizophora mucronata*, *Rhizophora stylosa*, and *Sonneratia alba*. Mangrove associate species include *Acacia farnesiana*, *Dolichandrone spathacea*, *Hibiscus tiliaceus*, *Ipomoea pes-caprae*, *Morinda citrifolia, Pongamia pinnata*, *Sesuvium portulacastrum*, and *Terminalia catappa*. (Samson 2012).

Table 12. Estimated areal extent of mangroves in Batangas (ha).

Old stand	Secondary growth	Plantation
517.27	0	93.67

Degradation of Mangrove Forests

The degraded forest structure of mangroves in Batangas is aggravated by the destruction of other important coastal ecosystems. Mangrove conversion to fishponds have negative impacts. The decline of mangroves due to conversion to other uses brings about a consequent decline of the following ecological functions of mangroves: nursery grounds for fishes, prawns, crabs and shellfish; production of leaf litter and detritus material; protection of shore and estuaries from storm waves and erosion; pollution sink for near shore waters; wildlife habitat; and biodiversity. The conversion of mangrove swamps into fishponds simply means a substitution of formerly highly diverse and naturally productive ecosystem into simplified and highly input dependent ponds that are economically and ecologically unstable. Fishponds are plagued with problems such as diseases, acid soil, deteriorating water quality, seepage of water through dikes, and market fluctuations resulting in low production (Alcala 1982)

Threats to Mangroves Forests

The mangroves of Batangas are faced with threats such as clearing, overharvesting, river changes, overfishing, pollution, climate change, and destruction of coral reefs. These threats are mostly anthropogenic in nature. Clearing of mangrove forests may be blamed on the development of coasts for aquaculture, residential settlements and tourist facilities, and infrastructures.

III. MANGROVE PROTECTION AND MANAGEMENT

The province of Batangas has mangrove protected areas located in Calatagan (28 ha), Lobo (44 ha), and Calatagan (496 ha). In 2009, the Carretonan-Quilitisan Mangrove Forest Conservation Area was declared by the local government as the first mangrove protected area in the VIP. Since then, other mangrove forest conservation areas have also been established in San Juan and Lobo. In 2005, the Lobo Municipal Government declared the Submarine Garden a fish sanctuary. The existing mangrove stands in Calatagan are under the management of Calatagan Mangrove Forest Conservation Park "Ang Pulo"-PALITAKAN. In Lobo, the Lobo Mangrove Conservation Area and the mangrove stands in San Juan in Barangay Baruarte, Bataan, Nagsaulay, Subukin Mangrove Protected Area are managed by Barangay Management Council as well as the Catmon Mangrove Protected Area, Imelda Mangrove Protected Area, and Pinagbayanan Mangrove Protected Area.

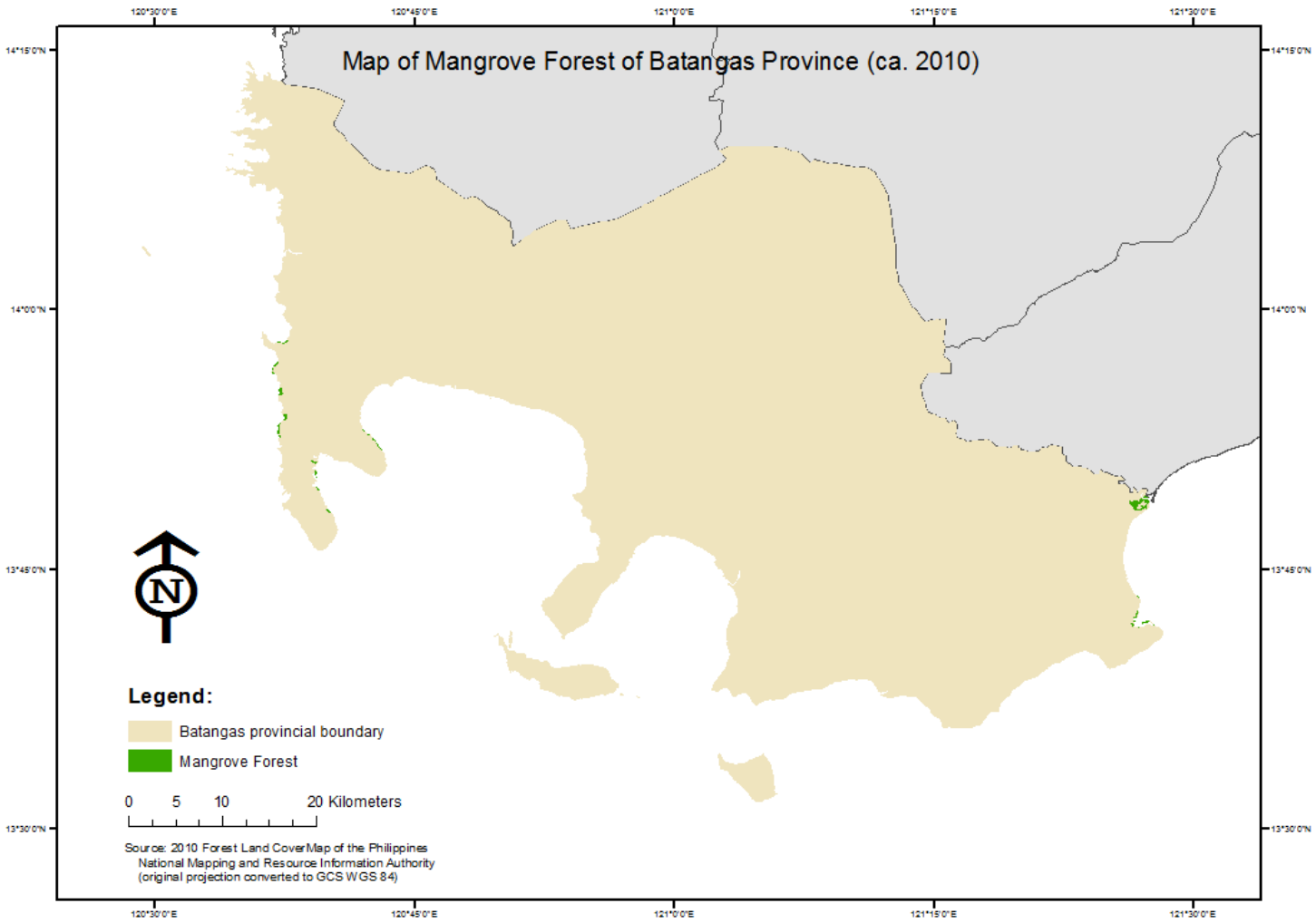

Figure 12. Mangrove map of Batangas Province

Mangrove Rehabilitation

Table 13 summarizes information on the Forest Management Projects in Batangas, which includes the implementing agencies, the budget allotted, number of hectares, survival rate of seedlings as well as the benefits and beneficiaries of the project.

Monitoring and Evaluation

Mangrove monitoring has not yet been established in the province. The groups who planted the mangroves are also the ones who monitor it. The plantation was monitored through counting. The survival of planted mangroves depends on the site. For example, in Lemery, survival ranges from 60 to 85%, while in San Luis where the site is directly facing the sea, the survival is around 10%.

Impacts of Mangrove Rehabilitation

The rehabilitation program aims to protect, restore, and manage mangroves to ensure sustainable benefits. Its success depends on the coastal communities' understanding of the importance of mangroves.

Mangroves are slow to regrow from cutting and several species do not re-sprout at all. Once they have been cut down, they might never recover unless replanted. When a large section of mangrove forest is cut, the roots can no longer oxygenate the oxygen-deficient soil, and the large amount of bacteria in the soil begins to churn out hydrogen sulfide. This makes the soil extremely acidic. After that, the soil may not support any mangroves, even when they are replanted.

For coastal residents of the province, the conservation, management and reforestation of mangroves are needed. They are beneficial not only in providing food and livelihood, but also in protecting the surrounding environment they are in.

Table 13. Mangrove Rehabilitation Projects of Batangas

	Forest management project (mangrove rehabilitation and conservation)	Batangas province mangrove rehabilitation program
Kind of project	***Rehabilitation*** – replanting in existing mangrove area	***Planting*** in new areas ***Rehabilitation*** – replanting in existing mangroves areas ***Mangrove nursery***
Duration of Project	November 2008 to present	November 2009 to present
Funding agencies/groups	Provincial Government of Batangas	Municipality of Calatagan, CI-Philippines
Implementing agencies/groups	PG ENRO MENRO	LGU (MAO) – financial and logistic assistance PO – Pro Mangrove Alliance and (implementing team), Kilitisan's Advocates of Nature (PALITAKAN, management body)
Other partner agencies/groups	NSTP, academe, different organizations - tree planting MENRO - maintenance First Gas - provision of seedlings Harbor Star CSR (San Luis)	Conservation International Philippines- financial and technical assistance
Budget allotted	Php 350,000.00/year	
Objectives of the project	• Rehabilitate and restore the degraded mangroves in the coastal areas of Batangas .	• Protect, maintain and improve mangrove areas. • Increase biodiversity and natural resources within the MPA. • Develop the knowledge of the community on the management of ecotourism site and open opportunities for new livelihoods in field of service for tourism. • Increase the level of awareness of fisherfolk on the importance of MPA in their livelihood.
Numbers of hectares planted/ rehabilitated/protected	Lemery: 7.0 ha San Luis: 0.5 ha	Calatagan "*Ang Pulo*": 7.5 ha
Survival rate of re/planted mangroves	Lemery: 85% San Luis: 10%	
Species planted	Bakawan, Calapinay, and readily available species	
Cause of mortality of the seedlings	Typhoon and solid waste (upstream)	Typhoon and solid waste (upstream)
Was the project monitored	Yes. By job order personnel of PGB	Yes. By LGUs, POs, and NGOs
Subprograms introduced by the projects	Trainings and seminars	Formulation of business plan
How has the community benefitted from the project?	• Thru selling of mangrove seedling to entities who conduct mangrove tree planting. • Increase in crab and shrimp catch for personal consumption.	• Youth trained as tour guides and given allowance by the management.

IV. SUMMARY AND RECOMMENDATIONS

There is a Comprehensive Mangrove Development Plan for the Province of Batangas for 2015–2030 which was drafted by the Provincial Government of Batangas, Conservation International, the LGUs, NGAs and POs. There is a need to revisit, review or adopt this plan, and to ensure that the mangrove development and management strategies provide the following:

1. A platform of cooperation among the key players in the province;
2. Guidelines that respect the natural ecosystem of mangroves and adopted by all stakeholders; and
3. A common higher goal in which every stakeholder can contribute to and complement each other.

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State of the Mangroves in

CAVITE

The Editors, based on inputs from Cavite participants

I. INTRODUCTION

Cavite has a total land area of 142,706 ha, constituting 8.72% of the total area of Region IV-A. The province has seven congressional districts, seven cities, 16 municipalities, and 829 barangays (**Appendix F**). Of these, seven municipalities (Rosario, Tanza, Noveleta, Naic, Ternate, Maragondon and Kawit), two cities (Bacoor City and Cavite City) and 316 barangays are situated along the coast. The coastal area of Cavite is approximately 93,679.38 ha with a shoreline length of 122.57 km.

The total population of Cavite is 3,090,691 (SEPP 2011) with 10.71% or 331,107 people living along the coast. The main sources of income among coastal residents are fishery activities, carpentry, and vending.

Coastal residents experience various socio-economic problems resulting from natural and anthropogenic causes. First is the impact of typhoons and accompanying floods on children's education. In school year 2009–2010, around 3,547 or 24.8% of children below six years old were affected by the disruption of classes due to flooding. Second is the decline in fish catch experienced by fishers. This is due to illegal fishing activities and diminishing fishing grounds, which is caused by reclamation, coastal development and water pollution. Third is the growing financial difficulties experienced by families. Lastly, informal settlers have been contributing to the pollution. Given the lack of central sewage and facilities as well as the lack of sanitary toilets in these areas, human wastes are directly emptied out onto the soil or water systems.

Table 14. Estimated areal extent of mangroves in Cavite (ha).

Old stand and secondary growth	Plantation
117.74 ha	32.65 ha

Importance of Mangroves

Mangrove areas are sources of products such as fishes, prawns, crabs, shellfish, and vinegar that are sold for extra income by coastal residents of the province. Mangroves provide ecological services such as shoreline protection, erosion control, climate regulation, sediment transport, and water purification. Lastly, mangroves also have cultural and aesthetic value as places for recreation, and reflection.

II. STATUS OF MANGROVES IN CAVITE

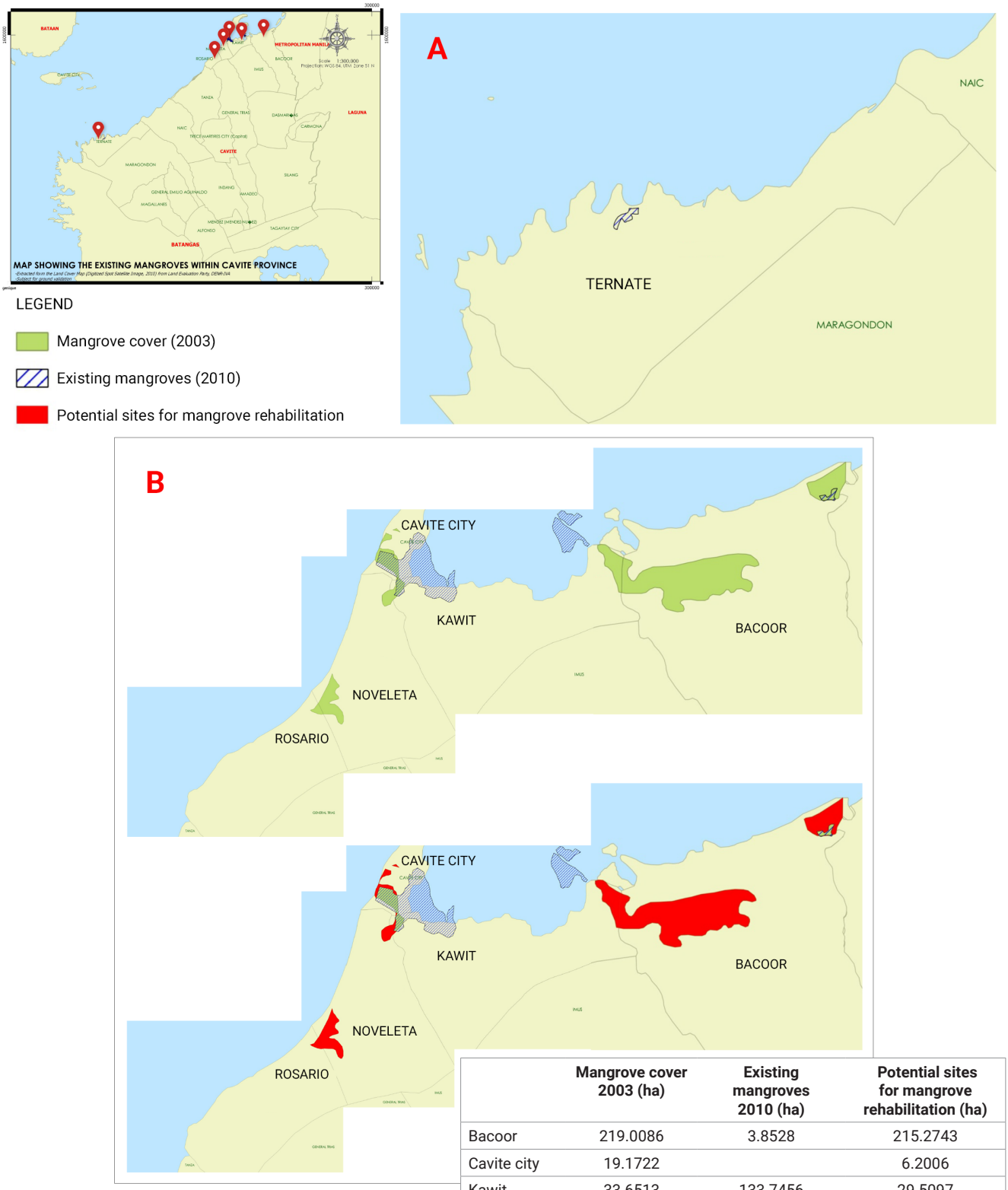
As of 2010, the total mangrove area of Cavite stands at 150.39 ha with plantation areas of approximately 32.65 ha (**Table 14**). **Fig. 13** provides an overview of the mangrove cover from 297.66 ha in 2003 to 150.39 ha in 2010. It also identified potential sites for rehabilitation of approximately 276.81 ha in the areas of Cavite City, Kawit, Noveleta, Rosario, and Bacoor.

Degradation of Mangrove Forests

The decline of mangrove forests in Cavite is due to their conversion into fishponds, salt beds and built-up or settlement areas. Mangroves are also used as wood for charcoal-making, particularly in the municipalities of Noveleta and Tanza (SEPP 2011). The decline of mangroves is being addressed through the management of Marine Protected Areas (MPA), mostly in Naic, Ternate, Rosario, Tanza, and Manggahan. The Province also leads mangrove planting and coastal cleanup activities.

Threats to Mangrove Forests

Coastal environmental threats include flooding due to human activities, weakening river capacity (i.e. rivers becoming shallower and narrower), and more frequent storms due to climate change; solid waste and pollution; coastal erosion due to coastal development; saltwater intrusion; tsunami and storm surge.



	Mangrove cover 2003 (ha)	Existing mangroves 2010 (ha)	Potential sites for mangrove rehabilitation (ha)
Bacoor	219.0086	3.8528	215.2743
Cavite city	19.1722		6.2006
Kawit	33.6513	133.7456	29.5097
Noveleta	23.0286		23.0286
Rosario	2.8		2.8
Ternate		12.7963	

Figure 13. Existing mangrove resources of Cavite in the municipalities of (A) Ternate, (B) Bacoor, Cavite City, Kawit, Noveleta, and Rosario, and potential sites for rehabilitation.

III. MANGROVE PROTECTION AND MANAGEMENT

Municipal, provincial and national government agencies are actively involved in the protection and management of mangroves in Cavite. The MFARMC primarily implements the monitoring and maintenance of mangrove areas. The Provincial Government-Environment and Natural Resources Office (PG-ENRO), Office of the Provincial Administrator (OPA), and the Department of Environment and Natural Resources (DENR) are also engage in the monitoring, maintenance, provision of funding support and protection of mangrove areas. The Cavite State University (CvSU) provides technical assistance.

Some of the mangrove protection and management initiatives in the province include the mangrove rehabilitation programs in the areas of Bacoor, Kawit, Cavite City, Noveleta, Tanza, Rosario, Naic, Ternate, and Maragondon in 2011 (**Table 15**). There are also initiatives that involve private companies. One of such is the mangrove planting in partnership with PTT Public Company Limited of Thailand in the municipality of Noveleta, where 50,000 mangrove propagules were planted by 600 volunteers in a one-day event (March 28, 2014). Another initiative is the one-hectare mangrove rehabilitation done in cooperation with the Island Cove Hotel and Leisure Park and the LGU of Bacoor City, Kawit Agricultural Office and their respective FARMCs. This was supported by the Provincial Environment and Natural Resources Office (PENRO) and DENR-CALABARZON.

Table 15. Rehabilitation areas in Cavite in the year 2011 (SEPP 2011).

City/ Municipality	Rehabilitated areas (ha)
Bacoor	0.26
Kawit	13.06
Cavite City	0.99
Noveleta	4.12
Tanza	6.5
Rosario	3
Naic	0.5
Ternate	2.12
Maragondon	2.1
TOTAL	**32.65**

A third initiative is the mangrove planting project conducted by the Coast Guard Station (CGS) in celebration of the Philippine Coast Guard's (PCG) 113th anniversary celebration in 2014. Planting of 2000 propagules provided by the MENRO and CGDNCR-CL was done at La Isla Bonita and Brgy. Ligtong II. Involved in the activity is a total of 171 representatives from the PCG, DILG, MENRO, Bureau of Fire Protection, PNP Rosario, Petron Terminal, 103rd PCGA Squadron, 125th PCGA Squadron, 129th PCGA Squadron, NSTP students of AIMS, Processing Export Zone Authority (PEZA), Philippine Dental Association-Cavite Chapter, and the barangay officials of La Isla Bonita, Brgy. Ligtong II, and Rosario.

Another CGS Cavite mangrove planting activity coupled with a coastal cleanup took place on March 21, 2014. This was initiated by the Coast Guard Marine Environmental Protection Office (CG-9) at Barangay San Rafael IV, Noveleta, Cavite. The participants planted 4000 mangrove propagules and collected approximately 200 sacks of garbage.

Monitoring and Evaluation

Editors' note: No data were provided regarding the monitoring and evaluation processes of the province.

IV. SUMMARY AND RECOMMENDATIONS

The mangrove cover of Cavite has been depleted in the past years due to aquaculture conversion and reclamation. Efforts have been made by various stakeholders in the province involving the government agencies, private organizations and academic institutions. As it continues to rehabilitate its mangrove areas, the Province of Cavite is guided by the five objectives of its PG-ENRO, namely to: (1) protect and improve the quality of the major resources of the province, (2) facilitate the exchange of scientific discussion, (3) identify challenges and opportunities in improving water efficiency, (4) strengthen the networks among key players, and (5) identify causes of impairment and pollutant sources.

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State of the Mangroves in the

NATIONAL CAPITAL REGION

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I. INTRODUCTION

The National Capital Region (NCR) or Metro Manila is a populous megacity and host the seat of the Philippine government. This 63,600 ha metropolitan area lies in the southwestern portion of Luzon and bounded by Manila Bay on the west. It houses about 11 million inhabitants from 16 cities and 1 municipality. Along its 41.22 km coastline, which stretches from Navotas in the north to Las Piñas in the south, are 17 barangays, some built-up areas, and patches of vegetation in the cities of Las Piñas, Parañaque, and Navotas (**Appendix G**). Based on the Survey and Mapping of Foreshore Report, the NCR has a total of 86.76 ha remaining foreshore areas.

These coastal barangays depend directly and indirectly on Manila Bay for their daily subsistence. The livelihood for the majority in the coastal areas relies on agricultural and fisheries production. Other residents have informal jobs, ranging from vending, backyard farming, and shellfish cultivation. The rest are employed in private and public establishments such as manufacturing industries.

Importance of Mangroves

The name Manila came from the word "may nilad." Nilad is a local term for a mangrove species, *Scyphiphora hydrophylacea*, that was once abundant along the coast of Manila Bay. This shows that mangroves have been a part of the region's ecology and history. The verdant mangroves of NCR provide the following ecosystem services: (a) carbon sink for residential, commercial and industrial emissions in the cities of Parañaque, Las Piñas, and Navotas; (b) natural filters of pollutants from the bordering rivers; (c) physical barrier to storm surge; (d) habitat of migratory birds; and (e) ecotourism area.

II. STATUS OF MANGROVES IN THE NATIONAL CAPITAL REGION (NCR)

NCR has approximately 65 ha of mangrove areas in the cities of Las Piñas, Parañaque, and Navotas. Overwashed and fringing mangroves cover about 36 ha of the Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA) and the adjacent Coastal Road. These mangrove communities boast the densest population of mangrove and mangrove-associated species in Manila Bay. The 29.47 ha mangrove areas in Sitio Pulo, Barangay Tanza, Navotas City hold the remaining old stands of mangroves in NCR. **Table 16** provides a breakdown of the old stand, secondary growth and mangrove plantation in NCR. Presently, there are about 15 mangrove species: Saging-saging (*Aegiceras corniculatum*), Bungalon (*Avicennia marina*), Api-api (*Avicennia officinalis*), *Bruguiera cylindrica*, Pototan (*Bruguiera sexangula*), Buta-buta (*Excoecaria agallocha*), Kulasi (*Lumnitzera racemosa*), Nipa (*Nypa fruticans*), Bakauan Lalake (*Rhizophora apiculata*), Bakauan Babae (*Rhizophora mucronata*), Bakauan Bato (*Rhizophora stylosa*), Nilad (*Scyphiphora hydrophylacea*), Pagatpat (*Sonneratia alba*), Tabigi (*Xylocarpus granatum*), and Piyag-aw (*Xylocarpus moluccensis*). Associated species are Bangkoro (*Morinda citrifolia*) and Banalo (*Thespesia populnea*).

Table 16. Estimated areal extent of mangroves in NCR (ha).

Old stand	Secondary growth	Plantation
29.47	36	0

Degradation of Mangrove Forests

Resource Ecological Assessment (REA) of Manila Bay in 1995 recorded a total of 794 ha of mangrove. In 2003, the remaining mangrove forest around Manila Bay was 298 ha for Cavite, 30 ha for NCR, and unknown for Region 3 (NAMRIA). These values were subject to ground truthing. In 2005, the ground truthing activity by the Manila Bay Environmental Project estimated 288.8 ha of mangroves for Cavite, 24 ha for NCR and 241 ha for Region 3.

In 1996, the REA recorded six mangrove species, namely: *Aegiceras corniculatum*, *Avicennia lanata*, *Avicennia marina*, *Avicennia officinalis*, *Nypa fruticans*, *Rhizophora mucronata*, and *Sonneratia alba*. In 2005, the mangrove monitoring (Aguinaldo et al. 2005) recorded the following 16 major mangrove species from nine families: *Aegiceras corniculatum*, *Avicennia marina*, *Avicennia officinalis*, *Bruguiera cylindrica*, *Bruguiera gymnorrhiza*, *Ceriops decandra*, *Excoecaria agallocha*, *Lumnitzera racemosa*, *Nypa fruticans*, *Osbornia octodonta*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia alba*, *Sonneratia caseolaris*, *Xylocarpus granatum* and *Xylocarpus moluccensis* (the dominant species).

III. MANGROVE PROTECTION AND MANAGEMENT

The need to preserve and protect the mangrove communities within Manila Bay and all the wildlife species therein is apparent. Because of this, the LPPCHEA was declared through Presidential Proclamation 1412-A (January 2008). LPPCHEA is the first declared "critical habitat" in the Philippines. The area was also designated as the 6th Philippine Ramsar site in 2013 which calls for a stronger and more serious effort in the maintenance and protection of all its biological resources. On March 5, 2012, Barangay Tanza passed Barangay Ordinance No. 04-S2011 to declare the mangrove area of Tanza as a "Marine Tree Park." This is in recognition of the area's biological richness and integrity, potential ecotourism value, ecological importance, and the need for its protection and conservation. Envisioning the same fate for the Navotas Marine Tree Park, the DENR-NCR has been working on having the area declared as another "critical habitat" for conservation in Metro Manila.

Monitoring and Evaluation

The Protected Area Management and Biodiversity Section of the DENR-NCR manages both the LPPCHEA and the Navotas Marine Tree Park. Mangrove rehabilitation, enrichment planting, and regular monitoring of survival rate have been undertaken since 2008. The overall survival rate of mangroves in Parañaque, Las Piñas, and Navotas is 70%.

Impacts of Mangrove Rehabilitation

The lost of mangroves corresponds to the reduction in fish catch per year. A hectare of mangrove produces up to 3.6 tons of litterfall per year providing a lot of food for marine life. The economic equivalent of one hectare of mangrove per year is estimated at Php 22,800 (White & Trinidad, 1998). Among the many intangible benefits of mangrove forests is its role in protecting coral reefs and seagrass beds from sedimentation and pollution.

IV. SUMMARY AND RECOMMENDATIONS

Since the mangroves of both the LPPCHEA and the Navotas Marine Tree Park are greatly affected by solid and liquid wastes deposition coming from various sources, laws on solid waste management must be strictly enforced. Strict compliance with the law will require the practice of mandatory garbage segregation at the household level and solid waste recycling. An intensified information and education campaign on the importance of mangroves and the threats they face must also be undertaken.

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STATUS OF MANGROVES AND MANGROVE MANAGEMENT IN THE PHILIPPINES

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The development of coastal resources in the Philippines in the early part of the 20th century has primarily been exploitative in nature. Mangroves, in particular, were viewed more as a commodity because of its value for firewood and tanbarks. From its original area of approximately 450,000 ha in 1918, it was drastically reduced to a range of 140,000 to 120,000 ha from 1991 to 1994 (Long & Giri 2011). Reasons cited were many such as logging for firewood and tanbarks and the conversion of mangroves to fishponds for milkfish and prawn culture. In the 1950s, mangrove firewood was the preferred fuel source in coastal villages and most bakeries because of its high heating value. But a greater volume was exported to Japan as firewood, which reportedly became the source of rayon. In the 1960s, the government adopted a policy aimed at increasing fish production by converting large areas of mangroves into fishponds for the culture of milkfish and prawns. Such policy was promoted by a government program, which classified and released mangrove timberland for fishpond development and opened loan windows in most government banks to finance fishpond development.

It was in the 1970s when the government realized the importance of mangroves as an ecosystem during which a National Mangrove Committee (NMC) was created in 1976 under the Ministry of Natural Resources. The NMC is a policy-making body for the conservation and sustainable management of the remaining mangrove forests in the country. At the same period, the Mangrove Forest Research Center (MFRC) was created under the Forest Research Institute (FORI) that was reorganized as the Ecosystems Research Development Bureau (ERDB) in 1987. During that time, the NMC was integrated to ERDB.

The Department of Environment and Natural Resources (DENR) has jurisdiction over mangrove resources as provided for in PD 705 (1975) or the Forestry Code of the Philippines. As such, all mangrove swamps set aside for coastal protection purposes shall not be subject to clear-cutting operation. Issuances enacted pursuant to PD 705 include: DAO 76, s1987 (establishment of buffer zones in mangrove areas); DAO 15, s1990 (mangrove conversion and conservation); and DAO 96-29, s1990 (awarding of mangrove stewardship contract). Notable government programs to promote mangrove rehabilitation and conservation in the country include:

1. The ADB - Fisheries Sector Program (1990–1994) was designed as the initial phase of the systematic government efforts to rehabilitate the country's coastal zone, reduce the extensive poverty prevalent among fisherfolk, and enhance sector productivity. Under the program, the DENR targetted the rehabilitation of 30,000 ha of mangrove forests within the identified priority bays, namely: Manila Bay, Calauag Bay, Lagonoy Gulf, San Miguel Bay, Tayabas Bay, Ragay Gulf, Sorsogon Bay, Carigara Bay, San Pedro Bay, Ormoc Bay, Sogod Bay, and Panguil Bay. The Department of Agriculture (DA) was the executing agency.
2. The Coastal Environment Program (CEP) was established in 1993 through DAO No. 19 by Secretary Angel C. Alcala through Executive Order No. 192 and Republic Act 7586. This program mandated the DENR to implement programs and projects on conservation and management of Philippine coastal environment and promote the use of environment-friendly coastal technologies; expand livelihood opportunities in, and assure equal access to, coastal resource; and upgrade the capabilities of all DENR personnel in the management of coastal environments.
3. The Coastal Resource Management Project (CRMP) based in Cebu City was also implemented in 1996 for the mangrove management and restoration along 3,000 km of shoreline which covered 16,000 ha of mangroves.
4. The Community-based Forest Management Agreement (CBFMA), EO 263 s1995 and its IRR as outlined in DAO 96-29 provided tenurial instrument available for communities who wish to manage their mangrove resources. The CBFMA integrates all other forms of tenurial instruments developed by the DENR including the Mangrove Stewardship Agreement (MSA) and the Community Forest Management Agreement (CFMA).

5. The ADB's support to the implementation of the Integrated Coastal and Resource Management Program (ICRMP) is viewed as a crucial step to assist the government in addressing critical issues for sustainable management of the marine and coastal resources and increase the income of rural communities. Technical assistance was provided to participating LGUs to develop and adopt municipal ICRM plans that shall guide local development initiatives towards sustainable management of coastal resources

The catastrophic impacts of Typhoon Yolanda in the Philippines in November 2013 has prompted the need to rehabilitate and restore mangroves as a primary line of defense against coastal perturbations such as typhoons, tsunamis, and storm surges. With the combined impacts of other typhoons immediately prior to Yolanda, the 7.2 magnitude earthquake in Cebu and Bohol, and the man-made damages wrought by the fighting forces during the siege in Zamboanga Sibugay, the Philippine Government has allocated a Php 1 billion budget for the DENR to specifically implement the Mangrove and Beach Forest Development Project (MBFDP). The project is pursuant to the special provision of FY 2014 General Appropriation Act (RA 10633) under the Section XIV (Reconstruction and Rehabilitation Program).

The ERDB was designated as the overall coordinator of the MBFDP and the PENROs and CENROs as field implementing units. Science-based rehabilitation and lessons from the failures of reforestation in the past are carefully integrated in the implementation of the project. Salient features of the project are:

1. Importance of mapping and baseline data collection on bio-physical characteristics of target sites as bases for future impact assessments;
2. Implementation of cash-for-work scheme in the different stages of plantation development including nursery establishment;
3. Incorporation of capacity-building and sustainability mechanism strategies;
4. Distinct target sites from that of regular NGP-mangrove;
5. Emphasis on sustainability which necessitates the extension of project life beyond 2015; and
6. Strong monitoring and evaluation system.

Considering the time limitation in project implementation as imposed by the government fiscal requirements and procedure, the MBFDP presents itself as a strategy to rehabilitate and/or restore 50,000 ha of mangroves and beach forest in 10 regions (4a, 4b, 5, 6, 7, 8, 9, 10, 11, and 13) to generate jobs and provide additional income for coastal communities. The project also hopes to correct unscientific strategies that were used in the past mangrove rehabilitation projects and capacitate the communities in various activities related to MBFDP. At least five ERDB techno-bulletins pertaining to site selection and validation, baseline data collection, mangrove nursery establishment, plantation development, maintenance and protection and beach forest development were issued (**Appendix H**). The importance of baseline assessment of the bio-physical characteristics of the representative planting sites per province has also been emphasized for use in future impact assessment.

Actual planting started in early 2015 and the succeeding two years (2016–2017) are intended for maintenance and protection. In all these years, a science-based monitoring and evaluation shall be undertaken by ERDB to document the lessons learned that can help improve and/or re-shape mangrove rehabilitation in the future. The timing of availability of planting materials has also been emphasized. Extreme and unpredictable climatic events are also anticipated to draw adverse impacts on established plantations. Part of the sustainability mechanism at hand is to encourage the community to replant the damaged sites.

The need to rehabilitate such a huge area is a gargantuan task, more so that mangrove planting is currently being undertaken by many entities such as the DENR, the DA through the Bureau of Fisheries and Aquatic Resources (BFAR), the LGUs, and the NGOs. The DENR has clear jurisdiction over mangrove resources. Given this mandate, all activities related to mangrove rehabilitation and management should be regulated by the DENR, particularly the identification of planting sites. Nevertheless, the convergence of all these government and non-government entities is needed in pursuit of the common goal of rehabilitating our mangroves. Such mangrove rehabilitation will strike the balance between coastal environment protection and food production and security, which epitomizes the coastal resiliency goal of the MBFDP.

MANGROVE FOREST EXTENT MAPPING IN SOUTHWESTERN LUZON USING 2015 LANDSAT IMAGERY

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KEY WORDS: Mangroves, Southwest Luzon, Remote Sensing, Landsat imagery

ABSTRACT: Accurate information on mangrove forest extent is essential for both natural resources management and integrated land and sea use planning. In this study, we assessed the spatial distribution of mangrove forests in the provinces of Southwestern Luzon for the year 2015 using publicly available Landsat 8 images. The images were calibrated and atmospherically corrected using the FLAASH model. Support Vector Machine (SVM) was used to classify the images into four classes (i.e., mangroves, terrestrial non-mangroves vegetation, built-up plus bare soil, and cloud cover plus shadows). Results generated the following total areas of mangrove forest cover per province: 42,999 ha in Palawan; 398 ha in Batangas; 3,259 ha in Oriental Mindoro, 1,386 ha in Occidental Mindoro, 137 ha in Cavite and 10,570 ha in Quezon. In general, the mangrove areal estimates of our study were comparable to previous remote sensing studies conducted in the Philippines. Although there are some discrepancies with the results, the overall accuracy of above 95% and kappa coefficient of above 0.9 indicate that the spatial distribution of mangroves was accurate. The results of this study are considered important contributions to rapid ecological assessment of mangroves, and can aid in mangrove conservation and management.

1. Introduction

Mangroves are trees and shrubs that are uniquely adapted to marine and brackish waters (Duke et al. 1998). Similar to coral reefs and rainforests, they are highly productive, complex and diverse coastal ecosystems. Healthy mangroves form dense stands along the coastal fringes and estuaries within the intertidal zones of the tropical and subtropical regions worldwide (UNEP 2014). Although mangroves can exist in isolation, they typically occur with other associated coastal ecosystems (i.e. coral reefs, seagrass beds, algal beds, mud flats, and sand flats; Nagelkerken, 2009) and their association with these ecosystems enhance important ecological functions such as fisheries and biodiversity (Ogden 2014).

Mangroves are often perceived as nothing more than muddy wastelands, but in fact, they offer a wide range of economic, social, and environmental benefits often referred to as ecosystem goods and services (MEA, 2005). Mangrove stands provide security from natural disasters as they serve as natural barriers along the land-sea interface. Moreover, the growth of mangroves at the land-sea interface promotes sediment trapping from both land and sea and not only prevents soil erosion but also facilitates soil accretion. In archipelagic countries where most of the population lives within coastal communities, such as the Philippines, mangroves are mainly utilized as a source of fuel wood and food. Mangrove fish and shellfish provide the main source of protein for many coastal communities, in addition to livelihood opportunities they bring. The association of multiple coastal habitats also affects species diversity, with increased number of species when adjacent mangrove habitat is present due to their nursery function (Nagelkerken et al. 2009, Mumby et al. 2004). A large number of commercially important fisheries such as shrimp, crabs, and fishes (e.g., snapper, mullet, wrasse, parrotfish, sharks, and rays) utilizes mangroves during at least a part of their life cycle, usually during the juvenile phase to maximize periods of development, i.e. consumption of food items that enhance juvenile growth (Nakamura et al. 2003). Moreover, some species show diel movements from adjacent ecosystems into the mangroves at high tide to feed on mangrove-associated food items (Honda et al. 2013), thus promoting growth and production in nearby associated ecosystems.

Despite its ecological importance, mangroves suffer the earliest and greatest damages among major marine ecosystems. The long history of conversion to aquaculture ponds have caused an estimated lost of 20% (3.6 million ha) of mangrove between 1980 and 2005 globally (FAO 2007; Primavera 2000), and is expected to continue (UNEP 2014). Overexploitation of mangrove resources for large scale industrial harvesting and small-scale collection for fuel wood and coal also caused significant declines in mangrove cover. Since mangroves occupy relatively flat coastal areas, the high demand for coastal development in these areas has also caused major loss in mangrove cover over the decades. In the Philippines, the largest decline was recorded from 1951 to 1988 where around half of the 279,000 ha of mangroves were lost due to development of aquaculture ponds (Primavera 2000). In 1994, only 120,500 ha of mangroves have been recorded and is continuously showing traces of overexploitation and other threats.

A vital part of mangrove management is to identify the spatial forest cover, key regions to protect, and possible sources of threats. Remote sensing has been a popular tool used in natural resources monitoring. It has been widely used in monitoring land use, tracking historical changes in forest cover, and habitat mapping. Although several studies have been conducted to provide best estimates of spatial mangrove extent, a consistent methodology is still lacking (Long et al. 2013). In the Philippines, several approaches have been used to provide accurate information on mangrove extent. Long and Giri (2011) provided a nationwide estimate of the mangrove forest cover using Iterative Self-Organizing Data Analysis Techniques (ISODATA) classification method. In 2013, a similar study has also been conducted by Long et al. using a different classification method, Support Vector Machine (SVM). Localized change detection of mangrove forest has also been conducted such as in the city of Puerto Princesa, Palawan (Pagkalinawan & Ramos, in prep).

This study aims to quantify the current areal extent of mangrove forest in the Southwestern part of Luzon, Philippines by detecting the spatial distribution of the mangroves through the analyses of satellite images acquired in the months of 2015.

2. Methodology

2.1. Study area

The study focused on the Southwestern provinces of Luzon: Cavite, Batangas, Quezon, Occidental and Oriental Mindoro and Palawan (**Fig. 14**).

Palawan is located in the westernmost part of the Philippines with coordinates 09°30'N and 118°30'E. It is known as the country's "last ecological frontier" supporting a repository of unique and diverse fauna and flora (Sandalo & Baltazar 1997). Previous studies reported varied estimates of mangrove forest cover in Palawan, from a value of 37,432 ha (Philippine Clearing House Mechanism for Biodiversity, 2009); 42,500 ha (CI-Philippines 2011) to an area of 56,660 ha (Long & Giri 2011). Batangas, Occidental Mindoro and Oriental Mindoro is located northeast of Palawan. These provinces border the Verde Island Passage, the "center of the center of marine biodiversity of the world" and the "center of the center of marine shorefish biodiversity" (Carpenter & Springer 2005). It houses diverse species of corals, algae, crustaceans, mollusks, marine reptiles, marine mammals, mangroves and fishes, including some globally threatened fish species (Carpenter & Springer 2005). A study conducted by CI through Coral Triangle Support Program (CTSP) reported a total of 2,583 ha of mangroves (circa 2010) and 2,317 ha (circa 1990) throughout the Verde Island Passage.

Like the island of Palawan, Puerto Galera in Oriental Mindoro was declared as a "Man and Biosphere Reserve" by UNESCO. There are 20 marine protected areas in Oriental Mindoro that include a marine turtle reserve and a mangrove forest reserve. In 2010, there is an estimate of 148 ha of mangroves in Occidental Mindoro (including Lubang Island Group) and 1,770 ha in Oriental Mindoro

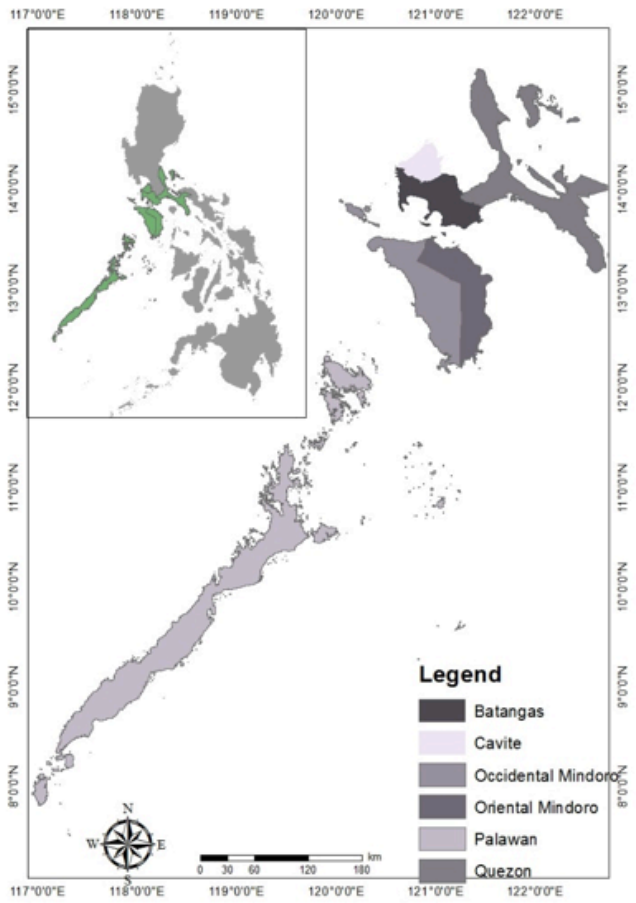

Figure 14. Study sites in Southwestern Luzon (Palawan, Batangas, Cavite, Quezon, Oriental Mindoro and Occidental Mindoro) Philippines for mangrove mapping.

(CI-Philippines, 2011). These estimates did not include the whole province, but only those within the coverage of VIP (northern part of Mindoro).

Cavite is situated near central Luzon at 14°28'N, 120°55'E. It is bounded by the provinces of Batangas and Laguna to the south, Metro Manila to the north and Manila Bay to the west. Cavite is known as one of the major producers of oysters and mussels. Fishers are also engage in prawn and milkfish production. Despite the wonderful beaches along the coast of the province, Cavite is also bounded by Manila Bay, a now polluted bay suffering from industrial and human wastes.

Quezon province is one of the largest provinces of Luzon located east of Manila and bordered by the provinces of Aurora to the north, Camarines Norte and Camarines Sur to the east, and Bulacan, Rizal, Laguna and Batangas to the west. The province is also one of the provinces in the Philippines with the most extensive coast extending up to 1,468 km bounded by Lamon Bay in the pacific side and Tayabas Bay, Sibuyan Bay and Ragay Gulf in the south.

2.2. Data

Satellite images taken by Landsat Data Continuity Mission were downloaded through the USGS Global Visualization Viewer website and served as our primary source of data. Scenes with minimum cloud cover for selected months in 2015 were obtained. The Landsat 8 satellite with Operational Land Imager (OLI) and Thermal Infrared Sensors (TIRS) was used in capturing the data for each month. Secondary data, such as existing mangrove maps and shape files of study sites, were obtained for comparison of results, mainly from the study of Long and Giri (2011).

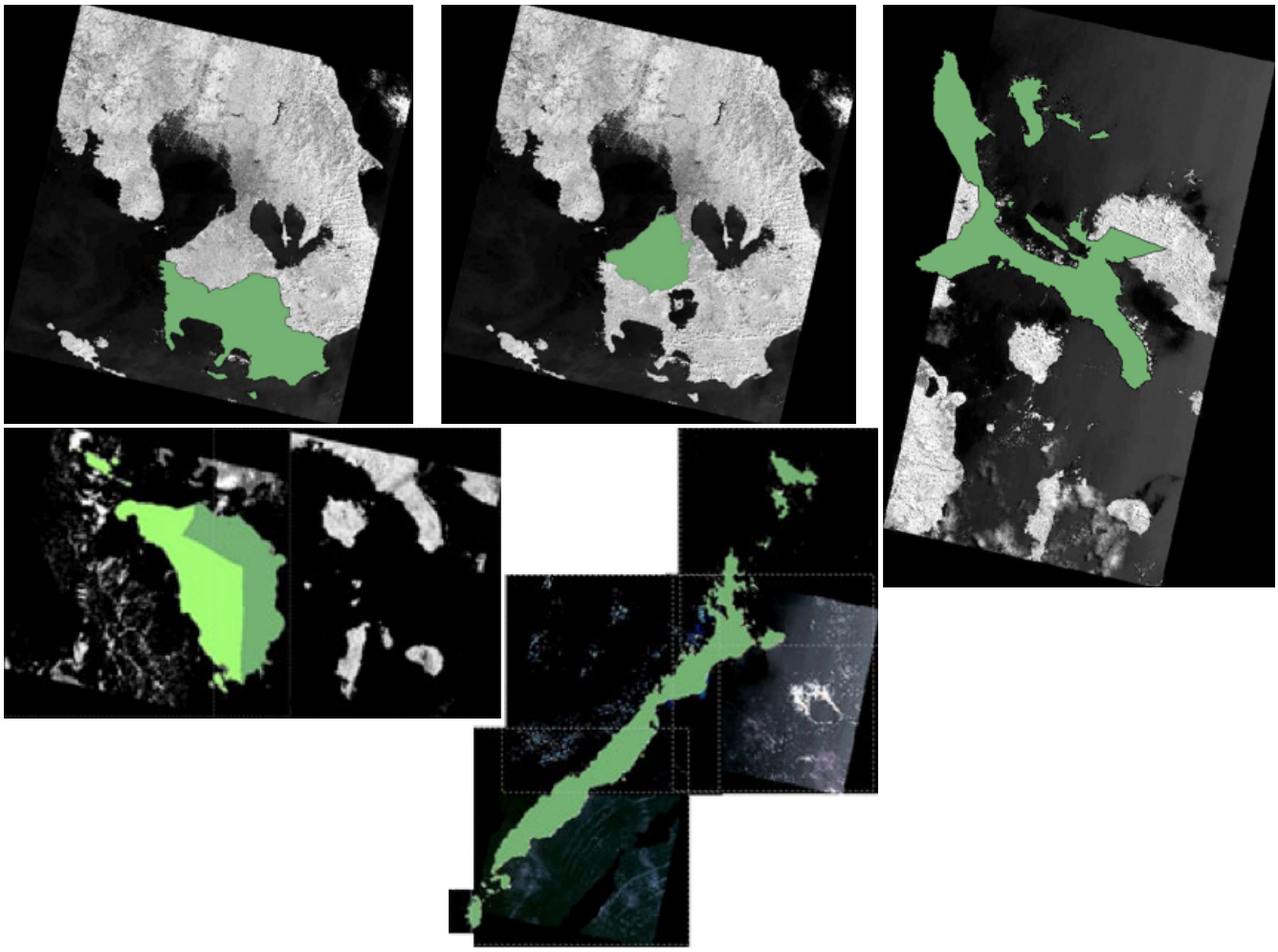

Figure 15. Landsat 8 Images downloaded for mapping mangrove forest extent in Southwestern Luzon, Philippines for year 2015.

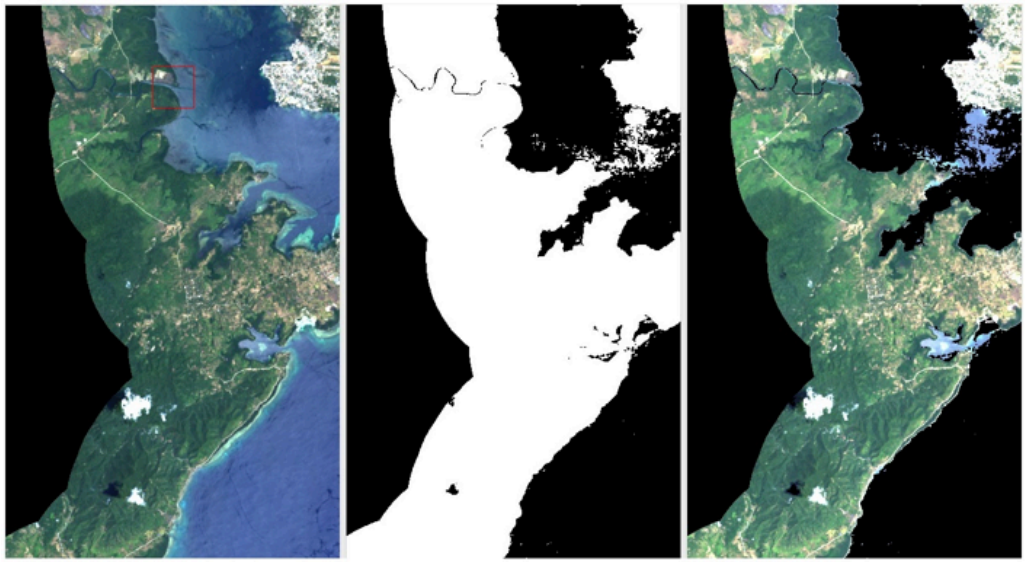

Figure 16. Mask Buffer Creation. A buffer of 4,000 m from the shore was applied to the pre-processed Landsat image (A). A water mask was then created (B) using Band 5 (NIR), and applied to generate an image ready for SVM classification (C). Image is a subset of Palawan scene 3.

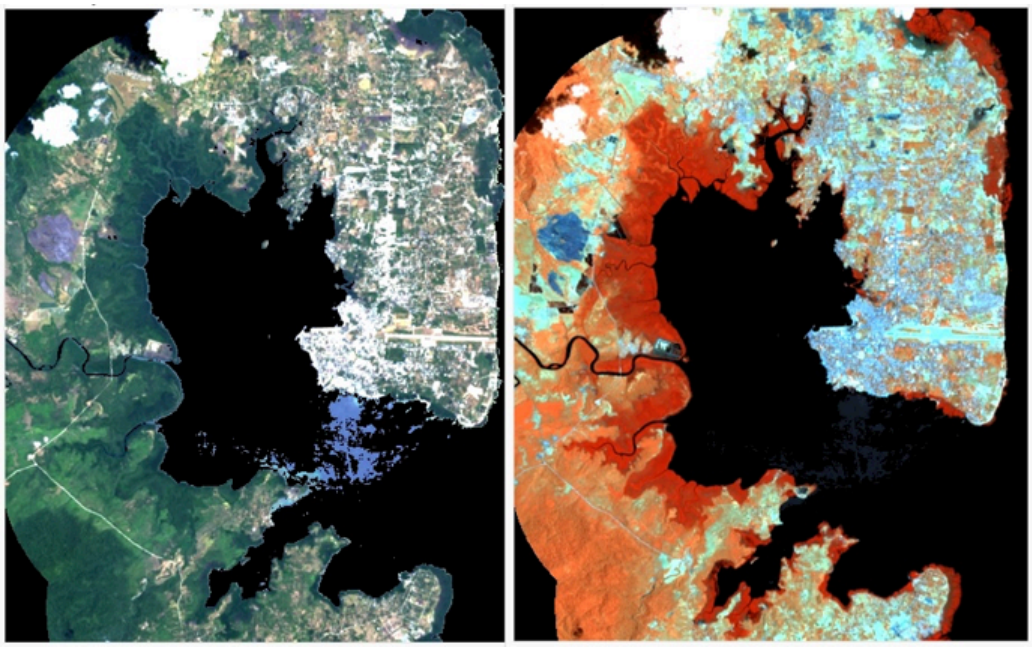

Figure 17. Appearance of mangrove forest from true color (left) to false color composite (right) of the masked Landsat imagery (subset showing Puerto Princesa, Palawan).

2.3. Methods

Pre-processing and processing techniques were applied to the downloaded satellite images to extract the mangrove forest extent. The Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes (FLAASH) model was applied to atmospherically correct the data using the ENVI classic software. Support Vector Machine (SVM) was then used to classify the images to four classes: (1) Mangroves, (2) Terrestrial non-Mangroves vegetation, (3) Built-up plus Bare soil and (4) Cloud Cover plus Shadows. Maps were created showing the location of the mangrove forest extent for each study site for the year 2015.

2.3.1. Pre-Processing and Calibration

Satellite images were calibrated by converting their DN values to radiance. This step requires the data for the LMin and LMax spectral radiance scaling factors specific to the downloaded scenes. The tool used is 'Landsat Calibration' under the Envi calibration utilities.

The FLAASH model was used to correct for the atmospheric effects in the images. This tool corrects wavelengths in the visible through near-infrared and shortwave infrared regions. The calibrated multiband image was converted to band-interleave-by-line (BIL) and used as the input to the FLAASH tool, with a scaled reflectance as the final output.

2.3.2 Masking

Observed land and water areas that can be easily identified as non-mangroves habitats were masked off. Since mangroves thrive only in intertidal zones, a buffer mask measuring 4,000 meter from the shore were created (**Fig. 16**). Areas beyond the 4,000 meter region are excluded in mangroves classification to avoid confusion with other inland vegetation with similar spectral signature. Water was also masked off by visual interpretation of color composites of Landsat ETM bands 4, 5 and 7; and by using either Band 5 (near infrared) or Band 6 (SWIR) for selecting the minimum and maximum value for building the mask.

2.3.3 Mangroves visual interpretation and classification

Mangrove forest cover was visualized using a false color composite of one near infrared band and two shortwave infrared bands (Bands 5-6-7). This composite image highlighted the mangrove vegetation with a bright orange color (**Fig. 17**) which aided in the selection of regions of interests (ROI). A minimum of 150 ROI was selected for the mangroves and other classes (terrestrial non-mangroves vegetation, built-up + bare soil and clouds + shadows). The supervised classification method SVM was applied on the calibrated and masked reflectance file using ENVI.

2.3.4 Mangrove area and post classification comparison

The area of the extracted mangroves was computed using ArcGIS. The area of mapped mangrove cover extent was compared to secondary sources. Accuracy assessment was conducted by generating random points within the buffer zone and cross validating each point with secondary data and Google Earth images. Mangrove forest cover maps of study sites for 2015 were then created using ArcGIS layout tools.

3. Results and discussion

3.1. Land cover classification

A mask was applied prior to classification to exclude water bodies during the classification process. A buffer was then used to limit the classification to within 4 km from the coast since mangroves are only found within this range. Four classes were used in the classification: mangroves, terrestrial non-mangroves, built-up + bare soil and clouds + shadows.

3.2. Mangrove extent and status

This study provides information on the current status of mangrove habitats in Southwestern Luzon provinces. Among sites, Palawan has the largest total mangrove forest extent of 43,000 ha followed by Quezon province at around 14,600 ha. However, in terms of mangrove cover per length of coastline, Palawan is only second to Quezon province with mangrove cover of 8.2 ha/km and 9.9 ha/km, respectively. On the other hand, Cavite has the least mangrove cover (137.4 ha) followed by Batangas (397.6 ha).

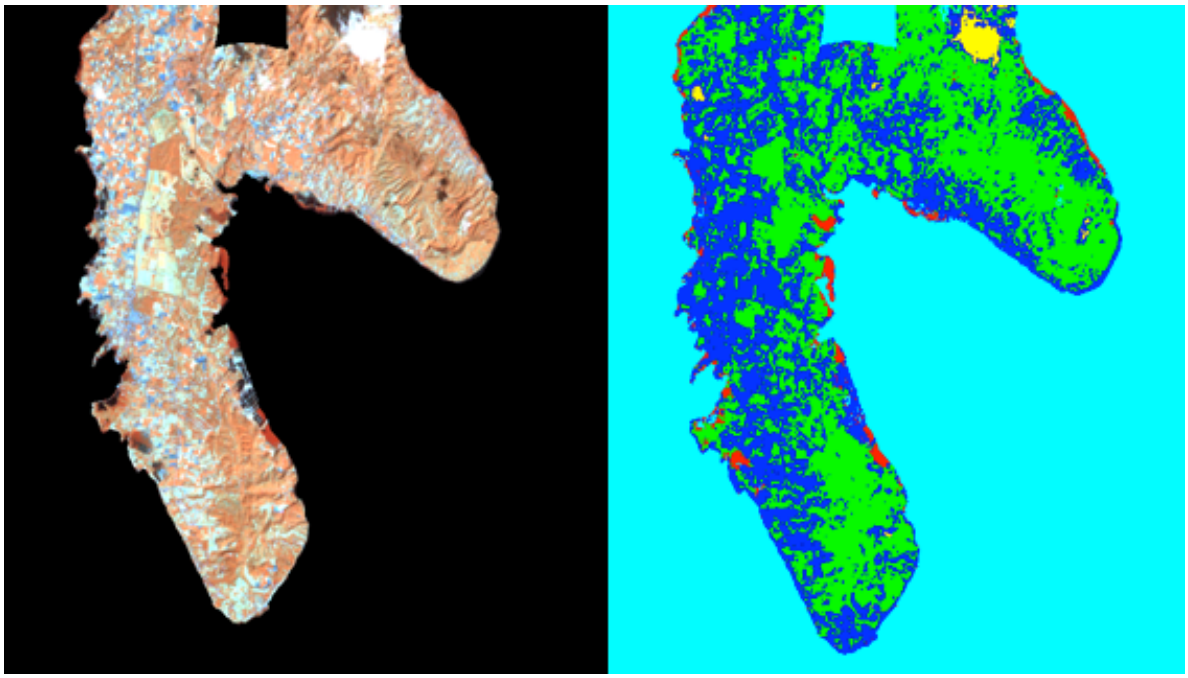

Figure 18. False color composite (left) and SVM classification result (right) in Verde Island Passage subset. (Red: mangroves, Blue: built-up and bare soil, Green: other land vegetation, Yellow: clouds and shadows).

Table 17. Status of Mangroves in Southern Luzon study sites based on current and previous estimates.

Site	Coastline	Areal Extent (ha)		Mangrove Cover per Length of Coastline (ha per km)	
		Long et al. 2011	This Study (2015)	Long et al. 2011	This Study (2015)
Quezon	1,468	10,570	14,620	7.2	9.9
Cavite	96	29.23	137.4	0.3	1.4
Batangas	422.5	503.3	397.6	1.2	0.9
Palawan	5,255	56,660	43,000	10.8	8.2
Oriental Mindoro	438.4	2,227	3,260	5.1	7.4
Occidental Mindoro	690.1	1,041	1,386	1.5	2

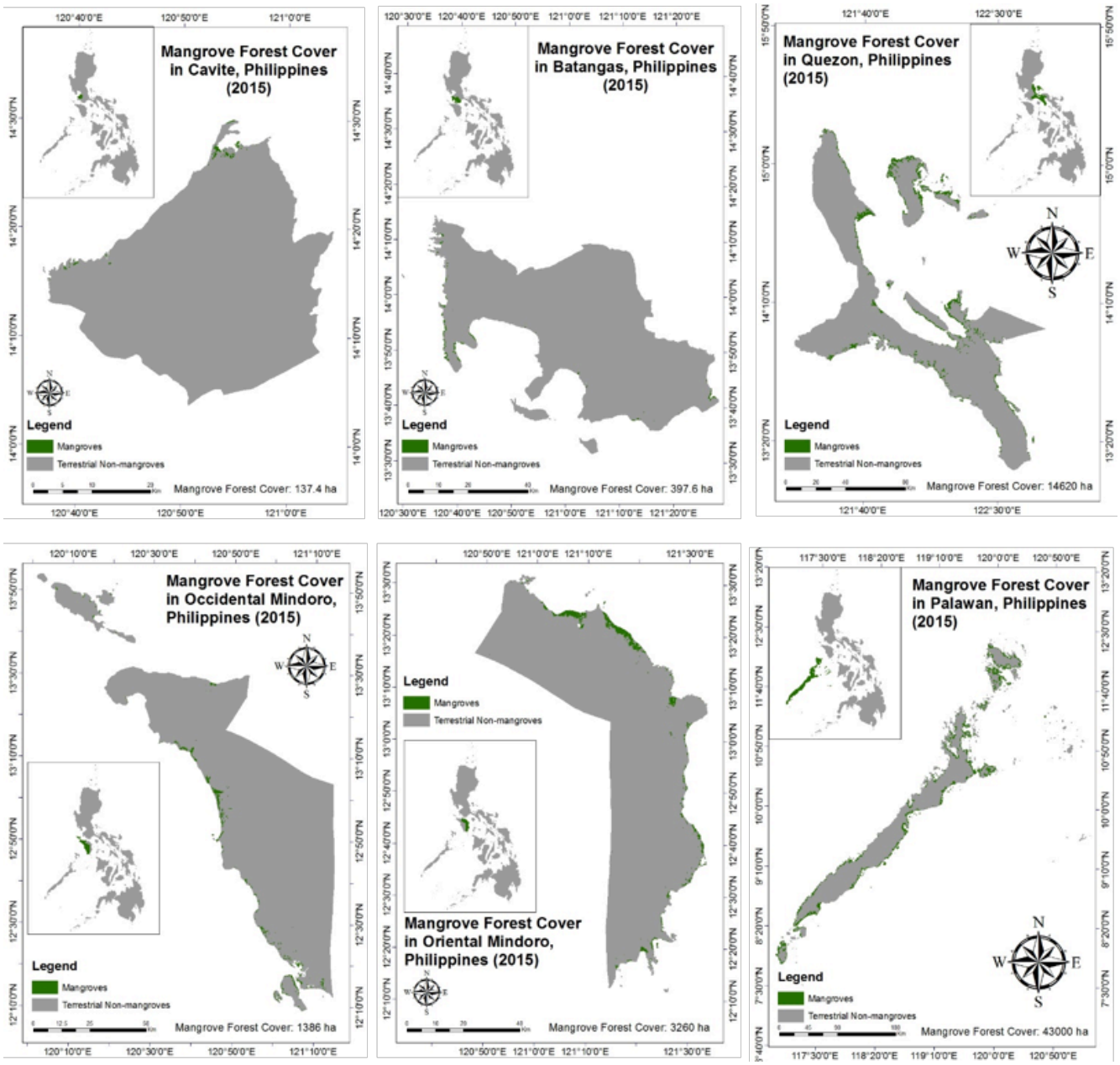

Figure 19. Mangrove forest cover maps of Southwestern Luzon Provinces in the Philippines.

In terms of mangrove cover per length of coastline, Cavite has greater cover than Batangas at 1.4 ha/km and 0.9 ha/km, respectively (**Table 17**).

In Palawan, mangroves were found throughout the coastal areas of the island. However, the eastern part has more continuous mangroves stands such as the mangrove forest from Puerto Princesa extending up to Brooke's Point. Remote islands such as Coron, Culion, Araceli and Balabac were all bordered by mangrove forests. In Oriental Mindoro, mangroves were concentrated on the northern part of the province within the towns of Calapan, Naujan, and Pola. There are thin stands along the coast of Pinamalayan extending up to Mansalay. The mangrove cover in Occidental Mindoro is less compared to Oriental Mindoro, with dense stands present only in Mamburao, Santa Cruz and northern Sablayan.

In Batangas, majority of the mangrove forests are found in Calatagan and San Juan. Barangay Quilitisan, Calatagan, has two islets declared as the Calatagan Mangrove Forest Conservation Park (CMFCP). The CMFCP is a marine protected area co-managed by the Barangay Local Government Unit and by a local people's organization called Talimusak, an organization of local fishers. On the eastern part of the province, San Juan, mangrove rehabilitation has been used to promote tourism. The movement not only enhances tourism, but also increases the awareness of locals and tourists about the importance and benefits of mangroves.

Mangroves are distributed along the lengthy coast of Quezon province. Thick mangrove stands are also notable in the northern coast of Calauag, southern coast of Infanta, and in the island of Polillo. Quezon is also known as the Philippines' "mangrove haven" due to the high survival rate of mangrove propagules planted in the area in 2012. The success of mangrove transplantation in Quezon was attributed to the coastal community's cooperation and awareness on the importance of mangrove forests.

In a study conducted by the Department of Environment and Natural Resources (ICM and PG-ENRO) in 2005, there are only 23.8 ha of mangroves in Cavite located mostly in the municipalities of Kawit and Ternate. The decline in mangrove forest cover is mainly due to conversion to aquaculture ponds, salt-beds and built-up areas. However, due to a joint awareness program and mangrove planting projects conducted by the coastal municipalities in the province, mangroves started to increase to 32.69 ha by 2007, and continue to increase until 2015.

In comparison with the mangrove estimates of Long et al. in 2011, the mangrove areas in Quezon, Cavite, Oriental and Occidental Mindoro increased from 2011 to 2015. The increase in cover can be attributed to the conservation efforts done in the area. On the other hand, there is a decline in mangrove cover in Palawan and Batangas, which may be due to the effects of typhoons. Although the differences in mangrove cover estimates may also be due to the differences in method of classification used, accuracy above 95% and kappa value above 0.9 indicate that our results are comparable with previous estimates.

4. Conclusions and recommendation

Using SVM classification algorithm, the current estimate of the mangrove forest extent in Southwestern Luzon was obtained. Based on the analysis of remotely sensed satellite images, all provinces have thin to dense mangroves cover. Palawan has the largest mangroves areal extent while Cavite has the least. However, based on the mangrove cover per length of coastline ratio, Quezon has the greatest mangrove cover per length of coastline while Batangas has the least. According to the LGU and Department of Environment and Natural Resources (DENR) officials from the study sites, factors inducing the changes in their respective mangroves forests include conversion to fishponds and other resource uses, zero or failed reforestation, pollution and over harvesting; and natural causes such as strong typhoons, sedimentation and climate change-related events (2nd State of the Mangroves Summit LGU Reports, 2015). Despite the challenge in providing mangrove cover estimates on a provincial level, our method proved to be effective for extensive and quick estimates using the limited resources available. However, ground truth validation, which the study lacks, can potentially enhance the result of the mangrove cover estimates. The results of our study provide important information that may improve mangrove monitoring strategies in protected areas. Moreover, it reports the most recent estimate of mangroves that will help the local government to assess the status of their management and conservation efforts in protecting their mangrove forests.

5. Acknowledgements

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RESILIENCY AND VULNERABILITY OF THE COASTAL ZONE AGAINST SEA LEVEL RISE

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1. Rationale

The Philippines is an archipelagic state with more than 7,000 islands, with a total coastline of around 37,008 km (SCTR Report 2012). The Philippines' warm tropical coastal waters are highly productive, more so that there are around 2,227,400 ha of coral reefs, more than 200,000 ha of mangrove areas, and almost 100,000 ha of seagrass beds (SCTR Report 2012). These nearshore habitats harbor thousands of marine species, resulting in its recognition as the global center of marine biodiversity (Roberts et al. 2002) particularly for its nearshore fishes (e.g. Carpenter & Springer 2005). Altogether, these provide vital ecosystem goods and services that are highly beneficial to human society (De Groot et al. 2002). One of the most salient ecological goods that can be derived from these ecosystems is fisheries for food, as well as livelihood to many fishers–especially in the small artisanal scale (e.g. Worm et al. 2009). There is high value in fisheries, especially for small pelagic catches (e.g. SCTR Report 2012). Moreover, ecosystems (e.g. coral reefs and mangroves) also provide indirect benefits such as coastal protection to climate stressors (e.g. wave surge) to reduce impact of disasters (see Villanoy et al. 2013). Therefore, under a changing climate, it is imperative to determine the vulnerability of the coastal ecosystems (e.g. Licuanan et al. 2015).

2. Marine Biodiversity and Ecosystem function

There are around 2,351 species of demersal fishes recorded so far in the coastal waters of the country; many of these are commercially important (SCTR Report 2012). Corals total to 533 species, mangroves to 42 species, and seagrasses to 16 species. These are distributed in their local geographic ranges; but are quite more abundant in the central and western parts of the country (i.e. Visayas Region, West Philippine Sea, Sulu Sea, and Celebes Sea) compared to the eastern side (i.e. northern Philippine Sea and southern Philippine Sea). Marine species have vital roles in an ecological domain. These species persist in their geographic ranges, whether local or regional, because of their evolutionary and ecological traits (e.g. Anderson 1981; Veron 1995).

In the past decade, advances in ecological and genetic studies revealed connectivity among marine populations and habitats (e.g. Palumbi 2003). There has been an increasing interests specifically on habitat connectivity, where coral reef fishes migrate ontogenetically within the mangrove-seagrass-reef habitat mosaic (Mumby et al. 2004, Nagelkerken 2009). This further emphasized the importance of these coastal adjacent habitats in the tropics. A large-sized grouper, the orange-spotted grouper *Epinephelus coioides*, which has a high fishery value in the Philippines, exemplifies this behavioral trait (e.g. Mamauag et al. 2009).

3. Threats and Pressure

The Philippines has a large human population, which recently passed the 100 million mark and it is still growing without any sign of slowing down. Sixty percent of the inhabitants reside within 100 km of the coasts; hence, a significant proportion of the population is highly dependent on the resources found in the coastal areas. This increases the pressure on coastal ecosystems and jeopardizes their health and condition (e.g. Gjertsen, 2005). These pressures take the form of rising coastal development, increasing levels of pollution and sedimentation, and increasing densities of fishers, leading to overfishing and destructive fishing practices (Burke et al. 2012; MSN Threat Assessment Workshop 2014).

4. Climate Change

There is another form of threat that exacerbates the present situation in the Philippines: climate change. Increasing sea surface temperature (SST), frequent storms with highly variable tracks, and sea level rise are just some of the evident characteristics of climate change (e.g. IPCC Report 2012). Species found in coastal ecosystems have

various degrees of sensitivity to variations in the climate (e.g. Cheung et al. 2009; Hoegh-Guldberg 2011, Munday et al. 2012; Lovelock et al. 2015) that indicates that they try to develop adaptation measures (e.g. Johnson & Welch 2009, Mamauag et al. 2013). Coral bleaching events have been occurring in the world (e.g. Hoegh-Guldberg 2007), including the Philippines. This was mainly attributed to the anomalous rise in the SST during the El Niño phenomenon in 1998 (e.g. Arceo et al. 2001).

5. Sea Level Rise and Mangrove Ecosystem

A topic relevant to this summit is the potential impact of sea level rise (SLR) to mangrove ecosystem. Alongi et al. (2009) offered the evidence that present human activities (e.g. deforestation and settlement) result in mangrove areas not able to keep pace with SLR; hence adaptation measures must focus on resolving these anthropogenic factors.

Mangrove habitats are vulnerable to SLR if the rate of soil elevation gain is lower than the SLR of the region (e.g. Lovelock et al. 2015). Soil elevation gain is attributed to local biological and geological processes in the area. Sediment supply, which can be sourced from the production of organic matter, or the lack of it caused by forest degradation, is a major factor that offsets SLR.

6. Vulnerability Assessment of Tropical Coastal Ecosystems

To address climate change impact and eventually attain resilient systems, the vulnerability assessment (VA) tools have been developed. These tools were developed to determine the sensitivity and adaptive capacity of the species, habitat, and social or institutional groups. A specific VA tool that mainly considers the tropical coastal ecosystem for climate change studies has also already been developed (Licuanan et al. 2015). This is known as the Integrated Coastal Sensitivity, Exposure and Adaptive Capacity for Climate Change (ICSEACC). Its vulnerability framework generally follows that of the IPCC (2001), with the vulnerability of systems or entities as a function of sensitivity (together with exposure will make up potential impact) and adaptive capacity. ICSEACC deals with several disciplines such as marine biodiversity, fisheries, socioeconomic condition, coastal integrity, and governance. This tool has been utilized to determine the vulnerability of coastal areas in the Philippines. Aside from knowing the vulnerabilities of sites, it also determines the adaptation measures that need to be taken, based on the scores and their corresponding management response, which are discipline-specific and site-specific. The major goal of the adaptation measures is to reduce the vulnerability of the sites through adopting and mainstreaming strategies that will lessen sensitivity (e.g. establish protected areas to decrease exposure to threats), and enhance adaptive capacity (e.g. provide capacity building mechanisms for the managers/stakeholders). The ICSEACC is relatively easy to use and permits participatory approach among stakeholders (e.g. local government officials). It aims to provide insights for resilient coastal ecosystems, by not only focusing on the biological and physical aspects, but also by addressing social inadequacies.

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INTEGRATING MANGROVE ECOSYSTEMS APPROACHES TO INTEGRATED COASTAL MANAGEMENT

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1. Introduction

The Philippine context of integrating land and sea is imperative; considering the country's total land area of 298,170 km^2, its territorial sea (up to 12 km) of 679,800 km^2, and Exclusive Economic Zone of 2.2 million km^2. The Philippines is considered as the center of shore fish marine biodiversity. This is a great blessing, but also a profound responsibility. Vesting the Benham Rise to the Philippines is another milestone in our archipelago's history. The archipelago's coastal resources have been shown to have an annual national economic benefit of more than 140 billion pesos. In fact, a square kilometer of coral reef and mangrove, allows us to feed at least 400 people with 50 kg of fish per year. This tremendous bounty derived from coastal ecosystem services justifies the effort to maintain the habitats' biodiversity and health.

2. Threats of Coastal Ecosystems and Communities

The Philippine coastal area as well as its resources is being threatened by several issues (such as unregulated coastal development, overfishing, destructive fishing, sedimentation, and pollution among others) which are widespread all over in the country. However, gaps exist in understanding how to use this natural heritage wisely for sustainable development. This is a continuing challenge. For instance, the clarion call and alarm of runaway conversion of fishponds and prawn farms has reduced these mangrove areas from around 250,000 ha to now only less than 120,000 ha (Primavera 1997). This has resulted in grave consequences in capture fisheries and deterioration of adjacent habitats (Primavera 1997). In addition, unregulated and unplanned mariculture can result in degraded sediment and water quality. This is evidenced by black sulfidic, high organic rich sediments as compared to un-impacted (oxygenated) sediments (Santander et al., 2008). In fact, some avoidable costs, such as the fish kills in Bolinao, Pangasinan (estimated to have a fisheries loss of around 300 million pesos), has now experienced a recurring annual algal bloom and fish kill, even with the reduced number of fish cages. Thus, changes in the biodiversity features of its critical habitats, and its associated resources, will have profound effects on the income and investments of the local governments in the coastal zone. Increased densities of our coastal populations, the intensity of fishing pressure, and unwise coastal development (exacerbated by climate change impacts), makes coastal fishers—who are one of the poorest of the poor sectors of our country—one of the most vulnerable sectors to climate change.

3. Proposed Frameworks to Combat Threats

The understanding of the connectivity of the coral reefs, seagrass and mangroves is steadily unfolding. Studies have shown that the loss of one habitat, such as the mangrove, has profound implications on the adjacent habitats' productivity, fisheries availability, and other ecosystem services. Thus, it is important to ACT NOW so that we will be able to move two steps forward against one step back (**Fig. 20**). This should result in accelerating conservation and protection, and improved Integrated Coastal Management (ICM) in coastal areas by replicating management effectiveness through: (1) The 3 R's; Restoring, Resiliency, Representativeness; (2) establishing an enabling policy framework for marine spatial planning; and (3) improved social-ecological sustainable development through ICM. We have to ACT NOW, wherein our science and technology enhances wise adaptation for resilient systems, to improve our effectiveness. We should also ACT NOW to: Accelerate management effectiveness, continue connectivity functionality, reduce threats and disaster risks, sustain networks and achieve objectives, strengthen and capacitate organizations, and optimize win-win combinations through adaptive management; (**Fig. 21**).

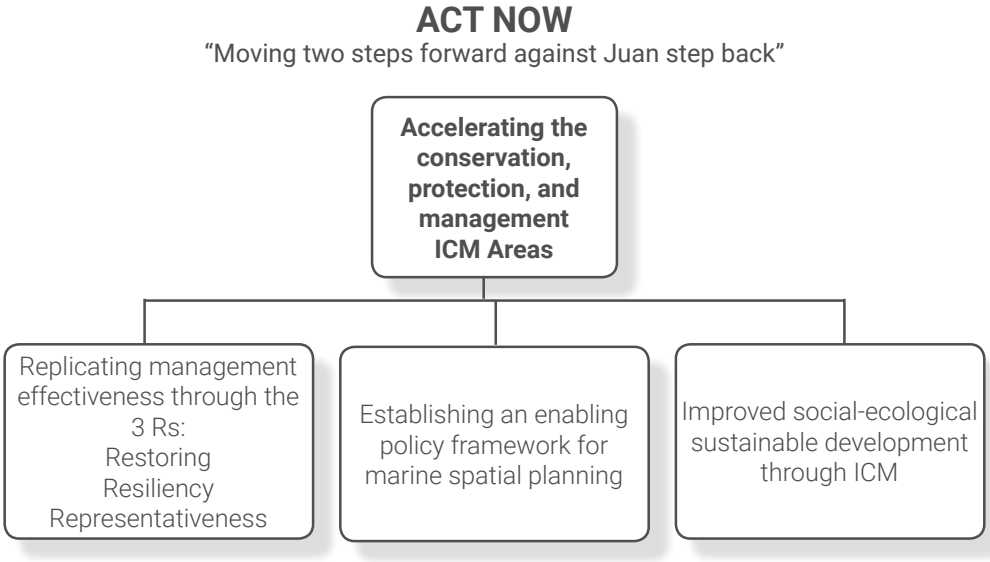

Figure 20. ACT NOW framework

ACT NOW STEWARDS (Science & technology for Wise Adaptation and Resiliency Development System)

- **A**ccelerate management effectiveness
- **C**onnectivity complementarity continued
- **T**hreat and disaster risk reduction
- **N**etworks sustained and institutionalized
- **O**rganizations strengthened and capacitated
- **W**in-win combinations trade offs options for adaptive management

Figure 21. ACT NOW STEWARDS framework

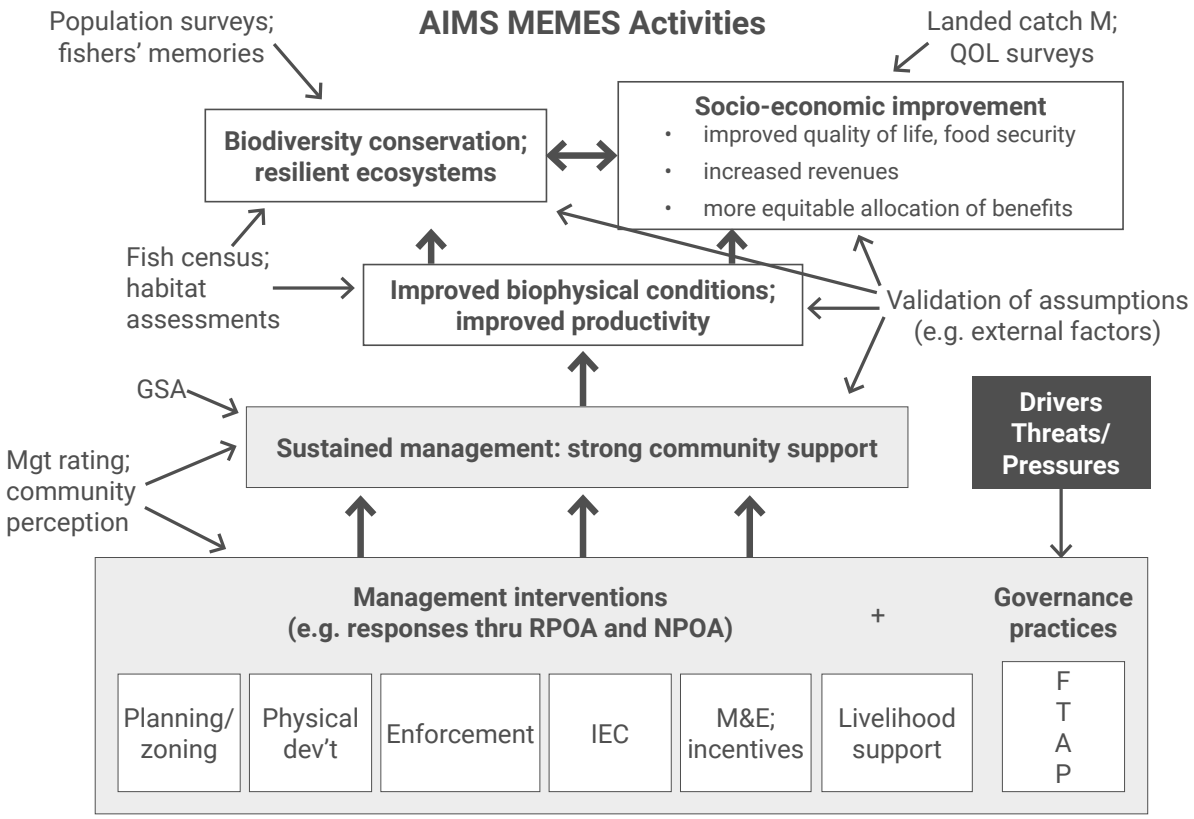

Figure 22. AIMS MEMES framework

"RESTORED" STRATEGIES

	Restoring resiliency through learning communities	Sustainable Philippine fisheries agenda	Maintaining coastal integrity and equitable access
R	Representative, replicated, resilient reserves	Reducing fishing mortality	Restoring coastal protection
E	Enhancing management effectiveness	Enhancing stock recovery	Effective erosion buffers
S	Sustaining healthy ecosystems	Sustainable fishieries use	Sustaining coastal integrity
T	Threat reduction in coastal ecosystems	Threat reduction to sustain fisheries with ecosystems capacity	Thresholds maintained within acceptable limits
O	Organizing knowledge based communities	Organizing fisher communities	Organizing a coast watch
R	Replenishing MPA networks for resilient reproduction and recruitment	Restoring resiliencyand connectivity	Reducing threats and sharing costs
E	Enhancing connectedness	EAFM development with equitability	Enhancing equitable access
D	Doing good governance	Diversifying livelihood options	Disaster risk reduction

Figure 23. RESTORED STRATEGIES framework

Mangrove adaptive management requires a MEMES approach, which calls for: (1) An Adaptive Integrated Management System (AIMS) and (2) An integrated trans-disciplinary learning, similar to the learning gene where mangroves have a regular monitoring system to adapt wisely to the rapidly changing times. Marine Protected Areas (MPAs) using the MPA management effectiveness assessment tool (MEAT) rating system, can also enhance its mangrove data inputs, as many of its present features are coral reef-based (**Fig. 22)**. Integrating the Suitability, Sensitivity, Susceptibility (SSS) analysis through the Integrated Coastal Climate Change Vulnerability Assessment, which is linked to the Governance Socio-ecological Integrated Systems (GSIS), allow for safety nets and investments (akin to an insurance policy system), to address Disaster Risk Reduction (DRR) and climate change impacts.

Our coastal ecosystems can act as sentinel ecosystems of our archipelagic seas, wherein we are able to gauge various threats from poor land use practices, siltation, nitrification and pollution. These monitoring activities can give us an indication of how well we are managing our environment. Response feedback mechanisms need to be put in place. These mechanisms are similar to those stipulated in the Philippine Marine Sanctuary Strategy (PhilMarSaSt), as incorporated in the Executive Order 533 (EO 533). EO 533 is still being discussed as the ICM bill in the senate and congress. Spatially explicit threat maps and analysis of threat reduction options need to be linked to their associated resources, their ecosystem services, and utility of stakeholders (e.g. value chain maps and socio-ecological network design). These long-term strategic action plans and tactical responses should look at various choices, decisions, and actions. These imperatives are necessary and need to be hastened, since if we do business as usual, it would take 100 years to fulfill our Convention on Biological Diversity (CBD) commitments. Thus, there is a need for accelerated areas of effective management to be covered and improved.

Fisheries monitoring across different habitats like seagrass and mangrove are currently inadequate; therefore, characterization of major fishing gears at various times of the year needs to be established. Designing MPA networks should integrate the extent of habitats, its quality and condition, and adjacency and connectedness, aside from understanding the source and sink. Understanding the quantity, like the extent of the habitats and their uses, help rationalize priority and consistent use within and among adjacent coastal zones. Note that in many areas, mangroves, seagrass and coral reefs require harmonization of use and non-use activities of multi-stakeholder user groups. In Bolinao, Pangasinan, one of the first coastal development plans had considerable technical inputs, but the challenges of good coastal governance can swamp some of these inputs. The DRR and the short and long term effects of coastal climate change requires integrated tools in building back better for the future. Natural calamities (such as typhoons, storm surges and floods) are frequent occurrences in the Philippines. Understanding these events through observations and simulations will help in identifying vulnerable areas, and allow careful planning to mitigate impacts on resources and communities.

While models such as FISH BE allow for the communication of complex interactions of systems and issues to be addressed, integrating this into the planning and implementation of management would require: (1) Enhancing participatory decision making processes; (2) establishing a transparent mechanism for timely and accurate information; (3) designating clear and accountable management bodies; and (4) regular functions to address their legitimized objectives. The ReSilient Seas RESTORED strategies have put forward various processes and principles to address these objectives (**Fig. 23**). The local actions and strategies would need to be scaled up, so that from a "projectized" approach, scaling up mechanisms and sustainability measures will institutionalize activities. This is shown in examples of cost sharing schemes, which likewise redound to further fund leveraging.

4. Conclusion

The adaptive integrated management system shows that the actions for management interventions, as outlined in the national plan of action and regional plan of action in the Coral Triangle Initiative (CTI), contributes to reducing threats and pressures. It also shows whether the results would lead to improved biophysical conditions and socio-economic benefits. Our partnerships are also looking at opportunities to motivate and enable awareness towards accelerating and nurturing healthy social and ecological systems. Various incentives are underway to find synergies in MPA networks; examples include design and institutional partnerships such as the Para El MAR, or the linking of champions who have shown good practices. With time, the planning and implementation of effective sustainable management, will lead to its sustainable use and redound to sustainable benefits, and improved quality of life.

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BLUE CARBON INITIATIVES IN THE PHILIPPINES

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Mangroves, tidal marshes, and seagrass meadows provide many benefits and services that are vital for climate change adaptation along the coasts. These include protection from storms and sea level rise, prevention of shoreline erosion, regulation of coastal water quality, provision of habitat for commercially important fisheries and endangered marine species, and food security for many coastal communities. Moreover, these ecosystems sequester and store substantial amounts of coastal blue carbon from the atmosphere and ocean, and hence are now recognized for their role in mitigating climate change. It covers less than 2% of the total ocean area, but account for approximately half of the total carbon sequestered in oceanic sediments.

Even with the benefits and services being provided by these ecosystems, they are some of the most threatened ecosystems on Earth. Mangroves are being lost at a rate of 2% per year. Experts estimate that carbon emissions from mangrove deforestation account for up to 10% of global emissions from deforestation, despite comprising just 0.7% of land coverage. Tidal marshes, which cover roughly 140 million hectares of the Earth's surface, are being lost at a rate of 1–2% per year. Seagrasses, on the other hand, which stores about 10% carbon buried in the ocean each year, are being lost at a rate of 1.5% per year and have lost approximately 30% of its historical coverage. If these trends continue at current rates, a further 30–40% of tidal marshes and seagrasses and nearly all unprotected mangroves could be lost in the next 100 years. When degraded or lost, these ecosystems can become significant sources of the greenhouse gas carbon dioxide.

As a response to the growing concern on the emission of carbon dioxide from both natural processes and human activities, the global community established the International Blue Carbon Initiative. This initiative is a trans-disciplinary, global program focused on mitigating climate change through the conservation and restoration of coastal and marine ecosystems. It coordinates the International Group of Experts on "blue carbon," which has formulated an action agenda to "identify effective, efficient and politically acceptable approaches to reduce the atmospheric concentration of CO_2." Together with the International Blue Carbon Policy Working Group, it provides guidance for needed research, project implementation and policy priorities.

Since 2005, so much advancement in blue carbon has happened (**Fig. 24**). The current realization about the importance of "blue carbon ecosystems" is the primary reason for the rapid progress in blue carbon science.

However, in the Philippines, from 2000–2013, only 18 publications on blue carbon from mangroves and directly related studies have been reported. This reflects the slow advancement in the topic locally, with more emphasis on forests in general and mangroves in particular. The establishment of the Blue Carbon Initiative gave a big boost in shifting interest and focus on the "blue carbon service" of seagrass beds, mangroves and salt marshes (the "blue carbon ecosystems"). Since the Philippines was first represented in the International Blue Carbon Group of Experts in 2011, several fora have been conducted on blue carbon. At least six major multi-country research proposals were submitted to international funding institutions (Fortes 2015).

To support the initiative on blue carbon, Conservation International–Philippines (CI-Philippines) initiated several informal discussions on Blue Carbon with conservation organizations, academic institutions and relevant government agencies. This has sparked the idea of establishing a National Blue Carbon Technical Working Group, which can help coordinate and provide recommendations for blue carbon work in the Philippines.

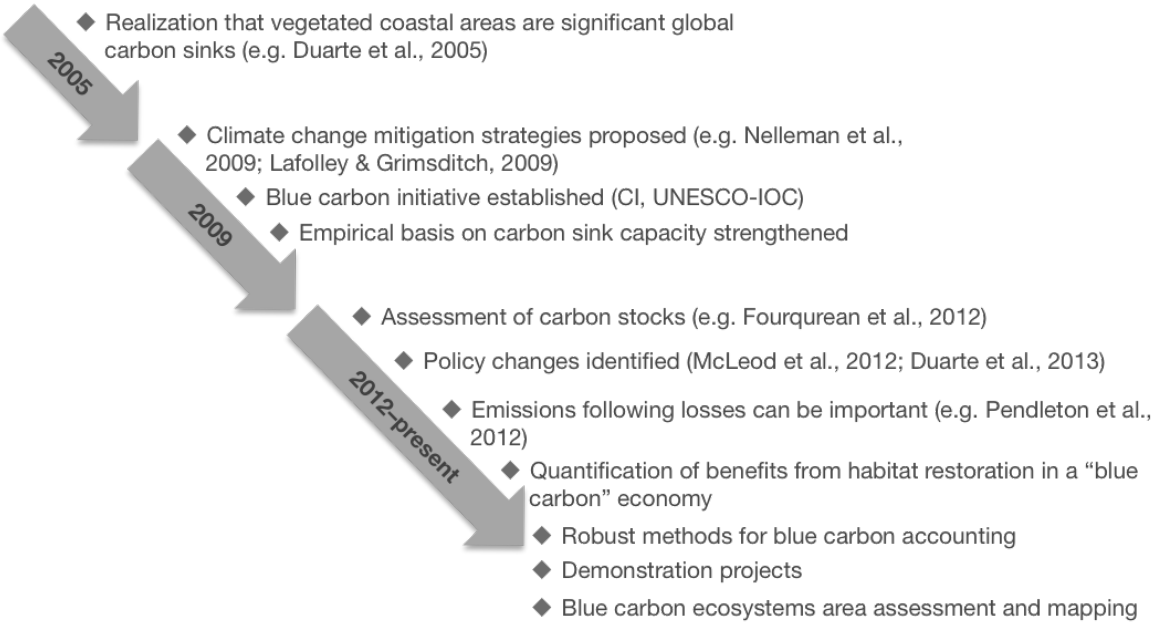

Figure 24. Developments in Blue Carbon Science

Since early 2015, a series of Blue Carbon Adhoc Working Group has been initiated by CI-Philippines. In July 2015, the Biodiversity Management Bureau (BMB) initially agreed to facilitate the Blue Carbon Technical Working Group meetings with CI-Philippines. There was an agreement that BMB will take the lead in the Blue Carbon Technical Working Group, if the National Government, through the Climate Change Commission, will give them the "go" signal to take on this task. To date, BMB is still waiting for advice from the Climate Change Commission regarding blue carbon work vis-à-vis climate change mitigation targets.

CI-Philippines has committed to continue facilitating Blue Carbon Technical Working Group for the meantime. As an initial target output of the series of Blue Carbon meetings, the group is consolidating information on research and implementation efforts related to blue carbon ecosystems. This is lodged in the Blue Carbon Google Group. The Blue Carbon Group has also agreed to start working on addressing the knowledge gaps on blue carbon as individual organizations. One of the key knowledge gaps that need to be addressed is the lack of awareness of the government and communities on blue carbon ecosystems and its potential for climate change mitigation. To address this knowledge gap, CI-Philippines will distribute copies of the International Blue Carbon Committee primer on coastal ecosystems to relevant government agencies. The group will also work on encouraging government and academic institutions to look for funding opportunities, and invest more in blue carbon research. This will support sustainable financing mechanisms for blue carbon ecosystems.

The Philippines needs a viable program on blue carbon. The program does not need to be entirely separated from existing biodiversity or climate change initiatives, but should actually complement these. An interagency collaboration, supported by active private enterprise is necessary to attain this objective. Interestingly, Indonesia has recently developed its blue carbon program, which is prioritized in the political agenda of the government.

Resources

Restore America's Estuaries - www.estuaries.org

Environment Science Associates - http://www.esassoc.com/services/sustainability-and-climate-change

The Coastal Blue Carbon Initiative - http://thebluecarboninitiative.org/

Blue Carbon Portal - http://bluecarbonportal.org/

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STATUS OF MANGROVE RESEARCH AND MANAGEMENT IN THE PHILIPPINES: CHALLENGES AND OPPORTUNITIES

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1. Introduction

The documented history of research and other studies on mangroves in the Philippines date back to the 17th century (1600–1699). This was mentioned in a book entitled, "*Libro de medicinas de esta tierra y declaraciones de las virtudes de los árboles y plantas están en estas Filipinas*" ("Book of medicines of this land and declarations of the virtues of trees and plants of the Philippine Islands"; De Mercado 1665–1698 cited by Zamora 1983). Historical research has enhanced the understanding of past human influences on mangroves and has provided insights that can improve current conservation and management efforts. This study presents one of the most comprehensive studies on mangroves in the Philippines. Historical changes in the country's mangroves and their use were examined in 875 published accounts for 1698–2014, a period of 316 years.

2. Sectoral, Regional and Topical Contributions to the Mangrove Literature

Six categories of institutions or sectors have been identified as contributors: academic and research institutions, peoples' organizations (PO), government (GOP), nongovernmental organizations (NGO), foreign international agencies (IA) and Others (Fortes & Salmo, in press). Understandably, academic and research institutions contributed 47% to the body of literature. It is followed, in the order of decreasing contribution, by Government (23%), Others (17%), NGOs (11%), and IAs (2%). The category "Others" are those individuals or groups without identified affiliations (**Fig. 25**).

In relation to the regions of the country, the following regions stand out (in the order of decreasing contribution; Fortes & Salmo, in press): Region VII (Central Visayas), Region IVA (CALABARZON), Region VI (Western Visayas), Region IVB (MIMAROPA), and Region V (Bicol) (**Fig. 26**, complemented by **Fig. 27**). The contributions of the other regions varied with the National Capital Region (NCR), Region IX (Western Mindanao), Region XII (Central Mindanao) and the Autonomous Region of Muslim Mindanao (ARMM), which have the lowest contributions. Knowledge contributions from Regions I (Ilocos), II (Cagayan Valley), III (Central Luzon), VII (Eastern Visayas), X (Northern Mindanao), and XI (Southern Mindanao) were variously intermediate. CAR (Cordillera Administrative Region) is landlocked and has no mangroves.

Interestingly, the greater bulk of what we know about our mangroves is directly tied up with the history of the degree of their use and availability, access to higher educational institutions, and presence or absence of mangroves. This is shown by the relative preponderance of publications in Central and Western Visayas, CALABARZON, MIMAROPA, and the Bicol Region. It should be noted that some of the earlier studies on mangroves were undertaken in the NCR. But probably because of urban development pressure, mangroves had to give way and were almost completely destroyed. Hence, our knowledge about them remains only in cursory and esoteric reports on fishpond development and in environmental impact assessments attendant to industrial and commercial constructions (Fortes & Salmo, in press).

In this paper, mangrove studies in the Philippines are initially categorized under seven topics: Taxonomy, Physiology, Economic Uses, Biogeography, Ecology, Biodiversity and Conservation and Management (Fortes & Salmo, in press). **Fig. 27** shows the distribution of literature on mangroves in the Philippines among the seven major research topics and at decadal periods from 1698–2014. The effort started with focus on the utilization of the resource and the more basic natural sciences that date back to the late 1600s. This was pursued until the mid-1900s. After this period, a significant increase in the effort was seen, especially in mangrove uses, taxonomy and conservation. This trend was consistent with the rising need of that time to respond specifically to the economic and environmental problems and imperatives. The 1970s was the "decade of awakening" on mangroves and fishponds. From 1977–1979, the then National Mangrove Committee of the DENR, formulated a national mangrove research and management program and implemented high intensity of mangrove studies, symposia and conferences.

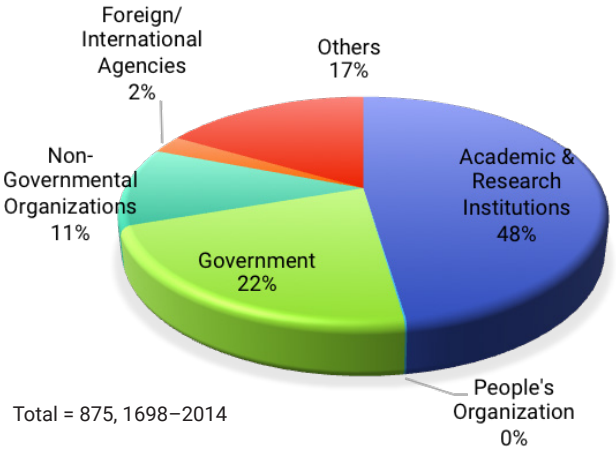


Figure 25. Contributions by institutions or sectors to the literature on mangroves in the Philippines (Fortes & Salmo, in press).

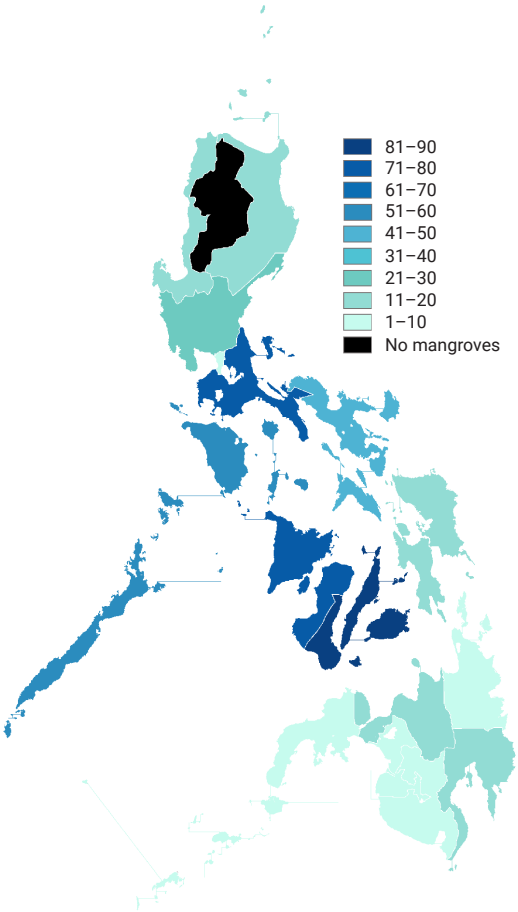


Figure 26. Regional distribution of literature on Philippine mangroves.

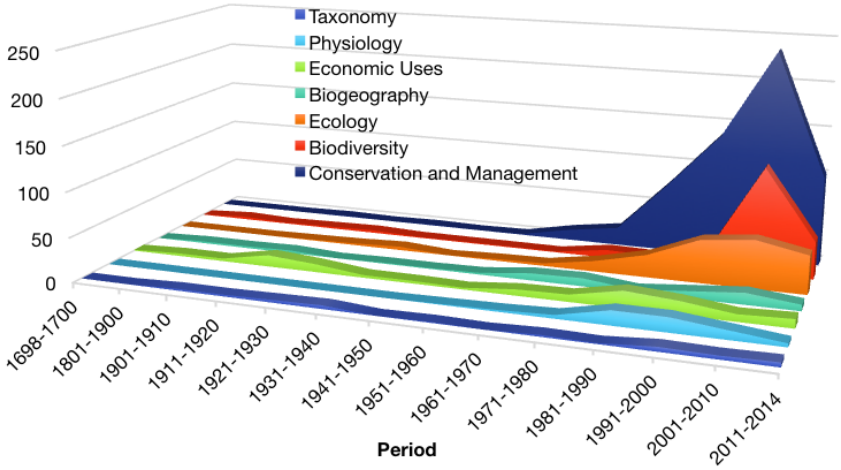


Figure 27. Distribution of literature on mangroves in the Philippines among the seven major research topics and at decadal periods from 1698–2014 (Fortes & Salmo, in press).

From the 1980s up to the present, studies under the seven topics continued with much greater vigor. Hence, in terms of research topics where the 875 literature materials are distributed, **Fig. 27** shows a clear bias towards the topics Conservation and Management, and Biodiversity and Ecology. These topics are fueled by directly aligned emphasis required by the funding institutions, e.g. the Fisheries Sector Program of the Department of Agriculture (FSP, 1992–1993), Coastal Environment Program of the Department of Environment and Natural Resources (CEP, 1993), the National Mangrove Inventory undertaken by the National Mangrove Committee of the then National Resources Management Center (NRMC, 1990s), and Coastal Resources Management Project (CRMP, 1996).

3. Mangrove Literature in the Philippines: Grey vs. Peer-reviewed

Among the 875 published works written during the period 1698–2014, 85% belong to the grey literature, while only 15% are internationally peer-reviewed (**Fig. 28**; Fortes & Salmo, in press). Three important implications of this finding include: (1) there has been huge investment on mangrove studies, which are largely unsystematic, "reactive," and mainly descriptive, not synthetic; (2) mangrove research in the Philippines, having non-robust empirical basis, has largely been marginalized to literature with outcomes having little reliability and predictive value; and (3) with reference to the preponderance of published works dealing with conservation and management (see **Fig. 28**), it is alarming to consider that mangrove conservation and management in the country, despite huge financial investments, lacks scientific inputs.

It should be emphasized, however, that in this paper, both ISI-indexed and grey literature are given equal importance, since it is our intent to mainly point out the history of research on mangroves. More importantly, in conservation and management, we give greater concern to the needs of varied users of the ecosystem's goods and services, plus policy decision makers who have less opportunity to access ISI literature, much less understand and use them directly to address their needs. Hence, the impact factor of an academic journal based solely on the number of citations, when used as a proxy for its relative importance, does not apply here. Interestingly, for a fisher, a boatman or a common local government official, a visually appealing and easily understandable and obtainable poster or a brochure is more useful than a rarely accessible and incomprehensible ISI-indexed article. It is desirable, though, that the latter published materials should result from high quality peer-reviewed journals.

4. Challenges and Opportunities for Mangrove Research and Management

It is clear that the early years of mangrove research in the Philippines is characterized by a high degree of impetus for fundamental research, which is influenced by the bright research atmosphere in the region. This impetus, however, soon waned in favor of direct utilization and protection of the resource infrequently backed only by 'research' with low degree of reliability and predictability (hence, sustainability). The imperatives of the times, however, has changed, characterized by rapidly dwindling coastal resources, largely influenced by equally increasing destruction of the habitats imposed by both natural calamities and human-controlled activities. The time is now calling for a renewed emphasis on research that directly and effectively addresses the need to support conservation and management of the resource. This effort should be focused on sustaining its ecosystem services through developing the resilience of coastal communities in the face of environmental uncertainties. This is

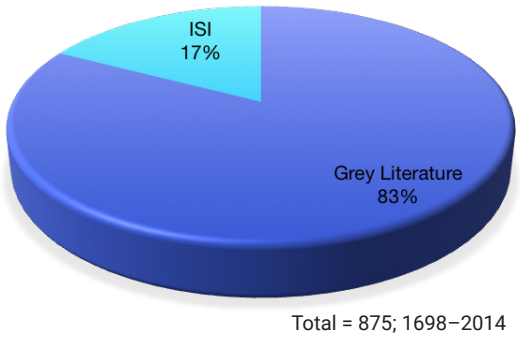


Figure 28. Number of ISI-indexed and grey literature in mangrove studies in the Philippines (1698–2014; Fortes & Salmo, in press).

the greatest challenge posed to mangrove managers. However, it could also be a big opportunity for them to improve and enhance existing practices and outlook on the resource. Some of the aspects of this challenge are discussed below.

5. Mangroves, Climate Change, and Natural Disasters

Although empirical data are still wanting in the Philippines, climate change is affecting mangroves principally through increasing temperature, which will tend to shift the vegetation to higher latitudes. On the other hand, it may cause potential problems through changes in rainfall pattern, increased frequency of storms, altered CO_2 levels, and possibly the impact of ultraviolet radiation. The changes in rainfall pattern now appear to alter flowering in some species in the southern Philippines, while the most obvious impact is the increased intensity of storms, which, in mangrove areas, have uprooted young and newly reforested areas (Fortes & Salmo, in press). If storms or their effects intensify over the next century, mangrove community structure and dynamics would inevitably be altered, bringing about a change in the timing and degree they make available their services to coastal communities.

Accelerated sea level rise (ASLR) is one of the most certain outcomes of global warming. With a coastline of 36,289 km, the Philippines take a serious view of the potential effects and possible responses to ASLR. The physical effects of sea level rise include inundation (submergence) of low-lying wetland and dry land areas, erosion, saltwater intrusion, increased risk of flooding, and storm damage. In turn, these physical changes may cause substantial socio-economic losses of coastal structures, both natural and man-made, and dislocation of the population and change of livelihood. The same physical changes may bring about certain ecological consequences such as redistribution of wetlands, destruction of coral reefs, reduction in biological diversity and loss of wildlife, and changes in the biophysical properties of the coastal zones. To avoid these unwanted changes, it may be necessary to

invoke a range of possible responses such as construction of seawalls and dikes, upgrading of coastal infrastructure in consideration of high water levels, relocation of coastal populations, mangrove regeneration, or other options. The threat of sea level rise (and associated changes in sediment dynamics and salinity) will inundate low-lying mangroves and erode their substratum. If sea level rise accelerates, some additional sites would also begin to slowly deteriorate and submerge. In some areas, the sinking or subsidence of the mangrove system, coupled with human development, is the major cause of wetland loss (Fortes & Salmo, in press).

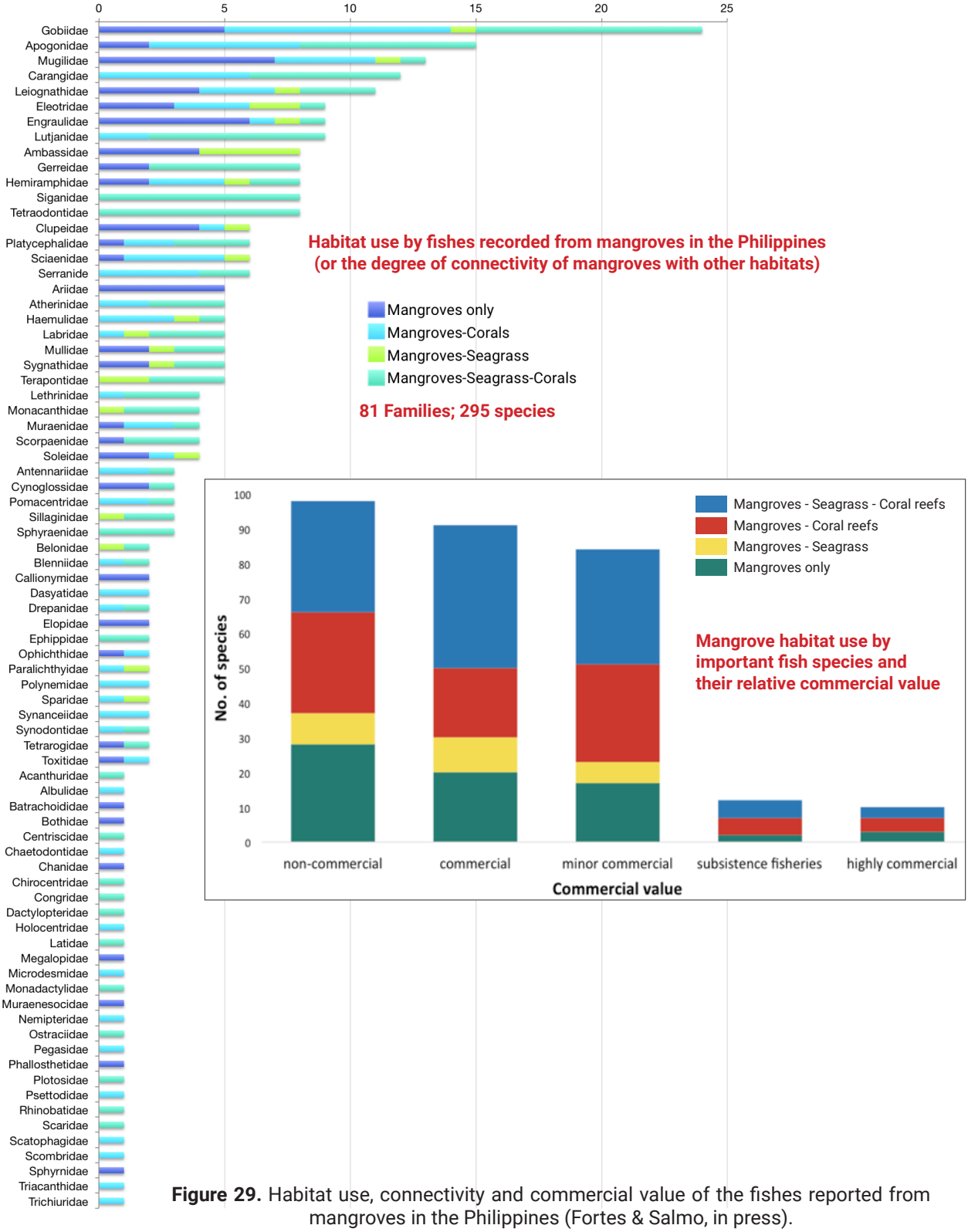


Figure 29. Habitat use, connectivity and commercial value of the fishes reported from mangroves in the Philippines (Fortes & Salmo, in press).

6. Habitat Use, Connectivity and Commercial Value

In the Philippines, a total of 295 fish species belonging to 78 families was found in mangroves, of which 139 can also be found in seagrasses, and 200 also in coral reefs (**Fig. 29**; Fortes & Salmo, in press). **Fig. 29** implies that habitat use by fishes from mangroves may reflect the degree of the connectivity among the habitats. The three most dominant families in terms of number of species listed were Gobiidae (gobies, 24), Apogonidae (cardinalfishes, 15), Mugilidae (mullets, 13 species), Carangidae (jacks and pompanos, 12 species); and Leiognathidae (ponyfishes, 11 species). Majority are carnivores that mainly feed on benthic invertebrates and small fishes. The community overlaps suggest that: (1) mangroves provide additional structural and functional services to those found in adjacent seagrass beds and coral reefs; and (2) these habitats are interconnected through fish migration.

These ecosystem services are not only important in maintaining the population structure of fish and other marine organisms, but also in supporting the livelihood of fishers that depend on fishery resources. Out of the recorded species of mangrove-associated fish, 197 have commercial importance (i.e. highly commercial, commercial, minor commercial, subsistence fisheries). This denotes that the mangrove ecosystem supports 27% of commercial fish species in the Philippines (FishBase 2014) and highlights the contribution of these habitats to food security. This also calls for further protection of this habitat in light of its rapid degradation. More information on the ecosystem services of mangroves are given below.

7. Mangrove Ecosystem Services and Human Well-being

People are aware of the fast depletion of mangroves. They are also aware of the importance of proper supervision of mangrove planting activities. People are currently recognizing that the ecosystem services of mangroves are tied closely with their well-being (**Fig. 30**). **Table 18** gives the status of our knowledge on the integrity of the mangrove ecosystem, and the services it provides, especially to coastal communities (Fortes & Salmo, in press).

8. Systems Analysis of Mangroves

With all the data and information now available, and being generated by numerous sectors and individuals on Philippine mangroves, the time is ripe to seriously adopt a systematic approach to the conservation and management of the natural resource. This way, the interactive nature and interdependence of external and internal factors in the ecosystem will be emphasized and be the focus of continuous studies and research. The outcome could be used to evaluate the ecological and market elements that affect the integrity of the system, and profitability of business initiatives emanating from it. In simpler terms, the approach could help in understanding how components of the ecosystem, living and nonliving (e.g. air, water, movement, plants, and animals), influence one another within one complete unified whole; or in understanding the larger system that makes their lives "healthy" or "unhealthy", or for them to survive or perish. **Fig. 31** (Fortes 2010, modified from MEA 2005) is an example of how the mangroves in the Philippines are looked at using the system analysis approach.

9. Mangroves as a Blue Carbon Ecosystem

The global community established the International Blue Carbon Initiative, a transdisciplinary, global program focused on mitigating climate change through the conservation and restoration of coastal and marine ecosystems. It coordinates the International Group of Experts on Blue Carbon (IGEBC), which has formulated an action agenda to "identify effective, efficient and politically acceptable approaches to reduce the atmospheric concentration of CO_2." Together with the International Blue Carbon Policy Working Group, it provides guidance for needed research, project implementation and policy priorities.

The IGEBC has identified mangroves as a 'blue carbon' ecosystem, together with seagrasses and wetlands. Recent reports produced by the United Nations Environment Programme and International Union for Conservation of Nature (e.g. 'Blue Carbon' and 'The Management of Natural Coastal Carbon Sinks,') found that, when healthy, mangrove forests, saltwater marshlands and seagrass meadows are extremely effective (up to 100 times faster and more permanently than terrestrial forests) at storing atmospheric carbon, thereby mitigating climate change. Hence, by conserving these "blue carbon ecosystems," carbon offsets could be far more cost effective than current approaches focused on trees. Preventing mangrove forest removal gives opportunity for countries to benefit from carbon payments for the preservation of threatened carbon stocks (Barbier et al., 2008). Furthermore, there would be substantial add-on benefits to biodiversity, fisheries, tourism and coastal protection–providing a strong argument for their protection and restoration. On the other hand, Lovelock et al. (2011) provides the first global impacts of carbon emissions that result from coastal ecosystem conversion, in addition to its economic implications. They estimate that 0.15-1.02 Pg (billion tons) of carbon dioxide are being released annually, resulting in economic damages of USD 6–42 billion annually. Indeed, "blue carbon provides a new opportunity for motivating and supporting coastal ecosystems conservation globally, hence, for sustaining the multiple benefits these ecosystems provide."

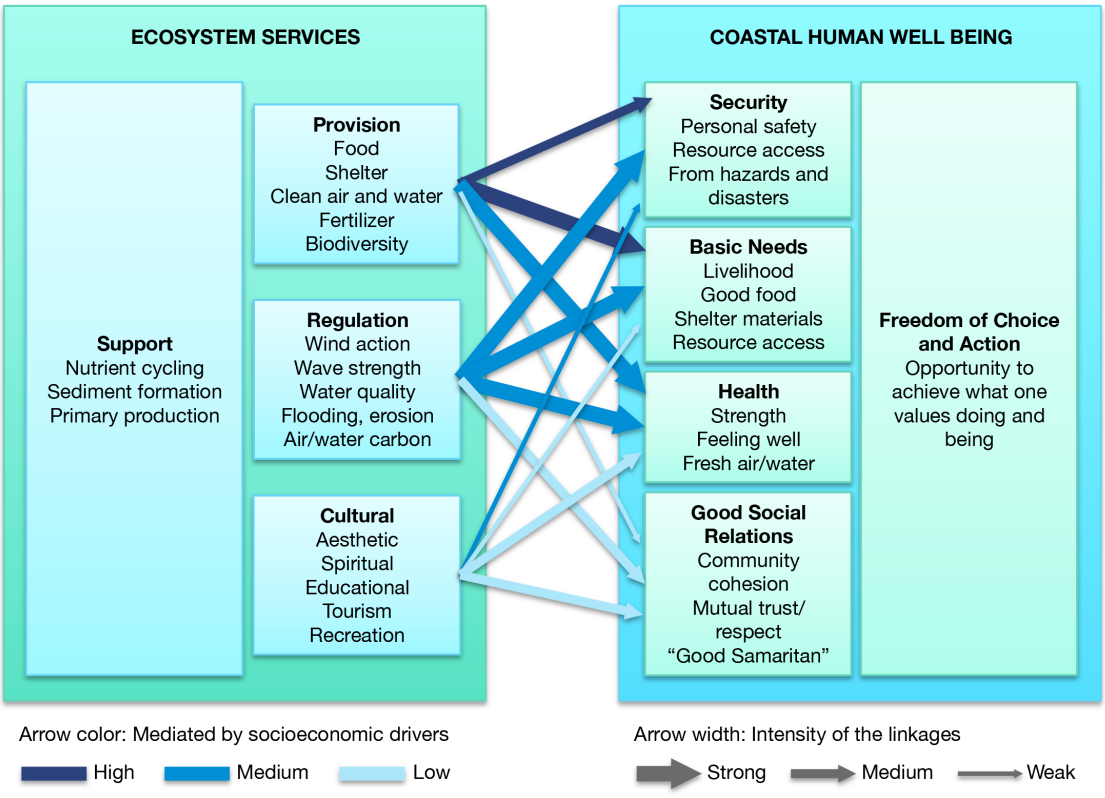
10. Problem in the Decision-Making Process in Community-Based Resource Management

There is a basic defect in natural resources management (including mangrove management) in the Philippines. This defect lies in incomplete or no serious objective-oriented interaction among the players. The major players are Policy (which has the authority and the power to make

Table 18. State of knowledge on mangrove integrity and its goods and services.

Rating	Components	State and Conditions ('traffic lights' and arrows)
	Water quality	Declining water quality due to fragmentation of habitats, pollution, soil erosion; studies recently initiated
	Trends in invasive alien species (IAS)	Largely unknown
	Traditional knowledge and practices	Needs more emphasis and urgent studies
	Goods and services and their economic valuation	Common goods, services largely known, but as largely not valuated
	Conservation and management policies	Many, still increasing, but enforcement remains problem for both

Color of traffic lights indicate the level of urgency: red, very urgent; yellow, moderately urgent; green, less urgent; length of arrows indicate the state of our knowledge on the topic: shortest, not yet known; longest, sufficient.



Fortes 2010 (Modified from MEA 2005)

Figure 30. Matrix of the ecosystem services of mangroves in the Philippines linked with aspects of human well-being (Fortes 2010, modified from MEA 2005).

decisions), the academic institutions or science (which has the knowledge or know-how), and the community (which has the real need to address the issues since they affect their lives and property). Oftentimes, funding agencies (which have the money) and NGOs (non-governmental organizations), which are strong in advocacy, also play a major part. In reality, however, the nature of the interaction among these players can be shown in **Fig. 32**. From the weak and inadequate interactions among the players, there is a need to convert these into the desired actions which are more regular and effective. **Fig. 32** shows that ideally, well-informed decisions should be fully disclosed to the communities.

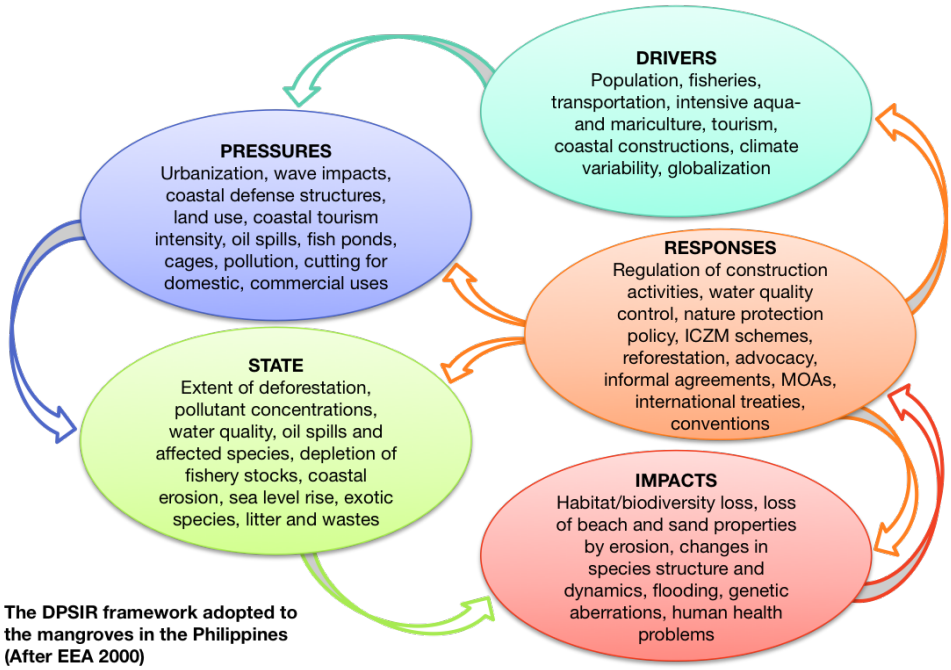


Figure 31. An example of how the mangroves in the Philippines are looked at using the system analysis approach (Fortes & Salmo, in press).

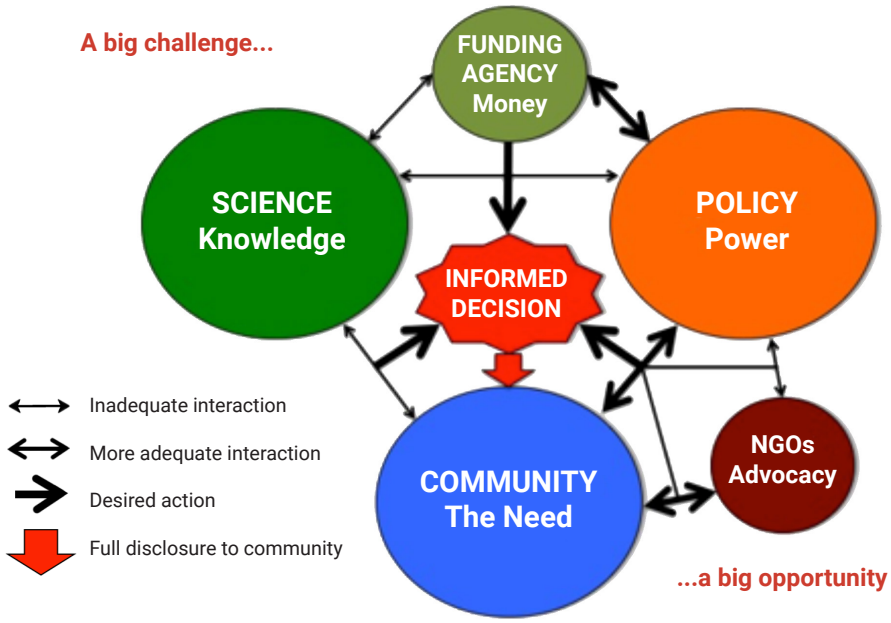


Figure 32. Interactions among the players in the decision-making process in natural resources management in the Philippines.

Table 19. Summary of the status and trends in research and management of mangroves in the Philippines (Fortes & Salmo, in press).

Rating	Components	State and Conditions ('traffic lights' and arrows)
	General knowledge on ecosystem	Good, but needs more focused studies
	Scientific knowledge on ecosystem	Fair, very slowly improving
	Conservation/ management knowledge on ecosystem	Good, but needs to be more science-based
	Total areal extent	Remains unknown, decreasing, but studies increasing in the last 5 years (remote sensing)
	Abundance and distribution of species	Fairly known (plants), both declining trend in species and fragmentation of habitats
	Status of threatened species	Needs more studies
	Genetic diversity of species	Virtually unkown, < 20 works exist in the region, studies proceeding slowly
	Species diversity of ecosystem	Fairly known for flora and fish, less so for other fauna
	Ecosystem diversity	Steady increase in studies
	Coverage of protected areas	Improving with notable increases and expansion; need to improve and document effectiveness

Color of traffic lights indicate the level of urgency: red, very urgent; yellow, moderately urgent; green, less urgent; length of arrows indicate the state of our knowledge on the topic: shortest, not yet known; longest, sufficient.

11. Conclusion

In a nutshell, the status and trends in research and management of mangroves in the Philippines are given in **Table 19** (Fortes & Salmo, in press). Slowly, a new trend is emerging wherein basic foundational research is gaining ground, with the realization that conservation and management cannot be successful and effective without the necessary scientific base. Our main collective challenge, is how to bring together the two worlds of science and policy, emphasizing the role of facilitating, synthesizing, translating and communicating science to inform, e.g. mangrove conservation action.

Acknowledgment

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Workshop output

Table 20. Output for Workshop 1: Core problems and their corresponding causes and effects

		CORE PROBLEMS		
	Core Problem 1: Mismanagement	**Core Problem 2: Siltation and sedimentation**	**Core Problem 3: Mangrove Areas not legally delineated**	**Core Problem 4: Weak coordination**
CAUSES	Socio-economic	Management plan Root causes: 1. No community strategy plan 2. Weak IEC 3. Weak M&E	Poor planning	Too much budget
	Knowledge	Agriculture Root causes: 1. Waste 2. Low IEC	Key players cannot be identified	Weak harmonization of programs between NGAs and LGUs
	Institutional Weakness	Economic Development Root causes: 1. High population 2. Reclamation 3. Relocation (housing)	Identification of who has the legal mandate to protect or rehabilitate	
EFFECTS	- Land use conversion - Employment/income reduction - User conflict - Attitude towards mangrove resources - CC Impact - Loss in supply of marine products - Exposure to natural hazards - Aesthetic/loss of value - Beach erosion - Biodiversity loss - Siltation	- Low ecosystem services - Low survival rate (suffocation) - Pollution - Oceanography sub-effects: 1. Effect on circulation of water 2. Bathymetry	- Waste of budget, time, resources - Duplication of activities - Poor planning - Poor partnership	- Sense of ownership - Waste of money, effort and time - Duplication - Poor partnership and governance

Two workshops were carried out during the two-day State of the Mangrove Summit for Southern Luzon. The workshops aimed to achieve the summit objective of coming up with a plan of action to enhance mangrove management.

The first workshop focused on issue identification and analysis using a problem tree. The main objective was to synthesize and analyze the issues surrounding the mangrove management of Southern Luzon. The participants were divided into three groups. Group 1 included the provinces of Mindoro Oriental and Palawan, representatives from the Institute of Social Order, Conservation International-Philippines, and graduate students from the Ateneo de Manila University. Group 2 consisted of representatives from Cavite, Batangas, Forest Management Bureau (FMB), and graduate students from the Ateneo de Manila University. Lastly, Group 3 was made up of representatives from Marinduque, Romblon, and the University of the Philippines–Marine Science Institute (UP-MSI). Three guide questions were posted to assist the participants. The guide questions are as follows:

1. As mangrove managers, what are the three most pressing problems in the management of mangroves?
2. What are the root causes and effects related to these pressing problems?
3. How are these problems, causes and effects interrelated or interlinked? Please show these through a problem tree.

	Core Problem 5: Poor implementation of mangrove management programs	Core Problem 6: Declining Mangrove Forest Cover	Core Problem 7: Lack of baseline data on mangrove cover
	Lack of community participation	Mangrove Cutting Root cause: Weak enforcement of environmental laws	Poor inter-agency coordination
	Lack of technical personnel Root causes: 1. Poor eco management zoning 2. Lack of science-based approaches in planning and implementation	Fishpond conversion Root cause: Weak enforcement of environmental laws	Institutional crisis
		Charcoal making Root cause: Weak enforcement of environmental laws	Weak dissemination on the use of standard tool on monitoring and reporting
		Land conversion into settlements Root cause: Weak enforcement of environmental laws	Low priority in establishing a mangrove data management
	- Lack of sense of ownership - Sustainability of projects - Low compliance to policy	- Low source of fingerlings - low income of fisherfolks and low fish catch - Siltation of other ecosystems (corals, seagrass beds) - High vulnerability to hazards (e.g. coastal erosion, sea level rise, storm surge) - Poor water quality	- Double reporting - Continuity of program - Inaccurate/ skewed data - Duplication of efforts and initiatives (manpower, resources) - Confusion among stakeholders

Table 20 provides a summary of the problem tree. Seven core problems were identified by the participants, namely: (1) mismanagement; (2) siltation and sedimentation; (3) mangrove areas not legally delineated; (4) weak institutional coordination; (5) poor implementation of mangrove management programs; (6) declining mangrove forest cover; and (7) lack of baseline data on mangrove forest cover. Various causes were identified for these core problems, which ranges from lack of knowledge on mangrove management to poor policy implementation due to weak institutions. The identified effects likewise varied from socio-economic consequences on those directly relying on mangrove resources to low survival of mangroves and consequently, low ecosystem services derived from this resource.

Workshop 2, on the other hand, focused on suggesting solutions for the identified problems from Workshop 1. The participants were grouped into their provinces and were requested to create a project plan. To come up with a plan, the participants started by choosing two core problems identified from Workshop 1, looking at its respective root causes and creating solutions that could address these root causes. These solutions served as the basis for the project plans, which were further detailed by enumerating the needed personnel, materials/ equipment, funding sources and the corresponding timeline for accomplishing it.

Table 21 shows the suggested solutions for the identified problems and its corresponding root causes. Some of the solutions include employing appropriate management interventions; enhancing scientific research to aid mangrove management; harmonizing efforts, policies, programs, and activities related to mangrove management; and community empowerment and awareness.

Table 21. Output for Workshop 2: Project Plan

Problem	Root Cause	Solution
Mismanagement	Institutional weakness	Harmonize programs, projects, activities: - Create multi-sectoral technical working group - Involvement in policy-making - Define roles and functions of each agency involved to avoid overlapping of functions
	Knowledge	Provision of adequate proper education, IEC trainings, capacity building to communities and stakeholders: - Adaption of research output - Provide technical assistance to coastal communities and other stakeholders
Siltation and sedimentation	Economic/Coastal Development	- Science-based data - Mangrove management plan - Policy for the allowed, restricted and prohibited use
	Lack of Management Plan	Development of mangrove management plan or inclusion to ICM plan of the LGU including its business plan
Weak coordination between NGA and LGU	Weak harmonization of programs between NGAs and LGUs	Integration of local and national projects
	Too much funding due to many different sources	Propose an inter-agency/multi-sectoral organization to do proper planning and proper allocation of funds
Poor implementation of mangrove management programs	Lack of community participation	Increase community awareness through IEC
	Poor eco-management zoning	Conduct scientific studies to support zoning
Declining mangrove forest cover	Weak enforcement of environmental laws	Community empowerment/ creation of community based monitoring system
Lack of baseline data	Inter-agency coordination	Harmonization of all mangrove initiatives including gathering and collection of data
	Low priority in establishing mangrove database management	Centralized data banking

Workshop output

Table 20. Output for Workshop 1: Core problems and their corresponding causes and effects

		CORE PROBLEMS		
	Core Problem 1: Mismanagement	**Core Problem 2: Siltation and sedimentation**	**Core Problem 3: Mangrove Areas not legally delineated**	**Core Problem 4: Weak coordination**
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	Low priority in establishing mangrove database management	Centralized data banking

Synthesis

STATE OF THE MANGROVES IN SOUTHERN LUZON: A SYNTHESIS OF EXPERIENCES, LESSONS, AND MANAGEMENT RECOMMENDATIONS

Marie Nathalie S. Ting, Abigail Marie T. Favis, Anne Brigitte Lim, Severino G. Salmo III

I. Biophysical and Socio-economic Setting

Southern Luzon has a shoreline length of 3,932 km with a coastal area of 6,170,917.38 ha. It is made up of 5,071 barangays, 120 municipalities and 27 cities. It is comprised of 20.2 million (20,231,956) people with 32.93% living along the coast (**Table 22**).

Table 22. Provinces in southern Luzon showing total and % coastal population per province

Province	Total Population	Coastal Population (% of total)
Marinduque	234,521 (2015)	~119,136 (50.8%)
Romblon	292,781 (2015)	~259,696 (88.7%)
Palawan	1,104,585 (2015)	908,420 (82.24%)
Mindoro Occidental	487,414 (2015)	
Mindoro Oriental	844,059 (2015)	253,129 (29.99%)
Batangas	2,540,618 (2015)	366,850 (43.06%)
Cavite	3,678,301 (2015)	195,643 (5.32%)
National Capital Region	12,877,253 (2015)	4,559,547 (35.41%)
TOTAL	**20,231, 956**	**6,662,421 (32.93%)**

The coastal ecosystem of Southern Luzon is rich and varied with important socio-economic, cultural and ecological significance. These include bays e.g., Batangas, Balayan, Tayabas, and Ulugan bays; and marine corridors such as the Verde Island Passage.

Mangrove forests were reported to provide various services commonly ranging from socio-economic to ecological services. Socio-economic services include provision of food and other products for human consumption or as a source of income. Common products are wood for charcoal or as housing material, fish, clams and shellfish; other products are honey, vinegar and traditional medicine. Aside from these products, tourism was also reported to be an additional source of income for the provinces of Marinduque, Romblon, Oriental Mindoro, Palawan, Batangas, and the National Capital Region (NCR).

As for ecological services, the most commonly reported benefits of mangroves are as wildlife habitat; as shoreline protection and stabilization; as protection from tsunami and storm surges, tides and currents; as water filtration; as flood and flow control; in breaking down of pollutants, and as a carbon sink.

In addition to these services, several provinces found historical, cultural and spiritual values from mangrove forests. Romblon and Cavite reported that mangrove forests help maintain spiritual and cultural values by providing spaces for recreation and reflection. NCR also mentioned the historical importance of Nilad (*Scyphiphora hydrophylacea*) which used to be abundant in the area, and from which Manila derived its name.

The coastal residents of Southern Luzon primarily rely on fishing and agriculture for their source of income. Secondary to this is the income from other coastal resources, i.e. seaweed farming and shellfish cultivation. Other sources of income are blue-collared work such as carpentry and vending as well as employment in manufacturing industries for provinces with urbanized cities such as Batangas and NCR.

Poverty was identified to be the main social problem experienced by the coastal residents. Financial difficulties may be due to limited livelihood options and limited government and institutional support systems. Moreover, since most coastal residents rely heavily on coastal resources, the decline of fish harvest affects those in the provinces of Oriental Mindoro, Batangas and Cavite. This decline was attributed to overfishing, illegal fishing activities, and coastal reclamation and development. A

third social problem is poor sanitation along the coast. This is due to inadequate solid waste management systems as reported by Romblon, Batangas and Cavite. Other social problems include the lack of potable water system, low compliance with environmental laws and the lack of education.

II. Status of mangroves in Southern Luzon

More than half of the mangroves in the Luzon mainland is found in Southern Luzon. The bulk of this (86.19%) comes from the province of Palawan that has 63,532 ha of mangrove forests and distantly followed by Marinduque with 3,197.78 ha. The smallest share of mangrove forest comes from the more urbanized areas of Cavite and NCR with 150.39 ha and 65 ha of mangrove forests, respectively. Of these, approximately 3,196.96 ha are old stands, 3,521.29 ha are secondary growth forests, and 1,069.62 ha are mangrove plantations (**Table 23**).

There is a total of 33 mangrove species present in Southern Luzon (**Table 24**). The province of Palawan has the highest species richness with 26 species followed by Mindoro Oriental with 21. The province with the least species richness is that of Romblon and Batangas with 13 and 12 species, respectively. The provinces of Marinduque and Cavite were not able to identify the existing mangrove species in their respective provinces. The mangrove species most commonly present among the provinces (in alphabetical order) are *Aegiceras corniculatum*, *Avicennia marina*, *Avicennia officinalis*, *Nypa fruticans*, *Rhizophora apiculata*, *Rhizophora mucronata* and *Sonneratia alba*. Species that are less common include *Acrostichum aureum*, *Bruguiera parviflora*, *Camptostemon philippinense* and *Sonneratia caseolaris*. The hybrid *Rhizophora x lamarckii* is reported in Palawan.

III. Issues and Threats

Similar to the Northern Luzon reports, there are contrasting figures on the actual mangrove extent and distribution practically in all sites. The differences in the estimates can be traced to varying methods and approaches as well as the availability of baseline data to compare with. Records on accounts of species presence and distribution per province are also inconsistent.

Nonetheless, apart from Palawan and Oriental Mindoro, all the other provinces in Southern Luzon reported a decline in their mangrove forests. Palawan reported an increase of 5,192 ha of mangrove areas within the years 2010–2015. Oriental Mindoro recorded a general increase in mangrove forests with losses only in some areas. Rates of losses for the other provinces are negligible. The issues and threats that have caused the decline of mangrove forests have been identified in most sites. The most common anthropogenic issue identified is land conversion—either for aquaculture or legal/illegal human settlement. The second set of identified threats are natural hazards such as typhoons, storm surge, sea level rise, saltwater intrusion, flooding, soil erosion and sedimentation and other effects of climate change.

Other human-induced issues and threats mentioned were cutting of mangroves for materials (e.g. construction materials, firewood, tan barking, and charcoal-making); improper waste management; and incorrect mangrove reforestation practices such as planting of inappropriate species and in inappropriate substrates. The increase in population for residential or for tourist purposes also causes pressure on mangrove and other coastal resources. From 2010 to 2015, there has been an annual population growth rate of 0.59–3.80% in the provinces of Southern Luzon. The province of Cavite has the highest growth rate in the last five years. Provinces, which have experienced rapid urbanization and development along its coasts like Cavite, Batangas and the NCR also seem to have the least mangrove forest cover. A particular threat specific for the province of Marinduque is the occurrences of mine waste dumping along its coastal areas from 1975 to 1994. The mine wastes not only affected the mangrove areas of Marinduque but also the coral reefs, seagrass beds and other coastal habitats. Illegal beach quarrying was also mentioned as a threat for the province of Romblon.

Effects of Mangrove Decline

These issues and threats have various effects on the different provinces of Southern Luzon. The provinces of Marinduque, Romblon, Occidental Mindoro, and Oriental Mindoro reported a decrease in fish catch. Romblon reported an average of 2 kg of fish catch at present in the municipalities of Sta. Fe and Calatrava as compared to the years 2001 and 2005, respectively. Unfortunately, aside from this, there was no other quantifiable data to verify this mangrove decline.

The decline of mangroves also affects the availability of food and other resources for coastal communities. It also leaves coastal dwellers vulnerable to strong winds, tidal waves, storm surges, sea level rise, and coastal erosion. There has also been an observed effect on wildlife biodiversity, such as migratory birds. The LPPCHEA where NCR is located is a stopover for migratory birds journeying the East-Australian flyway. The decline of mangroves affects the availability of food for these birds. Another observed effect is that the seagrass ecosystem becomes prone to runoff and sedimentation with the decline of mangroves.

Table 23. Summary of mangrove information per province showing the total, old and new stands as well as the coverage of mangroves declared as protected areas (in hectares)

Province	Total (Area)	Old Stand	Secondary Growth	Plantation	Mangrove Protected Areas
Marinduque	3,197.78	2,000	747.78	450	-
Romblon	1,263.29	230.22	539.77	493.3	1,114.98
Palawan	63,532			66	63,532
Occidental Mindoro	~2,500	420	2080	0	-
Mindoro Oriental	2,391.72	-	0	219.8	180
Batangas	610.94	517.27	0	93.67	567.04
Cavite	150.39	0	117.74	32.65	-
NCR	65	29.47	36	0	204.47
TOTAL	**73,711.12**	**~3,196.96**	**~3,521.29**	**~1,355.42**	**~65,598.49**

Table 24. List of mangrove species in southern Luzon

Species	Marinduque	Romblon	Palawan	Mindoro Occidental	Mindoro Oriental	Batangas	Cavite	NCR
Acanthus ilicifolius		X			X			
Acrostichum Aureum			X					
Aegiceras corniculatum		X	X	X	X		X	X
Aegiceras floridum	X		X		X			
Avicennia alba		X	X		X	X	X	
Avicennia lanata								
Avicennia marina	X	X	X	X	X	X	X	X
Avicennia officinalis		X		X	X	X	X	X
Avicennia rumphiana		X			X			
Bruguiera cylindrica	X	X	X		X		X	X
Bruguiera gymnorrhiza	X		X	X	X	X	X	
Bruguieria parviflora	X		X					
Bruguiera sexangula			X		X	X		X
Camptostemon philippinense			X					
Ceriops decandra	X		X	X	X	X	X	
Ceriops tagal	X		X	X	X	X		
Excoecarcia agallocha	X			X	X	X	X	X
Heritiera littoralis	X	X	X	X				
Lumnitzera littorea			X	X	X			
Lumnitzera racemosa			X	X	X			X
Nypa Fruticans	X	X	X	X	X		X	X
Osbornia octodonta			X		X			
Pemphis acidula	X			X				
Rhizophora apiculata	X	X	X	X	X	X	X	
Rhizophora x lamarckii			X					
Rhizophora mucronata	X	X	X	X	X	X	X	X
Rhizophora stylosa	X		X	X		X	X	X
Scyphiphora hydrophylacea			X					X
Sonneratia alba	X	X	X	X	X	X	X	X
Sonneratia caseolaris	X						X	
Xylocarpus granatum	X	X	X		X		X	X
Xylocarpus moluccensis			X	X				X
TOTAL	**17**	**13**	**25**	**17**	**21**	**12**	**15**	**14**

Table 25. Provincial mangrove rehabilitation projects/programs

Province	Name of Project	Duration	Funding and Implementing Agencies/ Groups	Hectares of Mangrove Planted/No. of Propagules
Marinduque	DBP Forest Project	2007–2015	Implementer: Provincial Government (PGM), DENR, LGU of Sta. Cruz & Torrijos Funder: Development Bank of the Philippines (DBP)	100 ha & 250,000 propagules
Romblon	Provincial Mangrove Nursery	2012–2014	Implementer: ENRO Funder: Prov. Gov't	0.02 ha
	CRM Project – Mangrove Rehabilitation	2012–2014	Implementer: SIKAT, Inc., LGU Calatrava Funder: DENR, BFAR	25 ha
	Plant Now, Pay Later Program	2012–2014	Implementer: ENRO, MLGU, MFARMC, BFARMC, & POs Funder: Prov. Gov't	Total: 5.95 ha Sta. Fe: 2 Looc: <0.5 Odiongan: 0.35 San Agustin: 0.5 Romblon: 0.5 Banton: 0.5 Calatrava: 1 Magdiwang: 0.3 Cajidiocan: 0.3
		2000–2014	Implementer: LGUs, DENR, SIKAT, Inc. Funder: P/M/ BLGUs	Total: 10.53 Sugod: 0.6 Carmen: 1.8 Cabulutan: 6.1 Dubduban: 1 Dona Juana: 0.5 Bachawan: 0.5
	Planting of Bitaog along coastal barangays	2012–2014	Implementer: LGU, RSU, DENR Funder: MLGU, RSU, DENR	–
	Mangrove Reforestation through Food for Work/ Cash for Work	Jun 2013 – Nov 2013	Implementer: ENRO Funding support: Department of Social Welfare & Development R4B	Total: 7 ha Magdiwang: 1 Cajidiocan: 1 Romblon: 1 San Agustin 1 Looc: 1 Sta. Fe: 1 Alcantara: 1
	Integrated Community-Based CRMP (Rehab. & Conservation of Romblon Passage Marine Corridor)	2011–2013	Implementer: SIKAT, Inc. & LGUs of Romblon Funder: USAID	Planted: 4.3 ha Protected: 34,738 ha
	Integrated CRMP Comprehensive Site Dev.	2011–2012	Implementer: GOP, GEF, DENR, BFAR, DILG, PLGU-ENRO, MLGU, MAO, FARMC, Bantay Dagat Funding support: ADB	322 ha
	Subay Bay Mangrove Reforestation Project	December 2009	Implementation and Monitoring: LGU-Corcuera Romblon State University Funding support: NEDA	10 ha
Palawan	Pista ng Kalikasan program of the Prov. Gov't	Annual planting since 1994	Prov. Gov't, Municipal Government and partner private entities and NGOs	3 ha per year

Project Location/s	Monitoring Mode	Survival Rate (%)	Factors Affecting Survival
Sta. Cruz: 19 barangays Torrijos: 5 barangays	–	88	Typhoons, flooding, pests, resistance from the community to participate, low budget cost, low support from implementing partners and change of political leaders
Odiongan	Daily	70	Typhoons, pests, stray animals, no permanent worker & insufficient budget
Brgy. Balogo, Calatrava, Romblon	Monthly – inventory & mapping	65	Limited funds for seedlings, organizing, planning, mapping & people's participation
Sta. Fe, Looc, Odiongan, San Agustin, Romblon, Banton, Calatrava, Magdiwang, Cajidiocan	Quarterly	Sta. Fe: 75 Looc: 80 Odiongan: 60 San Agustin:70 Banton: 50 Calatrava: 80 Magdiwang: 60 Cajidiocan: 80	Typhoons, monsoon rains, plastics and debris, abnormal weather, & irresponsible planters
Sugod, Carmen, Cabulutan, Dubduban, Dona Juana, Bachawan	Quarterly	Carmen: 50	Natural calamities, improper waste disposal, strong current and waves, stray animals & lack of fund
Brgy. Tan-Agan, Poblacion, Calunacon & Agpudlos of San Andres	–	30	Drought, human and animal destruction, insufficient fund for protection & monitoring, lack of information & dissemination
Magdiwang, Cajidiocan, Romblon, San Agustin, Looc, Sta. Fe, Alcantara	Twice only	Magdiwang: 20 Cajidiocan: 50 Romblon: 50 San Agustin: 5 Looc: 5 Sta. Fe: 5 Alcantara: 5	Typhoon, no sustainability, political intervention
Brgy. Ginablan, Li-o, Agnay, Mapula, Logbon, & Lonos in Romblon municipality	Twice a week; Semi-annual for mangrove assessment		Planted seedlings/propagules disturbed by shell/fish gatherer & waves; waste disposal; coastal development; delays in acceptance of community of cultural adjustment to resource use, project involvement, passage or approving agreement/ policies
Sta. Fe, Cajidiocan, Magdiwang, Odiongan & Ferrol		Sta. Fe: 90 Cajidiocan: 90 Magdiwang: 90 Odiongan: 90 Ferrol: 90	Typhoons & delayed payment of contracts
Subay Bay (Corcuera, Romblon)	Monthly	99	Lack of propagules
	Twice a year	60–70	Mortality of newly established plantation, inadequate fund for maintenance

Table 25 continued...

Province	Name of Project	Duration	Funding and Implementing Agencies/ Groups	Hectares of Mangrove Planted/No. of Propagules
Occidental Mindoro	Mangrove and Beach Forest Development Project (MBFDP)	2015	DENR, LGUs through the M/ BFARMCs	767.1 ha
	DENR Initiative Planting (DENR-CENRO, San Jose)	2014		2 ha
Oriental Mindoro	Mangrove Forest Protection & Ecotourism Site through establishment of MPAs	2001–present	PGOM partner NGOs (CI, Malampaya Foundation)	219.8 ha
	Establishment of mangrove areas & mangrove rehabilitation	2001–present	Prov. Agriculture Office, Fishery & CRM division	
Batangas	Forest Management Project (Mangrove Rehab. & Conservation	Nov 2008 – present	Prov. Gov't, PG ENRO, MENRO, NSTP (tree planting), academic institutions, MENRO (maintenance), First Gas (provision of seedlings), Harbor Star CSR (San Luis)	Total: 7.5 ha Lemery: 7.0 San Luis: 0.5
	Batangas Province Mangrove Rehabilitation Program	Nov 2009 – present	Municipality of Calatagan, CI-Philippines (financial and technical assistance), LGU-MAO (financial and logistic assistance), PO -Pro Mangrove Alliance & Implementing Team as Kilitisan's Advocates of Nature (PALITAKAN)- management body	7.5 ha
Cavite	Rehabilitation Program	2011		32.65 ha
	PPT Public Company mangrove rehabilitation project	2014	LGU-Noveleta, PPT Public Company Limited of Thailand	50,000 propagules
	Mangrove Planting project in celebration of PCG 133th anniversary	2014	PCG, DILG, MENRO, Bureau of Fire Protection, PNP Rosario, Petron Terminal, PCGA Squadron (103rd, 125th & 129th), NSTP students of AIMS, Processing Export Zone Authority (PEZA), Phil. Dental Association Cavite, Brgy. officials of La Isla Bonita and Brgy Ligtong II Rosario Cavite	Total: 2000 propagules La Isla Bonita: 1000 propagules Brgy. Ligtong: 1000 propagules
			Island Cove Hotel and Leisure Park LGU of Bacoor City Kawit Agriculture Offices, FARMC With support of PENRO and DENR-CALABARZON	1 ha
	CGS Cavite: Mangrove Planting & Coastal Clean-up	March 2014	Personnel of Coast Guard Station Cavite PENRO Cavite MENRO Noveleta COPS_EPOD	4000 propagules
NCR	Declaration of LPPCHEA (Pres. Proc. 1412)		PAMB of DENR-NCR	
	Declaration of Brgy. Ord. No. 04-S2011 Tanza as a Marine Tree Park		PAMB of DENR-NCR	

Project Location/s	Monitoring Mode	Survival Rate (%)	Factors Affecting Survival
6 municipalities			
1. MPA – Silonay, Calapan City; San Andres, Baco & Tabinay, Puerto Galera	Monthly; every other week, if necessary	30–60	1. Mangrove cutting 2. Mangrove conversion into fishpond and residential
2. Mangrove Rehabilitation - province wide (219.8 ha)			1.Assessment (substrate, species to be planted) must be done before planting National agency like BFAR, DENR implementing the same project must closely coordinate with local government and community
Lemery & San Luis		Lemery: 85 San Luis: 10	Typhoon & solid waste (upstream)
Calatagan “Ang Pulo”			Typhoon & solid waste (upstream)
Bacoor, Kawit, Cavite, Noveleta, Tanza, Rosario, Naic, Ternate & Maragondon			
Noveleta			
Brgy. Isla Bonita, Brgy Ligtong II of Rosario Cavite			
Bacoor			
Brgy. San Rafael IV, Noveleta, Cavite			
	Regular monitoring since 2008	70	
	Regular monitoring since 2008	70	

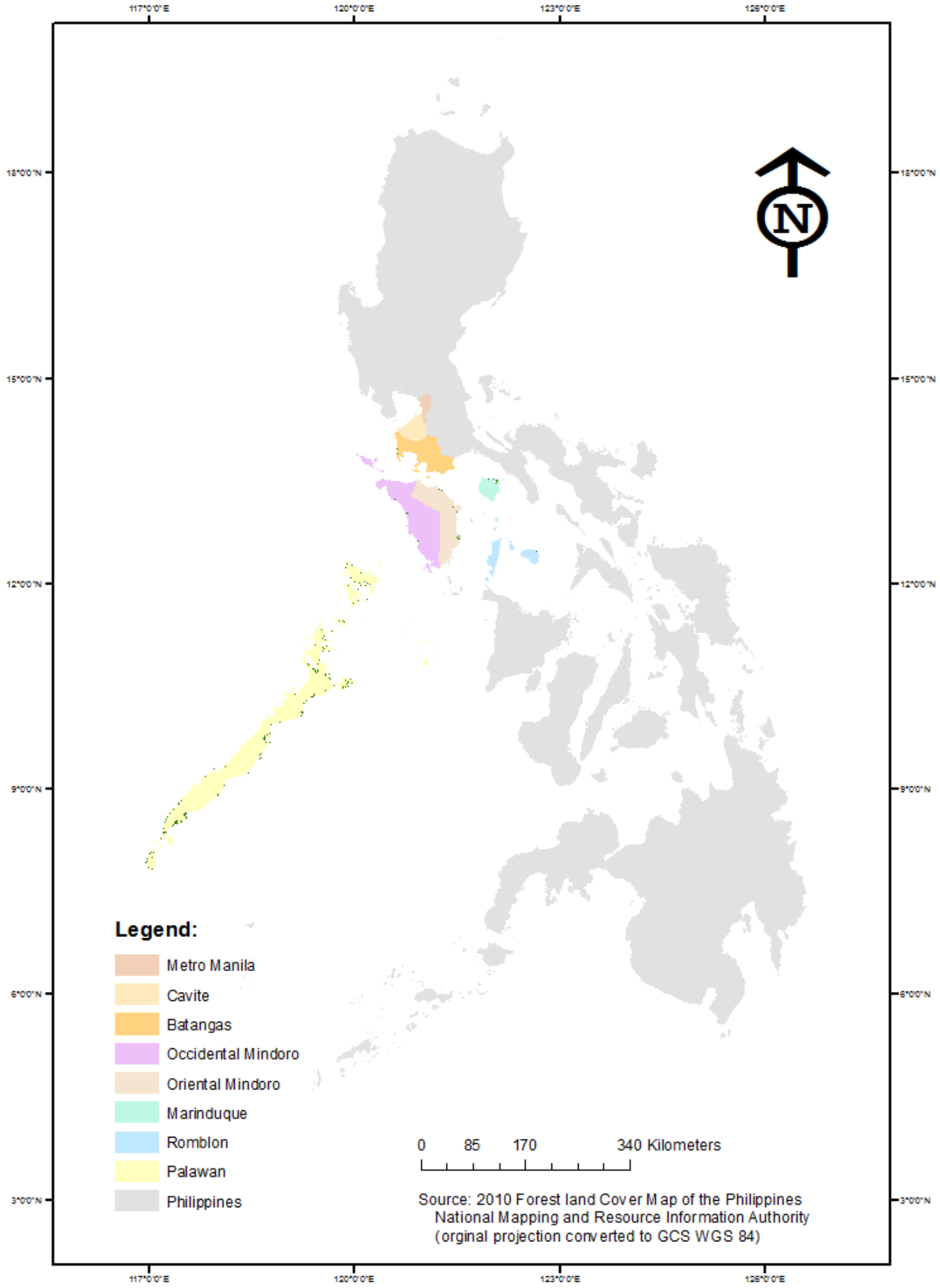

Figure 33. Mangrove map of Southern Luzon (map provided by ACastillo, ERDB and USQ)

IV. Mangrove Management in Southern Luzon

Mangrove management in Southern Luzon may be traced to the declaration of mangrove swamp forest reserves in December 1981 such as that of Sibuyan Island of Romblon as well as the entire island of Palawan (Presidential Proclamation 2152). Since then various mangrove protected areas, marine protected areas and protective ordinances have been declared in the national and local levels.

Apart from the NCR, which reported the declaration of LPPCHEA and Tanza Marine Tree Park as protected areas for their main program, most provinces of Southern Luzon reported the implementation of various mangrove rehabilitation projects or programs. All reported projects or programs involve various stakeholders from national government agencies, local government units, civil society organizations, people's organizations, and even private companies. These rehabilitation projects/programs have been in existence since the year 2000 but the bulk of these activities happened within the last 10 years.

Most of the reported projects are integrated within the respective Integrated Coastal Resource Management programs of the provinces with activities varying from mangrove planting, coastal cleanup and establishment of mangrove nursery for seedlings. Based on provincial reports, there is approximately 1,355.42 ha of mangrove plantation in Southern Luzon, excluding that of Occidental Mindoro and the NCR, which were undeclared. Monitoring of planted seedlings were generally declared to be on a monthly to quarterly basis. Oriental Mindoro has a commendable mangrove restoration and management program. They clearly envisioned that in the year 2020, there will be a 50% increase in forest cover and also 50% of abandoned fish ponds are reverted to mangroves. Along with this vision, is the manifestation of the need to have a clear and accessible records of FLAs.

Oriental Mindoro has declared an established monitoring and evaluation team i.e. the Oriental Mindoro Resource Monitoring team. This group is composed of trained technical personnel that conducts yearly monitoring surveys, which are recorded and analyzed. Romblon, Palawan, Batangas and the NCR also mentioned having monitoring systems, but their systems were not reported in detail. The process of monitoring varies and is not standard across the provinces. Batangas mentioned that monitoring was mostly done by groups who planted them and the process of monitoring was done through counting. On average, the survival rate of planted mangrove seedlings is 62.86%. In particular, the range of the survival rate of mangroves from the declared provinces are as follows: 88% in Marinduque, 5–99% in Romblon, 60–70% in Palawan, 30–60% in Oriental Mindoro, 10–85% in Batangas, and 70% in the NCR.

Factors affecting the survival of the planted seedlings include typhoons, monsoonal rains and flooding, strong current and waves, pests and stray animals, drought, improper waste disposal (e.g. plastics, debris); weak mangrove management, lack of information and dissemination to affected communities; wrong planting method in wrong substrates; and weak implementation of laws, which encourages illegal mangrove cutting and poor coastal development. Low budget, low support from implementing partners, change in political leaders were likewise mentioned.

Table 25 provides a summary of the declared mangrove projects/programs of the Southern Luzon provinces, its duration, agencies involved, number of areas planted, monitoring and survival rates as well as the factors affecting its survival.

V. Experiences and Lessons

The mangrove management experiences in Southern Luzon have evolved over three decades, providing us with a good number of lessons that are relevant in developing the mangrove management system of the country. Across the provinces, the most common experience is the establishment of policies that secure or protect mangrove ecosystems. From the large mangrove swamps of Palawan to the smaller but critical habitats of LPPCHEA and Tanza Marine Park of NCR, Southern Luzon provinces have protected areas that are intended for mangrove conservation and other purposes such as ecotourism and livelihood. Laws may be passed as a means of environmental protection for the ordinary Filipino because of political issues in the country. These laws legitimize the existence of protected areas and provide a concrete basis for claims that may further enhance mangrove conservation and protection.

Another good lesson from Southern Luzon is the need for a holistic and well-informed management of mangrove resources. Most Southern Luzon provinces have created sub-programs to complement their planting activities. These include cash-for-work programs, IEC, livelihood, and management trainings that answer to the socio-economic needs of the communities involved. These sub-programs are haphazard, varied, and far from perfect, yet it is necessary to acknowledge their relevance in garnering community support and aiding in the transition from mere mangrove-users to mangrove protectors. Moreover, practices such as scientific research in the provinces of Oriental Mindoro, Palawan and Batangas also prove to be extremely relevant in making decisions for mangrove management.

Table 26. Comparative table of mangrove areas in Cavite, Batangas, Palawan, Oriental Mindoro and Occidental Mindoro (in hectares)

Province	Long et al (2011)	Songcuan et al (2015)	Reported by Provinces
Cavite	29.23	137.4	150.39
Batangas	503.3	397.6	610.94
Palawan	56,660	43,000	63,532
Oriental Mindoro	2,227	3,260	2,391.72
Occidental Mindoro	1,041	1,386	2,500

Mangrove management will also be effective when it involves a wide range of stakeholders from different organizational levels. Each province reported a certain level of involvement either from national government agencies (NGAs), municipal and barangay local government units, private organizations, non-governmental organizations, people's organizations, and other civic organizations. A wide range of stakeholders secures a wider variety of inputs from political enforcement, personnel, funding, to sharing of best practices and innovative solutions for mangrove management. In addition to this, we also find the involvement of communities to be important in keeping mangrove interventions effective at the local level.

Lastly, the experiences in Southern Luzon emphasize the need to look at the larger picture of mangrove management. As mentioned in Dr. Mamauag's and Dr. Aliño's reports, coastal habitats are interconnected. Mangrove ecosystems are vital to its adjacent ecosystems, namely, seagrass and coral reefs, and vice versa. This characteristic of interconnectedness invites us to review current mangrove management measures. It calls for the development of holistic and integrated CRM in the country, which will help provide answers to the knowledge gaps in the sustainability of mangrove management programs.

VI. Future Directions, Gaps and Recommendations

We synthesize the knowledge gaps that may be necessary to tackle in order to shape the future of mangrove management in the country. An observable gap reported by the provinces is having weak institutional systems. Weak institutions affect the implementation of laws and policies that govern, protect, and conserve mangrove areas. Weak institutions may also be traced back to conflicting agencies and redundant inter-agency policies. A case in point is the abandoned fishpond areas (originally mangrove areas) governed by a Fishpond Lease Agreement (FLA) provided by BFAR. Since the lease is still in effect, owners are not compelled to rehabilitate or reforest these areas despite it being underutilized. Perhaps the existence of a National Mangrove Committee could be helpful in aligning the policies and governing bodies on mangrove resources.

Similar to the experiences in Northwestern Luzon, we emphasize a need to develop monitoring and evaluation systems for mangrove rehabilitation. Southern Luzon provinces have very weakly established systems for monitoring despite projects and programs for >10 years already. Only Oriental Mindoro claims to have an established monitoring system. Standardizing monitoring systems is vital in tracking mangrove forest growth not only in Southern Luzon but across the country. Standardized systems may also result to uniform baseline data, which is also another noticeable gap.

Baseline data collection is an essential starting point for effective interventions. This, as well as data from mapping is extremely relevant in strengthening mangrove management. As mentioned in the study by Songcuan et al. (2015), mapping is essential in visualizing land and sea-use plan. Comparing the data from Long et al. (2011) and Songcuan et al. (2015) versus those reported by the provinces, there is a noticeable difference in the figures (**Table 26**). We are not in the position to claim, which one is more accurate but the point is a uniform baseline data must be identified by aligning methodologies used in gathering it.

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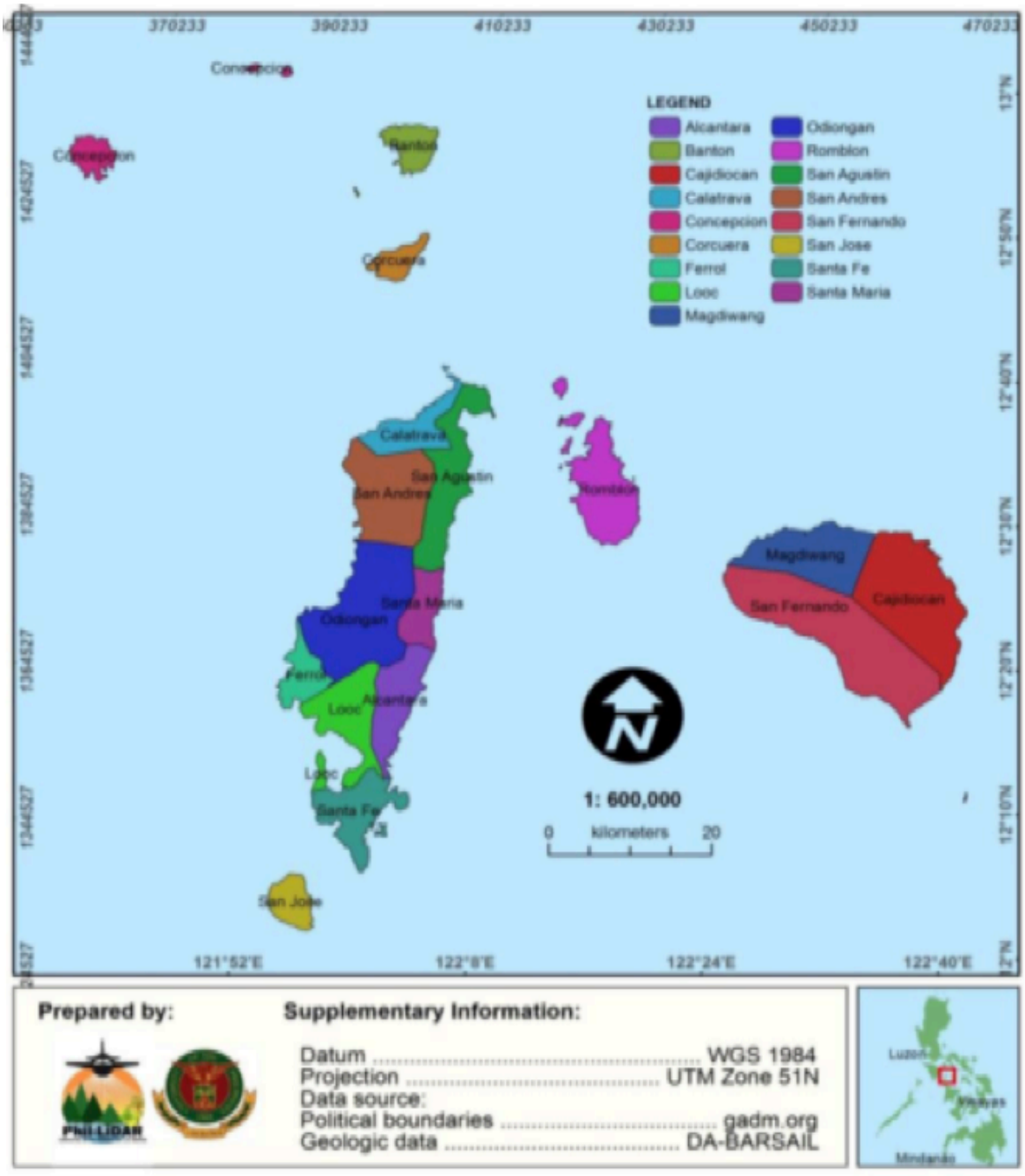
Appendices

Appendix A. Location Map of Romblon



Appendix B. Coastal Barangays of Romblon

MUNICIPALITY	COASTAL BARANGAYS OF ROMBLON
Alcantara (9 out of 12)	Bonlao; Calagonsao; Comod-om; Gui-ob; Lawan; Poblacion; San Isidro; San Roque; Tugdan
Banton (16 out of 17)	Balogo; Banice; Hambian; Lagang; Libtong; Mainit; Nabalay; Nasunogan; Poblacion; Sibay; Toctoc; Togong; Togbongan; Tumalum; Tungonan; Yabawon
Cajidocan (11 out of 14)	Alibagon; Cambajao; Cambijang; Cantagda; Cambalo; Danao; Gutivan; Poblacion; Marigondon; Sugod; Taguilos
Calatrava (6 out of 7)	Balogo; Linao; Pangulo; Poblacion; San Roque; Talisay
Concepcion (9 out of 9)	Bachawan; Calabasahan; Dalahican; Masadya; Masudsud; Poblacion; Sampong; San Pedro; San Vicente
Corcuera (11 out of15)	Alegria; Ambulong; Colong-colong; Ilijan; Labnig; Mabini; Mahaba; Mangansag; Poblacion; San Roque; Tacasan
Ferrol (5 out of 6)	Bunsoran; HInag-uman; Agnocnoc; Poblacion; Tubigon
Looc (10 out of 12)	Agojo; Balatucan; Buenavista; Camandag; Guinhayaan; Manhac; Pili; Poblacion; Punta; Tuguis
Magdiwang (7 out of 9)	Agsao; Agutay; Ambulong; Ipil; Poblacion; Silum; Tampayan
Odiongan (11 out of 25)	Batiano; Budiong; Canduyong; Dapawan; Gabawan; Libertad; Ligaya; Panique; Poctoy; Tabing-Dagat; Tumingad
Romblon (25 out of 31)	Agbudia, Agnaga; Agnay; Agnipa; Agpanabat; Agtongo; Alad; Bagacay; Cajimos; Calabogo; Capaclan; Cobrador; Ginablan; Guimpingan; Lamao; Li-o; Logbon; Lonos; Lunas; Mapola; Palje; Poblacion I; Poblacion II; Sablayan; Sawang
San Agustin (15 out of 15)	Bachawan; Binonga-an; Buli; Cabulutan; Cagboaya; Camantaya; Carmen; Cawayan; Doña Juan; Dubduba; Lusong; Hinugusan; Mahabang Baybay; Poblacion; Sugod
San Andres (7 out of 13)	Agpudlos; Calunacon; Linawan; Mabini; Matutuna; Poblacion; Tan-agan
San Fernando (12 out of 12)	Agtiwa; Mabini; Mabulo; España; Taclobo; Pili; Poblacion; Panangcalan; Camapingo; Azagra; Otod; Canjalon
Santa Fe (9 out of 11)	Agmanic; Canyayo; Guintigbasan; Guinbirayan; Mat-I; Magsaysay; Pandan; Poblacion; Tabugon
San Jose (4 out of 5)	Busay; Lanas; Pinamihagan; Poblacion
Sta Maria (5 out of 6)	Bonga, Concepcion Norte; Concepcion Sur; Paroyhog; Sto Niño

Appendix C. Coastal Areas of Palawan

LIST OF COASTAL BARANGAYS IN THE PROVICE OF PALAWAN			
BARANGAY NAME	MUNICIPALITY	BARANGAY NAME	MUNICIPALITY
Apo-aporawan	Aborlan	Malihud	Bataraza
Aporawan	Aborlan	Malitub	Bataraza
Culandanum (AB)	Aborlan	Marangas	Bataraza
Isaub	Aborlan	Puring	Bataraza
Ramon Magsaysay	Aborlan	Rio Tuba	Bataraza
San Juan (AB)	Aborlan	Sapa	Bataraza
Tagpait	Aborlan	Sarong	Bataraza
Tigman	Aborlan	Sumbiling	Bataraza
		Tabud	Bataraza
Balogo	Araceli	Tagnato	Bataraza
Dagman	Araceli	Tagolango	Bataraza
Dalayawon	Araceli	Taratak	Bataraza
Madoldolon	Araceli	Tarusan	Bataraza
Mauringuen	Araceli		
Osme±a (AC)	Araceli	Barong-barong	Brooke's Point
Poblacion (AC)	Araceli	Calasaguen (BP)	Brooke's Point
San Jose De Oro	Araceli	Ipilan (BP)	Brooke's Point
Sto. Ni±o (AC)	Araceli	Maasin (BP)	Brooke's Point
Taloto	Araceli	Malis	Brooke's Point
Tinintinan	Araceli	Mambalot	Brooke's Point
Tudela	Araceli	Oring-oring	Brooke's Point
		Pangobilian	Brooke's Point
Agutayan	Balabac	Poblacion I (BP)	Brooke's Point
Bancalaan	Balabac	Poblacion II (BP)	Brooke's Point
Bugsuk	Balabac	Salogon	Brooke's Point
Catagupan	Balabac	Samare±ana	Brooke's Point
Indalawan	Balabac	Saraza	Brooke's Point
Malaking ilog	Balabac	Tubtub	Brooke's Point
Mangsee	Balabac		
Melville	Balabac	Bogtong	Busuanga
Pandanan	Balabac	Buluang	Busuanga
Pasig	Balabac	Cheey	Busuanga
Poblacion I (BC)	Balabac	Concepcion (BG)	Busuanga
Poblacion II (BC)	Balabac	Maglalambay	Busuanga
Poblacion III	Balabac	New Busuanga	Busuanga
Rabor	Balabac	New Quezon	Busuanga
Ramos	Balabac	Old Busuanga	Busuanga
Salang	Balabac	Panlaitan	Busuanga
Sebaring	Balabac	Sagrada	Busuanga
		Salvacion (BG)	Busuanga
Bono-bono	Bataraza	San Isidro (BG)	Busuanga
Bulalacao (BZ)	Bataraza	San Rafael (BG)	Busuanga
Buliluyan	Bataraza	Santo Ni±o (BG)	Busuanga
Igang-igang	Bataraza		
Inogbong	Bataraza		

Appendix C continued...

Nusa	Cagayancillo	Jardin	Culion
Mampio	Cagayancillo	Libis	Culion
Santa Cruz (CG)	Cagayancillo	Libis	Culion
Talaga	Cagayancillo	Luac	Culion
Tacas	Cagayancillo	Luac	Culion
Calsada	Cagayancillo	Malaking Patag	Culion
Bantayan	Cagayancillo	Osme±a	Culion
Convento	Cagayancillo	Tiza	Culion
Magsaysay (CG)	Cagayancillo		
Lipot North	Cagayancillo	Balading	Cuyo
Lipot South	Cagayancillo	Bancal	Cuyo
Wahig	Cagayancillo	Cabigsing	Cuyo
Calsada	Cagayancillo	Caburian	Cuyo
Bantayan	Cagayancillo	Caponayan	Cuyo
		Catadman	Cuyo
Banuang Daan	Coron	Funda	Cuyo
Barangay I (CR)	Coron	Lagaoriao	Cuyo
Barangay II (CR)	Coron	Lubid	Cuyo
Barangay III (CR)	Coron	Lungsod	Cuyo
Barangay IV (CR)	Coron	Manamoc	Cuyo
Barangay V (CR)	Coron	Maringian	Cuyo
Barangay VI (CR)	Coron	Pawa	Cuyo
Bintuan	Coron	San Carlos	Cuyo
Borac	Coron	Suba	Cuyo
Buenavista (CR)	Coron	Tenga-tenga	Cuyo
Bulalacao	Coron	Tocadan	Cuyo
Cabugao	Coron		
Decabobo	Coron	Bacao	Dumaran
Decalachao	Coron	Bohol	Dumaran
Guadalupe	Coron	Calasag	Dumaran
Lajala	Coron	Capayas	Dumaran
Malawig	Coron	Catep	Dumaran
Marcilla	Coron	Culasian (DM)	Dumaran
San Jose (CR)	Coron	Danleg	Dumaran
San Nicolas (CR)	Coron	Ilian	Dumaran
Tagumpay (CR)	Coron	Latungay	Dumaran
Tara	Coron	Magsaysay (DM)	Dumaran
Turda	Coron	Poblacion (DM)	Dumaran
YKR	Coron	Poblacion (DM)	Dumaran
		San Juan (DM)	Dumaran
Balala	Culion	Santa Teresita	Dumaran
Baldat	Culion	Santo Tomas (DM)	Dumaran
Binudac	Culion		
Burabod	Culion	Aberawan	El Nido
Carabao Lumber*	Culion	Corong-corong	El Nido
Culango	Culion	Mabini (EL)	El Nido
Galoc	Culion	Manlag	El Nido
Halsey	Culion	Masagana	El Nido

Appendix C continued...

New ibahay	El Nido	Bagong Sikat (PP)	Puerto Princesa City
San Fernando	El Nido	Bagong Silang	Puerto Princesa City
Sibaltan	El Nido	Bahile	Puerto Princesa City
Teneguiban	El Nido	Bancao-bancao	Puerto Princesa City
Villa Libertad	El Nido	Barangay ng mga Mangi	Puerto Princesa City
Villa Paz	El Nido	Binduyan	Puerto Princesa City
		Buenavista (PP)	Puerto Princesa City
Kalayaan	Kalayaan	Cabayugan	Puerto Princesa City
		Concepcion (PP)	Puerto Princesa City
Barangonan	Linapacan	Inagawan	Puerto Princesa City
Cabunlawan	Linapacan	Inagawan sub-colony	Puerto Princesa City
Calibangbangan	Linapacan	Irawan	Puerto Princesa City
Decabaitot	Linapacan	Iwahig (PP)	Puerto Princesa City
Maroyogroyog	Linapacan	Kamuning	Puerto Princesa City
Nangalao	Linapacan	Langogan	Puerto Princesa City
New Culaylayan	Linapacan	Liwanag	Puerto Princesa City
Pical	Linapacan	Lucbuan (PP)	Puerto Princesa City
San Miguel (LP)	Linapacan	Luzviminda	Puerto Princesa City
San Nicolas (LP)	Linapacan	Mabuhay	Puerto Princesa City
		Macarascas	Puerto Princesa City
Alcoba	Magsaysay	Manalo	Puerto Princesa City
Balaguen	Magsaysay	Mandaragat	Puerto Princesa City
Canipo	Magsaysay	Marufinas	Puerto Princesa City
Cocoro	Magsaysay	Maruyogon	Puerto Princesa City
Emilod	Magsaysay	Masigla	Puerto Princesa City
Igabas	Magsaysay	Masipag	Puerto Princesa City
Los Angeles	Magsaysay	Matahimik	Puerto Princesa City
Lucbuan (MG)	Magsaysay	Maunlad	Puerto Princesa City
Rizal (MG)	Magsaysay	Napsan	Puerto Princesa City
		New Panggangan	Puerto Princesa City
Antipuluan	Narra	Pagkakaisa	Puerto Princesa City
Aramaywan (NR)	Narra	Salvacion (PP)	Puerto Princesa City
Batang-batang	Narra	San Jose (PP)	Puerto Princesa City
Burirao	Narra	San Manuel	Puerto Princesa City
Caguisan	Narra	San Miguel (PP)	Puerto Princesa City
Calategas	Narra	San Pedro	Puerto Princesa City
Ipilan (NR)	Narra	San Rafael (PP)	Puerto Princesa City
Malatgao (NR)	Narra	Santa Cruz (PP)	Puerto Princesa City
Panacan	Narra	Santa Lourdes	Puerto Princesa City
San Isidro	Narra	Santa Lucia	Puerto Princesa City
Tacras	Narra	Santa Monica	Puerto Princesa City
Teresa	Narra	Seaside	Puerto Princesa City
Tinagong Dagat	Narra	Sicsican	Puerto Princesa City
		Simpocan	Puerto Princesa City
Babuyan	Puerto Princesa City	Tagburos	Puerto Princesa City
Bacungan	Puerto Princesa City	Tagumpay (PP)	Puerto Princesa City
Bagong Bayan (PP)	Puerto Princesa City	Tanabag	Puerto Princesa City
Bagong Pag-Asa	Puerto Princesa City	Tiniguiban	Puerto Princesa City

Appendix C continued...

Aramaywan (QZ)	Quezon	Kemdeng	San Vicente
Berong	Quezon	New Agutaya	San Vicente
Calumpang	Quezon	New Canipo	San Vicente
Isugod	Quezon	Poblacion (SV)	San Vicente
Maasin (QZ)	Quezon	Port Barton	San Vicente
Panitian (QZ)	Quezon	San Isidro (SV)	San Vicente
Quinlogan	Quezon	Santo Ni±o (SV)	San Vicente
Sowangan	Quezon		
Tabon	Quezon	Banbanan	Tay
Tagusao	Quezon	Alacalian	Tay
Bunog	Rizal	Abo-abo	Espa±ola
Campong Ulay	Rizal	Calasaguen (ES)	Espa±ola
Candawaga	Rizal	Iraray	Espa±ola
Canipaan	Rizal	Isumbo	Espa±ola
Culasian (RZ)	Rizal	Labog	Espa±ola
Iraan (RZ)	Rizal	Panitian (ES)	Espa±ola
Latud	Rizal	Pulot Shore	Espa±ola
Panalingaan	Rizal	Punang	Espa±ola
Punta Baja	Rizal		
Ransang	Rizal	Abongan	Taytay
Taburi	Rizal	Alacalian	Taytay
		Banbanan	Taytay
Abaroan	Roxas	Bantulan	Taytay
Barangay I (RX)	Roxas	Baras	Taytay
Barangay II (RX)	Roxas	Batas	Taytay
Barangay III (RX)	Roxas	Bato	Taytay
Barangay IV (RX)	Roxas	Biton	Taytay
Barangay V (RX)	Roxas	Busy bees	Taytay
Barangay VI (RX)	Roxas	Calawag	Taytay
Caramay	Roxas	Casian	Taytay
Jolo	Roxas	Debangan	Taytay
Malcampo	Roxas	Depla	Taytay
Minara	Roxas	Liminangcong	Taytay
New Cuyo	Roxas	Mayteguid	Taytay
Nicanor Zabala	Roxas	Minapla	Taytay
Retac	Roxas	New Guinlo	Taytay
Rizal (RX)	Roxas	Old Guinlo	Taytay
Salvacion (RX)	Roxas	Paly	Taytay
San Miguel (RX)	Roxas	Pamantolon	Taytay
San Nicolas (RX)	Roxas	Pancol	Taytay
Sandoval (RX)	Roxas	Poblacion	Taytay
Taradungan	Roxas	Polariquen	Taytay
Tinitian	Roxas	San Jose	Taytay
Tumarbong	Roxas	Sandoval	Taytay
		Silanga	Taytay
Alimanguan	San Vicente	Tumbod	Taytay
Binga	San Vicente		
Caruray	San Vicente		

Appendix D. List of coastal barangays in Occidental Mindoro

MUNICIPALITIES	BARANGAYS
Abra de Ilog	Lumangbayan, Udalo (Camurong), Wawa
Calintaan	Concepcion, Iriron, Poblacion
Looc	Agkawayan, Ambil, Balikyas, Bonbon, Bulacan, Guitna, Kanluran
Lubang	Binakas, Cabra, Maligaya, Maliig, Tagbac, Tangal, Tilik, Vigo, Banaag at Pag-asa, Maguinhawa, Ninikat ng Pag-asa
Mamburao	Balansay, Fatima (Tii), Payompon, Talabaan, Tayamaan, Brgy. 2 (Pob), Brgy. 5 (Pob), Brgy 7 (Pob)
Paluan	Harrison, Lumangbayan, Mananao, Marikit, Brgy. 1, Brgy. 2, Brgy. 3, Brgy. 4, Brgy. 5, Brgy. 6, Tubili
Magsaysay	Alibog, Caguray, Calawag, Laste, Sta. Teresa, Sibalat
Sta. Cruz	Barahan, Dayap, Lumangbayan, Pob. 1, San Vicente, Pob. 2
Sablayan	Burgos, Gen. Emilio Aguinaldo, Ligaya, Poblacion, Sta. Lucia, Caludio Salgado
San Jose	Ambulong, Ansiray, Bagong Sikat, Bangkal, Bubog, Buri, Camburay, Caminawit, Catayungan, Ilin Proper, INasakan, Ipil, Labangan ilin, Natandol, Pag-asa, Pawican, San Roque
Rizal	Adela, Rumbang, Salvacion

Appendix E. List of coastal barangays in Oriental Mindoro

MUNICIPALITY	BARANGAY
Pto. Galera	Aninuan, Sinandigan, San Antonio, Poblacion, Dulangan, Balatero, Sto Nino, San Isidro, Sabang, Palangan, Tabinay, Villaflor,
San Teodoro	Ilag, Poblacio, Tacligan, Lumangbayan
Baco	Water, San Andres, Cabulo, Pulang-Tubis, Pambisan, Tabon tabon,
Calapan City	Wawa, Mahal na Pangalan, Baruyan Balite, Pachoca, Tibag, Ibaba East, Ibaba West, Calero, San Rafael, San Antonio, Lazareto, Silonay, Parang, Suqui, Gutad, Nag-iba 1, Navotas, Maidlang
Naujan	Nag-iba 2, San Antonio, Estrella, Sta Cruz, San Jose I, Melgar A, Melgar B, Montemayor, Masaguing, Hererra, Kalinisan,
Pola	Bacawan, Buhay na Tubig, Calima, Batuhan, Zone I (Bayanan), Zone 2 (Poblacion), Tiguihan, Putting cacao, Tagumpay, Misong,
Pinamalayan	Ranzo, Banilad, Pili, Quinabigan, Guinhawa, Wawa, Zone 1 (Poblacion), Lumangbayan, Papandayan.
Gloria	Tambong, Balite, Sta Theresa, Kawit, San Antonio, Maragooc, Guimbonan, Agsalin
Bansud	Proper Bansud, Proper Tiguisan, Sumagui, Salcedo
Bongabong	Labasan, Anilao, Cawayan, Poblacion, Aplaya, Masaguisi, Camantigue, Dayhagan,
Roxas	San Isidro, Paclasan, Danggay, San Jose-Dalahica, Bagumbayan
Mansalay	Wasig, Sta Brigida, B del Mundo, Cagulong, Poblacion, Cabalwa, Manaul, Budburan
Bulalacao	San Roque, San Juan, Poblacion, Milagrosa, San Francisco, Maujan, Balatasan, Maasin

Appendix F. List of Districts, Cities, Municipalities and Barangays of Cavite including its land area

CITY/MUNICIPALITY	LAND AREA (ha)	% DISTR.	NO. OF BRGYS
1st DISTRICT	3,631	2.54	143
Cavite City	1,183	0.83	84
Kawit	1,340	0.94	23
Noveleta	567	0.4	16
Rosario	541	0.38	20
2nd DISTRICT	5,240	3.67	73
City of Bacoor	5,240	3.67	73
3rd DISTRICT	9,701	6.8	97
City of Imus	9,701	6.8	97
4th DISTRICT	8,234	5.77	73
City of Dasmariñas	8,234	5.77	73
5th DISTRICT	19,671	13.78	105
Carmona	3,092	2.17	14
Silang	15,641	10.96	27
GMA	938	0.66	64
6th DISTRICT	30,105	21.1	119
Trece Martires City	3,917	2.74	13
Gen. Trias	11,768	8.25	32
Tanza	9,630	6.75	33
Amadeo	4,790	3.36	41
7th DISTRICT	66,124	46.34	219
Tagaytay City	6,615	4.63	35
Allfonso	6,460	4.53	26
GEA/BAILEN	5,103	3.58	14
Indang	8,920	6.25	36
Magallanes	7,860	5.5	16
Maragondon	16,549	11.6	27
Mendez	1,667	1.17	25
Naic	8,600	6.03	30
Ternate	4,350	3.05	10
TOTAL	**142,706**	**100**	**829**

Appendix G. Coastal Barangays of the National Capital Region

BARANGAY ALONG MANILA BAY

NAME_3	Shape_Length	Shape_Area
Daniel Fajardo	2400.436112	197725.477505
Elias Aldana	2717.785132	233345.050265
Ilaya	2161.73583	114262.941032
Manuyo Uno	5911.44474	977206.881029
Pulang Lupa Uno	7850.976365	1667364.815951
Barangay 100	900.474949	45774.082059
Barangay 101	1785.57928	132075.274271
Barangay 105	744.375727	33091.269389
Barangay 106	352.717598	7291.008809
Barangay 107	1144.04482	78869.069912
Barangay 110	625.991818	24427.133176
Barangay 112	752.023943	35342.391413
Barangay 116	654.647846	26081.739911
Barangay 118	968.050653	48336.098836
Barangay 119	895.036115	35068.563335
Barangay 123	408.426768	10325.131006
Barangay 124	814.473464	12995.92674
Barangay 125	334.230294	5129.897982
Barangay 127	741.195506	29562.295442
Barangay 129	1336.901282	41617.567605
Barangay 131	921.975786	30376.340936
Barangay 138	696.600333	26988.050133
Barangay 20	5888.63235	509013.623662
Barangay 275	6858.828869	1151743.127692
Barangay 30	1681.049647	78351.054269
Barangay 39	1045.052341	33648.174343
Barangay 44	765.017137	28473.663031
Barangay 649	7743.561239	848725.238791
Barangay 650	1455.539089	113887.967025
Barangay 651	1010.689934	62470.94385
Barangay 652	864.250753	45320.890184
Barangay 653	9012.414324	1059198.914989
Barangay 666	1848.000654	99033.118897
Barangay 667	1366.341745	114746.035749
Barangay 668	1410.31497	122631.830006
Barangay 699	1624.246309	141024.954901
Barangay 700	915.644655	32835.524459
Barangay 701	1546.418192	156567.310783
Barangay 704	785.222284	26820.318693
Barangay 715	313.618977	5468.763683
Barangay 719	1802.496821	164383.976764
Barangay 72	677.959153	25463.270481
Barangay 720	307.698183	5378.49272
Barangay 721	767.961245	32321.240716
Bagumbayan North	511.910231	16662.323849
Bagumbayan South	716.511817	27081.399973
Bangculasi	2820.481882	295376.392925
Daanghari	2608.494252	376847.966842
Navotas East	1103.705076	37916.672117
North Bay Blvd., North	1981.674894	217092.999331
North Bay Blvd., South	4242.557135	895324.307005
San Jose	2475.133266	337616.559779
San Rafael Village	4704.615577	376153.497528
San Roque	1982.2115	215475.003338
Sipac-Almacen	1549.623713	110411.298562
Tangos	1947.268133	221310.272365
Baclaran	6208.520688	1850170.860272
Don Galo	2262.665511	313708.63947
La Huerta	7360.815633	1013089.35307
San Dionisio	13569.196182	3518750.489189
Tambo	11475.642769	4606300.02832
Barangay 1	778.490715	32388.463249
Barangay 10	732.636489	28084.516028
Barangay 11	659.899401	18452.562488
Barangay 12	667.403274	18606.890126
Barangay 13	1557.679759	135957.2741
Barangay 15	915.45747	42864.549656
Barangay 2	658.596735	22950.352102
Barangay 3	639.434034	18017.429819
Barangay 33	1259.156821	72791.289087
Barangay 4	731.990408	27910.843642
Barangay 5	610.266347	13090.347751
Barangay 6	621.525169	14623.430658
Barangay 7	718.941803	25121.494081
Barangay 76	6345.238108	2216271.250202
Barangay 8	663.706526	19739.764518
Barangay 9	615.856097	14778.90811

ERDB TECHNICAL BULLETIN NO. 1

MBFDP - SITE VALIDATION AND ASSESSMENT

RATIONALE

The Mangrove and Beach Forest Development Project (MBFDP) is intended to develop and rehabilitate mangrove and beach forests in disaster-affected areas as a means to improve and enhance the natural defenses and resilience of the country's coastlines and its environs vis-à-vis the impacts of climate change. Following a systematic approach, **site validatio**n covers activities to confirm the geographical location (GPS points) of planting sites that were initially identified and mapped (shapefiles) by the CENROs/PENROs based on agreed targets. Assessment determines the suitability of the site including the identification of species most suitable to the site and other environmental conditions that need to be considered in the actual planting activities. A multi-disciplinary team comprised of members with sufficient experience in GIS and mapping, mangrove ecology and marine or environmental science will conduct the site validation and assessment. The output of the activity serves as reference for baselining and plantation establishment.

METHODOLOGY

2.1. Upload waypoints or shapefiles generated from the site identification and mapping using a Global Position System (GPS) or Android device. Using the uploaded data, locate on the ground the boundaries of identified/delineated mangrove and beach forest areas.

2.2. Obtain a site-specific tide table prior to ground validation. Tide table or information can be obtained online (e.g. http://www.mobilegeographics.com) or in commercial calendars.

2.3. Conduct the ground validation for mangroves during low tide and high tide to get the range of the intertidal area suitable for plantation establighment. Assessment of the identified sites must be done in terms of species composition, zonation, substrate type, tidal inundation, occurrence of barnacles, and exposure to waves and monsoon wind.

2.4. For beach forest area, extant vegetation, species distribution or zonation, soil type and existing land use within the beach forest area must be recorded. These information must be added as attributes during the preparation of validated map (Table1). Geotagged photos of validated sites (HD quality) using GeoCam android application must also be submitted to ERDB. KMLZ applications may be used to create KMZ files from geotagged photos.

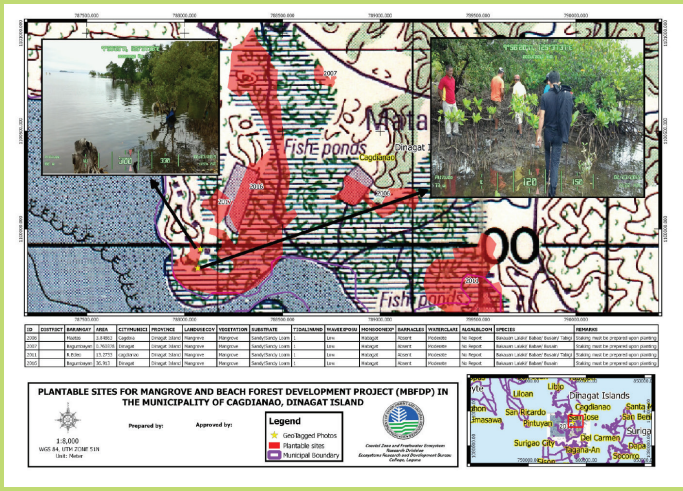
2.5. Determination of the suitability of the site for mangrove plantation establishment shall be based on the four criteria: (1) areas with remnant mangrove vegetation, (2) exposed 3-4 hours after highest tide, (3) areas with low energy waves (Melana et al., 2000; Primavera et al., 2012), and (4) firm substrate (foot do not sink above ankle). Areas with seagrasses and heavy barnacle infestation are not recommended planting sites for mangroves, and those areas with land use conflict. For beach forest, the proposed planting site should have existing or adjacent beach vegetation, mother trees and wildlings.

EXPECTED OUTPUT

The expected output includes a preliminary report on the biophysical characteristics and maps of the potential or suitable planting sites. Maps may be generated using ArcGIS or Manifold software. Map files must be in shapefile format with UTM projection and WGS84 datum. If site validation and assessment are undertaken by the CENROs/PENROs, the report and map files should be submitted to their respective Regional Offices for consolidation. The Regional Office should provide the ERDB-MBFDP Project Management Office with the consolidated report and map files.

Table 1. List of attributes that will be included in the validation map.

Required Field	Field Properties	Description	Sample Entry
Province	Text (50 Char)	Name of Province	Palawan
Mun_City	Text (50 Char)	Name of City/Municipality	Coron
District	Text (50 Char)	District Number	District I
Brgy	Text (50 Char)	Name of Barangay	Barangay I
Veg_Type	Text (100 Char)	Mangrove/Associate/Beach Forest	Mangrove
Area	Double (10, 4)	Area of Mangrove/Beach Forest Plantation Site (ha)	200 ha
LUC	Text (100 Char)	Close/Open Forest; Built up areas; Agricultural; Commercial/Recreational	Commercial (Beach Resort)
Species	Text (300 Char)	Species Present	Rhizophora sp.; Avicennia sp.
Substrat	Text (100 Char)	Sandy/Muddy/Clay/Rubble	Sandy-Muddy
Tidal_In	Double	Depth (meters)	0.5
Wave_Ex	Text (100 Char)	High, Moderate, Low	Low
ME	Text (100 Char)	Amihan (NEM)/Habagat (SWM)	Habagat
Barnacle	Text (100 Char)	Present/Absent	Present
Water_C	Text (100 Char)	Poor/Moderate/High	Poor
Algal_B	Text (100 Char)	Frequent/Seldom/No Report	No Report
Remarks	Text (300 Char)	Other Information (e.g. other government/NGO projects in the site/presence of claimants, etc)	



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ERDB TECHNICAL BULLETIN NO. 2
MBFDP - BASELINE SURVEY

RATIONALE

The Mangrove and Beach Forest Development Project (MBFDP) is intended to develop and rehabilitate mangrove and beach forest in disaster-affected areas as a means to improve and enhance the natural defenses and resilience of the country's coastlines and its environs vis-a-vis the impacts of climate change. Baseline survey of duly validated project sites for mangrove and beach forest development is intended to provide quantitative information on the present condition of the sites measured in terms of flora and fauna diversity indices, soil and water physico-chemical properties, and socioeconomic characteristics of nearby coastal communities. Results of the survey are essential in project monitoring and evaluation and impact assessment measured in terms of improvement in species composition of flora and fauna including the overall environmental condition. Baselining shall be carried out by a multidisciplinary core team with adequate knowledge in the abovementioned fields of science.

Specific sites for baselining shall be selected from validated sites that will be used for mangrove and beach forest planting for 2015 under MBFDP upon the recommendation of the PENRO/CENRO. Each province shall have one (1) candidate site for baselining. Criteria for site identification are as follows: 1) a contiguous area of 50 to 100 ha; 2) in proximal distance to a community who will also be tapped in mangrove planting and maintenance; 3) relatively peaceful; and 4) accessible.

METHODOLOGY

A. Mangrove Vegetation Assessment

1. A transect line shall be established perpendicular to the coastline from the seaward to landward extent of the mangrove forest. The transect shall run twice or thrice depending on the width of the mangrove. The interval between transect lines shall be between 50m or 100m depending on the size of the area. The length of the transect line shall depend on mangrove seaward-landward extent reckoned from the farthest low tide of neap tide. For each transect line, six (6) circular plots of 7-m radius (0.00154 ha or 154 m2) shall be established at an interval of 10-20m. These plots shall be used for trees with diameter at breast height (dbh) > 5cm. For each circular plot with a 7-m radius, a smaller plot (2-m radius from the plot center) shall be delineated and used for trees with dbh of less than 5cm (Figure 1). Two 1m x 1m plots at the front and rear ends of each 7m-radius shall be located to quantify the plants with height below 1.3m (e.g. seedlings, shrubs and herbaceous plants). All vegetation within each duly designated plot shall be identified and counted. The main stem tree diameter or dbh shall be at 1.3m above the ground. For stilt rooted species (e.g. *Rhizophora* spp.), the dbh shall be measured above the highest stilt root (Figure 2) (FAO, 1994; Kauffman and Donato, 2012).

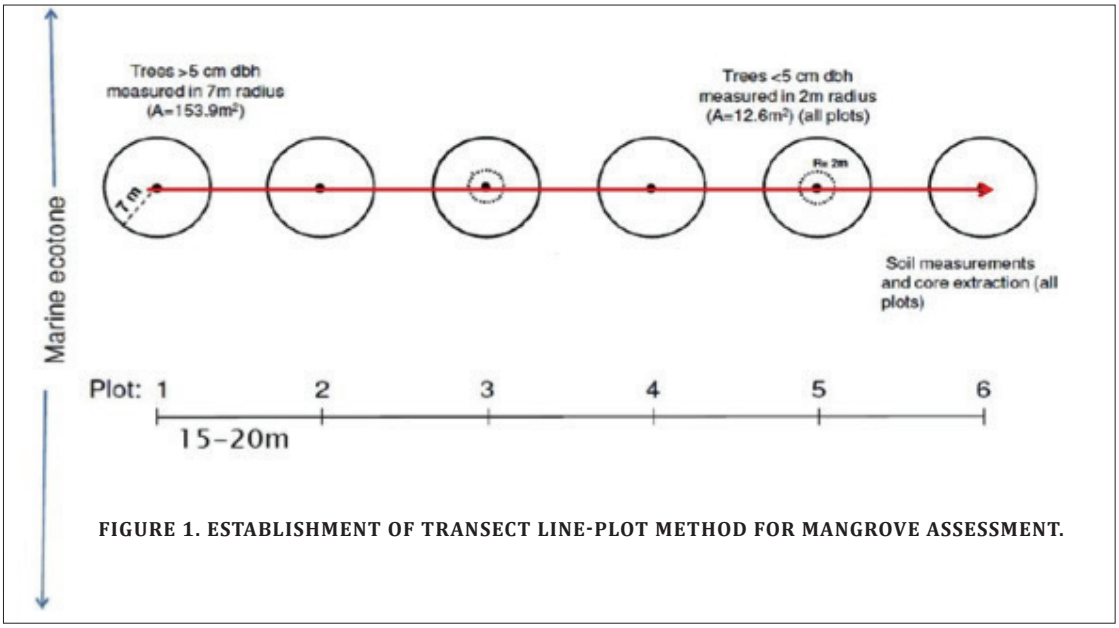


FIGURE 1. ESTABLISHMENT OF TRANSECT LINE-PLOT METHOD FOR MANGROVE ASSESSMENT.

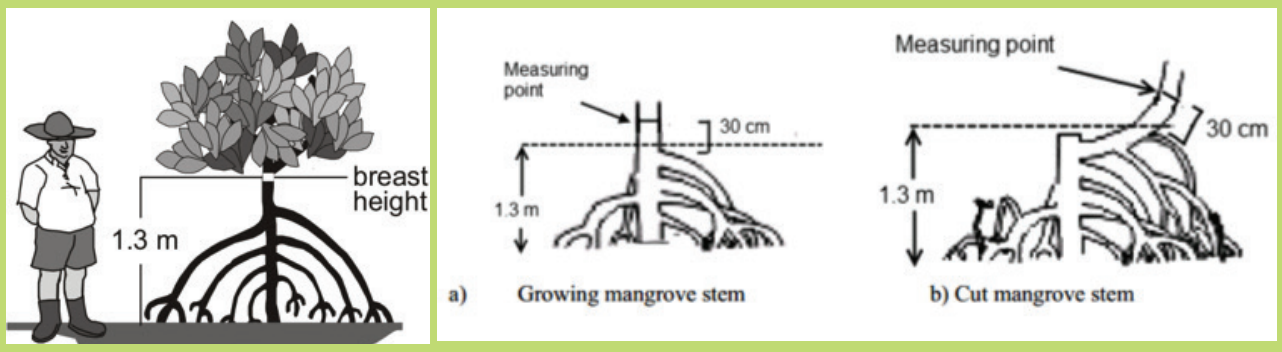


FIGURE 2. MEASURING THE DBH OF MANGROVE (SOURCE: DEGUIT ET AL., 2004) AND MANGROVE TREES WITH AERIAL ROOTS. (IMAGE SOURCE: NAFORMA, 2010).

B. Beach Forest Vegetation Assessment

A beach forest is a type of forest in sandy beaches above high tide limits and thus not influenced by tidal fluctuation. Beach tree species include Talisai *(Terminalia catappa*), Agoho (*Casuarina equisitifolia*) and Dapdap (*Crythrina variegata*) among others. Ecologically a beach forest serves as a protection forest, a line of defense protecting the coastal communities and their livestock and agricultural crops against the onslaught of strong winds and the storm surges.

Up to this time, published information on beach forest are very few. Information such as species composition, structure, density, dominant taxa and geographic locations are among the important inputs for effective beach forest rehabilitation, as part of coastal zone management.

Belt-transect Method

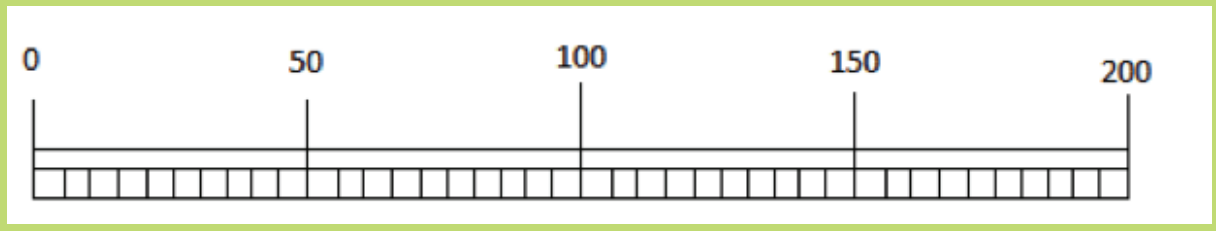
A 200m transect line shall be established parallel to the shoreline. The transect shall be divided into four (4) sub-plots each with a length of 50m (Figure 3). In each transect line, ten (10) quadrats measuring 5m x 5m will be established for a total of 40 quadrats (Smith, 2003). It is ideal to establish five (5) 200m transect lines spread in a beach forest, all of which are parallel to the shoreline. The distance of each transect line shall not be less than 50 meters. In each quadrat, all trees with 5cm of dbh shall be properly recorded (correct identification, total height (TH), merchantable height (MH), dbh, crown diameter and GPS reading). Each transect and sub-plot shall be geotagged using the Android application GeoCam. Every picture shall be properly interpolated in the base map using KML/Z technology and Google Earth.

The criterion for selecting a site for vegetation analysis is the presence of beach tree species. In beach areas with shrubs, vines, and weeds, a 3m x 3m quadrat shall be established for a complete enumeration of species within the said quadrat.

Data Analysis

Data shall be analyzed using the following statistical analysis:

1. Density, Frequency and Dominance, and Species Importance Value
2. Descriptive Statistics
3. Diversity Indices



☐ - sub-plot measuring 5m x 5m
Trees > 5cm dbh measured inside the sub-plot

FIGURE 3. ESTABLISHMENT OF BELT-TRANSECT FOR BEACH FOREST ASSESSMENT

C. Fauna Assessment

1. Avifauna assessment in mangrove and beach forests

a. **Timed species-counts (TSCs)** method shall be used. At least four (4) 30-minute observation posts shall be selected at intervals of at least 100m to 250m or 10 to 15 minutes walking distance from each post. The survey shall start at exactly 15 minutes after sunrise and end no later than 3.5 hours after sunrise. All bird species seen or heard during observation period shall be listed. The coordinates of each observation post shall also be recorded including period of survey. Photos of the species observed must be taken, whenever possible.

b. **Opportunistic Sampling** – Species that may be detected and identified opportunistically either by their call or by their appearance while travelling to and from survey sites or outside standard survey times or survey sites shall also be recorded. If the bird is seen perching on a tree, the trees' species shall be recorded. If there are nesting birds observed, the bird's species, the date observed, the number of eggs in a clutch (if accessible) shall be recorded. The dates and times of observation including GPS locations of the sighting shall also be recorded.

c. **Ethnobiological Account**s - Some species may not be encountered or observed during the survey period; thus the use of survey through interviews from the local folks shall also be considered to include small mammals, reptiles, amphibians, and birds.

2. Macrobenthos in mangroves

a. Within the established plots for vegetation, sampling for macrobenthos shall be done using a 0.5m x 0.5m (0.25 m^2) quadrat. A minimum of three quadrat will be sampled per vegetation plot.

b. Location of the quadrats shall be: one at the seaward periphery, one at the center, and one at the landward periphery for each circular plot (Figure 4). The location of each quadrat shall be marked using handheld GPS for mapping purposes.

c. For each quadrat, soil samples shall be collected at a depth between 25 and 30cm using a corer or spade. The soil samples must be placed in a 0.5-mm sieve and rinsed with water immediately after collection. All organisms that are retained in the sieve must be collected and placed in plastic bottles or Ziploc bags with ethyl alcohol. Each bottle or Ziploc bag shall be labeled as follows: Location (e.g. Barangay, Municipality, and Province), Transect No., Quadrat No., and Plot No. (e.g. Brgy. San Fernando, Barotac Viejo, Iloilo - T1Q1P1).

d. For each quadrat, the epifauna shall be counted and identified to the lowest taxonomic rank. Reference samples shall be collected to verify taxonomic identifications.

e. High definition photographs of the quadrat and associated organisms must be taken. For macrofauna, photographs of the whole organism must be taken; macro shots of the head/oral region, aperture, segmentations, whorls and other key structures must also be taken for identification. A dark background and lamps or strobe lights shall be used whenever possible, for better results. The size of the organisms must also be taken. Measurement may be done using a caliper, ruler, or ImageJ software. For microfauna, photographs shall be taken using a camera fitted in the dissecting microscope. Post-processing of the photos may be done using a digital image editor (e.g. Photoshop, GIMP, Photofiltre). Reference collections with tissue must be preserved in ethanol or diluted formalin. For molluscan shells, samples must be stored in dry plastic or paper boxes.

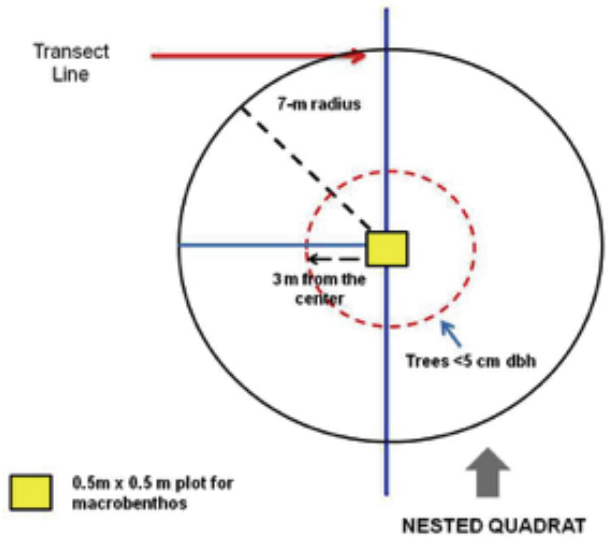


FIGURE 4. SAMPLING PLOTS FOR ASSOCIATED MACROBENTHIC/MACROINVERTEBRATES

3. Mangrove Pests (Arthropods and disease-causing organisms)

Mangrove Pest assessment shall be done in both mangrove and beach forests.

Sampling Design:

Within the established plots (main circular plot) for vegetation, sampling for pests including insects, barnacles and diseases shall be done using smaller subplot (5-m radius). Sampling intensity of 20% shall be used. Mangrove trees within the sample plots shall be examined for the presence of pests using assessment form and appropriate sampling techniques.

Walk though survey (McMaugh, 2005) shall also be done in the vicinity of the established transect lines.

Sampling techniques:

A. Net sweeping is a technique for collecting flying arthropods, across vegetation or onto the ground. This can be done by walking a transect of a fixed length at each site and making a fixed number of sweeps over the vegetation on the transect or fixing the search time.

B. For crawling insects, yellow sticky traps shall be placed on tree trunks and other suitable vertical surfaces to collect arthropods that orient on vertical surfaces (Bickel and Tasker, 2004).

Field Diagnosis

Using the DENR Forest Pests Surveillance Field Form presented in Annex 1, the following shall be noted on mangrove trees per sampling plot as well as those encountered through the walk through survey:

A. The host shall be identified (tree species).

B. External evidence of damage shall be determined (insect pests).

C. Symptoms and signs of diseases shall be located (e. g. mycelia of fungal agent, fungal spores, fruiting bodies).

D. Patterns such as distribution of symptoms (e. g. localized or widespread) and host specificity (Is the problem occurring in only one plant species or are different plant species also affected?) shall be observed.

E. Affected plant parts shall be identified (flowers and fruits, leaves, stems, roots).

F. Severity of infection shall be determined (% of trees infected/infested).

Laboratory Test

Sometimes neither symptoms nor signs provide enough specific or characteristic information to decide the cause of an infectious plant disease. In such cases, it may be necessary to bring a sample back to the laboratory for further tests to isolate and identify the causal agent (Riley, Williamson, and Maloy, 2002).

Samples for laboratory analysis can include those from diseased roots, stems, or foliage.
When collecting diseased specimens, newly diseased tissues for isolation shall be selected. Do not use

older diseased tissue as it will be colonised externally by saprophytic fungi and bacteria. Collected insects, barnacles and other arthropods may be preserved in 70-80 % ethyl alcohol.

D. Water Quality Assessment

1. Sample collection - A minimum of three (3) water samples shall be collected for each zonation (Kauffman and Donato, 2012) through surface grab sampling. A boat or raft will be required for deep sites where other means of access do not exist. This shall be done by submerging the container, mouth or opening first, and allowing the water to run slowly into the container until full. If water quality probe is available, in situ measurement, as well as probe's calibration and maintenance, must follow the probe's instruction manual.

2. Sample label - Sample labels shall include the following information: sample number, sample type, name of collector, date, time, place of collection and sample preservative.

3. Sample Preservation (Bacteriological Analysis) - Water samples must reach the laboratory in less than 2 hours. Preservation is not required. If it exceeds 2 hours to reach the laboratory, the samples must be rapidly chilled to about 4 °C by placing them in a cold water or ice mixture in an insulated container. If the time exceeds 6 hours, the condition must be noted in the laboratory report. The time between sample collection and analysis shall, in general, not exceed 6 hours, and 24 hours is considered the absolute maximum.

4. Sample Preservation (Physico-chemical Analysis) - Storage in glass or polyethylene bottles at a low temperature (e.g. 4°C) in the dark is recommended. Sample bottles must be clean but need not be sterile. The pH and turbidity must be immediately tested after sampling as they will change during storage and transport. The temperature and dissolved gases must be measured in situ. Nearest laboratory/ies must be coordinated for recommended sample preservation and analysis.

5. Laboratory Methods - Laboratory analysis is needed when the water quality parameters being studied cannot be measured with field instruments. The following methods can be used:

Water Quality Parameter	**Method**
Temperature (oC)	Thermometer
pH	Potentiometric Method
Dissolved oxygen (mg/L)	Winkler method
Total Dissolved Solids (mg/L)	Gravimetric method
Phosphate (mg/L)	Stannous chloride method
Nitrate (mg/L)	Brucine method for saline water, specific ion
Salinity (ppt)	Salinimeter

Water quality analysis shall only be conducted at the mangrove forests, as the water quality parameters influence the presence of macrobenthic organisms at mangrove intertidal flats.

E. Soil Properties

1. ***Sample container and label*** – Ziploc (polyethylene) bags shall be labeled with sample number, sampling date, location, soil depth, and sample description.

2. ***Sample collection*** – A sharp-edged steel cylinder with circumference of ~20cm and length of 40cm must be used for soil collection. Upon establishment of transect along mangrove sites (Kauffman and Donato, 2012), one soil sample per plot must be collected. Soil samples must be composited according to each zonation area. A minimum of 3 kilograms of the composited soil shall be collected for transport and analysis.

3. ***Sample preservation*** – The collected soil samples must be air-dried before transport. A subsample (~100 g) for moisture content analysis must be separated and must not be air-dried and properly sealed.

4. ***Soil Physico-Chemical Analysis*** - The following methods can be used:

Soil Parameter	**Method**
Moisture content	Oven-drying
Organic Matter Content	Walkley-Black Method
Soil pH	Potentiometric method
Nitrogen	Kjeldahl method
Phosphorous	Olsen method or Flame Photometer
Potassium	Ammonium acetate method
Soil Texture	Hydrometer method

Soil analysis shall be done both at mangrove and beach forests.

Socio-Economic Component. The socio-economic status of adjacent local community shall be determined through survey questionnaires (Annex 2). Supplemental tools (e.g. PCRA, FGD, KII) shall be used to obtain information on the knowledge and perception of the community, private organization and local government with regards to mangrove and beach forest rehabilitation.

Data Management and Analysis

a. Calculation of Basal Area, Stem Density and Importance Value

Basal Area (BA) – the cross-sectional area (m^2) of each tree stem shall be measured at breast height (1.3m).

To determine Tree Basal Area simply measure the diameter at breast height in centimeters (DBH) and calculate the basal area (m^2) using an equation based on the formula for the area of a circle (area = p r^2 where r = radius and p = 3.142) and the formula for radius (r=diameter/2 = DBH/2).

Therefore:

$$\text{Tree Basal Area } (m^2) = \pi r^2$$
$$= 3.142 \times (DBH/200)^2$$

Where: DBH is in cm

This formula also converts the diameter in centimeters to the basal area in square meters.

Stand Basal Area (m^2/ha)= (Sum of the basal area of each tree in the plot)/(Area of the plot (ha))

b. Calculation of stem density per hectare

Stems per ha= (No.of stems in plot x 10,000)/(Area of the plot)

c. ***Importance Value Percentage -*** The importance of the contribution of each component species to the stand in terms of density, contribution to basal area (dominance) and probability of occurrence throughout the plot (frequency) are described by the following parameters:

Relative density= (no.of individuals of a species)/(total of no.of individuals [all species]) × 100

Relative frequency= (frequency of a species)/(frequency of all species) × 100

Relative dominance= (total basal area of species)/(basal area of all species) × 100

d. Density of Macrobenthos

Density (individuals m^{-2})= (no.of individuals × 4)

Diversity Indices - F*ree statistical tools such as Biopro, MVSP, or PAST software shall be used to compute the diversity indices. Comparison of community through cluster analysis may also be done. Diversity indices can be computed in MS Excel using the formula below (Krebs, 1999; Magurran, 2004):*

Species Richness

Margalef's index was used as a simple measure of species richness (Margalef, 1958).

$$\text{Margalef's index} = (S - 1) / \ln N$$

Where:
S = total number of species
N = total number of individuals in the sample
ln = natural logarithm

Species Diversity

Shannon Diversity Index (H')

$$H' = -\sum p_i \ln p_i$$

Where;
P_i = The proportion of individuals in the population that belong to species i

Simpson's Diversity Index (D)

$$D = 1 - \sum[n(n-1)/N(N-1)]$$

Where:
N = Total number of individuals of all species
n = Total number of individuals of a particular species

Index of Evenness

Pielou's Evenness Index (Pielou, 1966) (e) will be used to calculate Evenness Index.

$$e = H / \ln S$$

Where:
H = Shannon Diversity index
S = Total number of species in the sample

Expected Output

The activity is expected to produce a detailed baseline report of the bio-physical status of the project site including the socio-related aspects. The report will also contain photographs and maps. Maps may be generated using ArcGIS or Manifold software. Map files must be in shapefile format with UTM projection and WGS84 datum. Baseline report and supporting files (photographs, map files, among others) shall be submitted to the ERDB-MBFDP Project Management Office for documentation, databasing, and consolidation.

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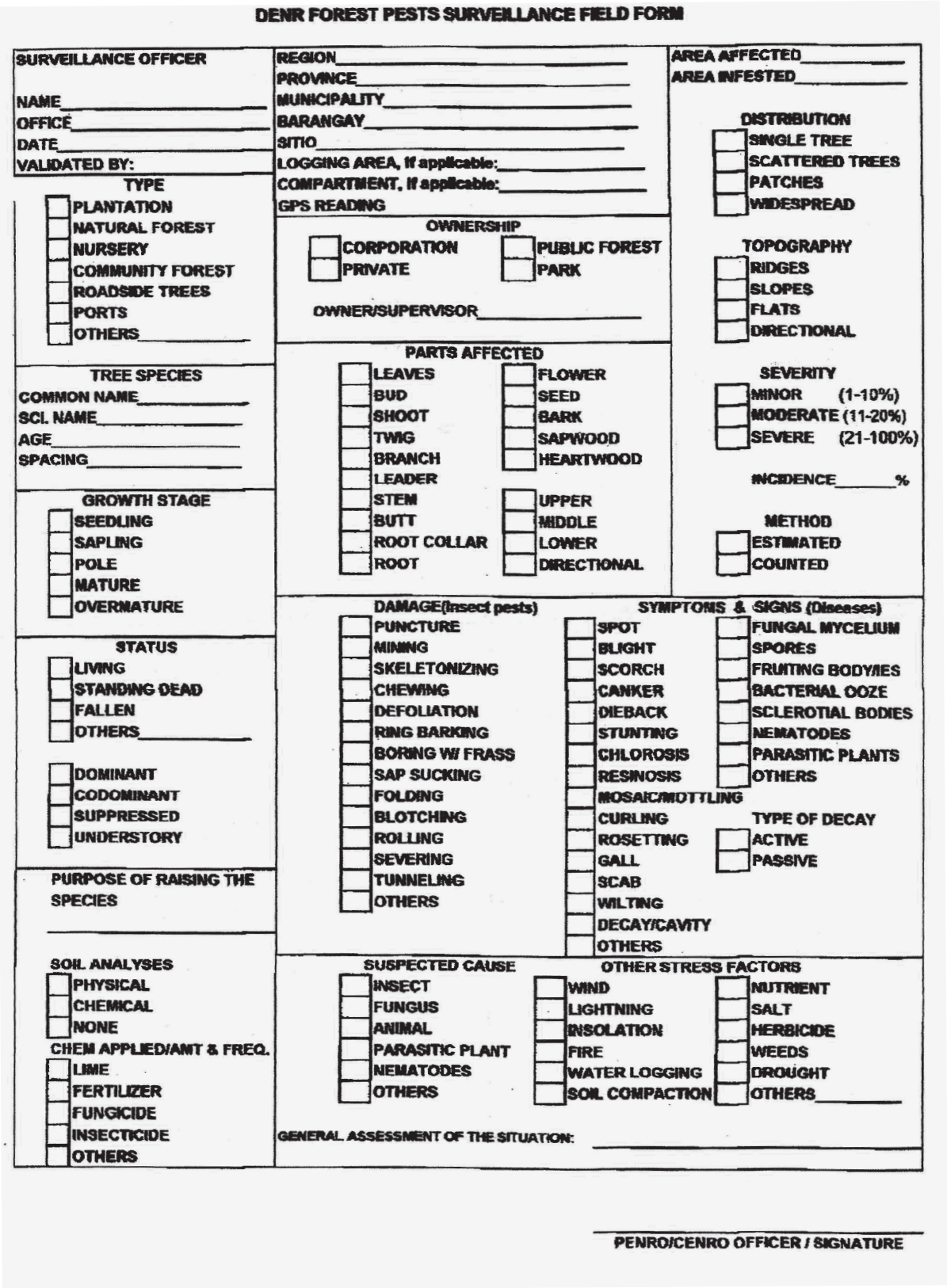
Annex 1. Pest Surveillance Form.



DENR FOREST PESTS SURVEILLANCE FIELD FORM

SURVEILLANCE OFFICER

NAME_____
OFFICE_____
DATE_____
VALIDATED BY:_____

TYPE
- ☐ PLANTATION
- ☐ NATURAL FOREST
- ☐ NURSERY
- ☐ COMMUNITY FOREST
- ☐ ROADSIDE TREES
- ☐ PORTS
- ☐ OTHERS_____

TREE SPECIES

COMMON NAME_____
SCI. NAME_____
AGE_____
SPACING_____

GROWTH STAGE
- ☐ SEEDLING
- ☐ SAPLING
- ☐ POLE
- ☐ MATURE
- ☐ OVERMATURE

STATUS
- ☐ LIVING
- ☐ STANDING DEAD
- ☐ FALLEN
- ☐ OTHERS_____

- ☐ DOMINANT
- ☐ CODOMINANT
- ☐ SUPPRESSED
- ☐ UNDERSTORY

PURPOSE OF RAISING THE SPECIES

_____

SOIL ANALYSES
- ☐ PHYSICAL
- ☐ CHEMICAL
- ☐ NONE

CHEM APPLIED/AMT & FREQ.
- ☐ LIME
- ☐ FERTILIZER
- ☐ FUNGICIDE
- ☐ INSECTICIDE
- ☐ OTHERS

REGION_____
PROVINCE_____
MUNICIPALITY_____
BARANGAY_____
SITIO_____
LOGGING AREA, If applicable:_____
COMPARTMENT, If applicable:_____
GPS READING

OWNERSHIP
- ☐ CORPORATION
- ☐ PRIVATE
- ☐ PUBLIC FOREST
- ☐ PARK

OWNER/SUPERVISOR_____

PARTS AFFECTED
- ☐ LEAVES
- ☐ BUD
- ☐ SHOOT
- ☐ TWIG
- ☐ BRANCH
- ☐ LEADER
- ☐ STEM
- ☐ BUTT
- ☐ ROOT COLLAR
- ☐ ROOT
- ☐ FLOWER
- ☐ SEED
- ☐ BARK
- ☐ SAPWOOD
- ☐ HEARTWOOD
- ☐ UPPER
- ☐ MIDDLE
- ☐ LOWER
- ☐ DIRECTIONAL

AREA AFFECTED_____
AREA INFESTED_____

DISTRIBUTION
- ☐ SINGLE TREE
- ☐ SCATTERED TREES
- ☐ PATCHES
- ☐ WIDESPREAD

TOPOGRAPHY
- ☐ RIDGES
- ☐ SLOPES
- ☐ FLATS
- ☐ DIRECTIONAL

SEVERITY
- ☐ MINOR (1-10%)
- ☐ MODERATE (11-20%)
- ☐ SEVERE (21-100%)

INCIDENCE_____%

METHOD
- ☐ ESTIMATED
- ☐ COUNTED

DAMAGE(Insect pests)
- ☐ PUNCTURE
- ☐ MINING
- ☐ SKELETONIZING
- ☐ CHEWING
- ☐ DEFOLIATION
- ☐ RING BARKING
- ☐ BORING W/ FRASS
- ☐ SAP SUCKING
- ☐ FOLDING
- ☐ BLOTCHING
- ☐ ROLLING
- ☐ SEVERING
- ☐ TUNNELING
- ☐ OTHERS

SYMPTOMS & SIGNS (Diseases)
- ☐ SPOT
- ☐ BLIGHT
- ☐ SCORCH
- ☐ CANKER
- ☐ DIEBACK
- ☐ STUNTING
- ☐ CHLOROSIS
- ☐ RESINOSIS
- ☐ MOSAIC/MOTTLING
- ☐ CURLING
- ☐ ROSETTING
- ☐ GALL
- ☐ SCAB
- ☐ WILTING
- ☐ DECAY/CAVITY
- ☐ OTHERS

- ☐ FUNGAL MYCELIUM
- ☐ SPORES
- ☐ FRUITING BODY/IES
- ☐ BACTERIAL OOZE
- ☐ SCLEROTIAL BODIES
- ☐ NEMATODES
- ☐ PARASITIC PLANTS
- ☐ OTHERS

TYPE OF DECAY
- ☐ ACTIVE
- ☐ PASSIVE

SUSPECTED CAUSE
- ☐ INSECT
- ☐ FUNGUS
- ☐ ANIMAL
- ☐ PARASITIC PLANT
- ☐ NEMATODES
- ☐ OTHERS

OTHER STRESS FACTORS
- ☐ WIND
- ☐ LIGHTNING
- ☐ INSOLATION
- ☐ FIRE
- ☐ WATER LOGGING
- ☐ SOIL COMPACTION
- ☐ NUTRIENT
- ☐ SALT
- ☐ HERBICIDE
- ☐ WEEDS
- ☐ DROUGHT
- ☐ OTHERS_____

GENERAL ASSESSMENT OF THE SITUATION: _____

_____
PENRO/CENRO OFFICER / SIGNATURE

Annex 2. Household Summary Form.

Socio-economic survey of households affected by Yolanda
(Baseline study)

Interview schedule

Sitio _____ Municipality_____
Barangay_____ Province _____
GPS reading_____

Demographic information

Name of respondent_____Sex _____ Age_____Religion _____
Educational attainment_____Civil status_____
Household size (including the respondent) _____

Settlement and Migration history

Nature of settlement [ ] Born-resident [ ] Migrant
Place of origin _____ Place of birth_____
Ethnic group _____ Length of stay in the area_____
Access to the area
[ ] Place of birth [ ] Seeking employment
[ ] Parental migration [ ] Access to land
[ ] Invitation from relatives/ friends [ ] Association through marriage
[ ] Others, specify_____

Settlement plans
[ ] Permanent stay
[ ] Place of birth [ ] Employment
[ ] Conducive environment [ ] Acquisition of property
[ ] No place to go [ ] Place attachment
[ ] Access to land [ ] Others, specify_____
[ ] Transfer of residence, explain_____
_____

Economic profile

A. Main occupation _____Estd. monthly income _____

B. Secondary occupation_____Estd. Monthly income_____

C. Total monthly income from main and secondary occupations_____

D. Property ownership and Housing amenities

Residential lot: [ ] Inheritance [ ] CSC/CBFMA [ ] Tenant [ ] Rent
[ ] Bought rights [ ] Informal settler [ ] Others, specify_____

House: [ ] Owned {_____Bought; _____Inherited; _____Built}
[ ] Rented {How much per month? _____}
[ ] Others, specify_____

Housing materials [ ] Nipa/Cogon [ ] Wood/Bamboo with GI roof
[ ] Concrete [ ] Combination of concrete and wood with GI roof
[ ] Others, specify_____

Cooking fuel [ ] LPG [ ] Charcoal
[ ] Kerosene [ ] Others, specify_____
[ ] Firewood

Lighting facility [ ] Electric current {Meralco/Coop} [ ] Kerosene
[ ] Others, specify_____

Health and Sanitation

Domestic/ Drinking water
[ ] Stream/Spring [ ] Local water utility (LOWA)
[ ] Water pump [ ] Deep well
[ ] Open tank (Sahod ulan) [ ] Others, specify _____

Illness/Disease
[ ] Cough and cold [ ] Diarrhea
[ ] Malaria [ ] Infections
[ ] Headache [ ] Tuberculosis
[ ] Asthma [ ] Skin allergy
[ ] Hypertension [ ] Others, specify_____

Toilet facility [ ] Open pit [ ] Close pit [ ] Shared with relatives
[ ] Communal [ ] Others, specify_____

Septic tank location [ ] Land [ ] River [ ] Others, specify_____

Quality/Condition of the air
[ ] Fresh air [ ] Humid air (maalinsangan)
[ ] Polluted air [ ] Others, specify_____

Solid waste disposal
[ ] Open pit [ ] Waste segregation
[ ] Burning [ ] Throw in river/creek
[ ] Composting [ ] Others, specify_____

Environmental condition

Coastal geohazards

Coastal geohazards common in the community
[ ] Coastal flooding [ ] Super typhoon
[ ] Storm surge [ ] Tsunami
[ ] Subsidence [ ] Accretion/Sediment build-up
[ ] Salt water intrusion [ ] Coastal/Beach erosion
[ ] Shoreline retreat [ ] Others, specify_____

Structures present in the community to mitigate effects/impacts of coastal geohazards
[ ] Mangrove plantation [ ] Beach forest
[ ] Seawall [ ] Sandbag
[ ] Breakwater [ ] Dike
[ ] Riprap [ ] Others, specify_____

State of mangroves

Condition of mangroves in the community
[ ] Dense/thick plantation [ ] Sparsely planted
[ ] Patch or cluster [ ] Absence or non-existent
[ ] Remnants of plantation [ ] Others, specify_____

Health of Mangroves
[ ] Disease(s)
[ ] Foliar [ ] Insect pest
[ ] Root/dead saplings [ ] Others, specify_____
[ ] Fruits

Uses/Functions of mangroves in the community
[ ] Firewood [ ] Material for construction of house
[ ] Medicine [ ] Protection from storm damage and river bank erosion

[ ] Windbreaker [ ] Dissipate impacts of tidal movement
[ ] Food for animals [ ] Spawning/Nursery ground of aquatic resources
[ ] Ecotourism [ ] Others, specify_____

Benefits derived/obtained from mangroves by households
[ ] Food for households [ ] Material for house construction
[ ] Medicine [ ] Income from fish, shrimp culture and wood gathering
[ ] Firewood [ ] Income from cottage industries (e.g., tanning)
[ ] Shelterbelt [ ] Others, specify_____

Observed fauna in mangrove area
[ ] Birds [ ] Amphibians (frog, toad)
[ ] Mammals (bat, rat) [ ] Reptiles (monitor lizard/bayawak, snake)
[ ] Others, specify_____

State of beach forest

Condition of beach forest in the community
[ ] Dense/thick plantation [ ] Sparsely planted
[ ] Patch or cluster [ ] Absence or non-existent
[ ] Remnants of plantation [ ] Others, specify_____

Health of Beach Forest
[ ] Disease(s)
[ ] Foliar [ ] Insect pest
[ ] Root/dead saplings [ ] Others, specify_____
[ ] Fruits

Uses/Functions of beach forest in the community
[ ] Firewood [ ] Material for construction of house
[ ] Medicine [ ] Protection from storm damage and river bank erosion
[ ] Windbreaker [ ] Dissipate impacts of tidal movement
[ ] Food for animals [ ] Ecotourism
[ ] Others, specify_____

Benefits derived/obtained from beach forest by households
[ ] Food for households [ ] Material for house construction
[ ] Medicine [ ] Firewood
[ ] Shelterbelt [ ] Material for Christmas tree
[ ] Shade against sunlight [ ] Others, specify_____

Skills and Aspirations of households

Skills
[ ] Fish culture [ ] Aqua-culture
[ ] Salt making [ ] Fish processing (patis, bagoong, dried fish)
[ ] Vinegar making [ ] Handicraft-making (necklace or bracelet made of shells)
[ ] Nipa shingle [ ] Seedling production
[ ] Wine making (e.g. tuba) [ ] Plantation establishment
[ ] Others, specify_____

Aspiration/Vision in life

[ ] For my children to finish their studies
[ ] Build a concrete house to withstand typhoon and other coastal geohazards
[ ] Food security for my family
[ ] Have our own house and lot
[ ] Have stable source of income
[ ] Good health for my family
[ ] Others, specify_____

ERDB TECHNICAL BULLETIN NO. 3
MBFDP - NURSERY ESTABLISHMENT AND MANAGEMENT

RATIONALE

The Mangrove and Beach Forest Development Project (MBFDP) is intended to rehabilitate and develop mangrove and beach forests in disaster-affected areas as a means to improve and enhance the natural defenses and resilience of the country's coastlines and its environs vis-a-vis the impacts of climate change. **Establishment of a mangrove nursery** is very important in order to provide the required number of mangrove seedlings anytime they are needed without depending on seasonal availability of propagules or wildlings. The seedlings raised in the nursery can be used for planting in degraded areas with the absence of natural planting material. A mangrove nursery enables the production of large numbers of seedlings required to plant larger areas, even if they are found distant to the sources of seeds/seedlings. In effect, nursery-raised seedlings have a higher survival rate compared to directly planted propagules and wildlings due to a well developed root system. Depending on the intended use of seedlings, permanent nurseries are intended for mangrove planting over a period of time. Subsidiary nurseries are areas located at a distance from a permanent nursery while temporary nurseries are generally set up where there is a small area. For the MBFDP, the intention is to initially develop permanent nurseries that can be managed by the community for sufficient maintenance and management of plantation sites under MBFDP.

PREFERRED SITES FOR NURSERY ESTABLISHMENT

1. Relatively flat land
2. Close to freshwater sources
3. Easy transportation access
4. Good drainaige (not waterlogged)
5. Close proximity to planting site

BUILDING THE NURSERY

1. **Site preparation** – The nursery site must be located in an open area to avoid the cutting of trees. If the cutting cannot be avoided, extra care should be exercised in trimming branches to let in more sunlight (Fig. 1).

2. **Seed boxes** – The number of required seed boxes depends on the species to be raised. Materials include: Boards 1 centimeter thick, 10 centimeters wide and at least 2 meters long; plywood (at least 1 centimeter thick) for the box base; and nails.

3. **Seed beds for germination** – For big seeded species like tabigi or piagao, the beds must be raised slightly by about 5 to 10 centimeters above the level of the surrounding area by adding potting soil to each bed or by digging out the soil from the 40-centimeter wide area immediately next to the beds. The soil must be kept from spreading by lining each bed with a wood or bamboo curb. If boards are used, a 2- to 3-centimeter groove must be dug around the bed to slot the board in.

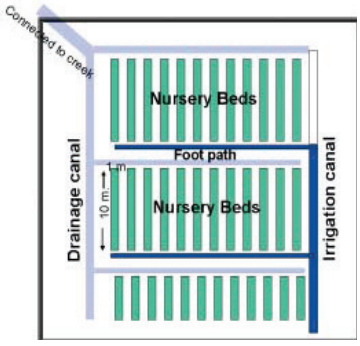


FIGURE 1. IDEAL AREA FOR NURSERY ESTABLISHMENT

4. **Germination shed** - The germinating shed needs only simple roofing materials like banana or coconut fronds with no walls. Roughly 3 x 5 meters in area, it is constructed by simply putting in four pieces of bamboo with a woven cogon grass roof. Under this roof is a simple bamboo table for the seed boxes. The legs of the table must be placed in cans filled with water to prevent ants and other crawling insects from reaching the seedlings (Fig. 2).

5. **Storage area** – The storage shed, which can be made out of nipa, will be used to store all materials required for a nursery such as dry soil and nursery tools and therefore should be enclosed and locked.

6. **Potting sheds** – This can be made out of nipa shingles, typically not smaller than 3 x 4 meters in area.

7. **Potting media** – This can be a combination of sand and ordinary garden soil. These materials may be brought in by truck and should be staged close to the bagging shed.

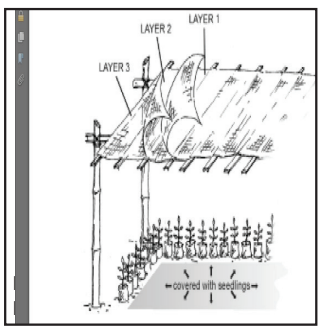


FIGURE 2. A SAMPLE HARDENING BED.

8. **Potted soil** – This should be protected with a roof similar to the potting shed.

9. **Hardening beds** – Hardening beds need not be raised from the ground as long as it is on level ground. Level ground hardening beds require a temporary roof with several layers of (coconut leaves or nipa shingles but typically mesh nets gauge 14 to control the amount of light reaching the seedlings. These beds are 20 to 30 meters long and 1 meter wide; bamboo poles can be used to support the roof. The roof should be at least 1.5 meters above the ground to allow easy access to the seedlings. Hardening beds should be located near the loading area.

NURSERY MANAGEMENT AND OPERATION

After nursery construction, The nursery shall be operated and managed on a daily basis. This requires caretakers to manage the nursery. Typically it takes 4 to 6 months for *Rhizophora* species. For *Avicennia* species, it takes more than a year to grow out seedlings to the point where they can be outplanted (Fig. 3). The typical nursery activities include:

- Collecting and transporting seeds and propagules,
- Propagation practices and maintenance of the seedlings and
- Preparation for outplanting.

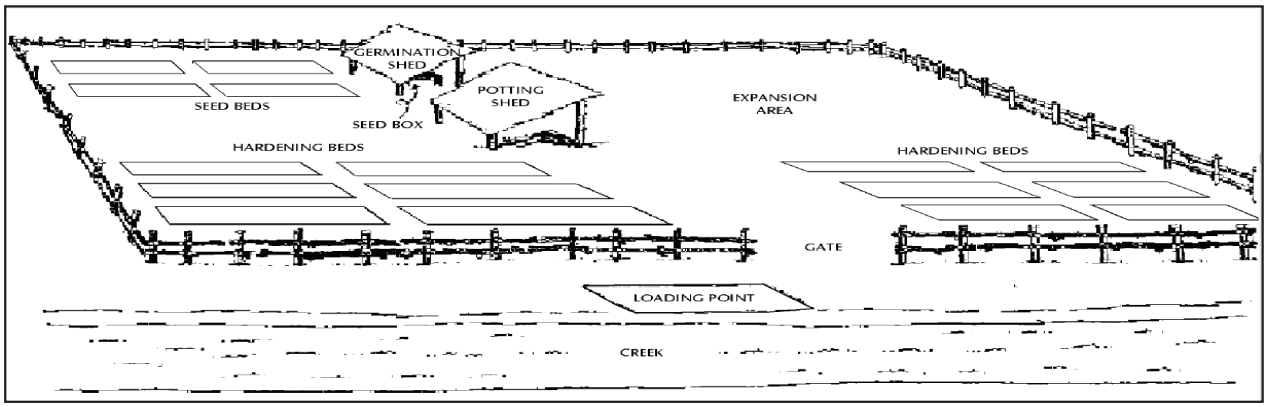


FIGURE 3. A TYPICAL NURSERY LAYOUT. (SOURCE: MELANA, D. M. ET AL. 2000)

Collecting and Transporting Seeds and Propagules

Supply of mangrove seeds and propagules is one of the most important considerations in massive reforestations, especially for less common species such as pototan and bakauan babae, busain, tangal, and tabigi. This is one of the reasons that the monoculture plantation of bakauan bato is very common. Another problem is the large number of seedlings that a mangrove plantation needs about 10,000 to 40,000 seedlings per hectare (at 1 x 1 meter to 0.5 x 0.5 meter spacing) respectively.

Timing of collection – Collecting propagules and seeds at the right time is critical. While collection is possible from some mangrove species almost every month of the year, peak seasons vary by area and date. Knowing the right time to collect the seeds or propagules also makes the operation quicker and more efficient.

Wildlings are uprooted by balling with a spade. For a 10-centimeter wildling, the diameter of the excavation should be approximately 10 centimeters; for a 20 cm wildling, 20 cm; for a 30 cm wildling, 30 cm.

Uprooting wildlings:
- Right after heavy rains
- No direct pulling of plants
- Use leverage: bolo/spade
  For small ones, flat bar for big ones

Use wildlings:
- In the absence of seedlings
- Short nursery time
- Lesser cost

Root/Shoot Pruning:
- Prune leaves by 50% (individual leaf)
- Prune tap

For seeds and propagules, collect only mature and healthy propagules (Tables 1 & 2).

Table 1. Maturity indicator of propagules of mangrove species.

Species/common name	Color	
	Immature	Mature
Avicennia marina (Bungalon)	green	Yellowish fruit skin
Rhizophora apiculata(Bakauan lalaki)	Dark green	Pale to red brown
Rhizophora mucronata (Bakauan babae)	Dark green	Pale green
Ceriops tagal (Tangal)	green	Pale to red brown
Sonneratia caseolaris (Pedada)	Pale green	Dark green
Lumnitzera racemosa (Kulasi)	green	Red brown
Heritiera littoralis (Dungon late)	green	Brown
Xylocarpus sp.	green	Brown
Aegiceras sp.	green	Pink

Source: Melana and Gonzales, 2000; Hoang Van Thoi and Pham Trong Thinh. 2010.

Table 2. Best collection time for selected mangrove species (adapted from Palis et al. 1988)

SPECIES	Climatic Type*1	Climatic Type 2	Climatic Type 3	Climatic Type 4
Bakauanbato	Jan. & May	Feb.-July	Feb.-April	Jan. & Feb.
Bakauanbabae	Oct.-Dec.	Jan-Aug.	April-June	Jan.-Feb.
Bakauanlalaki	Aug. & Sept.	Feb. & March; April-June	March & April	Jan. & March; May & June
Tangal	May	Jan. & Feb; May	May; Nov.& Dec.	**
Busain	Jan.; Oct.-Dec.	Jan. & Feb.; May -July	Feb. & May	May-Aug.
Pototanlalaki	Jan.-May; Oct.	May	April-June	**
Api-api	Jan.-Feb.; May & July	Jan. & Feb.; June-Aug.	**	August
Bungalon	April-July; Nov. & Dec.	Jan.; May-Oct.	Jan. & March	Jan.– Oct.
Pagatpat	Aug.-Nov.	Jan.	Feb.-March	Jan.-March
Tabigi	Aug.-Nov.	Jan.-Aug.	Jan.-April	March

*Climate type refers to rainfall pattern. Type I - Two pronounced seasons; dry from November to April, and wet during the rest of the year. Type 2 - No dry season. Very pronounced rainfall in November. Type 3 - Seasons are not very pronounced. Relatively dry from November to April and wet during the rest of the year. Type 4 - Rainfall more or less evenly distributed throughout the year.

**months not identified in this climatic type

Sorting, Packaging and Transport of seeds and propagules

Sorting. Materials should be inspected carefully to see whether it is mature, healthy, and free of pest and diseases damage and physical injury.

Packaging:

- Wildlings must be filed in bunch by size in 50s/100s
- Roots must be covered with thin, wet mud
- Roots must be wrapped with newsprint/used cloths
- 3-4 bunches on banana folded leaf sheets, whose ends are at the same height with wildlings, should be placed.
- For short distance collection – wildlings must be placed in an enclosed big plastic bag to maintain soil moisture
- Wildlings like propagules should also be packed in groups of 50 or 100 in a folded banana leaf, palm sheet, or gunny sack to protect plants from the sun while in transit.

Recommended storage of some seeds/propagules:

- *Avicennia marina* 4 – 6 days under moist conditions in plastic bags
- *Aegiceras corniculatum* 15 days
- *Sonneratia sp, Heritiera* 4 weeks
- *Xylocarpus* sp. 2 months
- *Rhizophora* propagules can be stored in plastic bags for 40 - 45 days under moist and shady conditions

Transport

- Wildlings must be placed on shaded places
- Wildlings must be piled properly
- Wildlings in banana leaf sheet could be piled on top of the other in case of limited space.

Propagation Techniques

Potting media preparation – Root development is enhanced when the potting soil is porous. Sandy-loam soil that is high in organic matter or compost mixed with cured sawdust or rice stalks should be utilized. The soil and organic matter should be pulverized, screened, and thoroughly mixed. A ratio of 50:50 is best. Potting soil should always be prepared in advance to avoid unnecessary delays in potting which can result in high seedling mortality, especially for wildlings. Thus, it is a good idea to prepare potting soil of several cubic meters.

Germination techniques – Mangrove plantations in the country are in monoculture. This is due to abundant supply of propagules all year round.

Bakauan, tangal and busain groups - These species have viviparous seeds or propagules that are sown or planted directly in the field and have a high survival rate in areas which are generally not exposed to strong waves. In cases where there is a need for nursery raised seedling, the species may be germinated in plastic bags.

Pagatpat group (pagatpat/pedada) – Pagatpat has big potentital for reforestation due to its wide range of habitat from the seaward side and high salinity to the landward portion. The boomerang-shape of seeds are planted or sown in assed box with sandy soil. Seeds are then covered with a thin layer of soil and watered daily with brackish water. For early and uniform germination, soak the fruit in fresh water for 7 days and sow the macerated seeds in depressed seed bed.

Tabigi group – its big angular seeds are germinated in seed beds or potted directly.

A**pi-api group (api-api, piapi, bungalon and bungalon puti)** – This group is considered semi-viviparous because of its emerging radical and split seed coat while still attached to the mother tree. It is the easiest to germinate, either in seed beds or directly in bags. Seeds are sown in upright position half buried with emerging leaf or the cracked portion of the seed at ground level.

Nursery care

- Wildlings must be immediately potted upon arrival in the nursery
- Plants must be placed under 100% shades for 2-3 days then gradual exposure to 40% shade in 2 weeks
- Regular watering should be done until hardening
- Hardening – full sunlight and reduced watering

Protection from pests, diseases and stray animals

- All trash, bottles, plastic and other garbage must be removed from the surroundings.
- The grass and weeds must be kept short.
- Weeds from nursery bags should be pulled. Weeds harbour pests and diseases.
- Diseased plants from the nursery must be removed so as not to spread the disease.
- Air should be allowed to circulate freely in the nursery. Poor air circulation promotes ocurrence of diseases.

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ERDB TECHNICAL BULLETIN NO. 4
MBFDP - MANGROVE FOREST ESTABLISHMENT AND MANAGEMENT

RATIONALE

The Mangrove and Beach Forest Development Project (MBFDP) is intended to develop and rehabilitate mangrove and beach forest in disaster-affected areas as a means to improve and enhance the natural defenses and resilience of the country's coastlines and its environs vis-a-vis the impacts of climate change.
Mangrove species are distributed in the swamps in distinct zonation patterns as influenced by salinity, tidal fluctuations, waves and water current; soil properties, water and soil salinity and plant morphology. Proper mangrove establishment and management is required to keep the efficiency of both the nursery and the potential plantation in terms of survival. Specifically, certain mangrove species are suited for one or more zones and varying environmental conditions.

As soon as the site for rehabilitation has been identified, the target sites must be delineated and mapped out on a scale of 1:10,000, where boundaries (natural, political, and administrative, location of passages, blocks, etc.) and coordinates are well-identified.

WHERE TO PLANT MANGROVES

- Areas previously occupied by mangroves with remnant mangrove individuals
- Areas exposed during low tide of neap tide
- Near or at the edge of a river in places affected by tide
- Areas not exposed to strong winds and wave actions
- Areas devoid of seagrasses and barnacle infestation
- Secondary growth, sparsely vegetated areas and abandoned fishponds with clearance from proper authorities for reforestation or enrichment planting.

Table 1. Zonation pattern and site species matching of mangrove plants. (Agaloos, BD. 1994)

Zone	Tidal regime	Soil types	Species recommended for planting
Seaward	Daily, including neap tides	Coral rubble, sandy, sandy loam	*Avicennia marina* (bungalon); *Sonnaratio alba* (pagatpat); *Rhizophora stylosa* (bakauan bato); *R. apiculata* (bakauan lalaki)
Middle	Daily except during neap tides	Silty to silty clay	*Avicennia alba* (bungalon puti); *A. officinalis* (api-api); *Rhizophora apiculata* (bakauan lalaki); *R. mucronata* (bakauan babae); *Aegiceras floridum* (tinduk-tindukan); *A. corniculatum* (saging-saging); *Bruguiera gymnorrhiza* (busain)
Landward	Inundated only during spring tides	Silty to silty-clay to clay	*Bruguiera sexagula* (pototan); *Ceriops tagal* (tangal); *C. zippeliana* (malatangal); *Excoecaria agallocha* (buta-buta); *Lumnitzera racemosa* (kulasi); *Nypa fruticans* (nipa)
Riverine: (Rivermouth and upstream forebank/ backbank)	Variable inundation brackish/ freshwater influence	Sandy to silty-clay to clay	Rivermouth: *Avicennia alba* (bungalon puti); *A. marina* (bungalon); *Aegiceras floridum* (tinduk-tindukan), *A. corniculatum* (saging-saging); *Rhizophora mucronata* (bakauan babe); *R. apiculata* (b. lalaki); *R. stylosa* (b. bato) Upstream : *Avicennia alba* (bungalon puti); *Aegiceras floridum* (tinduk-tindukan); *A. corniculatum* (saging-saging); *Bruguiera cylindrica* (pototan lalaki); *B. gymorrhiza* (busain); *Nypa fruticans* (nipa); *Rhizophora mucronata* (b. babae); *R. apiculata* (b. lalaki)

SITE PREPARATION

- The site must be cleared of debris such as stumps, tree branches, other unwanted vegetation and solid wastes to avoid injury of the young plants as tide recedes.
- The whole plantation area should be divided into compartments with size manageable by a planter (i.e. 20 m x 30 m) and 10 m for the passage of bancas/boats.
- Re-establishment of tidal flow by breaking dikes and other similar structures that block the natural flow of the tide in the areas to be planted.

COLLECTION, HANDLING AND TRANSPORT OF SEEDLINGS

- Collect mature *Rhizophora* spp. propagules with at least 1cm long ring like mark (abscission layer) below the pericarp.
- Mature propagules may be collected by climbing the mother tree, or by reaching out to the underneath canopy.
- Propagules must be collected from places with similar climatic and edaphic conditions as the planting sites.
- Collected propagules should be bundled in 50s or 100s to facilitate transport. They must be placed inside sacks which should be kept cool/open at all times. In transporting, the propagules must be kept in horizontal position and protected from heat.

PLANTING DESIGN

While the number of seedlings to be planted per hectare must be determined, actual planting should be done in random, irregular intervals to mimic the natural distribution of individuals in each zone.

Cluster planting

- Cluster planting is highly recommended in areas seaward zone areas.
- To maximize survival, spacing is much closer (25 x 25 cm) between *Rhizophora stylosa* propagules/seedlings of *Sonneratia alba* and *Avicennia marina*.
- Each cluster has a dimension of 5m x 5m containing 400 *Rhizophora stylosa* propagules per cluster.
- Distance between clusters is approximately 19 meters.
- A hectare can accommodate 25 clusters.

FIG. 1. CLUSTER PLANTING METHODS. (MELANA, ET. AL. 2000)

Advantages:

- Increased survival rate compared to standard planting
- More open space for gleaners and push nets
- Evenly distributed seedlings/propagules in the planting site

Strip planting:

- Strip planting is a common practice in plantation development.
- Strips (10 or 20 x 100 or 150 meters) are established 100-200 meters from the shore at very close spacing to withstand strong waves.
- Once established, the open areas between the bakauan strips and shoreline may now be planted at a wider spacing

SEEDLING DENSITY AND SPACING

- Spacing can range from 16 individuals per square meter to 1 individual per square meter.
- The closer the spacing, the greater the ability of the propagules to withstand wave impact.
- Inner sites along the seafront and in abandoned ponds with little wave action can be planted at 1.5-2m intervals.
- Spacing maybe widened to reduce competition for sunlight and nutrients.
- Deciding on the spacing will help to determine what the total requirement for your seedlings will be.
- Seaward sites exposed to frequent wave action and debris brought by incoming tide need to be planted at closer intervals of 0.5-1m and/or in clusters of 2-3m of 2-3 seedlings each.
- The planting of seedlings must be offset in consecutive rows so that the columns appear in zigzag pattern, avoiding uniformly empty rows between rows of plants.
- For *Avicennia* species, Seedlings/wildlings must be planted into the mud, or holes previously prepared at a depth of 6 cm. The holes must be filled with soil to protect the seedlings from toppling.

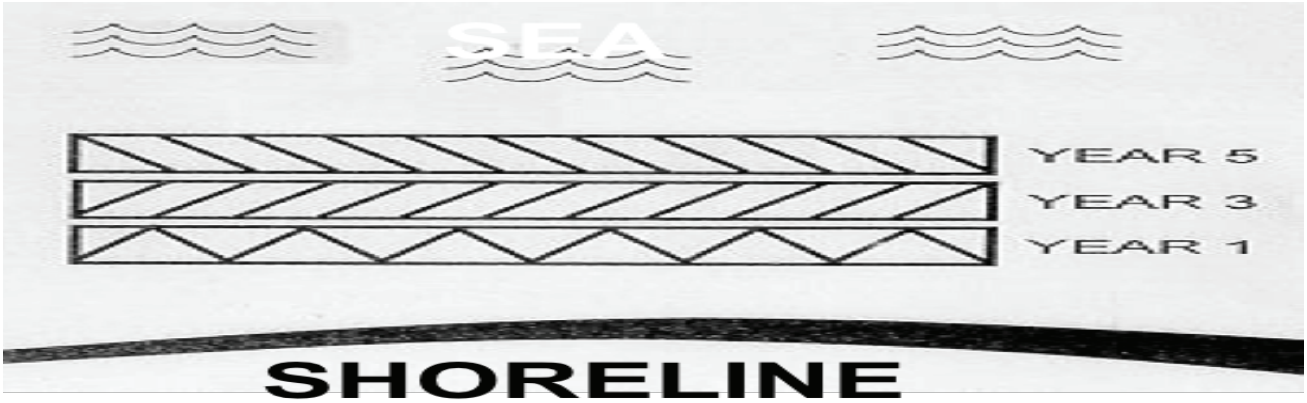

FIG. 2S. STRIP PLANTING METHODS (MELANA, ET. AL. 2000)

- Regular visits must be conducted daily for the first month.
- Debris that might hamper the growth of the seedlings must be removed.
- Dead seedlings must be replaced to maintain the spacing of the plants.
- Plantation must be enclosed with fence to prevent debris and stray animals in damaging the plants.
- Barnacles and other pest must be removed.

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ERDB TECHNICAL BULLETIN NO. 5
MBFDP - BEACH FOREST ESTABLISHMENT AND MANAGEMENT

RATIONALE

Beach forest species enhance the natural defenses and resilience of the country's coastlines and its environs vis-à-vis the impacts of climate change. FAO (2005) provides that this type of forest is found above the high-tide mark on sandy soil and may merge into agricultural land or upland forest. Sand dune and beach vegetation are mostly shrub-like with a high presence of stunted tree growths. These coastal forest ecosystems are adapted to growing conditions that are often difficult as a result of edaphic or climactic extremes such as strong winds, salinity, and a lack or excess of humidity. They are very sensitive to modifications of the ecosystem. A slight change in the groundwater level for example might eliminate the existing shrub vegetation.

Beach forests have not been given much attention given its nature of being part of coastal areas that are often private lands and cultivated. Its inclusion in forestry activities are limited to the 20-meter easement zones designed for shoreline protection. The protective role of beach forest species have been highlighted as it occupies areas where there are no mangroves serving as a first line of defense for the coastal areas. It can withstand strong waves, rocky substrates, and barnacle infestations among others. Beach forests serve as a natural barrier from storm surges, while arresting sedimentation of sea grasses and corals.

Beach forest rehabilitation includes two groups of beach forest species: a) the traditional beach forest species (TBFS) like agojo, bogo, dapdap; and b) the mangrove associate species (MAS) like bani, bitaog, and talisay. The two groups need to be differentiated because the former is not tolerant to sea-water intrusion while the latter is. This means only MAS should be planted within the first 10m of the easement zone. The marked distinction between the traditional beach species and the mangrove associates provides an easy guide on what to plant along the 20m easement zones.

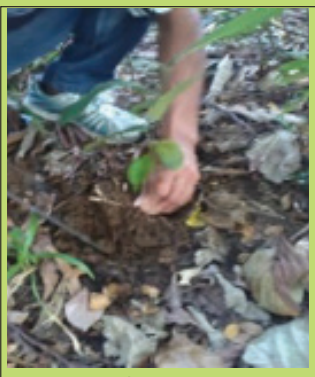
The success of plantation establishment largely depends on the kind of nursery operation that produces high quality seedlings at the least cost and at the earliest possible time. To produce quality seedlings, all nursery activities must be properly and efficiently done. This includes: using the right mix of potting soil for rapid development of the root system; proper seed/wildling collection from healthy mother trees for higher germination percentage; appropriate shading on the seedling beds; seedling care and hardening

SEEDLING PRODUCTION

- Seed collection/germination – Collect mature and healthy seeds for germination. Tiny, winged seeds like agoho, should be germinated on seed box with extra fine sand, sterilized, if possible, with seed box protection from ants. Use fungicides as agoho is highly susceptible to damping-off. Other tiny seeds need no treatments (dita, batino, bogo). Big seeds (banalo, bani, bitaog, butong, kalumpang) may be sown directly on plastic bags or on a seed bed.
- Wildling collection – In case of limited seedlings, wildlings may be used provided quality standards are followed. Following the procedure in mangroves: ready pots before collection; observe extra care in uprooting, packaging and transport; leaf/root pruning; and immediate planting in the nursery (Figure 1).
- Pot wildlings in 4cm x 6cm plastic pots with ordinary garden soil plus saw dust.
- Potted wildlings should be placed under full shade (100%) for the first three days for fast recovery. Shade is gradually reduced up to one half (50%) within two weeks.
- Conduct maintenance activities such as regular watering, weeding and segregation of overtopped seedling from the seedling bed for recovery.
- Seedling segregation – Overtopped seedlings in the nursery is very common, resulting in slow death of seedlings unless rehabilitated early. Seedlings in the seedling beds may look robust but underneath are 10-20% suppressed plants that needs immediate rehabilitation. The segregated seedlings — filed in two rows, four inches apart to accommodate more sunlight — will be watered with an organic fertilizer solution for fast recovery.
- Hardening – The seedlings are totally exposed to sunlight with watering gradually reduced before out-planting. The seedling must be really well-hardened to withstand the strong wind and intense heat of beach areas (2-6 weeks).

PLANTATION ESTABLISHMENT

If nursery establishment affects the success of the plantation, the various planting practices have a direct effect on the quality and survival rate of the plantation. In other words, no matter how good the nursery operation was, if planting practices are not properly done, the plantation may be at risk from factors such as stunted growth and low survival rate -- especially in beach areas, which are generally sandy and nutrient deficient.



Uprooting of wildling with leverage using bolo to minimize root damage.

Puddling of wildling with moss or wet newsprint to avoid root dehydration.

Placing wildling bundle on a cross banana leafsheet before folding.

Wildlings on a banana leafsheet pack ready for transport.

FIGURE 1: WILDLING COLLECTION AND PACKAGING.

Mapping and delineation

As soon as the site for rehabilitation has been identified, the target sites must be delineated and mapped out on a scale of 1:10,000, where boundaries (natural, political, and administrative, location of passages, blocks, etc.) and coordinates are well-identified.

Why plant beach forest species?

- They serve as the first line of defense against tsunamis and storm surges in areas with no mangroves.
- Beach areas are much longer than mangroves.
- Beach forests arrest sedimentations of sea grasses and corals.

Where to plant?

- Within the 20m of the easement zone.
- Within the 40m of the easement zone in cases where the area is timberland.

What is an easement?

- A right of an individual or entity to trespass a land not his own.

What is an easement zone?

- An easement zone is government land along a beach and riverbank indicated by dotted lines in the land tile and allows a title holder to use the area if the government is not yet using the said area.
- PD 1067, Art. 51, states that the easement zone along the shore is 20m, (40m if timberland), from the highest tide. In rivers and urban creeks they are 20m and 3m, respectively.

What to plant?

- Use MAS within the first 10m of the easement zone. MAS tolerates sea-water intrusion.
- Use TBFS behind the MAS. TBFS is not tolerant to sea-water, and may die when inundated (Table 1).

How to plant?

- Multi- storey – mixed planting of fast and slow growing species. First three rows of MAS: bitaog, balu, banalo and TBFS: agoho, dita, bogo at the back of MAS (Figure 2).
- Phase planting – use of creepers/vines: Ipomea pes capre at Year 1, brushes (sea lettuce) at Year 2 and MAS/TBFS at Year 3.

Yr 1- vines/creeper
Yr 2- shrubs
Yr 3- trees

Use of large planting materials (LPM), O.5m, up.

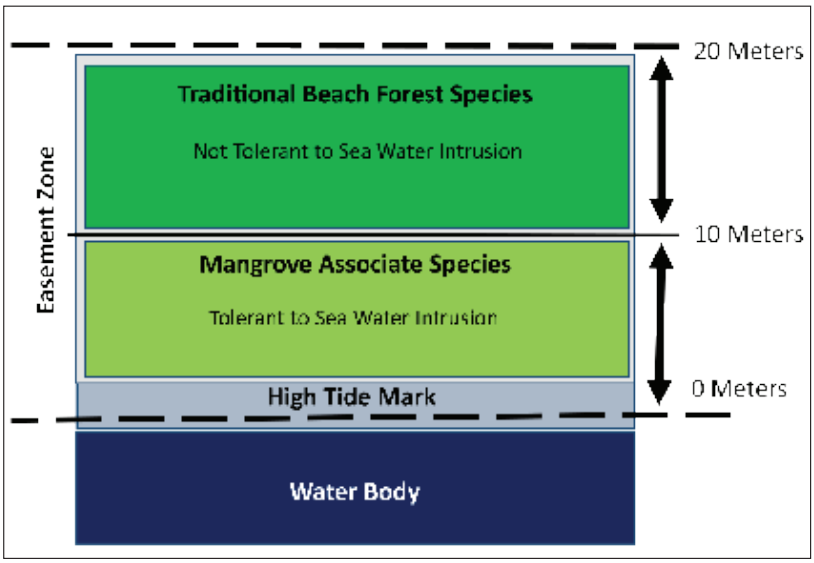


FIGURE 2: BEACH FOREST PLANTING LAYOUT.

Site Preparation/Planting

- Staking
- Strip brushing (2m x 2m spacing) or spot clearing of 1m diameter (4m x 4m).
- Hole-digging, 1cu.ft.
- Hauling/planting.
- Mulching, 3-4 inches thick topped with stones to avoid being windblown.
- Acclimatization — 2-3 weeks before outplanting
- Use tree guard

Table 1. Recommended Beach Forest Species.

Species	Characteristics	Uses
Agoho (*Casuarina equisetifolia*)	Fast Growing Nitrogen-Fixing Trees (FGNFT)	Timber, tool handle, medicinal
Akleng-parang (*Albizia procera*)	FGNFT,	Timber, firewood
Antipolo (*Artocarpus blancoi*)	Cylindrical bole, fast growth,	Food, fodder, timber
Batino (*Alstonia macrophylla*)	Prolific seeders, 2-3 times a year	Woodcraft, timber, ornamental
Balinghasay (*Buchanania arborescens*)	Prolific seeders	Woodcraft
Bakong (*Pandanus dubius*)	Spreading prop-roots	Mat making
Bogo (*Garuga floribunda*)	On rocky soil, flaking bark, prominent buttress.	Timber, propagated by cuttings
Camachile (*Pithecellobium dulce*)	FGNFT	Food, firewood, tannin
Dapdap (*Erythrina variegata*)	Red flower	Ornamental
Dita (*Alstonia scholaris*)	Horizontal branching	Ornamental, medicinal
Duhat (*Syzygium cumini*)	Sturdy trunk	Timber, food,
Kalumpang (*Sterculia foetida*)	Fast growth	Live fence, fodder
Katmon (*Dillenia philippinensis*)	Dense foliage	Ornamental, food
Malabog (*Parishia malabog*)	Cylindrical bole on rocky shores	Timber
Malambingan (*Broussonetia luzonica* var. *glabra*)	Himbabao look-alike, fruit bat favorite	Timber
Molave (*Vitex parviflora*)	Trifoliate leaves	Furniture, hard wood
Pandan Dagat (*Pandanus tectorius*)	Prop roots	Mat making
Tabon-tabon (*Atuna racemosa*)	Wide, low crown, dense foliage	Spice (kinilaw condiment)
Talisay Gubat (*Terminalia foetidissima*)	Towering tree, horizontal branching	Timber

Table 1. Recommended Beach Forest Species (continuation).

Species	Characteristics	Uses
Bani (*Millettia pinnata*)	Wide spaced branchin , sparse foliage, allows more sunlight for underplants	Medicinal
Balu (*Cordia subcordata*)	Fast growing, big bright yellow flower	Bast fiber, ornamental
Balitbitan (*Cynometra ramiflora*)	Pinkish to whitish pendulous shoots	Ornamental
Banalo (*Thespesia populnea*)	Propagated by rooted stem cutting dense foliage	Woodcraft, bast fiber
Bitaog (*Calophyllum inophyllum*)	Sturdy trunk, solid crown, extra	Ornamental, timber, medicinal
Botong (*Barringtonia asiatica*)	Wide crown, dense foliage	Ornamental, medicinal
Dungon-late (*Heritiera littoralis*)	Backmangroves, clay substrate	Spice (kinilaw) timber
Ipil (*Instia bijuga*)	Backmangroves, sandy-clay soil	Luxury lumber
Mala-piagau (*Xylocarpus rumphii*)	Multiple stems	Timber
Malubago (*Taliparitii tiliaceum*)	Dense, creeping branches	Bast fiber, live fence
Boto (*Scaevola taccada*)	Propagated by stem cutting	
Talisay (*Terminalia catappa*)	Wide crown, horizontal branching	Shades, timber
Shrubs and Vines		
Pataning dagat (*Canavalia maritima*)	Creeper with developing roots in nodes, sand benders	Sand stabilizer
Lagaylay (*Ipomoea pes-caprae*)	Perennial vine/creeper	Sand stabilizer

Source: Palis, H.G. 2013. Handbook of on the Identification of Beach Plants in the Philippines; Primavera, JH and R. B. Sadaba. 2012. Beach Forest Species and Mangrove Associates in the Philippines.

CARE AND MAINTENANCE

After raising high quality seedlings in the nursery and planting them in a harsh environment like beach areas, extra care and maintenance are necessary for the newly planted seedlings to survive the first onset of the dry season through the following interventions:

- Regular ring weeding/as needed, (05. radius).
- Monitoring for stray animals.
- Maintain mulching.
- Maintain tree guard

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State of the Mangrove Summit: Southern Luzon
1 -2 October 2015 | Faber Hall 302, Ateneo de Manila University

Background and Rationale

In the wake of the destruction left by Super Typhoon Yolanda, building natural coping mechanisms against climate change becomes more crucial as the world experiences the new "normal." This is especially significant for coastal inhabitants. Among these coping mechanisms, mangroves have proven to be life savers, protecting coastal dwellers and their livelihoods from storm surges and sea level rise (**see for example McIvor et al., 2013**). A press release by the **United Nations Development Program** entitled "Mangrove restoration saved our lives and our economy, says villager in Northern Samar, Philippines," published 13 November 2013, is just one of the many testaments to the value of mangroves. In the article, a resident of Northern Samar was quoted as saying, "Had we not protected the mangrove trees against illegal cutting and had we not planted the areas surrounding the fish farms, the super typhoon would have destroyed everything that the poor fisherfolk established."

The Role of Mangrove Systems

Mangroves perform several important ecological and socio-economic services. These plants do not only serve as protection against storms and strong waves, they are also habitat to marine organisms of commercial value (fisheries), residence to many threatened and endangered species, and can also be aesthetic and tourism areas (e.g. sport fishing, boating, bird watching, snorkeling). Mangroves may also serve as sources of fuel, wood and medicine (**Hogarth 2007**). In addition, mangroves are known to be an efficient sink of atmospheric CO2 and as such, play an important role in mitigating the impacts of climate change (**Chmura et al 2003**).

Like other coastal ecosystems, mangroves are threatened by both natural and human- induced stresses. Among these stresses are the occurrences of typhoons, pollution, siltation, land reclamation (e.g. wharf, pier, human settlement, etc.), obstruction of dikes and structures of waterways, tidal inundation, harvest of timber and fishery products, and conversion to fishponds (**Alongi 2009**). The latter appears to be the most significant factor, causing the decline of mangrove forests not only in the Philippines but also in Southeast Asia, where 40% of world's mangroves are located.

The loss of mangrove forests will result in the reduction in biodiversity and species richness that will lead to the reduction or loss of valuable ecosystem services naturally rendered by mangroves (**Duke et al. 2007**). Without mangroves, environmental catastrophes such as flooding, typhoons, coastal erosion and landslides will have more severe impacts on humans. With coastal development replacing mangroves and other coastal vegetation, humans are becoming more vulnerable to ecological disasters (**Danielsen et al. 2005**; **Kathiresan and Rajendran 2005**). Unless properly conserved or managed, the loss of mangroves will result in less stable coastal environments. The capacity of planted mangroves to effectively restore forest cover and function as a carbon sink largely depends on its growth performance. Unfortunately, there are very few monitoring reports on the success or failure of mangrove planting programs in the Philippines.

Mangroves in the Philippines: Southern Luzon

Out of the 255,448.85 hectares of mangroves left in the Philippines (Long and Giri, 2011), 94,549.86 ha (37%) is found in Mindanao, 51,547.98 ha (20.18%) in Visayas and 109,351.01 ha (42.81%) in Luzon. Of the mangrove forests found in Luzon, more than half are in the western side of Southern Luzon, namely in the provinces of Cavite, Batangas, Oriental Mindoro, Occidental Mindoro, Marinduque, Romblon, and Palawan. These provinces belong to parts of the West Philippine Sea and Visayan Sea biogeographic regions.

The island province of Palawan alone accounts for 22.23% of mangrove forests of the whole country and includes several key marine biodiversity areas for mangroves, such as Puerto Princesa Bay, Balabac Island, Pandanan Island, Calamianes Group of Islands, El Nido, and Malampaya Sound. Also located within the Southern Luzon region is the Verde Island Passage Marine Corridor, which has a wealth of coastal and marine resources, including highly diverse coral reefs, seagrass beds, and mangrove forests. Despite the extent and diversity of mangroves in the region, they are still threatened by natural and anthropogenic hazards. These areas are highly vulnerable to typhoons, tsunamis, storm surges, and sea level rise. In addition, unsustainable coastal development and land use practices also contribute to the destruction of mangrove forests in the area.

In response, most provinces regularly conduct mangrove-planting activities. However, planting sites are usually along the shoreline using species from the genus *Rhizophora* (Salmo and Duke 2010). Thus, survival rate is low, usually attributed to wrong species-substrate matching, and the inappropriate location and timing of planting. Similar to most mangrove rehabilitation programs in the country, most mangrove planting activities in the region are more of afforestation (which affects the nearby habitat – seagrass bed and mudflats) rather than reforestation of denuded mangrove areas. The planted stands are usually mono-specific (Walters 2004; Lewis 2005; Primavera and Esteban 2008) with stunted growth and poor survival (Samson and Rollon 2008).

The Need for a Mangrove Summit

The Mangrove Summit will serve as a platform for each province to share data on the extent of their mangrove forests as well as their practices in managing these resources. Taking-off from the success of the 1st State of the Mangroves Summit held for provinces in Northwestern Luzon, succeeding summit will be held in the remaining areas of Luzon, t be followed by Visayas, and then Mindanao. These will all lead to a bigger national summit on mangroves to take place on a regular biannual basis, and serve as an initial step towards the formulation of a national plan of action to enhance mangrove management in the vountry.

Summit Objective

The proposed **State of the Mangroves Summit: Southern Luzon** aims to complement the State of the Coast Reports of the UP Marine Science Institute by opening up the stage for provinces across the Philippines to discuss the status of mangrove forests in the country.

Specifically, the summit aims to accomplish the following objectives:

1. Provide avenue for provinces to share and discuss the status of mangrove forests in the Philippines, especially in the light of climate change vulnerability;
2. Invite experts in the field of mangrove ecology and management, climate change vulnerability, and blue carbon sequestration to share state of the art knowledge to enrich the workshop and action planning
3. Consolidate “more” accurate data from each province; and
4. Come up with a plan of action to enhance mangrove management.

Summit Design

Participants
Two (2) representatives will be invited from the provinces of Cavite, Batangas, Oriental Mindoro, Occidental Mindoro, Marinduque, Romblon, and Palawan and from the Regional Offices of the Department of Environment and Natural Resources in the National Capital Region, and Regions IV-A and IV-B. In addition, representatives from the academe, non- government organizations and national government agencies such as the Biodiversity Management Bureau of DENR (DENR-BMB), Bureau of Fisheries and Aquatic Resources (DA-BFAR) of the Department of Agriculture, Commission on Higher Education (CHED), and Department of Science and Technology (DOST).

A total of fifty (50) guests are expected to attend the summit.

Appendix I continued...

Day 1	
8:30 AM	**Registration**
09:30AM	**Welcome Remarks** John Paul C. Vergara, PhD *Vice President for the Loyola Schools – Ateneo de Manila University* Mr. Enrique A. Nunez, Jr. *Country Executive Director* *Conservation International – Philippines*
10:00 AM	**Summit Introduction and Overview** Dr. Severino G. Salmo III *Assistant Professor, Department of Environmental Science* *Ateneo de Manila University*
10:30 AM	**Status of Mangroves and Mangrove Management in the Philippines** Carmelita I. Villamor *Supervisor Scientific Research Specialist/ OIC-Chief* *Coastal Zone and Freshwater Ecosystems Research Division* *Ecosystems Research and Development Bureau* **State of mangrove research and management in the Philippines: challenges and opportunities** Dr. Miguel D. Fortes *Professor (ret.)* *The Marine Science Institute, University of the Philippines*
11:30 AM	**Open Forum**
12:00 NN	**Lunch Break**
01:00 PM	**Presentation and Update of Mangrove Status per Province**
04:30 PM	**Synthesis** Dr. Severino G. Salmo III *Assistant Professor, Department of Environmental Science* *Ateneo de Manila University*
06:00 PM	**Welcome Dinner**

Appendix I continued...

Day 2	
8:30 AM	**Day 1 Synthesis and Workshop Introduction** Abigail Marie T. Favis *Instructor, Department of Environmental Science* *Ateneo de Manila University*
9:30 AM	**Mangrove Mapping in Southern Luzon** Alvin B. Baloloy, Senior RS/GIS Research Associate *CCC-RAPID Natural Resource Assessment* *Department of Engineering, University of the Philippines, Diliman* Al Jayson Songcuan *Senior Research Assistant* *Coral Reef Visualization and Assessment (CORVA)* *Department of Engineering, University of the Philippines, Diliman*
11:30 AM	**Resiliency and vulnerability of the coastal zone against sea level rise** Dr. Samuel Mamauag *The Marine Science Institute, University of the Philippines* **Incorporating Mangroves in Integrated Coastal Management** Dr. Porfirio M. Aliño *Deputy Director for Research* *The Marine Science Institute, University of the Philippines* **Open Forum**
12:00 NN	**Lunch Break**
01:00 PM	**Blue Carbon Initiatives in the Philippines** Ma. Josella Pangilinan *Project Manager – Ecosystem-based Adaptation to Climate Change* *Conservation International – Philippines*
01:20 PM	**Workshop Proper** **Action Planning and Recommendations**
04:30 PM	**Summit Synthesis and Closing** Dr. Severino G. Salmo III *Assistant Professor, Department of Environmental Science* *Ateneo de Manila University*
06:00 PM	**Dinner**