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State of the Mangrove Summit: Northwestern Luzon Proceedings

23-24 October 2014

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Abigail Marie T. Favis
Marie Nathalie S. Ting

Ateneo de Manila University
Loyola Heights, Quezon City

Organized by:

ATENEO DE MANILA UNIVERSITY

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Fostering Partnerships for the Environment

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About the cover art: From their complex root system to their lush canopies, mangroves offer a highly productive ecosystem, and a diverse array of functions. Mangroves can also buffer the effects of looming natural disasters on coastal communities. Highlighted in the map are the areas in the West Philippine Sea biogeographic region of the Philippines which are included in the Proceedings.

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LIST OF ACRONYMS

ACCCoast – Adaptation to Climate Change in Coastal Areas
ADPLS – Agoo-Damortis Protected Landscapes and Seascape
AUU FLA – Abandoned, underutilized and undeveloped fishpond lease agreements

BCCF – Bataan Coastal Care Foundation
BFAR–RO – Bureau of Fisheries and Aquatic Resources – Regional Office
BICMP – Bataan Integrated Coastal Management Program
BMB - Biodiversity Management Bureau

CALABARZON – Cavite, Laguna, Batangas, Rizal and Quezon
CBD – Convention on Biological Diversity
CCEF – Coastal Conservation and Education Foundation, Inc.
CENRO – City Environment and Natural Resources Office
CEP – Coastal Environment Program
CI – Conservation International
CI-P – Conservation International –Philippines
CIVAT – Coastal Integrity Vulnerability Assessment Tool
CRM – Coastal Resource Management
CSEZ – Clark Special Economic Zone
CTI – Coral Triangle Initiative
CTSP – Coral Triangle Support Partnership
CVM – Contingent Valuation study

DA – Department of Agriculture
DA-BFAR – Department of Agriculture – Bureau of Fisheries and Aquatic Resources
DENR – Department of Environment and Natural Resources
DENR-RO – Department of Environment and Natural Resources –Regional Office
DENR-SCREMP – Department of Environment and Natural Resources – Sustainable Coral Reef Ecosystem Management Program
DILG – Department of Interior and Local Government
DMMMSU – Don Mariano Marcos Memorial State University
DOST-PCAMRD – Department of Science and Technology – Philippine Council for Aquatic and Marine Research and Development
DOT – Department of Tourism
DPWH – Department of Public Works and Highway

EIS – Environmental Impact Study
EMS – Environmental Management Specialist

FARMC – Fisheries and Aquatic Resource Management Council
FISH – Fisheries Resource Management for Improved and Sustainable Harvest
FLA – Fishpond Lease Agreement
FO – Fisherfolk Organizations
FPE – Foundation for the Philippine Environment
FRM – Fisheries Resource Management

HINP – Hundred Islands National Park

I-C-SEA-Change – Integrated Coastal Sensitivity, Exposure, Adaptive Capacity to Climate Change
ICRMP – Integrated Coastal Resources Management Project
IEC – Information, Education and Communication
IOC-UNESCO – Intergovernmental Oceanographic Commission of the United National Educational, Scientific, and Cultural Organization
ISODATA – Iterative Self Organizing Data Analysis Technique Algorithm
IUCN – International Union for Conservation of Nature

JBIC – Japan Bank for International Cooperation

LDCM – Landsat Data Continuity Mission
LGU – Local Government Unit
LIDAR – Light Detection and Ranging

MENRO – Municipal Environment and Natural Resources Office
MFO – Municipal Fisheries Ordinance
MIMAROPA – Mindoro, Marinduque, Romblon, Palawan
MMSU – Mariano Marcos State University
MOA – Memorandum of Agreement
MPA – Marine Protected Area
MSN – Marine Protected Area Support Network

NASA – National Aeronautics and Space Administration
NEMO – Natural Ecosystem Managers Organization, Inc.
NGA – National Government Agencies
NGO – Non Government Organization
NGP – National Greening Program
NIA – National Irrigation Authority
NMC – National Mangrove Committee

OPAg – Office of the Provincial Agriculture

PAMB – Protected Area Management Board
PD – Presidential Decree
PEMSEA – Partnerships in Environmental Management for the Seas of East Asia
PENRO – Provincial Environment and Natural Resources Office
PGIN – Provincial Government of Ilocos Norte
PHERNet – Philippine Higher Education Research Network
PHILMARSAST – Philippines Marine Sanctuary Strategy
PNAP – Philippine National Aquasilviculture Program
PO – People's Organization
PPP – Public-private partnership
PRII – Philippine Resins Industries, Inc.
PSU – Pangasinan State University

RA – Republic Act
REDD+ – Reduced Emissions from Deforestation and Forest Degradation and Foster Conservation, Sustainable Management of Forest, and enhancement of Forest Carbon Stocks
SALBA – Sagip Likas Yamang Dagat ng Bataan, Inc.
SAMMPA – Samahang Magsasaka at Mangingisda ng Panglit
SBMA – Subic Bay Metropolitan Authority
SBFZ – Subic Bay Freeport Zone
SBPAMP – Subic Bay Protected Area Management Plan
SLGP – Sagip Lingayen Gulf Project
STEWARDS – Science and Technology Enhances Wise Adaption for Resiliency Developing Systems
SUC – State Universities and Colleges
SUGPO – Samahan at Ugnayan sa Pangisdaan ng Orion, Inc.
SWM – Solid Waste Management

TAGIBIKA – Tagibien Ti Kabaybayan/Karayan
TURF – Tool for Understanding Resilience of Fisheries

UN – United Nations
UNFCCC – United Nations Framework Convention on Climate Change
UP MSI – University of the Philippines Marine Science Institute
USGS – United States Geological Survey

VIP – Verde Island Passage

WCPI – Woodward-Clyde Philippines, Inc.
WWF-P – World Wildlife Fund-Philippines

MESSAGES

The past has seen a rapid rise in an ever-burgeoning drive for economic progress in almost all sectors of Philippine society. This is key to the unrelenting and unsustainable utilization of our coastal resources, particularly mangroves. These, in concert with the intensified exploitation of the different marine habitats, plus the impacts of the little understood climate variability, have severely depleted our once abundant coastal store. Hence, the last two decades have brought a mix of scientific and social research studies and initiatives aimed at reversing the degradation trend. The *1st State of the Mangroves Summit: Northwestern Luzon* is a much-needed positive response to this urgent call.

The summit is an enthusiastic celebration of ideas from many mangrove practitioners, especially ideas engendered by the impacts of the country's current economic growth and climate change, made more dramatic with the loss of lives and damage to property wrought by the Super-Typhoon Yolanda in November 2013. It is also a unique tribute to the many participants who provided many current insights on mangrove status, mapping, climate change vulnerability assessment and blue carbon. The summit culminated with the formulation of an action plan that would direct immediate and long term actions towards effectiveness and prudence, learning from the country's vast experiences.

Although the summit represents only a small sample of the country's pool of mangrove-related experts and practitioners, it amply illustrates the importance of the ecosystem and the field of social-ecological science to humankind and the way in which the field is evolving.

I think that the organizers can be confident that there will be many readers of these summit proceedings who will have gained a broader perspective on the mangroves as we embark on the set of actions for their conservation and management.

Miguel D. Fortes, PhD
Professor of Marine Science (ret)
Marine Science Institute, College of Science
University of the Philippines, Diliman, QC 1101

MESSAGES

The Biodiversity Management Bureau (BMB) values the biological diversity in mangrove ecosystems and the role it plays in provisioning for food, fuel, medicine and other materials, in regulating climate and other ecological services such as providing nursery and feeding grounds to a wide variety of species, coastal protection and shoreline stabilization. Various mangrove species and its associates primarily support various juveniles of species that make up a large part of our coastal ecosystems. With thousands of kilometers of coastline, our country is indeed fortunate to possess large expanses of mangroves that showcase its rich biodiversity.

Unfortunately, the past decades show the rapid degradation of this natural resource brought about by natural and human perturbations. The pressures that mangroves received from the poor development of our coastlines and overexploitation (mangrove conversion to other uses) have exacted a heavy toll on these resources. Management efforts have been underway to address to these pressures. But there is a need for further consolidation and integration of data to enhance management efforts.

The BMB shares in the objectives and efforts of the *1st State of the Mangrove Summit: Northwestern Luzon* consistent with its mandate to conserve the biological diversity of the country. We find that the streamlining of data, networking and innovations through research provide us with better direction for the conservation and rehabilitation of our mangrove areas. The summit provides us with an opportunity to level off where we are in terms of our country's mangrove resources and share learning and ideas particularly on northwestern Luzon. It also encourages us to work together and use technological innovations for mangrove conservation and management.

Let us use the summit proceedings and the knowledge they generate to recall and develop our ideas for the enhancement of our mangrove resources. Let this be the start of a more diverse and participative consolidation effort that will eventually translate into feasible actions for mangrove management.

Theresa Mundita S. Lim
Director
Biodiversity Management Bureau
Department of Environment and Natural Resources
Quezon Avenue, Diliman, QC 1101

MESSAGES

ATENEO DE MANILA
UNIVERSITY

We are happy to have played host to a gathering of concerned and proactive experts and to have provided a venue for participants to discuss the state of an important natural resource. Please be assured that you have the support of the Ateneo de Manila University's Loyola Schools in the creation and implementation of plans to enhance the management of our mangroves in northwest Luzon.

I would like to thank all the speakers who shared their data and insights during the summit. I would also like to thank the Environmental Science Department for bringing together a group to really focus on this topic, which, if managed correctly, addresses many problems we face in this country—storm surges and flooding, pollution, and erosion, among others.

I hope that the summit proved to be informative, enlightening, and productive. It is also my hope that through sharing knowledge and ideas, everyone has been inspired to continually collaborate with each other for the protection and flourishing of the Philippines' mangroves.

John Paul C. Vergara, PhD
Vice President for the Loyola Schools
Ateneo de Manila University

MESSAGES

For an archipelagic country like the Philippines, mangroves are one of the most important ecosystems but sadly the least valued. The loss of mangroves means loss of nurseries for fishes and other aquatic organisms, which negatively affects the food supply of populations largely dependent on seafood. The global climate change phenomenon and climate change-related disasters highlighted another significant function mangroves play – protection mechanism for thousands of Filipinos living in coastal communities.

Challenged by global environmental changes, the Foundation for the Philippine Environment (FPE) now gives priority to climate change adaptation and disaster risk reduction and management (CCA-DRRM) issues by including it in FPE's 10-year strategic plan. This move is grounded on the insurmountable damage brought by super typhoon Yolanda never experienced before.

The Foundation has been supporting biodiversity conservation initiatives for local community development in the last 23 years, but now sees with greater reason the importance of conservation in building resilient communities. The 1st State of the Mangrove Summit: Northwestern Luzon timely supports FPE's vision of advancing a climate-proof biodiversity conservation and sustainable development agenda.

In addition, most research studies on mangroves in the Philippines are focused in the Visayas region, thus, this event which brought together local government units, regional representatives of the DENR, nongovernment organizations and experts from the academe, provided additional and up-to-date knowledge on the state of mangroves in northwestern Luzon, where primary and secondary data are limited or may be inaccessible.

FPE also recognizes the value of knowledge sharing and partnership building in resolving conservation and development challenges. FPE commends Ateneo de Manila University for organizing the Summit and facilitating the production of this publication that contains detailed profiles, status of mangroves in various provinces in northwestern Luzon, and related technical studies. This publication will provide FPE concrete basis in laying interventions in both of its competitive and proactive grant programs, including special projects.

It is our hope that a similar summit be conducted to focus on other equally-important areas and the result of such initiatives be shared to all possible stakeholders. This proceedings will definitely guide policymakers, and government and non-government organizations alike in advancing mangrove conservation in the country.

Godofredo T. Villapando Jr
Executive Director
Foundation for the Philippine Environment

I. INTRODUCTION AND OVERVIEW

Mangrove forests have long been recognized for their various ecological and socio-economic services. These forests do not only serve as protection against storms and strong waves, but also as habitat to various terrestrial and marine organisms. 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 and human settlement), its harvesting for timber products, and its conversion to fishponds. 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.

The loss of mangrove forests results in the reduction in biodiversity that leads 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). The impacts of an accelerated environmental change on coastal landscape, primarily global warming and sea level rise (popularly known as climate change), will result to more severe coastal disasters.

Mangroves are known to be efficient sinks of atmospheric CO_2, and as such, play an important role in mitigating the impacts of global warming. They have five times higher carbon stocks than the terrestrial forest types (Donato et al. 2011). The litter production and organic detritus that are deposited in the sediments help in maintaining surface elevation and therefore help in compensating the effects of sea level rise. The capacity of mangroves to adapt and mitigate the impacts of climate change has led coastal managers to intensify the management and rehabilitation of mangrove forests.

State of Philippine mangroves: forest cover, research and management

Out of the 255,449 ha of mangroves in the Philippines (Long & Giri 2011), around 94,550 ha (37.1%) is found in Mindanao, 51,548 ha (20.2%) in Visayas and 109,351 ha (42.8%) in Luzon. More than half of Luzon mangroves are in Palawan. Reports on Philippine mangrove statistics (in terms of status, extent and distribution) are confusing, and often inconsistent. Before year 2000, there are reports stating that mangroves occupy only around 120,000 ha from as much as 450,000 ha in early 1900s. At least 60% of mangroves losses were due to massive conversion to aquaculture ponds particularly in the 1970s-1980s (Primavera 2000). At the turn of the 20th century, however, the estimates on mangrove forest cover increased to around 240,000 ha (Long et al. 2011, Long et al. 2014).

The validity of these recent figures has been questioned. The differences in these estimates may be attributed to the varying resolutions on the remote sensing images used in mangrove mapping activities. It is also possible that the young planted stands from massive mangrove planting programs, despite not yet fully developed as mature forest, have been erroneously added to these estimates. In addition, there were some local initiatives on mangrove mapping that estimated the actual mangrove extent in a particular locality (see Bani, Pangasinan case study in this report). Manual mapping such as this initiative may have better resolution and an advantage in familiarity in the actual mangrove distribution. The capacity of humans to map out the actual extent may be constrained by its inherent physical limitation to map the entire stretch of a mangrove forest. Nonetheless, despite the advancement of technology, there are still instances where figures derived from remote sensing are either over or under-estimated as reported by local mangrove managers from the site (see Pagkalinawan's report). Thus there is a need to reconcile data from remote sensing and that of field-validated mangrove forest data. Obviously, the extent and types of mangroves determine the type of management action that will be implemented.

There are around 875 studies over a span of 316 years on Philippine mangroves. These studies make Philippines as one of the top research producing country in SE Asia until 1970s, but gradually declined thereafter. Surprisingly, 85% of these are found as grey literature and only 15% as peer-reviewed (Fortes & Salmo 2015). The academic and research institutions contributed 50% while the government accounted 25% of these studies. Areas that have high research outputs are (in order) in Region 7

(Central Visayas), Region 4A (CALABARZON), Region 6 (Western Visayas), Region 4B (MIMAROPA) and Region 5 (Bicol).

Early research studies on mangroves, dating back to the late 1600s up to the mid-1900s, focused on its utilization and basic natural sciences. Subsequent research efforts on mangroves significantly increased covering aspects of its uses, field surveys, taxonomy, biodiversity and conservation. Most studies on mangroves have been conducted near a research institution and on the bases of their presence, degree of usage, and the relevant environmental and socio-economic issues. In the 1970s–1990s, some studies were focused on fishpond development and in Environmental Impact Assessments resulting from industrial and commercial operations. From the 1990s onwards, studies have been heavily focused on its conservation and management, biodiversity and ecology, but often neglect the strengthening of basic sciences. Some studies were linked to national and international-funded programs such as the Coastal Environment Program, Fisheries Sector Program, Coastal Resource Management Program, Integrated Coastal Resources Management Program, among others.

Through the years, research priorities responded to the need to address economic and environmental problems of each period. Massive mangrove planting programs have proliferated in the country since 1990s. It is timely and interesting to know the actual contributions of these planted mangroves in terms of the delivery of the perceived ecological and socio-economic benefits. If done properly, restored mangroves have the potential to abate the impacts of typhoon, storm surge, global warming and even mitigate the impacts of sea level rise. Such performance will be influenced by the state and health of the planted mangroves. However, these mangroves were planted in sub-optimal conditions (i.e. highly inundated and saline), resulting to poor survival and stunted growth. Unfortunately, there are very few monitoring reports on the success or failure of mangrove planting programs in the Philippines.

Unless conservation and management issues are addressed, the further loss of mangroves will result in less stable coastal environments. There are several existing laws that define mangrove management (for examples, see Primavera 2000). Some policies related to mangrove management are the Philippine Forestry Code (PD 705 and the revised version, RA 7161), Philippine Fisheries Code (RA 8550 revised version), and the Local Government Code (RA 7160). The jurisdiction of mangrove management in the country have long been disputed, apparently because, on one hand, mangroves are viewed as habitats critical for biodiversity and as bio-shield against natural disasters, and on the other hand, as source of fisheries products that provide livelihood and source of income for the coastal communities. Some national programs overlap in areas as a result of such conflicts. On the bright side, there are some successful initiatives on the ground that are either implemented by the local government or community-based organizations. These initiatives include, for example, the declaration of mangrove protected areas, eco-tourism zones, and development of enterprise derived from non-extractive use of mangrove products.

A national coordinating body, similar to the National Mangrove Committee (NMC) in the mid-1980s, is needed. The NMC should be reactivated to oversee the national mangrove management plan. As originally envisioned, a regular updating of mangrove status in the country will be institutionalized. As of this writing, there are pending bills in Congress seeking the formation of a committee similar to the functions of the NMC. With the long absence of such a committee, however, critical reviews and inputs to guide the NMC are needed.

The Need for a Mangrove Summit

Given the important role of mangroves, the lack of consolidated data and some resource constraints, there is an urgent need to have the first Mangrove Summit. The summit will serve as a pioneering activity to help revitalize the NMC. It envisions institutionalizing a national State of the Mangrove biannual workshop that consolidates monitoring data (e.g. growth and biodiversity). This information, collated in an accessible online database, will also be useful in estimating the carbon sequestration of mangroves and in assessing vulnerability against sea level rise.

The summit will start with the northern West Philippine Sea biogeographic region, but is envisioned to cover the entire country. This biogeographic region covers three administrative regions (Regions I, II and III), eight provinces (Bulacan, Bataan, Pampanga, Zambales, Pangasinan, Ilocos Sur, Ilocos Norte and Cagayan), and one autonomous region (Subic Bay Metropolitan Area). The municipalities of Masinloc (Zambales) and Bani (Pangasinan) were also invited to share their lessons and experiences in mangrove management. The region still has

a substantial extent of mangroves but is highly vulnerable against anthropogenic and natural disasters.

The northern West Philippine Sea is home to several key marine biodiversity areas and marine corridors accounting for 22% of the Philippines' fisheries production. The provinces of Bulacan and Pangasinan have a notably high aquaculture production. Most coastal areas are highly vulnerable against natural hazards such as typhoons and the imminent danger of sea level rise. The region has a rich history of employing various mangrove management strategies – from declaration of protected areas, to locally initiated mangrove mapping, community-based approach and monitoring activities, among others. Some of these strategies were successful, others were not, but nonetheless are important to draw and share lessons with other mangrove managers in the country.

In all provinces, mangrove planting is a regular activity held at least once a year. Planting sites are usually along the shoreline using species from the genus *Rhizophora* (Salmo & Duke 2010). 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, Primavera & Esteban 2008, Salmo et al. 2013) with stunted growth and poor survival (Samson & Rollon 2008).

Summit Objectives

The **1st State of the Mangrove Summit** aims 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 summit provides an opportunity for mangrove managers to discuss the status of mangrove forests in the region.

Specifically, the summit aims to accomplish the following objectives:

- Provide a venue for provinces to share and discuss the status of mangrove forests in the Philippines, especially in the light of climate change vulnerability;
- 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;
- 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 and municipal reports. Prior to the summit, a survey form was sent to the eight provinces, the municipalities of Masinloc and Bani, and to SBMA. 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 in Northern Luzon, Philippines: Comparative Rates of Carbon Deposition in Natural versus Planted Mangrove Stands"

The survey yielded information on:

1. Province/area geographic and socio-economic profile (e.g. population in coastal areas, barangays and threats);
2. Mangrove assessment status (including areas of old-growth and planted stands, presence of protected mangrove area, importance of mangroves to the community, mangrove products utilized, managers of the mangroves, 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 and 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 on 30 November 2014. The Secretariat reviewed the submitted documents for formatting and copy-editing to achieve consistency (while

retaining the original contents submitted) throughout the Proceedings. In cases where the reporters did not provide data, the Secretariat labeled it as "no data provided." These individual reports constitute the bulk of the Proceedings, which is available at http://mangroveecology.com.

The second part is composed of four technical reports covering topics on: (1) mangrove mapping using remote sensing, (2) adaptation and vulnerability of mangroves against sea level rise, (3) inter-institutional networking, and (4) incentivizing blue carbon. These presentations were intended to complement mangrove status reports and provide an inter-disciplinary perspective on how to improve mangrove management. The needed improvements on mangrove management pertains to the viability and quality of mangroves in adapting to the effects of sea level rise, formation of a mangrove network to sustain the gains of this summit, and the inclusion of estimation of carbon stocks and sequestration rates in both natural and planted mangrove stands.

The third part is the summary of workshop-planning outputs drawn from three groups composed of academe/ NGO, provinces from Bulacan to Zambales, and provinces from Pangasinan to Cagayan. Each group was asked to identify data gaps, the priority issues and problems, and the activities they suggest to address the identified problems. In addition, all groups were asked to suggest strategies that will form and sustain the mangrove network. The workshop outputs were printed as submitted by the groups.

The last part is a synthesis of the 1st State of the Mangrove Summit. Information from all reports, technical presentations and workshop outputs were consolidated. Statistics on mangrove forest cover for the NW Luzon in terms of species composition, distribution and extent of old and planted stands are reported. Technical information (e.g. how to survey and monitor mangroves) and management gaps (e.g. issues on jurisdiction) were identified. Current and emerging issues that pose threats on the existence of mangroves (e.g. coastal poverty, habitat conversion and sea level rise) were discussed. Varying 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 65 participants from the academe, NGOs, NGAs and the local government attended the 1st State of the Mangrove Summit. There were a total of ten case study presentations from mangrove managers and four technical presentations from resource persons. The sharing sessions on mangrove statistics, the perceived threats and management responses as well as the difficulties and lessons learned on mangrove management were valuable. The concerns mentioned in the workshop and planning session will serve as inputs in crafting national mangrove management plan. This document will also be available online for public access.

Indeed, the summit has accomplished its objectives, paving the way for future mangrove summits both at the regional and national levels. Organizing a summit however is not without its challenges, namely matters on funding, coordination, participation and publication of proceedings, among others. As we attempt to complete the Philippines' mangrove status report, we invite and encourage all concerned mangrove stakeholders to participate and help improve mangrove management in the country.

We thank all the participants, the resource persons, 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, DENR – Biodiversity Management Bureau, and Conservation International – Philippines) for making the First Mangrove Summit a success!

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II. STATUS OF MANGROVE BIODIVERSITY MANAGEMENT IN THE PHILIPPINES

Department of Environment and Natural Resources
Biodiversity Management Bureau
Coastal and Marine Division

Mangrove forest ecosystems include mangroves and beach-associated plant species that are tolerant to brackish water and inundation of seawater during the high tide. Mangroves serve as important habitats for birds, insects and other animals, nursery for juvenile fish and invertebrates, and source of nutrients and food within the mangrove food web. The human population, especially those that live near the coasts, benefits from the ecosystem goods and services provided by the mangrove forest. Mangroves serve as spawning and nursery grounds for fish, natural pollution filters, shoreline protection from wave action, sediment traps preventing erosion to the seagrass beds and smothering coral reefs, source of food, fuel, medicines and building materials as well as for recreation and ecotourism. Equally important is the contribution of mangrove ecosystem to the regulatory function by carbon sequestration.

The total mangrove area recorded in the country is 450,000 ha. However, in the 1970s, conversion of mangrove forests to fishponds and illegal cutting became rampant, leaving less than one-third of the actual mangrove area.

In the Philippines, the Department of Environment and Natural Resources (DENR), the Department of Agriculture – Bureau of Fisheries and Aquatic Resources (DA-BFAR), and as well as the local government units (LGUs) are given the mandate of protecting the mangroves through enforcement of relevant laws, rules and regulations. As part of its task, the Biodiversity Management Bureau (BMB), under the DENR, leads the management of coastal biodiversity and wetlands ecosystem, which includes the mangrove ecosytem. The BMB-Coastal and Marine Division with other concerned Bureaus is currently reviewing existing policies and laws concerning various mangrove initiatives of the Department.

Under the National Greening Program of the current administration, 1.5 billion seedlings were targeted to be planted in 1.5 billion ha of public lands nationwide, including 38,411 ha of mangroves in six years (2011-2016). In 2012, an estimated 223,000 ha were planted.

Another project implemented by the BMB is the Integrated Coastal Resources Management Project (ICRMP) with two components (i.e., Policy and Institutional Strengthening and Development, and ICRM and Biodiversity Conservation) aimed at developing relevant guidelines focused on the need to improve the state of the country's mangrove forest. The project drafted guidelines and policy recommendations such as (1) reversion of abandoned, underutilized and undeveloped fishpond lease agreements (AUU FLAs), (2) cancellation of Illegally Titled Fishponds and Illegally Constructed Fishponds, (3) Special Agreement for Mangrove Area Development, (4) Foreshore Areas and (5) Cutting of Mangrove Forests and Collection of Forest Charges. For the Biodiversity Conservation component, the ICRMP has already rehabilitated and reforested a total of 3,878 ha of mangroves. In 2013, BMB drafted a manual for Ecological Rehabilitation of Mangroves, a set of technical guidelines relevant for the promotion of sustainable mangrove rehabilitation. Early in 2014, BMB also issued a Technical Bulletin to support Mangrove and Beach Forests Development in Disaster-Risk Areas in the Philippines. The Bulletin aimed at providing keys for successful mangrove development and rehabilitation that follow sound science-based protocols in site selection, species-suitability, planting strategy and density. Guidelines on mapping, survey and science-based site assessment, community mobilization and capability development, nursery establishment, operation and seedling production, plantation establishment, maintenance and protection and monitoring and evaluation were detailed in this Bulletin.

In the implementation of multilateral partnerships such as that of the Coral Triangle Initiative (CTI), BMB targeted mangrove rehabilitation as one of its priority activities. Under the Coral Triangle Support Partnership (CTSP), the Verde Island Passage-wide mangrove mapping was completed for incorporation in the development of

municipal and provincial Climate Change Adaptation Plan. It has supported the establishment of a learning site promoting mangrove conservation in Calatagan, Batangas and it has developed the *Ang Pulo* Business Plan hoping to utilize the mangrove site as an ecotourism area.

With support from the German government, the baselining and mapping of the status of mangroves and fishponds in six selected regions of the Philippines were also completed under the Adaptation to Climate Change in Coastal Areas (ACCCoast) Project.

Moreover, BMB conducts social marketing initiatives and included the Month of the Ocean celebration, which focus on mangrove protection for 2014 and the Coral Triangle Day annually to promote awareness on the importance of protecting the mangrove ecosystems.

At present there are gaps in information and data management as well as conflicting policies and mandates from various sectors and interests of stakeholders. Nevertheless, BMB is determined in recovering and restoring the status and ecological roles and functions of mangroves around the country following science-based approaches and achieve the optimum level of productivity for each hectare of mangroves.

III. STATUS OF MANGROVES PER PROVINCE

Photo by SSalmolll

State of the Mangroves in BULACAN

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I. INTRODUCTION

The province of Bulacan has one city and four municipalities located along the coast, which together comprise 15 coastal barangays. The coastal barangays are the following: barangays Pamarawan, Masile, Caliligawan, Babatnin and Namayan for Malolos City; barangays Puga, Tibaguin, San Roque and San Pascual for the municipality of Hagonoy; barangays Masukol and Sta. Cruz for the municipality of Paombong; barangays Taliptip and San Nicolas for the municipality of Bulakan; and barangays Binuangan and Salambao for the municipality of Obando.

Based on the total land area of these barangays, the province's coastal area measures about 12,189.8 ha with a shoreline length of 43 km (GIS-PPDO). Out of a total population of 2,924,433 in the province, 43,005 live in the coastal barangays (SEP 2010).

The primary sources of income of the coastal residents are capture fishing, fish processing, fish vending, fish culture and "fish worker."

Increase in population has been identified as one of the social problems encountered by coastal residents. Based on the historical population derived from the actual census conducted in 1995–2010, there is a significant increase from 10% in 2000, 23% in 2007 and 26% in 2010. The poverty incidence of Bulacan also increased from 6.9% in 2009 to 7.3% in 2012. These indicate an increase in population of the vulnerable or marginalized sector, which most farmers and fisherfolk are part of.

Another social problem is the limited livelihood opportunity of coastal residents. Most of them are geographically confined within their areas where available livelihood solely comes from fishing and fishery-related activities such as fish processing, fish vending and labor to fishpond operation. Consequently, they also have limited access to education—with primary education being the highest level—and to basic health services (e.g. vaccination) at barangay health centers. Fishing/passenger boats are the only means of transportation available to reach the mainland for their children to attend school or bring patients to the hospital.

Importance of Mangroves

The province identified four main ecological and socio-economic significance of mangroves in the area. First, it is a source of food. Second, it provides a good addition as a site for eco-tourism. Third, it provides ecological services for the community such as shoreline protection and erosion control. And lastly, it is a source of livelihood for the coastal residents. People earn income from products sourced from mangroves such as nipa hut materials, fish, prawns, crabs, shellfish, clams and nipa vinegar and syrup.

II. STATUS OF MANGROVES

Bulacan has a total of 585.14 ha of mangroves. **Table 1** shows the old stand, secondary growth and new plantations of mangroves in the province. The mangrove planting program started in 2008.

The true mangrove species planted in Bulacan are the *Avicennia lanata, Avicennia marina, Avicennia officinalis, Bruguiera cylindrica, Bruguiera gymnorrhiza, Rhizophora*

Table 1: State of mangroves in Bulacan (in hectares)

Old Stand	Secondary Growth	Plantation
72.43	318.71	194.0

apiculata, Rhizophora mucronata, Rhizophora stylosa, and *Sonneratia alba* (CENRO-Tabang, Guiguinto Bulacan, 2010).

The minor mangrove species and associate plants are *Acacia fernasiana, Acanthus sp., Achostichum aureum, Caesalpinia nuga, Dolichandrone spathacea, Exoecaria agallocha, Ipomea pes-caprae, Morinda citifolia, Nypa fruticans, Sesuvium ilicifolius, Terminalia catappa, Thespecia populnea,* and *Sonneratia caseolaris.* (CENRO-Tabang 2010).

Degradation of Mangrove Forests

The decline of mangrove stands in the province are due to the (1) conversion of mangrove areas to fishponds, (2) reclamation for resettlement of coastal communities, (3) cutting of mangroves for firewood and housing materials, and (4) flooding, soil erosion and sedimentation.

The decline of mangroves exposes the community to the dangers of sea level rise, tidal flooding, storm surge and increasing siltation. This also decreases the habitat for feeding and breeding grounds of many fishes, which affects its survival and reproduction. Thus, fisherfolks experience a decrease in fish catch.

To address the decline of mangroves, the following activities are being carried out in the province: the implementation of Integrated Coastal Management Program with PEMSEA, the implementation of Municipal Fisheries Ordinance (MFO), mangrove-planting led by the BFAR and initiated by the LGU, tree planting in upland areas to prevent further soil erosion, and the dredging of rivers and tributaries.

Threats to Mangrove Forests

Bulacan experiences a number of threats to its existing mangrove stands. One set of threat is from household and industrial pollution. The lack of proper household waste disposal system forces residents to throw household waste into the nearest body of water. Together with industrial pollution from manufacturing industries, these pollutants contribute to the degradation of the coastal environment and increase mortality of aquatic organisms.

Another set of threats is from aquaculture practices. First is the unregulated fishpond operation, which caused siltation, and narrowing and shallowing of rivers. Second is the unregulated use of commercial feeds by fishpond operators. This shortens fish growout period but increases the effluents from ponds, which contributes to the water pollution in the area.

Lastly, the direct threats to the decline of the mangroves in Bulacan is the unregulated cutting of mangroves for firewood, housing materials and other products.

III. MANGROVE PROTECTION AND MANAGEMENT

As a means to protect and rehabilite mangrove forests in the province, various efforts have been implemented. First is the establishment of a 24.64 ha protected mangrove area known as the Bulakan Mangrove Eco-Park in Sitio Wawang Capiz, Brgy. Taliptip, Bulakan .

The Municipal Fisheries Ordinance of coastal towns serves as a protective policy measure. This is supplemented by other programs such as the Fisheries Resource Management for Improved and Sustainable Harvest (FISH), Philippine National Aquasilviculture Program (PNAP), Save Manila Bay Project and the DENR-Mangrove Planting Project.

The managers of the existing mangrove stands are the local government units (LGUs), Fisheries & Aquatic Resource Management Councils (FARMCs), Fisherfolk Organizations (FOs) and Non- Government Organizations (NGOs).

Monitoring and Evaluation

The mangrove species *Rhizophora apiculata*, *Rhizophora mucronata* and *Rhizophora stylosa* are planted in the area and have a survival rate of 40–50%.

Impacts of Mangrove Rehabilitation

Continuous efforts in rehabilitating mangrove areas have heightened the awareness and elicited the support of the coastal community. The community has realized that in addition to the valuable timber products, mangroves provide protection to coastlines by breaking the waves during storms, and serve as sources of food and nursery areas for many aquatic species.

IV. SUMMARY AND RECOMMENDATIONS

There is a need to to raise environmental awareness of the community, to obtain their support in coastal resource protection and management and empower them. The awareness of the stakeholders on the value of mangroves, the effects of its loss on the coastal environment, and on the emerging environmental issues will enhance their appreciation on the need for management interventions for mangroves. Other steps that need to be undertaken are the promotion, establishment and management of mangrove nurseries, and mangrove-friendly aquaculture (MFA) or aquasilvicutlure.

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State of the Mangroves in BATAAN

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I. INTRODUCTION

The Bataan peninsular province, which juts out of the mouth of Manila Bay, is a strategic maritime gateway to the political, social and economic center of the Philippines. The peninsula is located right in the middle of one of the Philippines' major economic growth triad namely: the Subic Bay Metropolitan Authority, the Clark Special Economic Zone (CSEZ), and Metro Manila. The province has the key ingredients to become the new frontier of socio economic growth in the 21st century.

The province of Bataan is a first class province comprised of the city of Balanga and 11 municipalities, eight of which (namely, Hermosa, Orani, Samal, Abucay, Orion, Pilar, Limay and Mariveles) lie in the northwestern portion of Manila Bay. The municipalities of Bagac and Morong, which are parts of SBMA reserves, face the South China Sea. Dinalupihan is the only municipality in the province without a coastline. Bataan as a whole has a total land area of 1,373 km^2 with a population of 687,482. Bataan has total municipal waters of 133,962 ha with 188.66 km of coastline. It has 79 coastal barangays as shown in **Appendix A.**

Importance of Mangroves

Mangroves provide nursery grounds for fish, prawns and crabs, and support fisheries functions in coastal waters. Almost every living thing needs a safe place when it is young, small and fragile. Like human babies, young fish, shrimps, crabs, and other marine animals need a place to grow, away from many predators. Only those young animals that find refuge survive to mature size. Larger fish may soon eat smaller fish or shrimp swimming in open waters. Many commercial marine species, such as milkfish and prawns, spend their early lives within the mangrove area, where they find food and protection from predators. Even juveniles of some deep-sea fishes spend some time in the mangrove area.

Mangroves are good nurseries because they provide hiding places for young animals. The arched-shaped roots of the *bakauan* mangroves and the finger-like roots of the *api-api* and *piapi* mangroves are good examples. These protective structures, along with the abundant food supply that comes from decayed mangrove leaves, makes mangrove areas very good nurseries for many important marine animals. For every hectare of mangrove cut down, there is a corresponding reduction in fish catch of around 1.08 tons per hectare per year.

Moreover, mangroves produce leaf litter and detrital matter, which are valuable sources of food for animals in estuaries and coastal waters. The leaves that fall from a mangrove tree break up and decompose into small pieces known as detritus. The detritus is broken down by bacteria, fungi and other microorganisms that nourish marine animals.

The leaves are a source of food for fish, shrimps and crabs and other marine animals. The detritus is covered with a large amount of small organisms, which take up the nutrients in the leaves. Individually, these organisms are too small to be of value to larger animal, but together they form a coating around leaf particles, which many different animals use as food. Leaves eaten by marine animals are not totally digested. They are excreted almost intact, again coated with organisms, and then eaten by marine animals. This process is repeated several times, so that one leaf can literally nourish a juvenile fish for much of its life in the mangrove.

In addition to this, mangroves provide protection for coastal areas and communities by buffering storm surges, waves, tidal currents and typhoons. The crown and stem of mangroves serve as physical barriers. Their specialized roots trap and hold sediments and siltation from the uplands. Further, mangroves promote clear water including the growth of corals and seagrasses. The prop roots and

pneumatophores of mangroves serve as hiding places for small fishes. The turbidity of the water in the mangrove area also provides effective cover for smaller fishes and shrimps.

Another significance of mangroves would be its production of organic biomass (carbon) and reduction of organic pollution. Mangroves contribute 1,800–4200 gC/m^2/yr (approximating the contribution of the tropical rainforest and 10 times higher primary production in the open ocean).

Mangroves provide shelter for local and migratory wildlife and serve as roosting and foraging grounds, thus also serving as recreational grounds for bird and wildlife watchers. For instance, the Balanga Wetland and Nature Park in Barangay Tortugas, Balanga is well known for the presence of migratory birds during the months of September to March, and thus was declared as one of the Bird Watching Sites of the Philippines. Mangroves also provide access to highly diverse mangrove plants and animals and their adaptations, making them ideal field work/learning destinations for biology and ecology students and researchers.

Lastly, mangroves are good sources of wood, timber, nipa shingles for housing materials, firewood, charcoal, poles for fish traps, tannin, alcohol and medicine. Mangrove seeds and propagules can be harvested and sold. Fish, crustaceans and mollusks can also be harvested from mangroves. Aquaculture and commercial fisheries also depend on mangroves for juvenile and mature fish species.

II. STATUS OF MANGROVES IN BATAAN

At present (2014), Bataan has an estimated total mangrove area of 121.08 ha based on the ground truthing done by DENR Region III in 2012. With an additional area of about 30.9 ha in Orani that requires validation, the total mangrove area may be around 160.98 ha from Orani to Limay. Patches of Nipa and other riverine types of mangroves are also found in Mariveles to Morong.

Table 2: State of mangroves in Bataan (in hectares)

Old Stand	Secondary Growth	Plantation
no data	no data	120.2 ha*

*does not include private sector initiative and people's organization initiative under the UNDP, SGP project

Bataan's old stands can be found from Orani to Orion but there is no available data on the existing number of trees. **Figure 1** shows an example of old stands of mangroves in Bataan. The Provincial Environment and Natural Resources Office (PENRO) stated that the ground truthing of the old stands and the areas for validation will be included in their budget for next year (2015) and will be done during the second quarter.

Figure 1: Old stands of mangroves at Camachile, Orion, Bataan

The mangrove species recorded include nipa in the Family Arecaceae; *Avicennia, bungalon, api-api* in the Family Avicenniaceae; *saging-saging* in the family Myrsinaceae; *pototan, busain, pototan-lalaki, malatangal, tangal, bakauan lalaki, bakauan babae* and *bakauan bangkaw* in the Family Rhizophoraceae; and *pagatpat, pedada* and *Sonneratia* in the Family Sonneratiaceae.

Degradation of Mangrove Forests

In the 1980s, mangrove forests in the Province of Bataan declined due to conversion to aquaculture ponds. In the 1990s to early 2000s, the decline was due to the expansion of built up area or the proliferation of informal settlers in mangrove areas. But now these problems are being addressed by the joint effort of the different sectors like the LGUs; the national government agencies like DENR, BFAR, and DA; the academe; and the Provincial Government of Bataan through its Integrated Coastal Management Program together with the Bataan Coastal Care Foundation. Everyone joined hands through a massive IEC campaign in every municipality and Mangrove Planting and Rehabilitation Programs.

Threats to Mangrove Forests

The usual threat to mangrove forests in Bataan are land reclamation for various development initiatives, usually for housing projects; pollution and siltation; diseases, pests and fouling organisms such as barnacles, which envelope the stem of bakauan causing roots to rot; and typhoons that destroy most of our new plantations.

Figure 2: Mangrove cover in Barangay Tortugas before and after mangrove rehabilitation

III. MANGROVE PROTECTION AND MANAGEMENT

Bataan has no mangrove protected area at present. The national laws of BFAR and DENR on mangrove protection are being used by the local government units (LGUs) in managing the existing mangrove areas in every municipality through the Municipal Agricultural Office. The Fisheries and Aquatic Resources Management Council and the people's organization (PO) in every barangay are the ones managing the existing mangrove stands.

Mangrove Rehabilitation

The Bataan Integrated Coastal Management Program (BICMP) started its Mangrove Reforestation and Enhancement Planting in 2001. It is a multi-stakeholder partnership of the LGUs, POs, NGOs, private corporations, national government agencies, academe and the Bataan Coastal Care Foundation (BCCF). Recently, a total of 30.2 ha across 12 barangays under 4 municipalities were rehabilitated by almost 6,500 volunteers. **Figure 2** shows the mangrove cover in Brgy. Tortugas before and after the mangrove rehabilitation.

The BCCF together with the Provincial Government of Bataan shoulders the expenses for the seedlings/propagules and the fencing of identified sites. The LGU counterpart shoulders the snacks of the volunteers.

Other rehabilitation efforts have also been underway such as the DENR-PENRO Initiative, which started in 2007 resulting to 72 ha of mangrove plantations. Figure 3 shows some of the mangrove stands through the DENR PENRO Initiative. In addition to this would be the Private Sector Initiative which started in 2014 with approximately 9,000 planted seedlings and the POs Initiative with 250,000 planted propagules. **Appendix B** summarizes the mangrove rehabilitation initiatives for Bataan.

Monitoring and Evaluation

Monitoring system has not yet been established so the practice has been that the group/s that initiated the mangrove planting are also the ones to monitor it. The survival rate of the planted mangrove usually ranges from 60 to 70 %, excluding those damaged by typhoons.

Impacts of Mangrove Rehabilitation

Mangrove rehabilitation helps increase the catch of fisherfolk but most importantly it saves the lives of people in the coastal areas of Bataan during typhoons and storm surge. Mangroves protect most of our coastal communities. They also provide a source of livelihood for our POs, particularly the aquasilviculture project given by BFAR and some private companies.

Figure 3: DENR-PENRO Initiative (2007–2010)

IV. SUMMARY AND RECOMMENDATIONS

There are two main recommendations that the province would like to put forward. First is to conduct ground truthing for all the mangrove forests in the province with the Provincial Environment and Natural Resources Office (PENRO) of Bataan in 2015. Second is to have a Mangrove Master Plan for the province that will serve as a guide for all those who want to contribute to the conservation and protection of the mangrove forests in the province of Bataan.

State of the Mangroves in
SUBIC BAY FREEPORT ZONE

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I. INTRODUCTION

Subic Bay Freeport Zone is a former US naval base surrounded by the Subic Bay, Zambales Mountain Range and the Bataan Peninsula. In 1992, the Subic Bay Metropolitan Authority (SBMA) was created to manage and develop this former US base into Subic Special Economic and Freeport Zone by virtue of Republic Act 7227 also known as the Bases and Conversion Act of 1992. Consequently, by virtue of Presidential Proclamation 532, the meets and bounds of the economic zone with total area of 67,452 ha were declared composed of the (1) former Naval Reserve, (2) part of Olongapo City, (3) Subic and (4) San Antonio in Zambales, and (5) Hermosa and (6) Morong in Bataan. The strict security provided by the US Navy in the area significantly preserved its natural resources such as old growth forest, mangroves and marine resources. Apparently, these rich nature reserves made the Subic Bay Freeport a popular tourism destination (Woodward-Clyde 2001).

The Subic Bay Freeport Zone has a shoreline length of 16.5 km with coastal area of 11,500 ha. Dwelling in these coastal regions are 84 locators from currently 1,234 registered business/locators in the Freeport. These locators along the coast are engaged in manufacturing, trading, tourism related activities such as hotel operations, diving operations, marine transportation industries such as port operations, ship building and repair facility, and oil and gas depot. The Subic Bay is bound by the Subic town in Zambales and Morong in Bataan. There are coastal communities along the Subic Bay coast, but these are under the jurisdiction of the respective LGUs.

The coastal communities that rely on coastal resources are unique to the Freeport because these communities are non-fisher folk or coastal households but industrial companies. However, it is also significant to discuss some key characteristics of coastal communities outside the SBMA jurisdiction that directly affect the resource use in Subic Bay. Based from the study by Woodward-Clyde on Resource Inventory Summary Report in 2000, the coastal and/or lowland communities in Subic Bay were primarily engaged in municipal fishing while some are in deep-sea fishing and aquarium fish gathering. Others are involved in beach resort management, trading operations (market, buy and sell), or employed in one of the industries in the area. The study enumerated some key issues that the fishing sectors were facing, which include the following: (1) decreasing fish/marine resources, (2) inadequate fishing gears and equipment, (3) violation of marine regulations and laws, (4) the lack of sustainable financing and (5) the lack of marketing outlets.

As for the Subic Bay Freeport coastal communities, social issues experienced by the coastal locators include: (1) encroachment of neighbouring communities, (2) the lack of environmental awareness and ignorance to marine conservation guidelines, (3) conflict of interest and (4) social acceptability of the projects.

Several locators in the coastal areas have problems on encroachment despite the presence of SBMA Harbor Patrol in the Bay. Encroachers were composed of fisherfolks from adjacent towns that enter the Freeport's bay to fish and gather shellfish at rocky intertidal flats. However, the SBMA action was to increase the harbor patrol visibility in the area to abate the problems on poachers, looting and illegal fishing activities. The SBMA recently procured harbour patrol boats for this purpose.

The lack of public awareness on ecosystem dynamics and environmental rules and regulations leads to environmental degradation. In the case of Subic Bay Freeport, the SBMA Board approved the implementation of SBMA Marine Conservation Guidelines formulated in accordance with

the Subic Bay Protected Area Management Plan (SBPAMP). Ignorance to this law leads to non-compliance and consequently degradation of Freeport core ecological and habitat protection zones. Violation of the SBMA Marine Conservation Guidelines includes conduct of recreational fishing without permit and conduct of this activity in areas of no fishing zones and encroachment to marine protected areas.

Since Subic Bay is bound by several municipalities and the SBFZ, its coastal resources inevitably have multiple users, which result to conflicts in resource use. Contrasting interests and priorities of the LGUs, private institutions and the SBMA leads to ineffective coastal resource management. Hence, there is a great need to synchronize all coastal management initiatives and implement the Integrated Coastal Management Plan for Subic Bay.

Lastly, social problems arise when there are environmentally critical projects and/or projects that are proposed to be established in environmental critical areas that require social acceptability. In some cases, the SBMA mandate to provide employment opportunities lead to biases that are unfavorable to the environment and/or against the interest of the general public. For instance, a world class marine theme park was proposed few years ago, which required massive information dissemination activities and the acceptance of the community. Nevertheless, the SBMA ensures that each project operating inside the Freeport has undergone Environmental Impact Study (EIS) as required elsewhere in the Philippines and comply with the guidelines provided in the EIS.

Importance of Mangroves

Mangrove forests are among the most important coastal resources in the Philippines. Mangroves are known to provide sources of food, timber, wood, and medicinal and agricultural products. They also provide aesthetic values and ecological services such as shoreline protection, nursery grounds for fishes, enhancement of biodiversity and maintainance of water quality. This wide range of benefits and functions of a mangal ecosystem sustains social, environmental and economic activities.

Mangroves in the Freeport provide important ecological functions and services. They support the fisheries by providing feeding, spawning and nursery grounds to fisheries benefitting the fishing communities of Subic and Bataan. They also serve as habitat and refuge for birds and home of endemic wild duck *Anas luzonica*. The mangal ecosystems in the Freeport also cater to researchers both from local and international academic and research institutions serving as their natural laboratory. Since it is situated in close proximity to Manila, the accessibility, safety and security to these mangrove sites are not problematic.

Moreover, the Freeport's mangroves, particularly in the Triboa Mangrove Park, provide recreational and aesthetic value as a natural park and ecotourism facility. Apparently, contingent valuation study (CVM) using willingness to pay survey estimated that the park has a total economic value of Php 5,052,618 (Pescador-Mallari 2012). The valuation method took into consideration the ecosystem goods and services that the mangrove ecosystem provides such as habitat, nursery grounds, and aesthetic, recreational and existence values, which are indirect goods that cannot be brought to market and hence have no direct monetary value.

Finally, the mangroves of the Subic Bay Freeport serve as sources of food and housing materials for the indigenous people, the Pastolan Ayta tribe. As part of the tribe's ancestral domain and cultural heritage, the mangrove forests in Binictican-Malawaan and Boton serve as areas for gathering mollusks, crustaceans and fishes for their consumption. The utilization of these resources by the Pastolan tribe is in accordance with the Memorandum of Agreement between SBMA and the Pastolan Tribal Council.

II. STATUS OF MANGROVES

Subic Bay Freeport Zone has a total of six mangrove forest patches with a total area of 61.63 ha (**Table 3**). These mangrove forests are in Binictican-Malawaan, Boton, Nabasan, Triboa A, Triboa B, and Ilanin with area coverage of 30, 12.2, 6.6, 7.8, 2.5 and 2.5 ha, respectively. **Appendix C** provides a breakdown of the mangrove distribution in the area. Situated inside the former US Naval Reserve, these mangrove areas were protected and conserved by the strict security provided by the Americans for decades until 1992. Hence, these mangrove stands are considered old growth mangrove forest.

Baseline study on these mangrove stands conducted in 1999 showed diverse species composition, with a total of 20 species belonging to 13 genera and 11 families. Out of these species, *Avicennia officinalis, Rhizophora apiculata* and *Sonneratia alba* are the most widely distributed species (Woodward-Clyde 2000). The baseline information indicated that the mangrove forest in Nabasan had the poorest stand in terms of total tree basal area per ha, species diversity indices and production density due to ashfalls from Mt. Pinatubo eruption in 1991. The study

Table 3: State of mangroves in Subic Bay Freeport Zone (in hectares)

Old Stand	Secondary Growth	Plantation
61.63	no data	3.94

recommended that enrichment planting of *A. marina, R. apiculata* and *S. alba* should be undertaken in areas with poor stocking and extensive open spaces like in Nabasan.

A follow-up study was done in 9–21 March 2000 after the rehabilitation of the mangrove areas covered by the baseline resource inventory. The follow-up study showed that a total of 28 mangrove species and associates were present. The top five most dominant and abundant species were *A. marina, A. officinalis, Bruguiera cylindrica, R. apiculata,* and *S. alba*. Mangroves in Binictican had the highest species diversity followed by Triboa B and Boton. However, it is significant to note that Nabasan and Triboa A demonstrate a more equitable mangrove ecosystem in the sense that it is more stable. Wildlife takes refuge in these relatively isolated areas, which are inaccessible, uninhabited and hence less exposed to human disturbances.

The mangrove area in Boton had the highest total mean reproduction with 116,321 per ha (mostly of seedling stage), followed by Binictican and Triboa A with 73,903 and 60,559 per ha, respectively. *Avicennia marina* had the highest mean regeneration density (63,588 per ha), followed by *B. cylindrica* (48,415 per ha), *R. apiculata* (36,153 per ha), *L. racemosa* (27,633 per ha) and *Nypa fruticans* (22,408 per ha).

True mangrove species present in the area are the following: *Aegiceras corniculatum, Avicennia marina, Avicennia officinalis, Bruguieria cylindrica, Bruguieria gymnorrhiza, Bruguieria parviflora, Bruguieria sexangula, Ceriops decandra, Ceriops tagal, Excoecaria agallocha, Lumnitzera littorea, Lumnitzera racemosa, Nypa fruticans, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Sonneratia alba, Xylocarpus granatum and Xylocarpus molluccensis.* The mangal-associated species in the area are the following: *Acanthus ebracteatus, Barringtonia asiatica, Barringtonia racemosa, Heritiera littoralis, Hibiscus tiliaceus, Intsia retusa, Pandanus tectorius, Terminalia catappa* and *Thespesia populnea*.

Degradation of Mangrove Forests

- Mangrove Conversion

In SBF, approximately 74% or 30 ha of the former Binictican area and 43% or 12.23 ha of the former Boton area have previously been converted and developed into an industrial and commercial area (Woodward-Clyde 2000). These mangrove areas are still threatened by conversion to other uses due to economic pressures. With the degradation of mangrove areas, the ability of the mangroves to prevent upstream flooding, landslide and erosion has been reduced. The residents of Olongapo City consider the conversion of mangrove areas as a major factor for the frequent flooding they experience in the city.

- Encroachment

Encroachment in mangrove areas, particularly by the Ayta communities, leads to overharvesting of resources (particularly mollusks and crustaceans), improper solid waste disposal in the area, and the trampling of mangrove sediments that affect mangrove ecosystem processes such as reproduction and nutrient cycling.

- Natural Disaster

Deposition of pyroclastic materials from the eruption of Mt. Pinatubo in 1991 led to the suffocation of mangroves and land buildup that altered the hydrobiological process of mangrove ecosystems. A survey indicated that this natural disaster created natural openings or cleared areas with an aggregate area of 3.1 ha, and also caused sporadic deaths of matured trees.

III. MANGROVE PROTECTION AND MANAGEMENT

As stated in the Implementing Rules and Regulation of RA 7227, the Subic Bay Metropolitan Authority was given two important mandates. First is to promote the economic and special development of the country and particularly Central Luzon. Second is to recognize the importance of maintaining a high degree of environmental quality as a precursor to sustainable economic development. The Ecology Center was created to take charge in managing the natural environment of the Freeport. In this regard, the SBMA commissioned consultants to develop the Subic Bay Protected Area Management Plan (SBPAMP) through a loan from JBIC.

Under SBPAMP, all mangrove areas within SBMA jurisdiction are categorized as Habitat Protection Zones defined as "areas with significant habitat and species values where management practices are required periodically to maintain specific non-climax habitat types or conditions required by rare, threatened or endangered species" (SBPAMP 2001). This zoning category has the following management prescriptions as shown in **Table 4**.

Mangrove Rehabilitation

Following the recommendation from the initial mangrove survey, the Woodward-Clyde Philippines, Inc. (WCPI) commissioned by the SBMA, conducted a one year Mangrove Reforestation Project in 2000. This project reforested 3.94 ha of open areas with *R. stylosa* species. This species was used because of the off-seasonal and meager production of the recommended propagules. Reforestation areas are located at Nabasan, Triboa, Silangin and Ilanin. Approximately 2.25 ha were used for direct planting of propagules and 1.69 ha were planted with nursery-raised

Table 4: Habitat Protection Zone Management Prescription

Permitted Activities	Prohibited Activities
• Scientific research and monitoring • Active habitat management • **Swimming and snorkeling (human immersion)** • Traditional indigenous peoples activities • **Supervised scuba diving** • **Non-powered (engine or sail) small boats activity (dinghy, kayak, canoe, row boat) in open water zones only**	• **All extractive activities** • Water sports involving motor powered craft (speed boats, jet skis, launches) • **Sports fishing** • **Spearfishing** • Turtle eggs collecting • **Harvesting of ducks and other shore birds** • **Mining** • **Dumping of wastes (garbage, sewage, etc.)** • Drop anchorage

Note: Prescriptions applicable to mangroves are in bold letters

seedlings (**Fig. 4**). Seedling survival was recorded with 92% and 90% survival rate of direct planted propagules and nursery-raised seedlings, respectively (Woodward-Clyde 2000).

Furthermore, during the implementation of the Second Subic Bay Freeport Project under the Roads, Bridges component, the Malawaan, Boton and Binictican bridges were retrofitted affecting 8,811 mangrove trees within 0.33 ha of the forested area. Nevertheless, the SBMA through the Ecology Center facilitated the replanting of 1.33 ha with a total of 26,000 propagules of *R. stylosa* species.

Currently, the Ecology Center encourages Subic Bay Freeport stakeholders to participate in mangrove conservation activities including mangrove seed collection and planting, monitoring, awareness campaign, cleanup drives, and research and development. At the same time, the Center continually surveys the mangrove forests to identify cleared areas needing reforestation and rehabilitation.

Monitoring and Evaluation

The Ecology Center, through the Protected Area Division, conducts regular monitoring of mangrove areas within the SBMA jurisdiction. The monitoring activity is conducted at least annually and at most quarterly to assess the mangrove area cover, identify areas for rehabilitation, describe habitat boundaries, ensure that the area is protected from encroachment and illegal collection of wildlife and mangrove resources, and ensure prompt abatement of environmental degradation of economically, aesthetically and ecologically important coastal resources. Currently, the Ecology Center is establishing permanent transects and monitoring plots for long term ecological assessment.

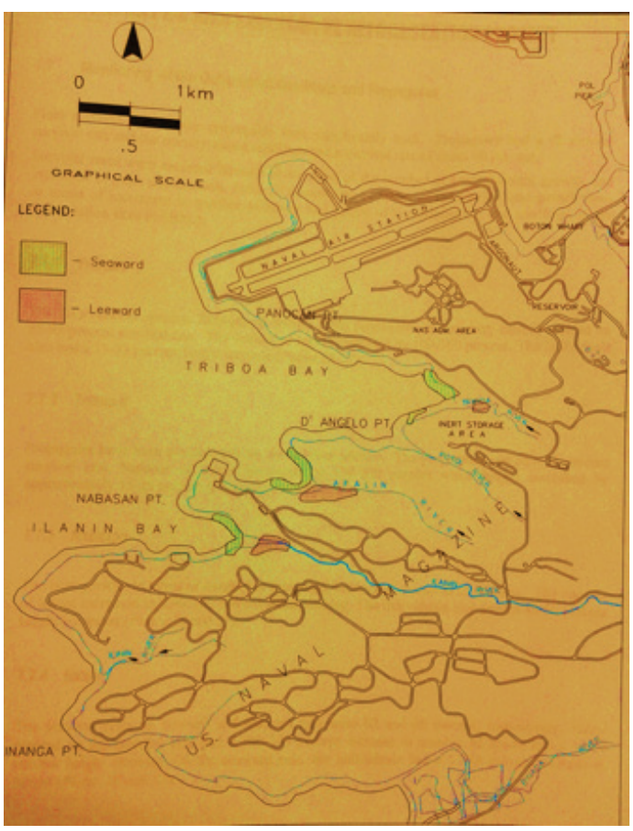

Figure 4: Areas reforested with *Rhizophora stylosa* species

A special monitoring team was created to conduct a more scientific monitoring and evaluation of mangroves. This monitoring team is composed of members from the Forest Ranger Branch and Harbor Patrol Branch of the Law Enforcement Department, Monitoring Support Group from the Pastolan community, and environmental specialists from the Ecology Center. Members of the team

Figure 5: SBMA Biodiversity Monitoring Team in action: (A) training and capability building, (B) laying of quadrat plots for epifaunal survey, and (C–D) actual monitoring of mangrove areas.

undergo capability building processes and receive trainings on mangrove identification, monitoring protocols and other skills/knowledge related to environmental management. At the end of each year, the team aims to collate all the data gathered, publish the results for public awareness and submit a report to the SBMA management to provide bases for crafting mangrove policies and management actions (**Fig. 5**).

IV. SUMMARY AND RECOMMENDATIONS

The 60 ha of mangrove areas in Subic Bay Freeport remain intact. Because of the strict enforcement of SBMA environmental rules and regulation, the mangrove forest ecosystem services have been enhanced. Preservation of these resources provides benefits not only to the present stakeholders but, more importantly, also to the future generations. The SBMA's mandate to protect and conserve the environment is geared towards sustainable development of the Subic Bay Freeport Zone. These can only be achieved by addressing the present threats to mangroves (and pre-empting those already foreseen) by conducting massive IEC utilizing all possible channels of information dissemination such as internet media, radio, posters and flyers, newspaper ads, forums and workshops.

We recommend strict enforcement of environmental laws and increasing harbor patrol and forest ranger presence in the area to discourage encroachers and poachers. Obsolete guidelines should be updated or amended, and new polices for mangrove management should also be developed.

The Ecology Center aims to conduct monitoring programs that are more detailed and include the status of mangrove planted, survival and growth rates and other ecologically important parameters. In line with this, we intend to attract more researchers to focus their study on the mangroves of the Subic Bay Freeport by strengthening our network and collaboration with academic and research institutions.

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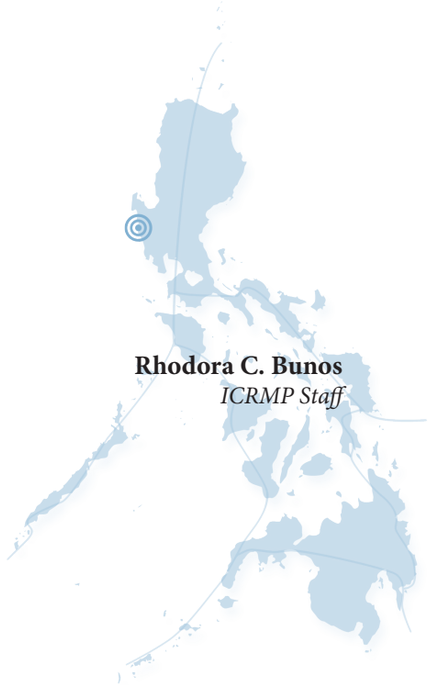
State of the Mangroves in ZAMBALES



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I. INTRODUCTION

The province of Zambales, with capital municipality Iba (15°20'N, 119°59'E), is located along the western coast of Central Luzon facing the West Philippine Sea. It is bounded by provinces of Pangasinan (north), Tarlac (east), Pampanga (east), and Bataan (south). Zambales covers two congressional districts, one city, 13 municipalities and 247 barangays (**Appendix D**). It is the second largest province in Region III, covering a total land area of 373,795 ha, which is 19.8 % of the entire region. The total population of Zambales is 534,443, with 190,120 making up the coastal population (NSO 2010).

The major sources of livelihood in the coastal barangays are fishing, aquaculture, fish processing, fish trading, farming and employment in government or private establishments. Other jobs identified were seasonal labor as carpenters or masons, drivers, contract workers abroad, mango sprayers, gleaners, salt makers and charcoal makers. All the members of the community who are engaged in fishing turn to other occupations during the lean months of fishing.

Importance of Mangroves

Mangroves play a significant role in the life of the community. First, they provide nutrient enrichment for aquatic and terrestrial flora and fauna. They form unique ecological niche and habitats for various marine and terrestrial animals. They play an important role in coastal protection. With the diversity of sub-habitats provided by mangroves, they offer a range of opportunities for recreation and tourism, and also provide a natural laboratory for education. Lastly, they provide sources of livelihood for coastal residents.

II. STATUS OF MANGROVES

Mangrove establishment in the province of Zambales under the Integrated Coastal Resources Management Project (ICRMP) covers an area of 326.5 ha, broken down as follows: 204.5 ha (65 ha rehabilitation and 139.5 ha reforestation) existing plantation and 193.75 ha new mangrove rehabilitation (**Table 5**). Mangrove sites for reforestation and rehabilitation are located in the municipalities of Botolan, Cabangan, Sta. Cruz, Candelaria, Masinloc and Palauig and some of its corresponding barangays.

The province has the following mangrove species: *saging-saging (Aegiceras corniculatum), tinduk-tindukan (Aegiceras floridum), piapi (Avicennia lanata), bungalon (Avicennia marina), api-api (Avicennia officinalis; Avicennia rumphiana), pototan lalaki (Bruguiera cylindrica), busain (Bruguiera gymnorrhiza), pototan (Brugiera sexangula), gapas-gapas (Camptostemon phillipinense), malatangal (Ceriops decandra), tangal (Ceriops tagal), buta-buta (Exoecarcia agallocha), palonapoy (Heritiera littoralis), tabau (Lumnitzera littorea), kalapini, kulasi (Lumnitzera racemosa), nipa (Nypa fruticans), taualis (Osbornia octodonta), bakawan lalake (Rhizophora apiculata), bakawan babae (Rhizophora macrunata), pagatpat (Sonneratia alba), and tabigi (Xylocarpus granatum).*

Table 5: State of mangroves in Zambales (in hectares)

Old Stand	Secondary Growth	Plantation
no data	211	no data

Degradation of Mangrove Forests

The causes of mangrove degradation in the area are the following: conversion of mangrove into fishponds, reclamation of mangroves for development, pollution and siltation, dikes and structures, sea level rise, pests and diseases, overexploitation, and storms.

III. MANGROVE PROTECTION AND MANAGEMENT

Panglit is the only island sitio in Barangay San Lorenzo, Masinloc. One of the problems that the fisherfolk of Panglit experience is the decreasing fish catch, which eventually resulted in lower income of fishers. To increase the number of fish catch in Panglit, the establishment of a Marine Protected Area (MPA) was deemed necessary. The MPA serves as nursery ground for fishes and other marine species that help enhance biodiversity, maintain genetic diversity, improve the habitat, increase productivity and promote species protection.

The Panglit MPA was established on 3 April 2007 after consultations and meetings with the concerned stakeholders and the passing of Barangay Ordinance No. 02-06 approved by the Sangguniang Barangay. The LGU of Masinloc manages the Panglit MPA. A subsequent legislation, Barangay Ordinance No. 02, Series of 2011, was approved in June 2011 entitled "Ordinance Approving the Expansion of Marine Protected Area in Sitio Panglit, San Lorenzo, Zambales," which expands the total area of Panglit MPA to 115.5 ha. Through this ordinance, the MPA was subdivided into four zones: (1) core/no-take zone – 22.6 ha, (2) mangrove reserve zone – 8.79 ha, (3) seagrass bed zone – 15.61 ha, and (4) buffer zone – 68.5 ha.

Mangrove Rehabilitation

The province of Zambales is one of the seven provinces with an Integrated Coastal Resources Management Project (ICRMP) in the Philippines. ICRMP aims to manage coastal and forest resources sustainably, and to uplift the socio-economic conditions of people living in the coastal and upland areas surrounding marine and forest biodiversity corridors of national and global importance as identified in the Philippine Biodiversity Conservation priorities. One component of the project is Biodiversity Conservation wherein mangrove reforestation is one of the major activities.

ICRMP assisted in the Mangrove Establishment Project of the province of Zambales, which covered a total area of 204.5 ha, comprising 64 ha rehabilitation and 139.5 ha reforestation areas.

A total of 11 POs from the municipalities of Sta. Cruz, Candelaria, Masinloc, Palauig, Botolan and Cabangan were recipients of the mangrove reforestation and rehabilitation projects under ICRMP (**Table 6**).

Table 6: List of mangrove reforestation and rehabilitation project under Integrated Coastal Resources Management Project (ICRMP)

PO Name	Area (ha)	Location
Small Fisherfolks of the Municipality of Palauig	13	Palauig
LGU of Barangay Sto. Tomas	17	Palauig
Mangingisda at Magsasaka sa Palauig	24	Palauig
Samahang Mangingisda ng Panglit	7.5	Masinloc
United Palauig-MPC	33	Palauig
Samahang Magsasaka ng Libaba	23	Palauig
Samahang Mangingisda ng Candelaria	8	Candelaria
Samahang Mangingisda ng Panglit	34	Masinloc
Burador Fisherman's Association	10	Sta. Cruz
Samahang Pangkaunlaran ng San Salvador	15	Masinloc
Panan Fisherfolks Movement Association	10	Botolan
Kalipunan ng Liping Cabangan	5	Cabangan
Parel Union for Water Environmental resources and Social	5	Botolan
Total	**204.5**	

Monitoring and Evaluation

The ICRMP Composite Evaluation Team monitors and evaluates the site preparation, planting, maintenance, and protection activities conducted by the contractor (i.e., the POs). The evaluation employs statistical sampling and inspection to ascertain the amount and quality of work accomplishments of the POs. **Table 7** shows the survival rates of mangroves under the various POs handling the ICRMP.

Impacts of Mangrove Rehabilitation

The mangrove rehabilitation projects have resulted to increases in fish catch. These projects have also provided employment for the members of the POs living near the site and increased the awareness of the communities on nature conservation, especially on mangrove protection and conservation. Moreover, these projects have promoted shoreline stability, clearer waters and the reduction of organic pollution .

Table 7: Status of mangrove reforestation and rehabilitation projects under the Integrated Coastal Resources Management Project (ICRMP)

PO Name	Survival rate of mangroves (%)
Small Fisherfolks of the Municipality of Palauig	80–90
LGU of Barangay Sto Tomas	82.1
Mangingisda at Magsasaka sa Palauig	86.6
Samahang Mangingisda ng Panglit	80–87
United Palauig-MPC	83
Samahang Magsasaka ng Libaba	86.6
Samahang Mangingisda ng Candelaria	85.4
Burador Fisherman's Association	87
Samahang Pangkaunlaran ng San Salvador	82
Panan Fisherfolks Movement Association	80
Kalipunan ng Liping Cabangan	65.6
Parel Union for Water Environmental resources and Social	100%

IV. SUMMARY AND RECOMMENDATIONS

Mangrove forests have been exploited by excessive wood gathering, fishpond operation, mining, and development of coastal areas, among others. Effective mangrove management and restoration can be achieved through the following activities:

- Intensify local people's awareness on mangrove protection and conservation;
- Promote sustainable utilization and management of mangrove forests;
- Conduct more research on the mangrove ecosystem;
- Strengthen collaboration with institutions and other agencies in the management of mangrove resources;
- Conduct mangrove rehabilitation and reforestation projects; and
- Strengthen coastal law enforcement.

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State of the Mangroves in
MASINLOC, ZAMBALES

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I. INTRODUCTION

The municipality of Masinloc is located in the northern part of Zambales and lies on a coastal plain between the Zambales mountains to the east and the West Philippine Sea to the west. Masinloc is bounded on the north by the municipality of Candelaria, also of Zambales province; on the east by Mount Masinloc; on the south by the Municipalities of Palauig and Iba; and on the west by Oyon Bay and Masinloc Bay.

It has a total land area of 33,150 ha, with a total coastal length of 42.2 km. Eleven out of 13 barangays are located along the coastal areas. These are Barangays San Lorenzo, Sto. Rosario, Bamban, Inhobol, North and South Poblacion, Collat, Baloganon, Taltal, Bani, and the island of San Salvador. It is inhabited by 47,210 Masinloqueños.

Importance of Mangroves

The coastal resources of the municipality are ecologically, scientifically and economically rich. In fact, it has a total area of 7,560 ha and was declared as Protected Seascape by virtue of Proclamation No. 231 on 18 August 1993 primarily to protect and conserve its ecological, scientific and educational features.

About 29% of the total population of Masinloqueños are highly dependent on coastal resources for their daily living. Fishing is the major source of income. Mangrove forests provide abundant food resources, foraging and living places for wildlife. Some bird species can be found in Yaha Mangrove Area, their ideal habitat, which also serves as recreational ground for bird watching and observation of other wildlife. It also promotes the ecotourism industry in Masinloc, which serves as the supplemental livelihood of the people living in the island, particularly the Samahang Magsasaka at Mangingisda ng Panglit. Mangroves also stabilize the shorelines of the river, and protect the coastlines from waves.

II. STATUS OF MANGROVES

In general, the coastal vegetation of Masinloc is still extensive, with approximately 90% of the shoreline covered by vegetation. Mangroves are mostly sparse but stretch from San Lorenzo River (which forms the southern border of Palauig) to slightly beyond the BFAR station in Bamban. Mangroves are also found in Baloganon (north of Poblacion) and Atob (in Oyon Bay). A total of 109 ha was validated in the municipality based on the mangrove ground truthing of DENR (ICRM plan of 2010). The initial assessment of the Coastal Resources Management Office shows that almost half or 89.85 hectares of the mangrove areas are still plantable areas. It should be noted that 55.5 ha of the existing mangrove areas are either natural growth areas or plantations (32 ha). It is, however, noticed that there were mangrove areas which were declared as private properties (39.25 ha) with existing tenurial status. Hence, conversion of these areas remains unregulated. **Table 8** provides an overview of the distribution of mangroves in Masinloc.

Table 8: State of mangroves in Masinloc, Zambales (in hectares)

Old Stand	Secondary Growth	Plantation
37.75	39.25	32

Based on the floral diversity assessment of mangrove ecosystem in Masinloc, Zambales conducted by Rowena Remojo Sazon and Antonio F. Gascon of the Ramon Magsaysay Technological University, there are at least ten true mangrove species belonging to five families found in the study sites namely: Rhizophoracea, Sonneratiacea, Avicenniacea, Palmae, and Combretacea. There are also four minor components belonging to four families (namely: Euphorbiacea, Sterculiaceae, Myrsinaceae and Rubiaceae) and six mangrove associates belonging to six families.

The study also shows that three of the four sites studied are within the level of "high enough for disturbed habitat" (Kairo et al. 2002).

The species *Sonneratia alba* (*pagatpat*) was estimated to have the highest mean density of 508 trees/ha in four sites. *Rhizophora apiculata* had the highest density in San Lorenzo (1133 trees/ha). *Rhizophora mucronata* and *R. apiculata* have estimated densities of 467 and 400 trees/ha, respectively, in Inhobol.

Table 9: Mangrove stand population density in Masinloc, Zambales

Location	Density (trees per ha)
Inhobol	2202
San Lorenzo	2032
Baloganon	1200
San Salvador	1033

Source: RMTU

Degradation of Mangrove Forests

The arrival of investors in the Municipality of Masinloc saw the alteration of estuaries in Masinloc - Oyon Bay Marine Reserve. As population increased along Masinloc's coastline, there has been a corresponding increase in resource use and development. The main threats to mangrove habitat come from conversion, land use change and the indirect effects of sediments and chemicals in runoffs (from catchments degraded by clearing of upland vegetation and intensive agriculture). Insects such as larvae of caterpillars was also among the threats observed over the past year, particularly in the mangrove plantation project of the AES Masinloc Power Partners Company Ltd., Inc.

Coastal natural resources including mangroves have come under increased risk, particularly near industries and mariculture parks (fish cages). Degradation of mangrove habitats by the direct loss or alteration of trees or conversion reduces its capacity to function effectively as an ecosystem. Around 101 ha have been converted into fishponds. Almost 29 ha of mangroves near a developing barangay have been systematically destroyed and converted into residential areas. Investors, particularly of mariculture projects, chose to situate near the coastline where an estimated 57 ha of the mangroves have been subjected to reclamation landfill.

III. MANGROVE PROTECTION AND MANAGEMENT

The first Mangrove Protected Area declared in the Province of Zambales is located in Yaha, Sitio Panglit, Barangay San Lorenzo, Masinloc. It was established in 2011 through Barangay Ordinance No. 02-2011. It has a total mangrove reserve area of 8.79 ha, a mangrove-formed island located in the middle of the bay where a rare mangrove can be found. It is a hybrid mangrove called (*Rhizophora x lamarckii*) produced by *Rhizophora apiculata* (*bakauan-lalaki*) and *Rhizophora stylosa* (*bakauan-bato*). This was discovered in 2008 by an Australian scientist, Dr Norman Duke (principal research fellow of the University of Queensland's Center for Marine Studies) with his then graduate student, Dr Severino Salmo. Aside from this rare hybrid, Yaha also has a 57% distribution of R*hizophora apiculata* (*bakawan-lalaki*); 42% distribution of *Rhizophora stylosa* (*bakawan-bangkau*), and 1% distribution of *Sonneratia alba* (*pagatpat*).

The mangrove areas in Masinloc are being managed by people's organizations of artisanal fishers such as the *Samahang Magsasaka at Mangingisda ng Panglit* (SAMMPA) Inc., the Panglit Marine Protected Area Management Council, the *Samahang Pangkabuhayan ng San Salvador*, the Duhok Bani Fisherfolk Association, the Masinloc Marine Sanctuary Association with assistance from Department of Environment and Natural Resources through Integrated Coastal Resources Management Project (ICRMP), the AES Phils Power Foundation, Inc., the IPED Fordham University, and the Municipal Environment Natural Resources Office of the Local Government Unit of Masinloc, Zambales.

Mangrove Rehabilitation

With the advent of the ICRMP of the DENR, a mangrove rehabilitation project was initiated in the different areas of Masinloc. **Table 10** summarized the location, beneficiaries, the amount spent, current status and the species planted for the project.

Monitoring and Evaluation

Determination of the historical and present extent of mangroves in coastal barangays has been recently established by Natural Ecosystem Managers Organization, Inc. (NEMO), a community-based people's organization in Masinloc through the Sustainable Coral Reef Ecosystem Project (SCREMP) of the DENR Region 3. However, the said data cannot yet provide valuable information on the role and impact of mangroves in Masinloc for climate change adaptation.

The latest Participatory Coastal Resources Assessment facilitated by the Department of Agriculture-Bureau of Aquatic and Fisheries Resources (DA-BFAR) under the ICRM Project showed that eight of the 11 areas assessed were of fair to poor condition while only two were excellent and one in good condition. Below is the summary of their assessment **(Table 11).**

Table 10: ICRMP mangrove rehabilitation

Area and Location	Beneficiaries	Total Amount	Status	Species Planted
9 ha in San Salvador, 3 ha in Taltal, 3 ha in Bani	Samahang Pangkabuhayan ng San Salvador, STFVA, BDFA	Php 375,000	Completed – 80% survival rate	*Rhizophora apiculata* (*bakawan-lalaki*), *Rhizophora mucronata* (*bakawan-babae*), *Avicenia alba* (*kalapini*)
41 ha in Panglit, San Lorenzo, Santo Rosario, Bamban	SAMMPA	Php 902,000	Completed – 85% survival rate	Not indicated

Table 11: Assessment results of mangrove stand of Masinloc, Zambales (DA-BFAR, 2009)

Barangay	Criteria			Mangrove Condition
	Crown cover (%)	Average height (meters)	Regeneration per square meter (No. of seedlings)	
Bamban	32	7	0	Fair
Bani	138	6	1	Excellent
Baloganon	15	6	0	Poor
Collat	62	3	0	Fair
Inhobol	29	5	0	Fair
North Poblacion	25	4	0	Poor
San Lorenzo	0	3	2	Good
San Salvador	105	7	2	Excellent
South Poblacion	15	4	0	Poor
Santo Rosario	37	6	0	Fair
Taltal	41	5	0	Fair

Source: BFAR

IV. SUMMARY AND RECOMMENDATIONS

There is a need for a province-wide management approach in Zambales. This will provide a more comprehensive development and management plan for the coastal and marine waters of Zambales. In Masinloc, the formulation of a comprehensive conservation and management plan for mangroves with an identified management body and annual budget allocation from the LGUs and other agencies is highly recommended. The DENR through its Integrated Coastal Resources Management Project (ICRMP) in Masinloc has motivated the declaration of the Mangrove Area in Yaha as protected area. However, it is necessary to scale up these initiatives all throughout the municipality and up to the provincial level.

Moreover, Masinloc aims to have a clean and climate change resilient coastal area by providing a resettlement area to informal coastal settlers; improving coastal pollution mitigation; and maintaining coastline protection through the formulation of management strategies for mangrove ecological and bio-economic factors.

Furthermore, a plan to enhance ecotourism in Masinloc through interpretative programs such as high-quality guided tours (by those knowledgeable in mangrove management) is also recommended. Eco-tourists normally seek educational experiences to learn more about environmental awareness and cultural understanding.

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State of the Mangroves in PANGASINAN

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I. INTRODUCTION

Pangasinan is one of the largest provinces in Region I and in the country. It is located in northwestern Luzon, bounded in the north by La Union province, in the east by Nueva Ecija province, in the south by Tarlac province, and in the west by Zambales province. Pangasinan covers a total land area of 536,818 ha with four cities, 44 municipalities and 1,364 barangays. Its 285.66 km coastline extends from San Fabian in the east to Infanta in the west, and is the longest in the region covering 2 cities, 12 municipalities and 123 coastal barangays. Most of the cities and municipalities lie along the historic Lingayen Gulf and Dasol Bay along the West Philippine Sea with an area of approximately 428,400 ha. The Gulf, along with 9,000 ha of communal bodies of water, is a major fishing ground of the coastal communities. Pangasinan is the third most populous province in the country and in Region I with a population of 2,906,085 people as of 2013. About 29% of the population resides in the coastal areas comprising around 135,000 families who are highly dependent on fishing as their main source of livelihood and income.

The province's coastal area is endowed with productive coastal ecosystems, such as seagrass, coral reefs and mangroves, that provide fishing grounds. Mangrove areas located in coastal areas and riverbanks presently cover 615.02 ha from an area of about 990 ha in 1978. These important marine ecosystems harbor high biodiversity. Other habitats include brackish water fishponds located in 14 coastal cities/municipalities and 4 inland municipalities covering a total area of 11,303 ha. These are utilized for bangus, shrimp and siganid culture. Fish farming in cages and pens started in the early 90s and intensified in the last decade, reaching a total of 2,825 units installed along the municipal waters of 11 LGUs. Due to the degradation of water quality that resulted to fish kills, LGUs have greatly regulated this industry resulting to only six LGUs presently engaged in the management of this aquaculture method with a total 2,323 units (as of 2013). These aquaculture units are located in Alaminos City, Dagupan City, Anda, Bolinao, Agno and Sual.

Fishing is the main source of livelihood and income in the coastal areas. In 2013, there were around 8,162 units of motorized *bangkas* and 4,246 non-motorized *bangkas* operated by a total of 27,022 fishers. At present, there are 60 commercial fishing vessels with 1,212 workers, although only 44 vessels are registered in Region I. Other fisheries-related livelihoods include: (1) fish culture in fish cages and fishponds, (2) seashell/seaweeds gathering, (3) fish processing like bangus deboning and smoking, fish drying and *bagoong*-making. Based from OPAg reports in 2013, the total fish production is recorded at 124,863.304 mt. Fish sufficiency level in the province is high at more than 100%, which makes Pangasinan not only the major fish producer and supplier in Northern Luzon but also the fish bowl of Region I.

Other sources of livelihood in the coastal zones are mining and ecotourism. Some of the major industrial players like Team Energy Power Corp, Sual Port, Pacific Farms, Anjo Farms and several ecotourism establishments like the Bangrin MPA in Bani are located in the coastal areas. These industries provide not only employment and income to both the coastal and inland communities but also contribute a significant share to the provincial as well as the regional economy.

Over the years, Pangasinan has been exposed to various natural hazards such as floods, earthquakes and storm surges due to its geographical location, topography and the presence of vast rivers that greatly affect those living in the low lying areas. Aside from these natural calamities,

current trends in coastal migration and the increasing human activities on land, coasts and seas have exerted pressure on the sustaining capacity of coastal and marine areas. These also amplify the risks of environmental degradation, destruction of vital coastal habitats, loss of marine biological diversity and deterioration of near shore water quality. Coral reefs have experienced dramatic degradation and decline due to natural calamities, climate change impacts like coral bleaching and unabated human pressures like overfishing, sedimentation and domestic pollution. Most seagrass beds are moderately degraded and destroyed due to erosion and mine tailings.

Indiscriminate cutting of mangroves for fuel wood and conversion of mangrove forests for other uses contributed to deforestation of mangroves in the area. Destructive and illegal fishing practices like the use of cyanide, blast fishing and the use of fine mesh nets are also among the problems in the area, albeit at quite minimal levels. These illegal practices being done by some fishers may be attributed to weak coastal law enforcement.

Coastal pollution persists due to improper waste disposal from residential wastes and industries like mine tailings that discharge along the Agno River. Another perennial problem is the fish kill due to the indescriminate aquaculture practices that release excess feeds and waste products, which increase nutrient and organic loading. Hence, the deteriorating water quality of Caquipotan Channel, which is used as a major fish farming site.

Another alarming concern is the proliferation of informal settlers along the coastal areas, which cause not only pollution but also increase the areas' vulnerability to degradation, destruction and exploitation. The tendency of persistent overfishing of our marine waters and the declining fish catch may be attributed to poverty in the coastal areas and open access to the sea. Also notable in the coastal zone of Lingayen, Binmaley, Dagupan City, Labrador, and Alaminos City are fishponds that have already been converted for commercial, industrial and tourism development purposes.

Importance of Mangroves

Many significant benefits can be derived from mangrove reforestation projects. However, their impacts cannot be realized immediately, considering that mangroves reach sapling stage 5 to 8 years after planting. It is only during this stage that the mangroves can function as sanctuaries, breeding grounds and nursery grounds of fishes, crustaceans and migratory birds. Their specialized roots (i.e. pneumatophores) can trap sediments carried by runoffs from upstream. Mangrove roots also minimize erosion along riverbanks, thereby preventing sedimentation into seagrass beds and coralline areas.

Mangroves serve as barrier against storm surges and typhoons. In fact, some coastal residents of Anda and Bolinao that live near diverse mangroves have attested that they were not greatly affected by storm surges during typhoon Emong that hit the province in 2009. Mangroves help mitigate the effects of climate change, which is the most challenging problem of our country today.

Mangroves provide sources of livelihoods through aquasilviculture particularly in Alaminos City and the municipalities of Anda, Bani, Sual and Infanta. In Bugallon, Lingayen and San Fabian, *Nypa* leaves are harvested as shingles for house roofing and their saps are processed into wine (*tuba*) and vinegar. Likewise, the seeds of *Nypa* and *Dungon late* are used as decorative materials for various handicrafts.

II. STATUS OF MANGROVES

The province has experienced severe mangrove destruction due to illegal cutting and conversion for other uses. Deforestation of mangroves is a major factor contributing to the degradation of the marine ecosystem. At present, most of the remaining mangrove forests are secondary growth or in plantations and only few are from primary growth. Mangrove areas today cover some 615.02 ha from an area of about 990 ha in 1978 located in coastal areas and riverbanks. An estimated area of about 283 ha are old stand mangroves that are located along the coasts of Bolinao, Bani, Alaminos City, Anda, Dasol, and Infanta. **Table 12** provides a summary of the status of mangroves in Pangasinan whereas **Table 13** shows the distribution, present area of mangroves and potential area for planting mangroves by municipality.

Of the 47 mangrove species in the Philippines, about 25 species are reported in the province. These were identified as the following species: *Aegiceras corniculatum, Aegiceras floridum, Avicennia alba, Avicennia lanata, Avicennia marina, Avicennia officinalis, Bruguiera cylindrica, Bruguiera gymnorrhiza, Bruguiera parviflora, Bruguiera sexangula, Camptostemon philippinense, Ceriops decandra, Ceriops tagal, Excoecaria agallocha, Heritiera littoralis, Lumnitzera racemosa, Nypa fruticans, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Sonneratia alba, Sonneratia ovata, Sonneratia caseolaris, Xylocarpus granatum,* and *Xylocarpus moluccensis.*

Table 12: State of mangroves in Pangasinan (in hectares)

Old Stand	Secondary Growth	Plantation
283.0	332.02	no data

Table 13: Mangrove distribution in Pangasinan and potential sites for planting.

Municipality/ City	Existing Area (ha)	Potential Area (ha)
Agno	104.97	23.26
Alaminos City	42.47	18.50
Anda	85.50	25.50
Bani	66.91	22.03
Binmaley	11.96	13.65
Bolinao	67.70	39.00
Bugallon	6.50	16.66
Calasiao	0.40	11.66
Dagupan City	20.33	3.22
Dasol	69.24	29.00
Infanta	20.66	14.66
Labrador	3.73	6.50
Lingayen	93.66	20.82
Mangaldan	3.17	16.66
San Carlos City	1.16	21.00
San Fabian	6.66	3.00
Sual	10.00	14.00
Total	**615.02**	**301.12**

Threats and stressors of mangrove forests are typically manmade, particularly the cutting and conversion of mangrove areas for other purposes. Additional threats are natural such as typhoons, storm surge, sedimentation, and mortalities due to diseases and barnacle infestation.

III. MANGROVE PROTECTION AND MANAGEMENT

At present, 17 MPAs are already established in four LGUs found in the northwestern part of Lingayen Gulf (Bolinao, Anda, Bani, and Alaminos City) with a total area of about 361.21 ha excluding the Hundred Islands National Park (HINP) with an area of 1,844 ha. Of the 17 MPAs, 14 are located in coral reefs, one in seagrass beds, and two in mangrove areas, thus classified as "mangrove protected areas" (San Miguel, Bani with an area of 42.25 ha and Pilar, Bolinao with an area of 10.0 ha). All of these MPAs are primarily managed by local POs with support from the municipal, provincial and national government as well as private institutions.

Coastal Resource Management as implemented in the province has had a long history. It has always been considered a core and flagship program of provincial leaderships. This is because the province has always associated itself with beaches, seafood and the seascape. Under the present leadership of Gov. Amado Espino, Jr., the province has continued building on past achievements in this area and has strengthened the program. Mangrove reforestation is a major component of the CRM program, and strategies in implementing this program to a successful state are borne on several elements namely: (1) mangrove seedling production, (2) mangrove reforestation, and (3) IEC campaigns, monitoring and linkaging.

The mangrove seedling production was created in support to the province's Mangrove Reforestation Project. It is a 2,000 m^2 mangrove nursery located at Arnedo, Bolinao (**Figure 6**). It was established in 2008 in partnership with the Sagip Lingayen Gulf Project (SLGP). With these mangrove nurseries, the Provincial Government aims to continuously produce and provide the seedlings required by the province's reforestation program, as well as continually aid in providing orientations on the importance of mangrove in environmental protection and marine ecology. Presently, the nursery has 26 units of hardening/ seedlings beds, 1 unit potting shed, and a concrete water tank for storage of brackish water used in watering the mangrove seedlings. It is now a source of mangrove seedlings to sustain mangrove tree planting activities in the province. From 2008 to 2013, the provincial nursery was able to produce a total of about 451,070 multi-species mangrove seedlings. **Appendix E** provides a breakdown of the mangrove seedling production per year.

Figure 6: Provincial Mangrove Nursery in Arnedo, Bolinao.

Mangrove reforestation includes activities such as planting of mangroves in new areas, rehabilitation of existing areas, and replanting in historical mangrove areas that have been severely distressed by both natural and manmade calamities. The several decades of effort on this front have been showing positive signs of improvement. The disastrous deforestation of our mangrove resources have been reversed and, just as importantly, have also made significant inroads in re-establishing this very important ecosystem.

IEC campaigns, Monitoring and Linkaging are very important support systems to the mangrove reforestation project. These ensure that the importance of the mangrove ecosystem to the environment and to the welfare of the community is established and that the community understands their role in the sustainability of this resource.

Honorable Governor Amado T. Espino, Jr., being the only Governor in Region I deputized by the DENR as the Special Environment and Natural Resources Officer for Pangasinan, has bolstered the Provincial Government's efforts to protect, preserve and enhance the environment for this and future generations.

Mangrove species being propagated in the nursery are *Aegiceras* spp., *Avicennia* spp., *Brugueira cylindrica, Brugueira gymnorrhiza, Ceriops tagal, Heritiera littoralis, Lumnitzera racemosa, Nypa fruticans, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Sonneratia alba* and *Xylocarpus moluccensis*.

Figure 7: Mangrove planting activities along the riverbank and coastal area.

Table 14: Mangrove reforestation summary, 2008–2013

Year	Seedlings planted	Area planted	
		Hectare (coastal)	Kilometer (riverbanks)
2008	6,500	1.75	
2009	43,650	7.19	24.46
2010	46,811	10.14	9.04
2011	85,506	8.46	23.50
2012	76,331	11.99	15.95
2013	79,896	11.52	13.8
Total	**338,694**	**51.05**	**86.75**

Mangrove Rehabilitation

- Mangrove Reforestation

Wetlands and riverbanks along the coastal and inland municipalities are the planting sites of mangrove seedlings being propagated in our mangrove nursery (**Fig. 7**). Recipients are active fisherfolk organizations and barangay councils responsible in maintaining the project.

Since the start of the massive mangrove tree planting in 2013, a total of 338,694 seedlings have already been planted to date in 51.05 ha area along the coastal areas and 86.75 km stretch along riverbanks, as shown in **Table 14.**

To attain the sustainability of the reforestation project, the Provincial Government of Pangasinan is presently implementing a multi-sectoral adaptive approach in reforestation. Some of these strategies include the following:

1. Establishing implementation protocol in mangrove reforestation project to attain better survival rate.

   Phase I. Pre-Implementation Information, Education and Communication

   a. Identification of mangrove beneficiaries and steward (fisherfolk associations)

   b. Submission of Resolutions/Letter of Intent to the Governor

   c. Project Assessment

      - Consultation dialogue with LGUs and proposed beneficiaries
      - Organization profiling
      - Project site validation and assessment

   d. Submission of Assessment Report to the Governor and approval

   Phase II. Implementation

   a. Project orientation

   b. Site preparation - Fencing and installation of nets if needed

   c. Distribution, hauling and acclimatization of mangrove seedlings

   d. Planting

   e. Provision of technical assistance and monitoring

2. Networking to strengthen the implementation of mangrove reforestation projects thru signing of MOA between the Provincial Government of Pangasinan and Department of Environment and Natural Resources and the Bureau of Fisheries and Aquatic Resources.

3. Organization and Mobilization of Communities.

The Provincial Government greatly considers coastal communities as partners in undertaking environmental management projects like the Mangrove Reforestation Project since they are the stewards of this important habitat. Their involvement can also increase their awareness on the importance of mangroves in the ecosystem. Partner stakeholders in mangrove tree planting activities include civic organizations, LGUs, national government agencies and the academe.

- Information, Education and Communication (IEC)

Information, Education and Communication (IEC) is considered as an important tool in advocating the sustainable management, utilization, and protection of natural resources. It is in this context that the Province in partnership with the Sagip Lingayen Gulf Project (SLGP) embarked in the establishment of two units of Learning Centers: the Mangrove Information Center in Brgy. Arnedo, Bolinao, and the CRM Learning Center in Barangay Libsong, Lingayen. These facilities serve as venues in promoting advocacies on the importance of mangrove resources to the environment thereby ensuring that the community understands their role. These also serve as a major stopover for the study tour of government employees, students, local and foreign tourists, the media, and the academe.

On the other hand, a more formal and ordered system in disseminating CRM information is now implemented in 14 elementary schools located in Anda, Bani, Alaminos City and Bolinao; and eight secondary schools located in Lingayen, Anda, Bani, Alaminos City and Bolinao. This is a scheme initiated by the SLGP through the localization and integration of Coastal Resource Education in the basic curriculum of the DepEd, particularly in the Science subject of Grade VI and First Year High School students.

The importance of mangroves and other environment-related advocacies, which include climate change orientation, are also disseminated to students in the elementary and secondary schools along the coastal LGUs. Students are being oriented on the importance of conserving and protecting our environment as well as measures in addressing various problems as part of the outreach program. Information dissemination on Environmental Protection through exhibits has been regularly conducted at the Capitol Beachfront during Special Events like *Pistay Dayat* and environment-related celebrations.

Development, reproduction and distribution of IEC materials are being done to disseminate some measures in protecting and conserving our environment like the brochure *Bakawan ng Pangasinan*. Audio-visual presentations on the management of coastal and inland resources are also being produced by the Provincial Information Office and these are shown to visitors coming to the province.

The Provincial Government likewise considers the giving of recognitions and incentives in the form of contests as another approach in IEC for coastal and non-coastal LGUs. The annual search for the cleanest coastal municipality/city dubbed as *Dayat ko, Aroen ko* Program was carried out for almost ten years already. It was administered by a search committee chaired by the PENRO with the DILG, PSU, PNP, NGO and the Provincial Government as members employing a set of criteria prepared by the committee. This was an all out campaign of the Provincial Government to protect, preserve and conserve Pangasinan seas and coastal environs. It is a year-round activity of the province and culminates in an awarding ceremony held during the province's *Pista'y Dayat* festivities. The province allocates a yearly budget for this undertaking; however; national government agencies and capable private companies in the province were also solicited as sponsors for prizes to the winning LGUs. Prizes given are in the form of appropriate projects for implementation in the locality.

In 2009, the province realized that the strategy that brought so much success to the *Dayat ko, Aroen ko* Program could be refocused to address the environmental problems besetting its riverways. The program was dubbed the *Ilog ko bilayen tan aroen ko* Program, which is a contest similar to what was undertaken in the coastal LGUs. It is an annual search for the cleanest river/river bank. Since 2009, this program has become a mainstay in the environmental efforts of the province. It is also hailed as a best practice program garnering awards and citations at the regional level. This search does not only focus on monitoring LGUs' performances in the utilization, protection and conservation of river ecosystems. It also strengthens partnership through the provision of incentives/recognitions as a way of motivating them to do their responsibilities in managing this resource.

An inter-agency evaluation committee composed of the DENR, BFAR, PSU, DILG, DPWH, NIA, PGP and an NGO has been organized. They conducted field evaluation

and validation using the prescribed search criteria. It has two categories: Municipal and Barangay for Inland and Coastal River. The barangay level was further classified into two categories namely: (1) Barangay Sub-Category A, concerning LGUs benefited with the river clean-up conducted by the Task Force Kalikasan of the Provincial Government, and (2) Barangay Sub-Category B, which includes LGUs that have not been reached yet by the river clean-up project. Prizes given to the winning LGUs are in the form of projects and cash.

Monitoring and Evaluation

Generally, agencies that are in charge of reforestation/afforestation projects in the province directly monitor the status of their respective projects. The Provincial Agriculture Office monitors projects through ocular inspection. In 2012, it was revealed that seedlings planted along river banks have greater survival with a rough estimate of 53% compared to those planted along intertidal flats with only 45% survival rate. Factors such as wave action, barnacle infestation, algal blooms that entangle newly planted seedlings, and sedimentation affected the survival of plantings along intertidal flats. Rapid currents, sedimentation and flooding were observed to cause mortalities among seedlings planted in riverbanks. The municipality of Bani adapted a more scientific monitoring tool for determining the status of their mangrove plantation.

Impacts of Mangrove Rehabilitation

Some valuable information gathered from fisherfolks in Binmaley, Lingayen, Dagupan City, Bolinao, Anda, Bani, Mangaldan, San Fabian and Alaminos City revealed that fish/seashell catch in areas near mangrove sites that were reforested has increased—an indication that the habitat has been enhanced ecologically, resulting in higher income for fishers in the locality. The continuous implementation of this reforestation project would definitely rehabilitate, albeit on a staggered basis, the mangrove habitat as breeding and nursery grounds of fishes.

The exemplary performance of the province in the area of coastal resource management where mangrove development is a major component has been recognized by the Regional Development Council as the *Most Outstanding LGU Coastal Resource Management Program Implementer – Provincial Government Category* from 2008 to 2010. Because of this, the province was elevated to the Hall of Fame for CRM Implementers in 2011. In recognition of the province's laudable efforts, DENR has provided funds in the amount of P287,500 as an incentive for the rehabilitation of about 25 ha of mangroves. The municipalities of Infanta and Dasol were identified as planting sites in 2011.

In 2012, the Provincial Government bagged the *Likas Yaman Awards* for Environmental Excellence as the *Best LGU Initiated Environment – Project Category*, which was organized by the DENR. Recently, the Bureau of Fisheries and Aquatic Resources (BFAR) also recognized this noble project of the province, which was awarded with the *Gawad Pagkilala Award* during the Fish Conservation week celebration in October 2014.

IV. SUMMARY AND RECOMMENDATIONS

With the available potential areas for mangrove tree planting estimated at 301.12 ha along the coastal areas and along riverbanks, the province shall carry on this project by intensifying its mangrove seedling propagation. This hopes to obtain greater impact in conserving the ecosystem and in protecting the communities residing in the coastal areas from intense typhoons and storm surge. Support from barangay councils and community-based organizations in the protection and maintenance of this project shall be further strengthened.

Eight units of fishponds, acquired by the government through the Fishpond Lease Agreement, has been recently terminated by the BFAR and have been included in the targeted total area of 33.39 ha mangrove reforestations in Alaminos City, Sual and Anda.

Climate change mitigation and adaptation measures are priority concern of the government where mangrove reforestation is a major component. Thus BFAR, DENR, LGUs, NGOs and other environmental partners must prepare a more comprehensive plan, particularly on the role of mangroves. In this manner, a more unified approach shall be obtained that would eventually address problems on planting sites, budget, monitoring, and functions/responsibilities of each agency involved with the DENR as the probable lead agency.

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State of the Mangroves in
BANI, PANGASINAN

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I. INTRODUCTION

Bani is a second class municipality found in the westernmost part of Pangasinan province. It has two bodies of municipal waters: Tambac Bay with 8.56 km shoreline, which is part of Lingayen Gulf in the east, and Olanen Bay with 4.87 km coastline, which faces the West Philippine Sea. Two barangays (namely Aporao and San Miguel) face Tambac Bay while four barangays (namely Colayo, Centro Toma, Dacap Sur and San Simon) face the West Philippine Sea. The six coastal barangays have a total area of 6,294 ha with a population of 10,868 or 23% of Bani's total population of 46,225.

The primary sources of income at the Tambac Bay side are aquaculture, salt making, farming and fishing. Fishing, charcoal making and farming are the primary sources of income in Olanen Bay. Some of the social problems experienced by the coastal communities are the limited fishing area due to municipal boundary disputes; lax implementation of fishery, coastal and forestry laws and ordinances, cutting of trees for charcoal making, and construction of illegal structure along rivers and shorelines; erosion, siltation and sedimentation combined with water pollution causing shallowing and eutrophication of rivers; and natural hazards such as flooding of riverine barangays (Tambac Bay side) and tsunami-prone areas at Olanen Bay.

Importance of Mangroves

The mangrove ecosystem in Bani has a prominent role in litter and detritus production, which provides a food source to a variety of juveniles of fishes, prawns, crabs and shellfish as well as serve as the nursery and habitat of 123 bird species. Mangrove roots shelter fishes, prawns, crabs and shellfish, which all serve as human food sources of protein and calcium. Mangroves play a very important role in protecting the coastal shorelines predominantly composed of fishponds (Tambac Bay side) and forests (Olanen Bay side).

Plenty of mangroves died when the MPA was hit by Typhoon Emong in 2009. As silviculture practice and with the LGU's permission, dead mangroves were cut and made into charcoal, serving as an additional source of income of Bangrin Federation members. Riverside residents trim mangroves during riverine cleanup to use them for fuel.

II. STATUS OF MANGROVES

Based on the data from the Provincial Government of Pangasinan, Bani currently has 66.91 ha of mangroves with 22.03 ha of potential planting area. The breakdown for old stands, secondary growth and new plantations was not provided (**Table 15**).

Degradation of the Mangrove Forests

Originally, more or less 2,000 ha of old stands and natural growing mangroves were abound in the alienable and disposable as well as private lands located in barangays San Miguel, Aporao, Luac, Garrita, Banog Norte, Ambabaay, Poblacion, Masidem and Tugui Grande. Degradation took place when all mangrove forest areas were converted into

Table 15: State of mangroves in Bani, Pangasinan (in hectares)

Old Stand	Secondary Growth	Plantation
no data	66.91	no data

fishponds and salt farms without leaving the 20-m salvage zone as buffer, as provided in the terms and conditions of the Fishpond Lease Agreement (FLA).

In the 1970s to 1990s, more than 374 ha were applied for by rich Bulakeños and Nueva Ecijanos and were awarded wide areas for fishpond development under a 25-year FLA tenurial instrument renewable for another 25 years to the Department of Environment and Natural Resources (DENR) and the Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR). Sixty-two leaseholders, few of them Bani residents, operate aquaculture ponds predominantly containing bangus. Salt intrusion affected rice lands found nearby and were also converted into fishponds. Prawns, sea basses, siganids and crabs are minor aquaculture commodities. Some aquaculturists who were affected by typhoons, flash floods and fish kills converted their fishponds into salt farms because of the lower cost of capital. Degradation of mangroves in the municipality resulted in the decline of fish catch due to limited fish nursery areas; polluted river water due to wastes, toilets and piggeries coming from an increasing riverside population; erosion due to few vegetation that helps prevent siltation; and weakened coastal/riverine protection from storm surge.

Threats to Mangrove Forests

Like other mangroves in other parts of the Philippines, Bani coasts face threats such as high salinity. Being a brackish water dweller, mangroves incur mortality during the dry season. Irrigation dams and small water impounding projects reduce the amount of freshwater flowing to the river systems, thus salinity reaches as high as 50 ppt.

Erosion from upland areas due to deforestation pushes down sediments, leading to the shallowing of rivers and overcoming the filtration ability of mangroves resulting to their drying out and suffocation.

Overfishing affects the ecological balance of food chains in the river and estuary. Herbivorous fish populations cannot consume all the algae scattered all over the shoreline. *Lumut* topples the newly planted mangroves and shells cling to their stems, killing the plants.

Strong water movements and waves, typhoons, and floods are also threats to the new plantation. Moreover, sea level rise brought about by climate change can kill mangroves, especially newly planted *Avicennia* and *Rhizophora* species. These species die during the month of July to August when water fluctuation and ebb tide are high, thereby drowning the plantation.

III. MANGROVE PROTECTION AND MANAGEMENT

The local people of Bani, aware of the consequences of the massive destruction of their coastal and riverine ecosystem, decided to save and rehabilitate the remaining mangroves. In 1990, the DENR Integrated Mangrove Rehabilitation Project was started through a 3-year community and family contract between the Bani LGU and DENR. DENR allocated PHP 522,000 in funds and LGU-Bani, represented by the late Mayor Marcelo C. Navarro, Sr., and Punong Barangay Pedro Camba, along with the community pioneered the mangrove reforestation project by planting 100,000 propagules.

The idea of establishing a Marine Protected Area started with consultation with the fisherfolk of Brgy. San Miguel by BFAR and LGU-Bani (20 October 2000), in line with the celebration of Fish Conservation Week. A petition was made and signed by the fisherfolks with the assistance of the Barangay FARMC, proposing for the MPA establishment. It was then supported by a resolution passed by the San Miguel Barangay Council on the same day. The occasion also paved the way for hearing the community's voice on suggested management strategies, allowable activities at the sanctuary and fishery reserve, violations and penalties. The resolution and petition were forwarded to the Sangguniang Bayan for legislation.

Mayor Gabriel E. Navarro issued Executive Order 05 Series 2000 that created the Multi-sectoral Technical Working Group on Marine Protected Area I Management Planning. The MPA I Management Plan was passed to the Sangguniang Bayan by the Technical Working Group to support the resolution and petition. The Sangguniang Bayan enacted Ordinance No. 01 declaring Bangrin Mangrove Marine Protected Area on 8 October 2001. It has a total area of 42 ha and is co-managed by Bangrin Federation (Aporao Fisherfolks Association Inc. and Nagkakaisang San Miguel Association Inc.) and the Local Government of Bani.

Since its establishment, the NGAs, NGOs and foreign funding institutions have been partners in coastal and riverine reforestation with LGU-Bani: BFAR-Fishery Resources Management Program (2000–2005), DENR-RO I, UP-MERF Sagip Lingayen Gulf Project (2003–2007) and NEDA-KR2 Project (2008-2010), Provincial Government of Pangasinan, PMA Class '72, Hundred Islands Rotary Club, US Peace Corps-Volunteer's Environmental Grant, and the DENR-BFAR's Tanim Kalikasan National Greening Program.

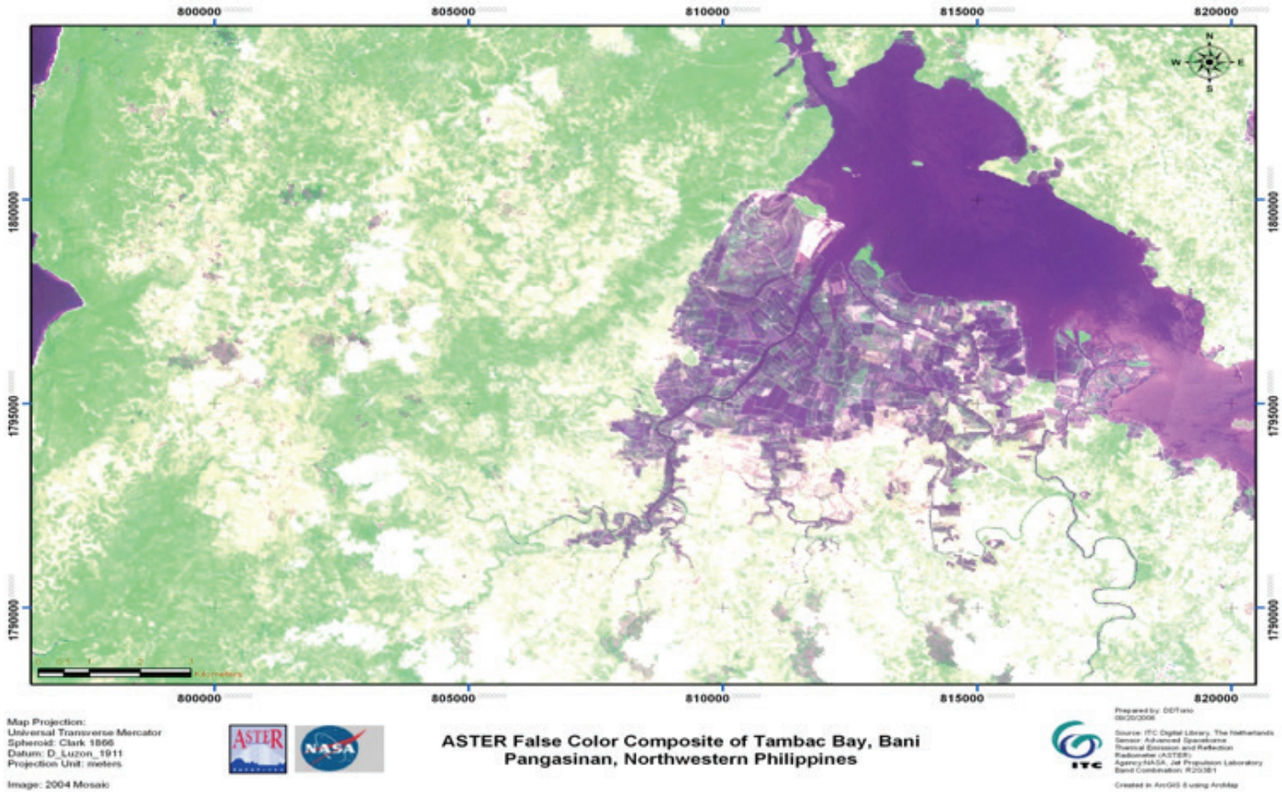

Figure 8: Map of rehabilitated mangrove areas in Bani, Pangasinan.

From this period up to the present, Bangrin Federation and fisherfolk organizations joined hands with the local government unit for sustainable management. Municipal Fishery Ordinance No. 02 was enacted by the *Sangguniang Bayan* on 25 October 2004 and embodied in this ordinance in Section 41 (management of mangrove along riverbanks), Section 42 (management of mangroves), and Section 43 (immediate restoration of mangroves). At present, the planted mangrove species are composed mainly of *Rhizophora mucronata* and a few *Rhizophora apiculata, Avicennia marina* and *Sonneratia alba*. **Figure 8** shows the map of rehabilitated areas.

Mangrove Rehabilitation

With the inspiring award won by Bani in 1995 for its mangrove reforestation efforts and as the country's Best Community-Based Coastal Development Project, the succeeding mayors, Ireneo Orlino, Gabriel Navarro, Marcelo Navarro, Jr., and Gwen Palafox-Yamamoto, and the Banians continued to support coastal and riverine mangrove reforestation, as embodied in the different Coastal Resource Management Plans from years 2000–2002, 2003–2005, 2005–2009, 2010–2012, and in the Integrated Management Plan for 2013–2017. For them, reforestation is one of the best ways to reduce vulnerability and risk brought about by climate change. *Rhizophora mucronata* is the dominant species planted. *Avicennia marina* and *Sonneratia alba* were rarely planted due to its high mortality from nursery to outplanting. A total of 37.05 ha in coastal and 32.41 ha in riverine areas had been reforested, maintained and protected in the last ten years. **Appendix F** provides a summary of the mangrove reforestation activities in the municipality.

Monitoring and Evaluation

Monitoring of new plantations includes survival and growth rates. Since the first to the last mangrove monitoring, survival ranged from 34% to 64%. High mortality is attributed to the toppling of the plantation by *lumut* and heavy infestation of barnacles at the stems. The assessment of mangrove forests is done once a year. The average tree density is 1,400 per ha. Typhoon Emong, in 7 May 2009, caused the dilapidation and eventual death of many mangrove trees. It was also during monitoring that damage/defoliation of leaves by insects were observed.

Impacts of Mangrove Rehabilitation

After 14 years of mangrove reforestation, increase of daily fish catch was noticed from 2.0 kg in 1995, to 3.25 kg in 2000, to 6.68 kg in 2007. The 23.05 ha mangrove plantation at Bangrin MPA served as nursery ground for fishes, crustaceans and shellfish feeding on its thick litters and detritus. It serves as sanctuary and breeding ground of shore birds during the cold months, from December to February. The man-made mangrove forest was declared as the 13th Bird Watching Site of the Philippines in 2008 by Recreation Outdoor Exchange and Wild Bird Club of the Philippines and was also a DENR-accredited tourism facility in 2009. In 3 March 2014, it was strongly endorsed by the Sangguniang Bayan of Bani as an important flyway network site of migratory birds for the Philippines, which is identified as among the countries located along the migration route of the East Asian-Australasian Flyway—hence, a partner country to the international partnership on the conservation and protection of migratory birds.

The thick forest serves as buffer, weakening gusty winds and water surge in times of typhoons. It protects coral reefs by absorbing sediments from erosion and organic nutrients from solid wastes flowing down from the river system. Mangrove seedling production and reforestation served as livelihood for Bani fisherfolks.

IV. SUMMARY AND RECOMMENDATIONS

All these mangrove rehabilitation, management and protection efforts in the Bangrin Marine Protected area garnered the following awards: Tambuyog Award was won by Bangrin Federation as *Model Barangay Fisherfolk Organization for MPA Management* in 2009 by the Pangasinan Provincial Government Unit; *Accredited Ecotour Facility* in 2009 by the Department of Tourism (DOT); 2009 *Philippine Wetlands Conservations Award Special Citation* by the Protected Areas and Wildlife Bureau DENR-Quezon City; and 2*nd* Place for the *Most Outstanding MPA Award* in *Para El MAR* 2011.

LGU-Bani, Municipal FARMC, Bangrin Federation and the POs envisioned that Bangrin Marine Protected Area would become a well-maintained ecotourism area in the country, attracting visitors and offering quality facilities and services. A concrete road going to Pataga Fish Port in barangay Aporao (a jump-off point to the MPA) was built in 2013. To mark its boundary and to prevent poaching, a concrete boardwalk will be constructed from funds to be provided by DENR-Sustainable Coral Reef Ecosystem Management Project and DOT; a view deck and the rehabilitation of guard house to be funded by DOT; skills training for appreciation, utilization and marketing. DENR-Regional Office I is now extending technical assistance to the LGU in updating and formulating a Wetland Management Plan for Bangrin. The FARMC IEC Committee plans to conduct periodic IEC/advocacy campaigns on coastal habitat protection and resource management to maintain its sanctuary and fishery reserve. Livelihood projects for Bangrin Federation such as the bottling of fish and deboning of bangus, are being processed for funding by DENR-SCREMP. A proposed amendment of Municipal Fishery Ordinance and strict enforcement of national and local laws is lobbying for its reactivation. The municipality needs to adopt and implement the best practices in coastal management for mangroves.

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State of the Mangroves in LA UNION

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I. INTRODUCTION

The province of La Union is located in the northern part of Luzon. It is a regional capitol of the Ilocos Region and is bounded by Ilocos Sur province in the north, Pangasinan province in the south, the Cordillera Region in the east, and the Lingayen Gulf and West Philippine Sea in the west. The province has a land area of 149,309 ha with an estimated coastline of 155.4 km. The province is primarily agricultural, but includes fisheries as a subsidiary income-generating source. It has a total population of 787,823 as of 2013.

La Union has the least number of municipalities and second least number of barangays. Twelve of its 20 cities/municipalities lie at the coasts comprising of 94 barangays as shown in **Appendix G**. As of 2013, these areas have a total coastal population of 185,038. Most of the coastal inhabitants depend on fishing for their livelihood, which the Provincial Government of La Union considers a priority program.

The primary sources of income in the coastal areas are: (1) aquaculture – fishpond, fish pen, fish cages, mariculture, oyster farming, sea garden (sea urchin, seaweed and sea cucumber), (2) fishing in municipal and commercial waters, (3) fish processing post-harvest livelihoods – production of dried fish, *bagoong*, deboned *bangus*, *relyenong bangus* and smoked fish, (4) fish vending or buy and sell of fresh fish harvest, (5) boat and net making, and (6) eco-tourism – rental of temporary beach sheds, during summer seasons and long holidays, shell craft vending, bancathon competition and exhibition and the popular surfing activities, particularly in San Juan and Bacnotan, which are also famous for their floating restaurants.

However, these income sources seem to be insufficient to support the growing population. Some of the social problems encountered are rooted in the overall attitude and behavior of the populace, specifically the lack of concern for sustainable resource use practices, combined with the increasing rate of poverty, particularly in the coastal areas, where the population grows faster. Consequently, the amount of waste increases, the competition for livelihood and resources becomes stiffer, and the pressure on the environment and its resources reaches a point where it does not allow sufficient time for recovery. Unemployment is also considered a problem since most children in the coastal communities lack access to higher education. Other problems include malnutrition, poor health and poor sanitation attributed to improper waste disposal.

Importance of Mangroves

Mangroves in the province provide spawning and nursery grounds of fishes and crustaceans, and habitat for local and migratory birds (particularly in Sto. Tomas and Agoo). Mangroves serve as sources of livelihoods, providing fish, crustaceans and mollusks (particularly in Sto. Tomas, Agoo, Aringay, Bauang, San Fernando, and San Juan), products such as nipa shingles for roofing (in Aringay), firewood and charcoal (in Aringay, Agoo, San Fernando, and San Juan). The establishment of the *Aquasilvi* project in the municipalities of Bauang, Aringay and Sto. Tomas favored beneficiaries from identified or accredited fisherfolk associations. The project serves as additional income of the association aside from planting of mangrove propagules.

Mangroves also protect our coastal areas from typhoons and storm surges due to its crown and trunks, which break the impact of strong winds and excessive flow of water.

II. STATUS OF MANGROVES

The total area planted with mangroves is approximately 80 ha, which include both secondary growth and new

Table 16: State of mangroves in La Union (in hectares)

Old Stand	Secondary Growth	Plantation
no data	no data	80.0*

*Does not include BFAR plantation

plantation and excludes BFAR plantation (DENR Region I File). There is approximately 70 ha planted within the last ten years. We have potential mangrove areas of 162.6 ha (Provincial Fishery Profile 2013).

In 2011, 97,000 mangrove propagules were planted in total of 23.28 ha area in nine coastal barangays within four municipalities. In 2012, 200,000 propagules were planted in 14 barangays within nine municipalities. In 2013, 360,350 propagules were planted in 14 barangays from eight municipalities, and in 2014, 80,000 propagules were planted in 19.05 ha. Thus, according to BFAR records for 2011–2014, a total of 737,350 mangrove propagules have been planted in 175.75 ha. The species planted were *Avicennia* spp. (*bungalon*), *Nypa fruticans* (nipa), *Pemphis acidula* (*bantigue*), *Rhizopora apiculata* (*bakawan lalake*) and *Rhizopora mucronata* (*bakawan babae*).

Degradation of Mangrove Forests

Mangrove areas declined at about 20% of the total areas primarily due to human activities such as conversion to aquaculture and illegal settlements, cutting of mangroves for fuel wood and charcoal making, and also due to more natural causes of mangrove mortality such as land subsidence or erosion, siltation and sedimentation, and infestation by pests and barnacles.

The decline in mangrove areas resulted to the decrease in the productivity of coastal habitats, erosion of shorelines and the resulting loss of residential and agricultural states, and higher vulnerability to natural disasters and events attributed to climate change like sea level rise.

Threats to Mangrove Forests

The threats to mangrove forests and their productivity are linked to the increasing coastal population, which has resulted to increasing food demand, pollution and losses in natural coastal habitats. The destruction of coastal habitats is mainly caused by illegal and destructive fishing practices, conversion of mangroves to fishponds and land reclamation.

The decline of mangroves is also attributed to pollution and siltation, and climate change-related problems. Pollution and siltation are caused by the improper waste disposal coming from upland and lowland residences. Wastes trapped in mangrove roots hinder the flow of water to the coast. Climate change-related problems, which include sea level rise have been evident in the region for the last ten years. This has resulted to the depletion of the shoreline. It also hastens coastal erosion, which has been experienced in the municipalities of Aringay, Sto. Tomas, and the city of San Fernando.

III. MANGROVE PROTECTION AND MANAGEMENT

Agoo-Damortis Protected Landscapes and Seascape (ADPLS) was declared as an MPA through an approved management plan (DENR). It has a total area of 60 ha and spans the municipalities of Agoo and Sto. Tomas. The mangrove protected areas are managed by the POs, DENR, PAMB (Protected Area Management Board) and the LGU.

Mangrove Rehabilitation

A memorandum of agreement was entered into by the Provincial Government, BFAR and other concerned LGU and fisherfolk associations for the rehabilitation of mangroves in La Union. The different projects and programs implemented were the Mangrove Population Enhancement Program of BFAR; Integrated Coastal Management Program (ICMP); Philippine National Aquasilviculture Program and Upland Development Program of DENR; Solid Waste Management (SWM), Municipal Fishery Ordinance; the National Greening Program (NGP) of DENR, which covers the riverine/estuarine and coastal areas from the municipality of Sto. Tomas to Bacnotan; and the development of IECs to enhance awareness of communities. To add to this would be the planned multi-sectoral mangrove planting, which will be spearheaded by either DENR or BFAR and other stakeholders.

The community has benefitted from the existing projects because they are being paid on a contractual basis. The issue of the declining fish catches are also addressed as their resource-based livelihood is rehabilitated. The concern on the resilience of the coasts to climate change hazards is also being addressed through the rehabilitation of the vital coastal habitats serving as buffer against winds and other adverse events.

Monitoring and Evaluation

Monitoring and evaluation have been delegated to the fisherfolk associations and the Barangay Councils thru a MOA signed by both parties to protect the newly planted mangrove propagules to attain 100% survivorship. The province and BFAR have joint monitoring activities every quarter to evaluate the growth and survivorship of mangroves. Unfortunately, the natural growth and the second growth of mangroves do not have a monitoring and

evaluation component following the minimum parameters like the tree stand structure, tree abundance, species richness and diversity, invertebrate abundance and species richness and diversity (Salmo et al. 2007).

Impacts of Mangrove Rehabilitation

Mangrove forests in Agoo, San Fernando, and Aringay have protected the environment and communities from storm surges, waves, tidal currents and typhoons, and reduced organic pollution through entrapment of wastes from upland by the mangrove roots. Mangrove reforestation conducted by BFAR has also increased the income of the fisherfolk association.

IV. SUMMARY AND RECOMMENDATION

The Provincial Government of La Union with other national agencies like the DENR, BFAR, DMMMSU and LGU conceptualized an Integrated Coastal Management Plan. One of the priority activities/programs is Mangrove Rehabilitation and Management. Another is the periodic IEC/advocacy campaign on the protection and conservation of the marine habitats and the awareness of the communities in their respective areas through PPP (public-private partnership).

It is recommended that the LGUs, down to the barangay level, enact an enhanced local ordinance for the protection of mangroves. LGU staff should attend an enhanced training on mangroves for monitoring, evaluation, resource mapping and all other relevant aspects. Since different agencies have their own data that are inconsistent with our own, we also recommend a mangrove profiling by the Provincial LGU with the help of the DENR and BFAR.

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State of the Mangroves in ILOCOS SUR

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I. INTRODUCTION

The province of Ilocos Sur is centrally located in Region I with Vigan City as the capital. It is bounded in the north by the province of Ilocos Norte, in the south by the province of La Union, in the east by the province of Abra, Mountain Province and Benguet, and in the west by the West Philippine Sea. It has a total population of 665,575 (NSO 2010) and a total land area of 257,965 ha (DENR-Land Management Service 2010), composed of 34 municipalities. Sixteen municipalities and two cities comprised of 118 barangays are situated along the coast (**Appendix G**). The province has a total shoreline length of 157.626 km. The total coastal area is 47,286 ha with 131,426 inhabitants (NSO 2010).

The primary sources of income of the coastal residents are fishing, farming, aquaculture and livestock production. The social problems encountered by the coastal residents are illegal fishing (in some areas), increasing number of fishers due to increasing population, encroachment of fishers from other provinces, and low fish catch volumes of commercially important fishes.

Importance of Mangroves

Mangroves provide nursery grounds for fish, prawns/shrimps, crabs, shellfish and other marine organisms. They serve as natural buffers for coastal areas and communities from the onslaught of strong waves and storm surges. They reduce organic pollution in nearshore areas by entrapment or absorption of organic wastes. They produce litter/detritus, which are valuable sources of food for aquatic and marine animals. They provide food and housing materials (e.g. nipa shingles). They also serve as shelter for migratory wildlife, recreational grounds for bird watching, and provide field venue for education and research.

II. STATUS OF MANGROVES

The mangroves in Ilocos Sur have a total area of 122.95 ha. Of these, 26.88 ha are old/natural stands, 8.58 ha are rehabilitated and 87.49 ha are new plantations that were established within the last ten years. The mangrove planting program in the province started in 1989. These were conducted by different agencies such as DENR, PGIS-ENRMO, BFAR, SUCs and NGOs. **Table 17** summarizes the state of mangroves in Ilocos Sur while **Table 18** shows the breakdown of old stands and new plantations per barangay.

True mangrove species found in Ilocos Sur were identified as: *Aegiceras corniculatum, Avicennia marina, Avicennia officinalis, Bruguiera cylindrica, Bruguiera gymnorrhiza, Bruguiera sexangula, Ceriops decandra, Derris trifoliate. Dolichandrone spathacea, Excoecaria agallocha, Ipomoea pes-caprae, Lumnitzera racemosa, Nypa fruticans, Osbornia octodonta, Pemphis acidula, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Sonneratia alba* and *Sonneratia caseolaris.*

Mangrove associates found in Ilocos Sur were identified as: *Acrostichum aureum, Acanthus ilicifolius, Barringtonia asiatica, Calophyllum inophyllum, Heritiera littoralis, Hibiscus tiliaceus, Pandanus tectorius, Pongamia pinnata, Sesuvium portulacastrum,* and *Terminalia catappa.*

Table 17: State of mangroves in Ilocos Sur (in hectares)

Old Stand	Secondary Growth	Plantation
26.88	8.58	87.49

Table 18: Distribution of mangroves in Ilocos Sur (in hectares)

Location	Old Stands	Plantations
Apatot, San Esteban	5.6	0
Bao-As, Sta. Lucia	0.09	2.73
Baracca and San Pedro, Mindoro, Vigan City	0	1.54
Bateria, San Esteban	0.14	0
Bia-O, Sta. Maria	0	2.88
Bulala and Mindoro, Vigan City	0	2.27
Cabangtalan, Sinait	0	1.11
Cabittaogan Sta. Catalina	0	0.02
Calongbuyan, Santa	0	0.22
Caterman, Candon City	1.01	0
Magsaysay, Santa	5.31	0
Dadalaquiten Norte, Sinait	0	0.97
Darapidap, Candon City	0	18.49
Dardarat San Juan	0	4.99
Dardarat, Cabugao	0	6.81
Don Alejandro Quirolgico	0	0.17
Don Leopoldo Yabes, Sinait	0	6.54
Katipunan, Sinait	0	2.87
Libtong, Tagudin	0	0.28
Mindoro, Vigan City	0	1.27
Nagsayaoan, Sta. Maria	0	0.08
Nangalisan, Sta. Lucia	0	0.53
Pagsanaan Sur, Magsingal	0.2	0.4
Pantay Laud, Mindoro, Vigan City	0	14.07
Paratong, Sinait	2.13	0
Paratong, Sta. Lucia	0	0.67
Paypayad, Candon City	0	3.89
Pilar, Sta. Cruz	0.71	0.49
Pug-Os, Cabugao	0	5.38
Rancho, Santa	0	0.3
Sabang, Cabugao	0	2.16
Salapasap, Cabugao	0.1	0.21
Salomague, Cabugao	1.16	1.9
San Sebastian, San Vicente	0	1.95
Solot-Solot, San Juan	0.58	0
Sulvec, Narvacan	0.17	0
Surngit, San Juan	1.91	2.67
Suso, Sta. Maria	2.2	0
Tamurong Primero, Candon City	8.19	1.96
Tamurong, Caoayan	0	4.58
Villa Hermosa, Sta. Cruz	0	1.64
Villamar, Caoayan	0	2.03
Total	**29.51**	**98.09**

Degradation of Mangrove Forests

Some of the causes of the decline of mangroves in the province are natural calamities, inadequate information dissemination, weak implementation of coastal laws, and collection/gathering of *bakauan* for materials such as decors and firewood. The decline of mangroves affected the community and environment due to the resulting erosion, siltation and low fish catch. Since there is a decline of mangroves, it is being addressed through reforestation/rehabilitation such as coastal/riverbank planting activities conducted by the different agencies and through Information, Education and Communication (IEC) campaigns.

Threats to Mangrove Forests

The mangrove-related environmental threats experienced by the province are: (1) coastal erosion due to improper construction of shoreline engineering structures, (2) lack or weak implementation of zoning ordinance, development of coastal areas for tourism and residential areas, (3) pollution due to improper waste disposal and other anthropogenic causes (e.g. oil spill), (4) storm surges, and (5) pests such as barnacles that cloak the stems of propagules and young seedlings.

III. MANGROVE PROTECTION AND MANAGEMENT

A 5-ha Mangrove Protected Area was established at Barangay Dardarat, Cabugao. It was implemented by the concerned LGU. There are policies related to mangrove protection and management such as the Provincial Environment Code, SP Resolution No. 083, s. 2011 (*Establishment of Mangrove Nursery*) and the *Bantay Kalikasan* Program. The existing mangrove stands are being managed by the PGIS-ENRMO, DENR, LGUs, SUCs, FARMCs and the Ilocos Sur Federated Fishermen Association.

Mangrove Rehabilitation

There have been efforts in the province to protect, rehabilitate or plant more mangroves. These are implemented by the different programs and projects of the PGIS-ENRMO through its TAGIBIKA Program (T*agibien Ti Kabaybayan/Karayan*) and *Bantay Kalikasan* Program; DENR- National Greening Program (NGP) and Coastal Environment Program (CEP); LGUs, BFAR, SUCs and NGOs – Mangrove Rehabilitation Projects. The different mangrove species planted were *bakauan bato, bakauan babai, bakauan lalaki, pototan lalaki* and nipa. Mangrove associates such as *botong, bittaog, talisai, bani* and *dungon-late* were also planted.

Monitoring and Evaluation

Monitoring and evaluation are being conducted on a biannual basis. Mangrove assessment is also conducted to determine the development of the project. The survival rate is 90% (Source: BFAR).

Impacts of Mangrove Rehabilitation

The rehabilitation of mangroves help improve fisheries production (given that they serve as life support systems for different fish species), stabilize the shoreline, and reduce the effect of climate change.

Figure 9: Mangrove assessment in Ilocos Sur

Figure 10: Mangrove survey and validation

IV. SUMMARY AND RECOMMENDATIONS

1. Establishment and protection of existing mangrove areas in the province.
2. Institutionalization of a mechanism in the evaluation and monitoring of mangrove programs, projects and activities.
3. Conduct public awareness campaigns.
4. Updating of the mangrove database of Ilocos Sur.

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State of the Mangroves in
ILOCOS NORTE

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I. INTRODUCTION

Ilocos Norte has a shoreline length of 155.37 km. It has a total population of 568,017. No information has been provided on the coastal population of the province, apart from the fact that 80% of its residents rely on fishing as their primary source of income, 10% from farming and the other 10% from hired labor.

The coastal population encounter various socially-rooted environmental issues such as sporadic incidences of cyanide fishing. A decrease in live coral cover has also been noted, possibly due to the typhoons that hit Ilocos Norte. The common problems of overfishing and blast fishing have already been overcome. The establishment of alternative livelihood projects like aquaculture, livestock raising and farming have addressed the tendency to overfish while the implementation of the CEP program has eliminated the incidences of blast fishing.

Importance of Mangroves

Mangroves provide various ecological services. Since mangroves serve as spawning grounds for fish and other young crustaceans, they provide sources of food and income from fisheries. As an ecotourism area, Ilocos Norte also sees mangroves as potential areas for ecotourism.

II. STATUS OF MANGROVES

Ilocos Norte has a total mangrove area of 66 ha, 23 ha of which are old stands and are located at Sitio Nagabungan, Davila and Pasuquin. Data on secondary growth are not available. The mangrove planting program of the province started in the year 2010 with nipa and *Rhizophora* propagules as the main species planted. New plantations are present in Laoag City and the municipalities of Badoc, Pasuquin, Bacarra and Paoay. A total of 214,700 propagules has been planted with a 90% survival rate. **Table 19** provides a summary of these data.

Degradation of Mangrove Forests
- No data available.

Threats to Mangrove Forests
- No data available.

Table 19: State of mangroves in Ilocos Norte (in hectares)

Old Stand	Secondary Growth	Plantation
23.0	no data	43.0

Table 20: Monitoring and evaluation plan of Ilocos Norte

Process	Pressure	Response	Sustainability	Impact
BEGINNING: • Site profiling undertaken • Problems identified and prioritized • Planning undertaken • Stakeholders consulted • Public Awareness raised	• Types and levels of pollutants • Nature and levels of conversion of coastal habitats/ overexploitation of natural resources • Environmental risks quotients for water quality and ecosystem	(OUTPUTS) • Local level interagency, multi-sector mechanism for policy and management coordination established and operational • Coastal strategy/Strategic Environmental Management Plan developed and adopted • Communication plans developed and adopted	(IMMEDIATE OUTCOMES) • Local government resolution to establish an interagency committee • Stakeholder participation	• Perception and behavior changes among stakeholders detected.

III. MANGROVE PROTECTION AND MANAGEMENT

Mangrove protection and management is carried out through the following methods: (1) replanting, (2) hiring of barangay ranger officers with a PHP 3,000 monthly salary, (3) ICRM orientation, (4) mangrove planting, (5) strict implementation of relevant national and provincial laws and ordinances, and (5) provision of patrol boats for Bantay Dagat

Monitoring and Evaluation

Table 20 summarizes the various processes of mangrove rehabilitation and its corresponding responses, immediate outcomes and impact to the community.

IV. SUMMARY AND RECOMMENDATIONS

In support to the wealth of life, it is imperative that these resources be given emphases in every Provincial Development Plan for their proper management, conservation and protection.

State of the Mangroves in CAGAYAN

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I. INTRODUCTION

The province of Cagayan comprises an aggregate land area of 929,500 ha making it the second largest province in the region. It is bounded by Balintang Channel and Babuyan Group of Islands on the north; Pacific Ocean on the east; Isabela province at the south; and the Cordillera Mountains on the west. A set of islands can be found at the northern tip of the province namely, Palaui, Fuga, Calayan, Dalupiri, Camiguin and Babuyan Claro.

Cagayan has 28 municipalities and one city divided into three congressional districts, and consists of 820 barangays. Tuguegarao City is the provincial capital, regional seat, and the center of business, trade and education.

Cagayan has a total coastal land area of 143,874 ha. There are 11 coastal municipalities in the mainland corridor along the Babuyan Channel. These municipalities are divided into western and eastern segments by the mouth of the Cagayan River: Santa Praxedes, Claveria, Sanchez Mira, Pamplona, Abulug and Ballesteros on the western segment, while Aparri, Buguey, Santa Teresita, Gonzaga and Santa Ana are on the eastern segment. Calayan Municipality comprises the Babuyan Group of Islands and lies north of the main corridor. The municipalities of Peñablanca, Lallo and Baggao are in the Pacific eastern seaboard.

Cagayan's 455-km coastline constitute ~73% of the regional coasts of Cagayan Valley. The province has among the longest coastlines in the country. Aside from its long coastline, the province also has extensive inland shores around large rivers and their tributaries, lakes, creeks and streams that provide rich fishing and aquaculture grounds. There are untapped coastal fishing grounds along the northern coasts or the Babuyan Channel corridor (from Santa Praxedes to Santa Ana), and along the Pacific eastern seaboard (from Santa Ana to Peñablanca). Despite this endowment, the province's fish production is not enough to supply and sustain its own fish requirements.

Cagayan's deep-sea fisheries are known for its tuna, tuna-like fishes, hairtail, snapper, scad, slipmouth, mullet, grouper, shrimp, squid and lobsters. The inland waters are used primarily by subsistence fishers. Few privately operated fishponds and fish cages contribute to the overall fish supply of the province. Only about 1,894 ha are used for fishpond operations and only 1,369 ha of this are used for brackish fishpond operations. Various fish cage cooperators use a total of 1,289.5 m^2, of which operators of brackish fish caging use a total of 1,189.7 m^2.

About 91 ha are used for other aquaculture activities like oyster, mussel and seaweed culture. The beaches and waters surrounding Port Santa Ana up to Cape Engaño in Palaui Island offer haven for fishing and SCUBA enthusiasts. This area is also known for the diversity of prime value fish species caught. Santa Teresita is traversed by two rivers: the Buguey Lagoon and the Caroan River of the adjacent municipality of Gonzaga. Santa Teresita abounds with swamps and marshes that are rich in aquatic resources especially those located at barangays Buyun, Simbaluca, Caniugan, Simpatuyo, Centro East and Centro West. An aggregate area of 183.8 hectares is partially developed fishponds producing four metric tons of fish annually. Aquatic products from brackishwater fishponds and a creek include milkfish, mullet, tilapia, and crustaceans such as shrimps, prawns and crabs.

Importance of Mangroves

Mangroves have a unique set of characteristics compared to other set of ecosystems, one of which is its tolerance for high salinity. The range of economic and ecological benefits were briefly discussed by Fortes and Jara (1987).

Mangroves play an important role in maintaining the ecological balance of coastal communities at Cagayan. It provides habitat and nursery ground for many species, and thus supports the fisheries. Mangrove areas provide important sources of seafood such as mollusk, gastropods, and numerous food fish. Mangroves also serve as defense against strong typhoons and storm surges. In spite of their enormous importance, mangrove trees have been continually cut and mangrove forests are now degraded and reduced.

The awareness in the importance of mangroves came with the growing concern on biodiversity, conservation and the dwindling forest cover. The estimated original cover that ranged from 400,000 to 500,000 ha has been reduced to 139,000 ha in 1988.

II. STATUS OF MANGROVES

Cagayan has approximately 3,967.9 ha of mangrove areas. The distribution of old stands, secondary growth and plantations were not identified (**Table 21**). These are distributed throughout the municipalities of Abulug, Aparri, Buguey, Calayan, Claveria, Gonzaga, Pamplona, Sanchez-Mira, Santa Ana and Santa Teresita.

The mangrove forest of Abulug covers an aggregate area of approximately 841.40 ha. These are sporadically located in the coastal barangays of Centro and Siguiran. The general status of mangroves here is classified as fair since less than 41% of the area has living mangrove trees. Most of the areas manifested severe cutting, heavy erosion and siltation.

As for Aparri, the DENR latest data show a total aggregate area of 1,093.5 ha of mangroves. These are located in barangays Linao, Bisagu, Sanja, Bulala Sur, Navagan, Binalan, Caagaman, Gaddang and Maura. The mangrove areas of Aparri are dominated with *Nypa fruticans* (nipa) equivalent to 98% while the remaining 2% are made up of the mangrove species *Bruguiera sexangula* (*pototan*), *Ceriops decandra, Ceriops sp.* (*lapis-lapis*), *Dolichandrone spathacea* (*tui*), *Excoecaria agallocha* (*buta-buta*), *Heritiera littoralis* (*dungon late*) and *Sonneratia alba* (*pagatpat*), which are mostly found along rivers and creeks.

Table 21: State of mangroves in Cagayan (in hectares)

Old Stand	Secondary Growth	Plantation
no data	no data	278

Most of the mangrove areas of Buguey are either lost or degraded mainly because of the unabated reclamation, alteration or massive conversion of mangrove forests into fishpond, residential and other purposes. The decline of the mangroves is paralleled by the decline of municipal fisheries catch. Conversion of mangrove areas into fishponds has left only small patches of mangrove stands in the area. However, good mangrove stands are still found in barangays Villa Leonora and Calamegatan. The mangrove areas of barangays Quinawegan, San Vicente, Santa Maria and Pattao of Buguey are dominated by *Nypa fruticans*, as observed during assessements of planting site for mangrove reforestation and rehabilitation. There were also a few stands of mangrove tree species such as *Avicennia officinalis* (*api-api*), *Aegiceras corniculatum* (*saging-saging*), *Bruguiera sexangula* (*pototan*), *Rhizophora mucronata* (*bakauan-babae*) and *Sonneratia alba* (*pagatpat*). A total of 121.4 ha are being surveyed as proposed planting site for mangrove reforestation and rehabilitation. Based on the observation, nipa species in other barangays were cut for nipa shingles because this is one of the alternative sources of livelihood among the people.

Mangroves are found in three of the four islands of Calayan Municipality, namely: Calayan Island, Camiguin Island and Dalupiri Island. In Calayan Island, few mangroves are found in Barangay Dibay whereas Barangay Dilam has around 10 ha of mangrove area comprised of the mangrove species *Ceriops tagal* (*tangal*), *Rhizophora mucronata* (*bakawan-babae*), *Rhizophora apiculata* (*bakawan-lalaki*) and *Sonneratia alba* (*pagatpat*), and other associated tree species. These same species of mangroves and associated trees were found in the 24-ha mangrove area in Camiguin Island, particularly along the coast of Barangay Naguillian and the Nagtamurungan creek. Dalupiri Island has patches of mangroves approximately 5 ha in area, notably inhabited by the Philippine crocodile (*Crocodilus mindorensis*) as documented by the Mabuwaya Foundation based in Isabela State University.

Mangrove areas in the municipality of Claveria are estimated to be around 45 ha and comprise mainly of *Nypa fruticans* (nipa) and *Ceriops tagal* (*tangal*). They are found in barangays Centro IV, Centro V, Centro VI, Centro VII, Pinas, Santa Maria, Dibalio, D. Leaño, Pata West, Pata East, and Magdalena particularly along Cabicungan River, Pata River and their tributaries. Most of these areas have been converted into settlements, agriculture (e.g. rice, vegetables and coconut), and fishponds. About one hectare was eroded into the rivers and some remained unplanted. There were about 17.5 ha mangrove areas within alienable and disposable lands in Pata East, but some were already

titled and utilized in the establishment of fishponds and palay production, while portions are under the stewardship of BFAR for its research and production purposes.

The municipality of Gonzaga has mangrove forests sporadically located in seven coastal barangays with swamp and brackish areas, which cover an aggregate area of approximately 69.1 ha. Generally, the status of the mangrove forests of the municipality is poor with an average of 25% living mangrove trees. Most of the areas manifested severe cutting, heavy erosion and siltation specifically observed in barangays Caroan and San Jose, where the largest tracts of mangrove forest in the municipality are located.

The municipality of Pamplona has mostly inland nipa swamps, which cover an aggregate area of approximately 702 ha situated within "alienable and disposable lands" (515.0 ha) and public lands (187.0 ha). Nipa swamps are found along the riverbanks, waterways and tidal flats of riverine areas and tributaries. Nipa swamps are located in barangays Tupanna, Tabba, Cabaggan and Nagtupakan. In barangay San Juan, strips of *Nypa* also draw inward following river tributaries, gullies and waterways as far as the saltwater tide can reach. Along Bangan River in barangays Allasitan and Bidduang, only strips of *Nypa* clumps with an average of 10 meters can be found.

The municipality of Sanchez-Mira has a two-hectare nipa swamp in Barangay Masisit, which has been described to be in good condition. Several stands of *Sonneratia caseoralis* (*pedada*), *Sonneratia alba* (*pagatpat*), *lapis-lapis* (*Ceriops decandra*) and *Osbornia octodonta* (*tualis*) grow along the waterline while thick vines, grasses and shrubs are observed along the shoreline. Thin strips and patches of mangrove-associated species can be observed in Barangay Namuac, particularly along the Namuac-Pata River with a stretch of 3 km near its end. Patches of *Nypa* are dense and thick serving as bank protection for the rice fields.

The municipality of Sta. Ana has approximately 639.2 ha of mangroves. These areas serve as fish sanctuary, buffer zone and more importantly habitat and breeding ground of various species of fish, crustaceans and mollusks. Some community residents depend on mangrove resources as their source of livelihood such as fuel, fence, fish corrals and housing materials. Mangrove areas are found in barangays San Vicente, Tangatan, Sta. Cruz, Diora-Zinungan, Rapuli and Patunungan. Dominant species include *Acanthus* spp. (*lagiwliw*), *Avicenia* spp., *Bruguiera* spp. (*pototan*), *Nypa fruticans* (nipa) and *Rhizophora* spp. (*bakawan*). Other species observed include *Aegiceras corniculatum* (*saging-saging*), *Avicennia lanata* (*piapi*), *Avicennia marina* (*bungalon*), *Avicennia officinalis* (*api-api*), *Ceriops tagal* (*tanga*l), *Terminalia catappa* (*talisay*), d*ungon-late, langarai, mangasiriki* and *sapinit*.

The municipality of Santa Teresita has an aggregate mangrove forest area of approximately 340.1 ha. These are sporadically located in six coastal barangays, namely: Simbaluca, Centro East, Caniugan, Simpatuyo, Buyun and Centro West.

Degradation of Mangrove Forests

The declining mangrove forest cover is one of the increasing concerns of the government. On top of the of the annual investment on rehabilitation activities of remaining forest stands, the present administration set aside one billion pesos to cover expenses on the rehabilitation of remaining mangrove forests. However, there are still threats to the mangrove areas of Cagayan as enumerated below.

1. *Urbanization*. Mangrove forests are reduced into much smaller patches to create more settlements for the growing coastal population. The expansion of agricultural areas in Cagayan also contributed much of the degradation of mangrove forest.
2. *Fishpond Expansion*. Large areas of mangroves were converted into fishponds in the municipalities of Buguey, Santa Teresita, Aparri and Santa Ana. Most of these mangrove areas have been claimed as part of the alienable land. The owners have reaped the short-term benefits at the cost of deteriorating these areas. This has led to higher costs of fish production than profits. Saltwater intrusion are also evident in some mangrove areas of Aparri.
3. *Lack of awareness or priority.* Coastal inhabitants have not fully appreciated the value of mangrove forests nor the efforts to rehabilate them. The incessant gathering of firewood and the trampling of mangrove seedlings attest to this. Rehabilitation of mangrove areas also lack the needed attention from their managers, resulting to the low survival of seedlings. Thus, instead of being rehabilitated, these mangrove areas may become further degraded.
4. *Rehabilitation techniques*. Two decades of mangrove rehabilitation saw little success in terms of increasing vegetative cover because the site managers were not able to determine the right mangrove species and the appropriate techniques for restoration and silviculture. The rehabilitation efforts did little to consider zonation patterns, which was already a basic concept or practice in such efforts. Most rehabilitation activities were project-driven and primarily focused on the number and height of seedlings being planted. Site managers

tried to resolve these issues by planting *Rhizophora* species, which also turned out to be unsuitable for the area. Only the recent prohibition of planting mangroves in seagrass areas broke the cycle of failures that was repeated for two decades. Ironically, most of the reforestation sites were situated in the low inundated areas.

5. *Potential effects of increased seawater temperatures*. In 2010, most of the *Avicennia* propagules planted at Buguey lagoon swelled. The people's organization, local government and project coordinators replanted the area several times but survival rates were low. It was later speculated that the low survival rate in the area was due to the increased water temperature.

III. MANGROVE PROTECTION AND MANAGEMENT

Monitoring and Evaluation

The implementation of foreign-assisted project on integrated coastal resource management improved the vegetative cover of mangrove areas in Cagayan. Most of the efforts in monitoring and evaluating the state of mangrove resources are through the participatory coastal resource assessment conducted every two years by coastal LGUs. Resources are shared during these activities. The community and LGUs are actively involved, and technical assistance is provided by the DENR and BFAR. The results of these assessments are presented and discussed with the community, which serve as basis for participatory planning, and planning by the provincial government.

Impacts of Mangrove Rehabilitation

Mangrove rehabilitation is a growing interest among the coastal municipalities of Cagayan. Rehabilitation was supported by foreign donors and regular funds from DENR. This resulted to 278 ha of rehabilitated area from 2001 to 2006. Petron Philippines is also a regular partner in mangrove rehabilitation activities especially during the annual celebration of "Ocean Month", which happens in May. Other government entities also assist voluntarily during tree planting activities. Abulug and Pamplona maintain a good cover of *Nypa* stands for the production of shingles, wine and vinegar. This also helps in the growth of different crustaceans that the fisherfolks regularly catch to supplement their income.

The different calamities that hit the country have increased the awareness of the people on the importance of caring for their mangrove areas. As a remarkable example, the owners of titled mangrove areas at Gonzaga voluntarily gave their land rights to the local government for the development and protection of mangrove areas.

IV. SUMMARY AND RECOMMENDATIONS

In coastal areas, mangroves serve as a line of defense during calamities and therefore should be given top priority in resource management. The large tract of mangroves in the province that were converted into fishponds, agriculture, and other land uses should be reverted back to its natural state. The direct and indirect ecosystem services of mangroves, particularly its carbon sequestration potential, still need to be further developed.

Cluster planting is highly recommended in rehabilitation efforts since it was observed that propagules have higher chances of survival with closer spacing as compared to the conventional terrestrial planting of forest species. The best management option is to engage the coastal communities in the maintenance and protection of mangrove areas.

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IV. TECHNICAL PRESENTATIONS

Photo by SSalmoll

Mangrove Forest mapping Using Landsat 8 Images

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I. INTRODUCTION

Remote sensing is the practice of deriving information about the earth's land and water surfaces using images acquired from an overhead perspective, using electromagnetic radiation in one or more regions of the electromagnetic spectrum, reflected or emitted from the earth's surface (Campbell 1966). Remote sensing data can be derived from the different regions of the electromagnetic spectrum. Examples are middle resolution Landsat and high resolution WorldView satellite images that utilize the visible to infrared region, RadarSat from radio waves and Light Detection and Ranging (LIDAR) which employs ultraviolet light.

Landsat Data Continuity Mission (LDCM), commonly called Landsat is among the publicly accessible remote sensing database. Starting operation in 1972, LDCM is the world's longest continuously acquired collection of space-based, moderate-resolution (15/30m), land remote sensing data. LDCM was a joint initiative between the US Geological Survey (USGS) and National Aeronautics and Space Administration (NASA). In 2013, they launched their latest satellite platform called Landsat 8. Data acquired by the mission are accessible through public domain in the web pages of Global Visualisation Viewer (www.glovis.usgs.gov) and EarthExplorer (www.earthexplorer.usgs.gov).

Using Landsat imageries, Long et al. (2014) mapped and assessed the condition of mangrove forest in the Philippines from 1990 to 2010. Their study found out that from 268,996 ha in 1990, mangrove areas decreased to 256,185 ha in 2000 and further down to 240,864 ha in 2010. Shown below (**Fig. 11**) is the mangrove forest map for 2010 based on Long's findings.

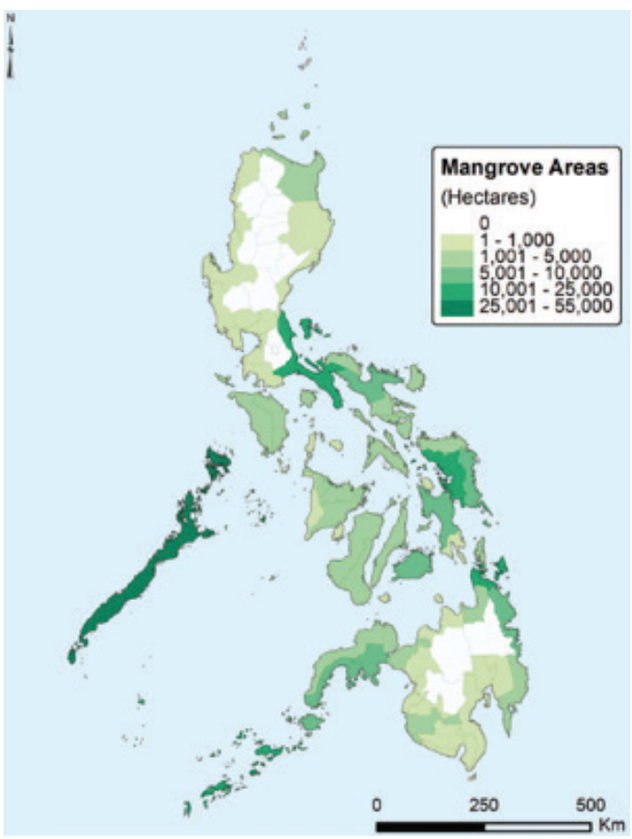

Figure 11. Mangrove forest cover 2010 by Long et al.

II. MAPPING OF MANGROVES

Using Landsat 8 imageries, mangroves can be characterized visually through combinations of bands. In **Figure 12**, a true color combination of bands 4-3-2 (red, green and blue) shows that mangroves appear to have a darker green color than other vegetation. On the other hand, a false color combination of 5-4-3 (infrared-red-green) displays mangroves as darker red compared to other vegetation. Another false color combination of bands 5-6-7 (infrared-midinfrared1-midinfrared2) represents mangroves in a striking orange hue compared to other vegetation. Among these combinations, bands 5-6-7 was deemed to be the most useful in identifying mangroves.

Also, mangroves, just like other objects, have their own spectral signature which can be used for their classification. Spectral signature refers to the unique response of object when subjected to varying wavelengths of the electromagnetic spectrum. The value of spectral response of mangroves in mid-infrared is lower compared to other vegetation (see **Fig. 13**).

True Color Composite
Landsat 8 Bands 432

False Color Composite
Landsat 8 Bands 543

True Color Composite
Landsat 8 Bands 567

Figure 12. Characterization of mangrove forests from different band combinations

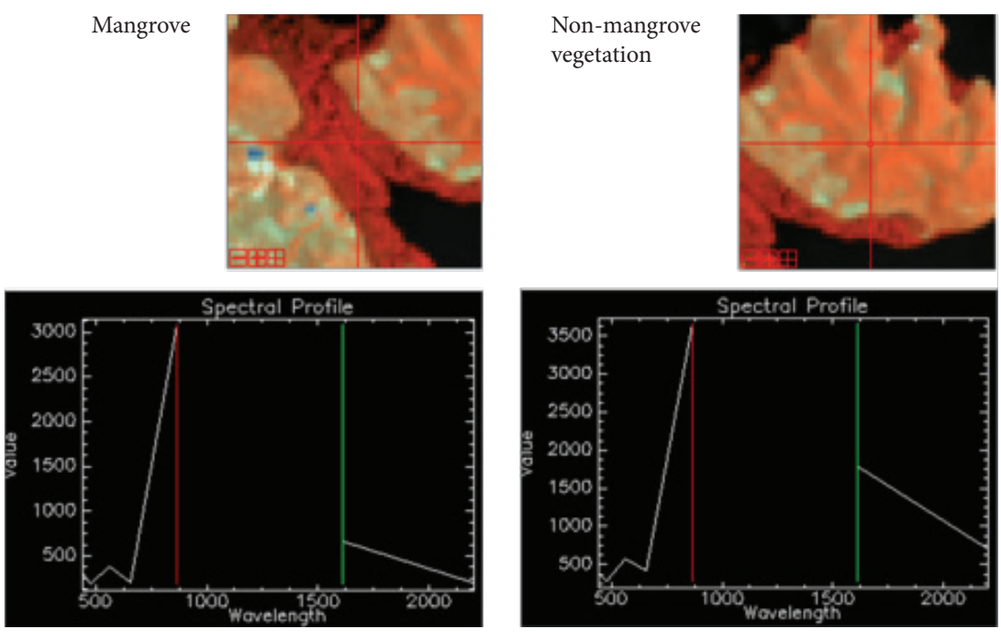

Figure 13. Comparison of spectral response between mangroves and other vegetation

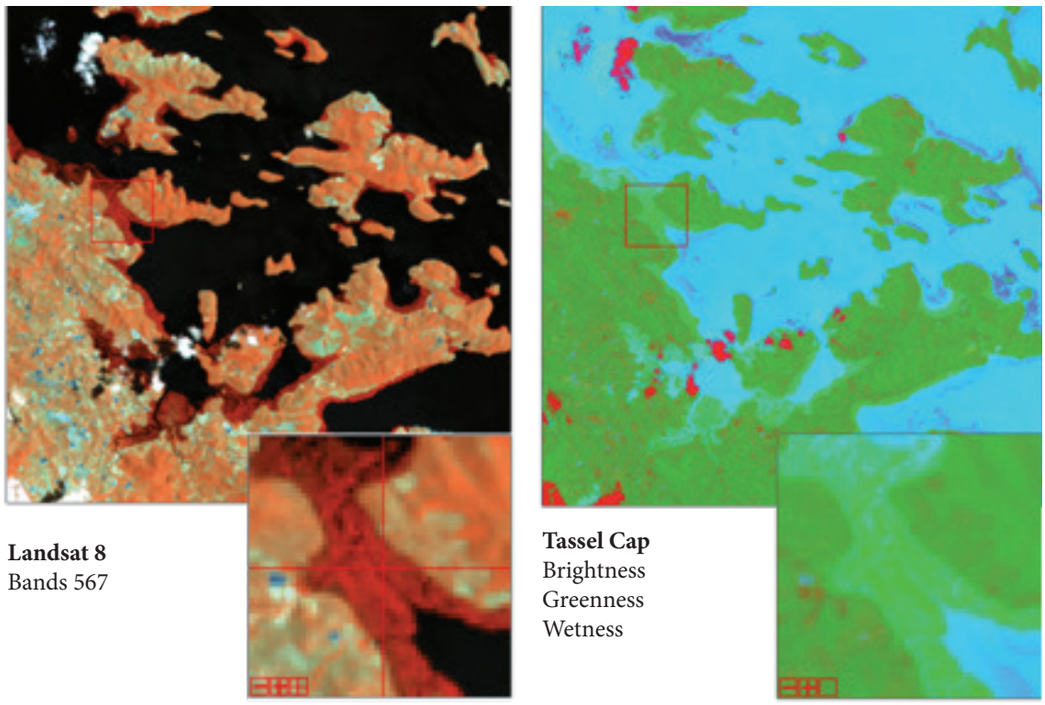

Figure 14. Comparison of a false color combination and tasselled cap transformation

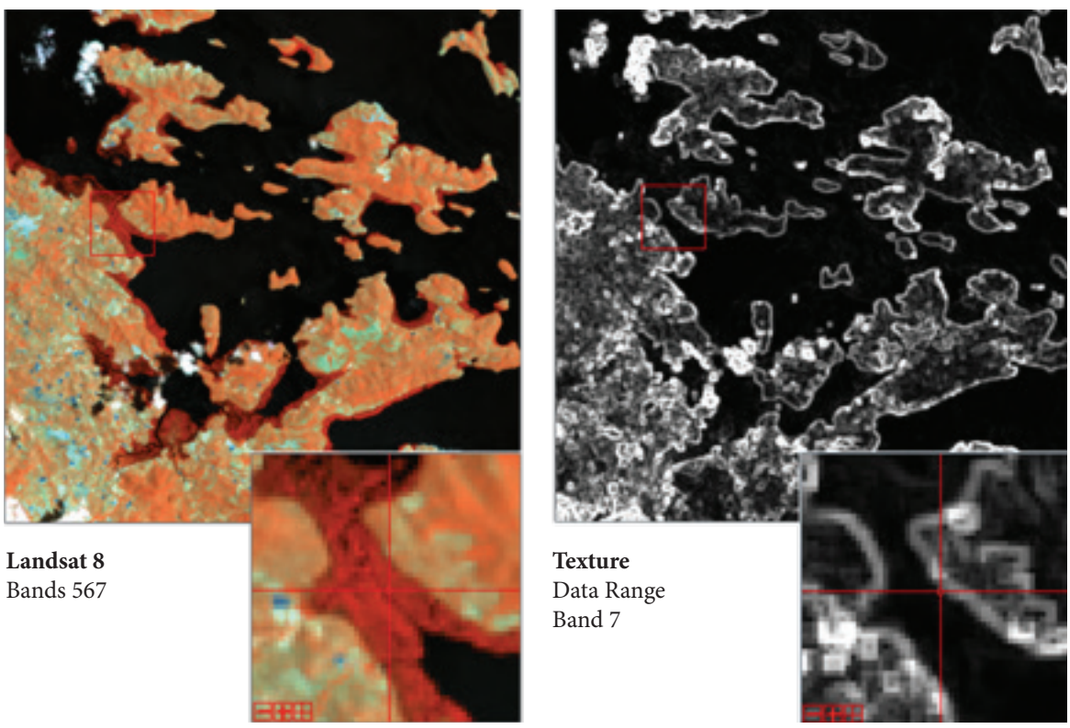

Figure 15. Comparison of a false color combination and texture Filtering

Tools in remote sensing such as tasseled cap transformation and texture filtering were also used to identify mangroves. Tasseled cap transformation refers to orthogonal transformation of the original data into index bands. These indices are called brightness, greenness, wetness, fourth (haze), fifth and sixth. A combination of brightness, greenness and wetness indices can be useful in differentiating mangroves from other vegetation as shown in **Figure 14**.

On the other hand, texture filtering smoothens the spatial variation of image brightness and was found to be helpful in differentiating mangroves from rainforest. Band 7 (mid-infrared 2) was applied with texture filtering for this study.

Infrared, mid-infrareds (1 and 2), brightness, greenness, wetness and texture filtered mid-infrared 2 bands were used as input for classification. Method used was Iterative Self Organizing Data Analysis Technique Algorithm (ISODATA), an unsupervised classification wherein classes/clusters are iteratively splitted and merged based on user defined threshold. No fieldwork was conducted for the study, thus ISODATA was appropriate for this study since it does require a training class for classification.

III. RESULTS

Five Landsat 8 images dated 2013 were used for the classification of mangroves. User accuracy, which refers to the probability that a pixel labelled as a certain class is really the said class, ranges from 64% to 88%. On the other hand, producer's accuracy, or the probability that a certain object on the ground is classified as such, had values from 68% to 96%. Kappa coefficient, which measures the degree of agreement from 0 (no agreement) to 1 (complete agreement), ranges from 0.769 to 0.792. **Table 22** shows a summary of these accuracy parameters.

A total of 2,159 ha of mangroves were estimated to be within the provinces of Bataan, Bulacan, Cagayan, Ilocos Norte, La Union, Pampanga and Pangasinan. This is lower compared to the 2010 mangrove forests identified by Long et al. (2014) as well as those declared by LGUs.

Table 22. Accuracy Parameters

Path	Row	User's Accuracy	Producer's Accuracy	Kappa Coefficient
116	50	81.91%	80.70%	0.79
116	49	64.93%	96.39%	0.77
116	48	70.36%	70.02%	0.70
116	47	68.55%	82.77%	0.71
117	49	88.83%	68.83%	0.77

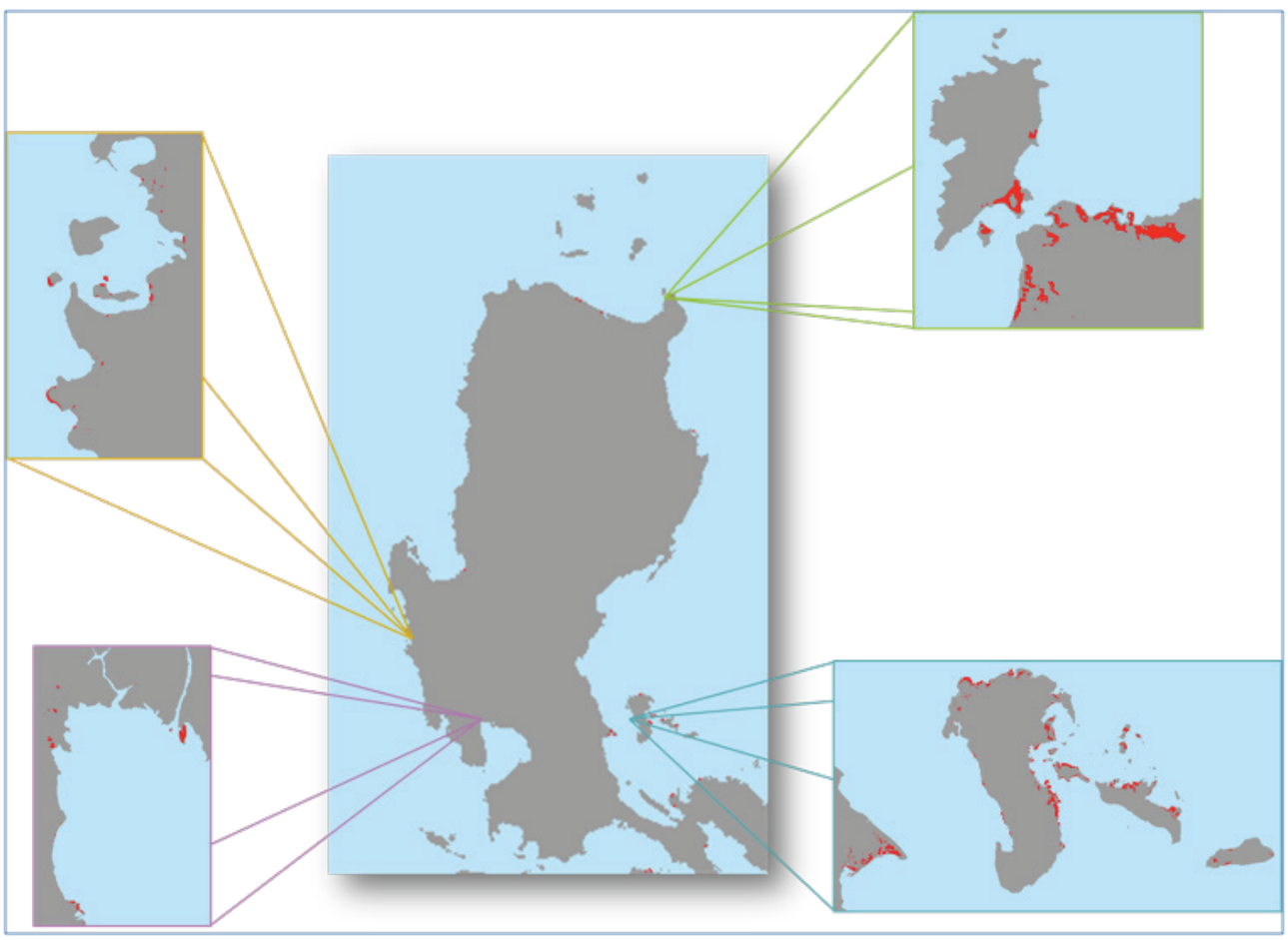

Figure 6. Mangrove areas with areas of concentration zoomed in

Among the areas with mangrove forests, Palaui Island (Cagayan), San Narciso (Zambales), Bataan and Polilio Island (Quezon) are areas of concentration.

Table 23. Mangrove Forest Area per Province

Province	2013 (in ha)	2010 Long et al (in ha)	As per LGU (in ha)
Bataan	42	172	282
Bulacan	33	265	294
Cagayan	1,655	4,737	5,336
Ilocos Norte	1	58	38
Ilocos Sur	0	40	169
La Union	78	44	79
Pampanga	56	132	159
Pangasinan	205	207	470
Zambales	89	217	604
Total	**2,159**	**5,872**	**7,431**

IV. SUMMARY AND RECOMMENDATIONS

The study showed preliminary results of mangrove mapping using remote sensing data. Different tools were explored to come up with accurate classification results. Compared to results of another study, which employed more complex rules in identifying mangrove forest, the study yielded lower results. However, the said study lacks field validation for their results. Similarly, figures declared by the LGUs are also higher. This can be attributed to newly planted areas included in their total mangrove areas.

For more accurate results, the use of higher resolution satellite images, other remote sensing data or combination of both are recommended. However, it should be noted that higher resolution images will require more processing time, thus more experts and manpower. Other classification techniques can also be explored. In collecting field data, the actual data on the location of the mangroves is encouraged. This can be done in collaboration with the concerned LGU.

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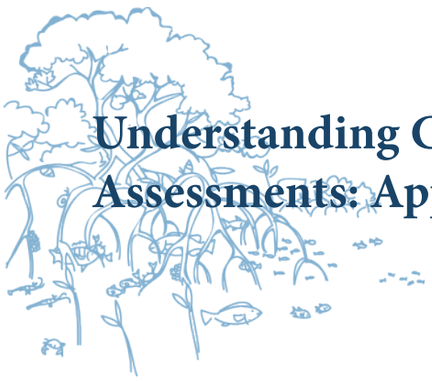

Understanding Climate Change Vulnerability Assessments: Application to Coastal Mangrove Forests

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ABSTRACT

Increased global temperature and its consequences pose threats to coastal habitat health and productivity, which, in turn, impact biodiversity, fisheries and coastal integrity. Assessment of vulnerability of the coastal area therefore involves not only investigating climate and ocean exposure and their potential impact but should likewise include evaluating socio-economic development and the ability of affected communities to cope with such changes.

To this end, three tools were developed to assist local government units in conducting assessments of their respective areas. The first is the Integrated Coastal Sensitivity, Exposure, Adaptive Capacity to Climate Change VA Tool (I-C-SEA-Change by Licuanan et al.), which is a scoping and rapid reconnaissance tool intended to offer comparison of general vulnerabilities across barangays. For adaptation planning, I-C-SEA-Change must be complemented with the two other tools, TURF (Tool for Understanding Resilience of Fisheries by Mamauag et al.) and CIVAT (Coastal Integrity VA Tool by Siringan et al.). TURF and CIVAT are finer resolution analyses intended to provide direct guidance in developing CC adaptation strategies. Specifically for mangrove ecosystem, vulnerability assessment includes land-use planning (including the marine environment), measures of habitat protection, measures of coastal integrity and presence/absence of marine infrastructure.

In general therefore, adaptability of the mangrove ecosystem to climate change can be enhanced with synergistic management of the watershed and the coast.

The Need for Institutional Networking in Integrated Coastal Management: Interconnectivity among Coral Reefs, Seagrass beds and Mangroves

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INTRODUCTION

The Philippines is an archipelagic country where millions of inhabitants are, in one way or another, dependent on the fisheries and ecosystem services provided by coral reefs, seagrass beds and mangroves. However, these valuable resources are being threatened by issues such as coastal development, overfishing, destructive fishing, sedimentation and pollution, which are widespread in the country. Coastal fisheries all over the country have been drastically declining especially over the last few decades because of overfishing and irresponsible coastal development activities, which are further exacerbated by climate change impacts (Muallil et al. 2014). The deteriorating conditions of coastal ecosystems will have serious implications on food security, poverty and the overall well-being of millions of coastal inhabitants in the country.

CONNECTIVITY AMONG MANGROVES; SEAGRASS BEDS AND CORAL REEFS

The interconnectivity among coral reefs, seagrass beds and mangroves are widely acknowledged in the literature (Fig. 1). Some fishes, for example, use one type of habitat as their nursery ground and move to another as they mature. Honda et al. (2013) showed that over 20% of commercially important fish use multiple habitats indicating the importance of seagrass beds, mangroves and coral reefs to the fisheries or to the biology of coastal fishes.

Healthy habitats are known to support higher fisheries productivity and provide more ecological services than degraded habitats. For example, fisheries production for invertebrates (i.e. shrimps and prawns) and fishes (different species in the families Carangidae, Mugilidae, Siganidae, Serranidae and Lutjanidae) was shown to be positively related to mangrove cover/extent (Manson et al. 2005, Aburto-Oropeza et al. 2008, Mamauag et al. 2009). Further, the condition of one habitat (e.g. mangroves) will also affect the productivity of adjacent habitat (e.g. coral reefs). Mumby et al. (2004), for example, showed that fish biomass is generally higher by tens to thousands of percent on coral reefs adjacent to extensive or rich mangroves than those with scarce mangroves. Nagelkerken et al. (2012) further showed that coral reefs adjacent to mangroves had considerably higher fish biomass than isolated coral reefs.

MPAS AND MPA NETWORKS

Establishment of marine protected areas (MPAs) has been one of the commonly applied approaches for integrated coastal management in the Philippines. In fact, the number of MPAs in the country increased from less than a hundred in 1990 to about five hundred in 2000 to more than 1800 in 2014 (Cabral et al. 2014). MPA works by protecting critical habitats (i.e. coral reefs, mangroves and seagrass beds) where marine organisms live and spawn and where larvae recruit and settle. More efforts are now geared toward establishing MPA networks, which are simply "a collection of individual MPAs operating cooperatively and synergistically, at various spatial scales, and with range of protection levels to fulfill ecological aims more effectively and comprehensively than individual sites could alone"(IUCN/WCPA 2008). A network can be ecological or social. Ecological network is based on biophysical connectivity (e.g. current circulation, bathymetry, geomorphology, adult home range, sources and sinks for larval dispersal) among sites that enhance ecological functions. On the other hand, social network is based on interaction among management bodies to link institutions through exchange of information, experiences and good practices and also sharing of resources. A network that is formed based on ecological and social considerations is considered ideal in terms of effectiveness and efficiency of conservation activities.

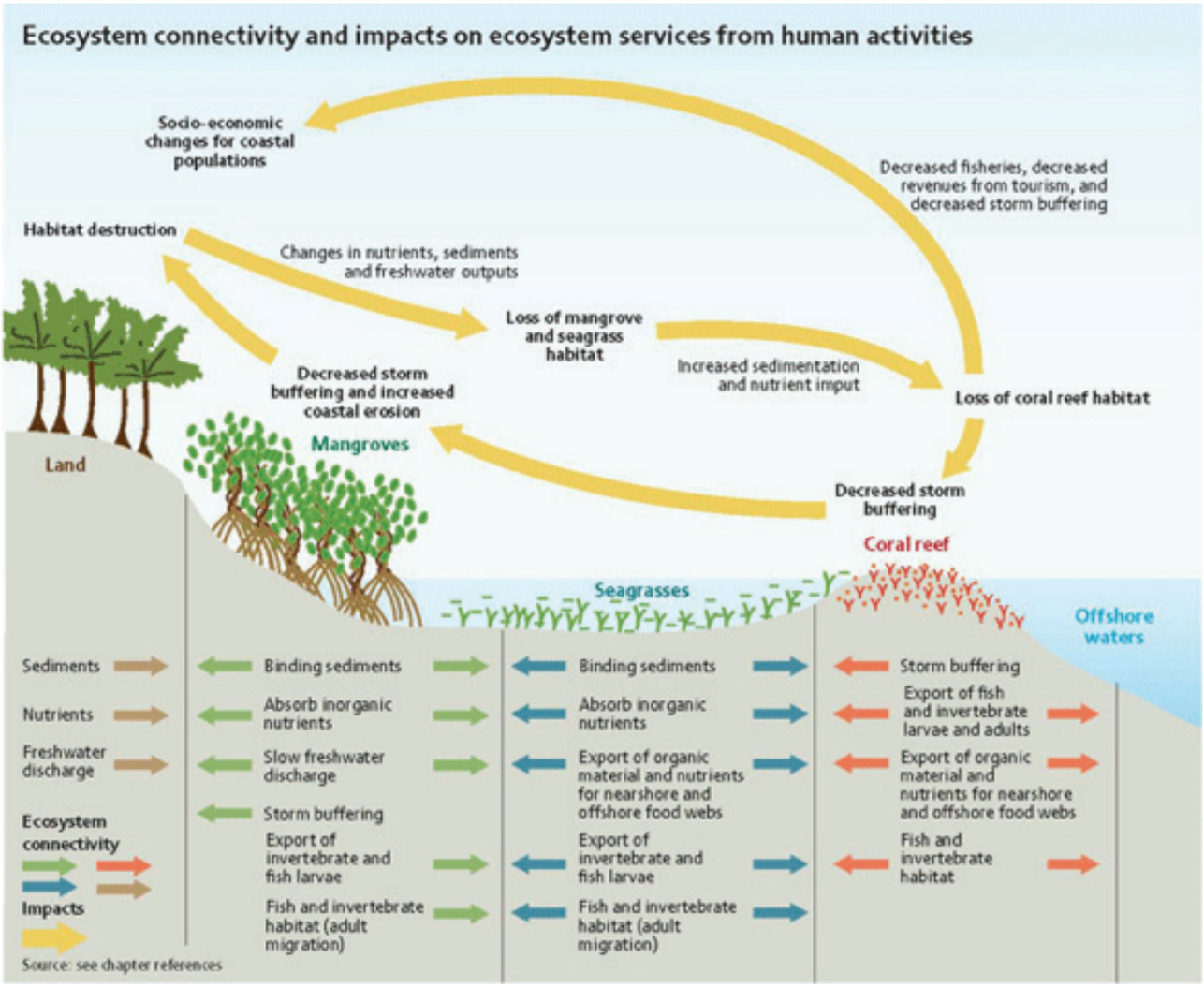

Figure 16. The interconnectivity among mangroves, seagrass beds and coral reefs (Silvestri & Kershaw, 2010).

Establishment of MPA networks has legal bases particularly those stipulated in R.A. 8550 (Fisheries Code) and R.A. 7160 (Local Government Code). R.A. 8550 recommends for an integrated management of continuous fishery areas to facilitate management as a single resource system (Section 16). Similarly, R.A. 7160, article 61 discusses inter-local government loans, grants, subsidies and other cooperative undertakings. The following are some of the main reasons why is it important to scale up to MPA network:

1. It protects larger areas of threatened and critical marine habitats.
2. It ensures that species in a given area will have enough habitat space to reside and reproduce, thus dispersing larvae into surrounding MPAs (e.g. giant clams, groupers and lobsters)
3. It increases survival rate of settling larvae due to larger areas of undisturbed habitats, thus ensuring increase of fish stock.
4. It sustains fisheries production that benefits both fisheries and conservation.
5. It can create information base that helps in making logical choices for MPA expansion and improving MPA management.
6. It provides an opportunity for stakeholders or communities to collaborate and share experiences to enhance efforts in managing and protecting their respective MPAs.
7. It can assist in financial leveraging to achieve economies of scale including marketing such as eco-labeling

For an MPA network to be effective, it is crucial that each constituent MPAs is already effective in their own right. It is also important to determine whether the MPAs in the network are interconnected, both ecologically and socially, with one another. It is crucial to determine the capacity of management bodies within the network to work effectively together. Some tips on how to make inter-LGU collaboration for coastal resource management activities more effective and some benefits to the LGUs working together are provided in **Box 1**.

Finally, scaling up from MPAs to MPA network involves coordination, expansion and replication. Coordination or integration is a joint initiative of various stakeholders from planning to management. Expansion can be spatial, functional and temporal. Spatial expansions happen at local jurisdictions to entire bays, gulfs and coasts. Designing and management of MPA networks encompass larger areas and hence require functional expansion as well. Functional expansion involves restructuring of the organizational structure, wherein members have clear roles and responsibilities (e.g. in the enforcement or designing of the MPAs). The temporal element of expansion involves prioritization of activities and scheduling. At some point, managers and stakeholders must ask questions relevant to their priorities such as: Where should the members put the next MPA? Should they emphasize more on awareness campaigns or focus largely on enforcement, or both at the same time during initial stages of establishment? After working in one area, the management approaches will be replicated in other areas.

Box 1. Tips on effective inter-LGU collaboration on coastal resource management activities and benefits to the LGUs working together.

Inter-LGU collaboration for coastal and fisheries resource management is especially effective when collaborating LGUs:

- *collectively sign a MOA that formally establishes the alliance/collaboration*
- *establish an organizational structure with clearly defined working protocols*
- *identify specific activities, targets, and accountabilities for collective and individual-member LGU actions*
- *set and monitors commonly agreed standards of performance among members and promotes their compliance through incentives*
- *mainstream sharing of good practices through regular fora, standardization workshops, and inter-linked information system*

Inter-LGU collaboration enhances benefits from:

- *Law enforcement as various other stakeholder groups at different levels are engaged to support cluster activities.*
- *Information, education, communication and advocacy as support groups at different levels, share knowledge and links IEC to capability-building and decision-support*
- *Financing CRM activities due to economics of scale and implementation of a functional finacial management system involving diverse and sustainable financing sources*
- *Monitoring and evaluation of areas under joint protection to measure the biophysical, socio-cultural and economic impacts of conservation and track of governance improvement over time*

THE MPA SUPPORT NETWORK (MSN) AND MPA NETWORK IN THE PHILIPPINES

Currently, there are already more than 40 formally established MPA networks in the country, formed by alliances ranging from MPAs within a single municipality, to more than 21 municipalities, and spatial scales ranging from baywide, to corridor, to seascape, to regional levels (Horigue et al. 2012). Table 1 shows some of the milestones in the development of MPA networks in the Philippines. One of the main highlights was the creation of the Marine Protected Area Support Network (MSN) in 2005. MSN is a multi-sectoral organization formed by memorandum of agreement (MOA) among various government agencies, NGOs, and academic institutions. The signatories to the original MOA include DENR-PAWB, DA-BFAR, DILG-BLDG, DOST-PCAMRD, UP-Marine Science Institute (UP-MSI), Conservation International-Philippines (CI-P), World Wildlife Fund-Philippines (WWF-P), and Coastal Conservation and Education Foundation, Inc. (CCEF). UP-MSI has been serving as the network coordinator.

The main purpose of MSN is to facilitate coordination among various agencies and institutions for them to integrate management efforts and share experiences and best practices with one another, and to increase the effectiveness and efficiency of conservation activities in the Philippines. Part of MSN's support includes providing venues for multi-stakeholder sharing forums such as the MPA Awards and Recognition, a biannual recognition awards to communities with outstanding MPA management performance, which helps motivate and empower coastal resource management practitioners to further improve their conservation strategies. Further information about MSN is available at its official website, http://www.mpasupportnetwork.org/about-msn/.

Table 24. Milestones in the establishment of MPAs and MPA Networks in the Philippines.

Year	Milestones
1997	International Year of the Reef National Workshop on MPAs (PCAMRD-PhilReefs) Best Managed Reef Awards
2000–2003	Annual MPA Workshops (DA-BAR/ AFMA MFR Project)
2001	National Biodiversity Priority Setting Workshops
2002	Best Managed Reef Awards (PCAMRD-PhilReefs)
June 2003	Philippine Marine Sanctuary Strategy (PHILMARSAST)
2004	Formulation of the Archipelagic Development Strategy
2004–2006	Drafting of the National Coral Reef Strategy
2005	MPA Support Network (MSN) formalized with MOA
2007	Coastal Zone Philippines 2
2007, 2009	1st and 2nd MPA Awards and Recognition Event, respectively
2011–2014	3rd and 4th MPA Awards and Recognition Event, respectively MPA management effectiveness benchmarking and tracking

Table 25. The ACT NOW strategies framework

STRATEGIES	OBJECTIVES			
	Governance		Ecological	
Accelerate improvement	Levels/ Scale up river basin and coordinated interLGU cooperation, governance for social enterprises	Economies of scales showing reduced costs	Recovery rate	Costs or value
			Biomass and Diversity enhanced	Reducing mortality and habitat degradation
Connectivity functions facilitated	Scaled up inter-LGU alliances	Reducing transactional costs	Nursery, spawning etc.	Health of inter-connected habitats
Thresholds maintained; capacity/threat	Functionality and governance history	Standards and incentives	Right sizing to ABC	Minimize over-capacity
	Internal and external; EAFM	Enforcing against IUU	Carrying capacity	Reduce Threats
	Multiple use governance	Conflict resolution	Resiliency building	Right sizing costs
Network design	Inter-LGU alliance features and scale		States and change at varying design	
Organizational development	Sustainable development trajectory		Ecological sustainability	
Win-Win/win-lose options	Tradeoffs; who, what, when and where?		Ecological structure and function	

ACT NOW

The urgent need to act on the coastal management issues has been unfolding before us — it is a complex reality that lives beyond our imaginative constructs. Our first Mangrove Summit should allow us to find and seize opportunities to apply our understanding of mangroves and other coastal ecosystems, and the interconnectivity among them. We hope this leads to deeper appreciation and better implementation of sustainable resource management strategies.

			SAMPLE RESEARCH QUESTIONS
	Social-economic		
	Governance costs through safety nets : insurance, CCT ++	Benefits thru income and diverse livelihood	Show faster rate of improvement; How outcomes can be improved; How impacts can be sustained and mechanism
	Larger stock and flows facilitated	Cooperative coordinated and complementary	Source or Sink functionality and flow; Directionality optimized
	Equitable sustained use	Good mix of sustained use fisheries	Carrying capacity measures and gap filling processes
	Acceptable change	Incentives for good practice	Limits to acceptable change
	Social resiliency		Assessing integrated impacts
	Intermediate outcomes and beneficial impacts		Many small few large; complexity
	Social economic resilience		Governance arrangement design; SAP objectives and goals
	Inclusiveness; Well-being [HEI]		Combined with SSS-GSIS and RUSLE / DASLE (Decision Assisted Sea-Land Enhanced)

Our suggested frameworks for management strategies are embodied in the acronym ACT NOW and detailed in **Table 25**. Coastal resource management requires the collaboration of stakeholders, government and non-government institutions, and the academic and research communities, which can collectively act as stewards of coastal resources. As a guiding principle, we offer the acronym STEWARDS, which stands for **S**cience and **T**echnology **E**nhances **W**ise **A**daptation of **R**esiliency **D**eveloping **S**ystems. ACT NOW, STEWARDS should enable practitioners to accelerate the achievement of management goals, enhance the connectivity and functionality of MPA networks, reduce various threats, and improve management effectiveness through better network design, organizational development and social equity.

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Blue Carbon: An Opportunity For Coastal Conservation In The Philippines

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ABSTRACT

This paper provides information on the importance of coastal ecosystems to maintaining human-well-being and biodiversity. It aims to promote a better understanding of the benefits and ecosystems services values of coastal ecosystems such as mangroves and seagrasses as these contribute to the ability of people to mitigate and adapt to the impacts of climate change. Coastal ecosystems such as mangroves help reduce vulnerabilities of coastal communities to storm surges and sea level rise. Aside from these, mangroves have the ability to store carbon. The presentation hopes to increase the awareness and understanding of participants of the Regional Mangrove Conference (organized by Ateneo de Manila University, Conservation International, Foundation for Philippine Environment, DENR – Biodiversity Management Bureau, and other stakeholders and partners) of their role in protecting this important ecosystem and ensuring that mangroves are recognized as important natural resources that they are. CI-Philippines has been working with communities and partners to find solutions to reduce the risks of climate change; this involved promoting ecosystem-based approaches to adaptation and demonstrating the importance of natural systems. In recent years there has also been growing recognition of coastal blue carbon in mitigating the impacts of climate change. While much more work is needed to better understand the co-benefits of mangrove, coastal blue carbon should be seen as an opportunity for coastal conservation in the Philippines and a national blue carbon initiative must be undertaken not only by experts and conservation organizations but also by national government agencies.

Keyword: *blue carbon*

AQUACULTURE, CLIMATE CHANGE AND DISASTERS

Aquaculture such as shrimp cultivation exerts a lot of pressure on our mangrove systems and is one of the primary reasons for mangrove deforestation. Cutting down these natural systems releases high amounts of carbon and depletes storage capacities. Mangrove deforestation also makes people living in and around the coast more vulnerable to sea level rise and storm surges.

The mangrove forests, seagrass meadows and tropical coral reefs of the Philippines are among the richest marine habitats in the world. These habitats provide livelihoods and bolster food security for many Filipinos. They also help protect coastlines from typhoons and other natural disasters such as the recent super typhoon Haiyan, which wreaked havoc in the Philippines and claimed over 6,000 lives. Evidence is emerging that areas in the Philippines with intact mangrove systems and coastal greenbelts suffered less damage than those where these systems had been destroyed (for more details, see articles by Public Radio International and the UN Office for Disaster Risk Reduction).

The Intergovernmental Panel on Climate Change suggests that climate change is projected to increase the frequency and intensity of storms in the coming years. Thus protection and rehabilitation of natural buffers, such as mangroves and coral reefs, to the impacts of large waves and erosion are becoming increasingly important. These coastal ecosystems may also help mitigate impacts from rising sea

levels due to climate change. As United Nations Secretary General Ban Ki-moon said during the UN Climate Talks in Warsaw, super typhoon Haiyan puts "an anguished human face" on climate change, considering the devastation on 8 November 2013. The impacts of climate change indeed pose significant threats to coastal communities in the Philippines. The Philippines experiences an average of 20 to 22 major storms per year, and it is anticipated that the magnitude of the storms impacting the Philippines will increase. Many small islands and low-lying coastal communities are threatened by rising sea levels, increased ocean temperature and coral bleaching attributed to climate change; along with ocean acidification, this has already begun to negatively affect not only the region's fragile ecosystems and species, but also the communities that rely on fishing and tourism for their livelihoods.

COASTAL ECOSYSTEMS – MANY CRITICAL ECOSYSTEMS SERVICES

Coastal ecosystems provide many critical ecosystems services. They provide protection from storms and sea-level rise, prevention of shoreline erosion, regulation of coastal water quality, provision of habitat for numerous commercially important and endangered marine species, and food security for the country's populous coastal communities. In addition to serving as barriers against strong winds and waves, storm surges, and erosion, mangroves serve as nursery, feeding and breeding grounds for many biologically and economically important shellfish, finfish, and shrimp species. Functionally linked with other coastal ecosystems, healthy mangroves enhance the biomass of nearby habitats such as seagrass beds and coral reefs. Mangroves provide refuge and food for juvenile reef fish and predators that increase their chances of survival. Further degradation of mangroves will have serious effects on coastal biodiversity and fish productivity.

After the devastating effects of super typhoon Haiyan, there is growing recognition among government officials and local communities of the value of coastal greenbelts as represented by mangroves, beach forests and other coastal ecosystems. Mangroves are also being recognized for sequestering and storing large amounts of carbon, and therefore contributing to climate change mitigation. However, these ecosystems and the way of life they support are under intense pressure from rapid population growth, detrimental development and the increasing threats associated with the impacts of climate change.

MANGROVES IN THE PHILIPPINES AND THE VERDE ISLAND PASSAGE

In the Philippines, mangroves and associated coastal wetland habitats such as beach forests and seagrass beds are recognized as some of the world's richest ecosystems. But at the same time they are among the most threatened natural ecosystems on Earth with an estimated 340,000 to 980,000 ha of mangroves being destroyed globally each year (Murray et al. 2011). In the early 1900s, the Philippines boasted approximately 500,000 ha of mangroves. That area has been reduced to approximately 100,000 ha due to coastal development, land conversion—particularly for the creation of aquaculture fishponds—and reclamation.

As an example, the Philippines' Verde Island Passage (VIP), located in the heart of the Coral Triangle and within the Sulu-Sulawesi Seascape, is considered the epicenter of the world's marine fish and coral biodiversity. The VIP encompasses 16,627 ha of critical habitats and has been identified by Conservation International as a Marine Biodiversity Conservation Corridor, with 27 true and 40 associated mangrove species.

The VIP's rich ecosystems are threatened by the demands of the rapidly increasing human population. About 1.8 million people (approximately 43% of the VIP population) live in 31 coastal municipalities and two cities bordering the VIP—a population that is projected to increase rapidly in the next 10 years. Approximately 830,000 people directly depend on the coastal resources of the VIP for their income, livelihoods and food security. In the VIP, the total area of mangrove forests in Batangas and Oriental Mindoro provinces alone is 2,583 ha, composed mostly of the riverine and fringing types of mangroves dominated by species of *Rhizophora* and *Avicennia*. Most of these mangrove areas are near coastal communities and are being affected by anthropogenic coastal development activities such as conversion to fishponds, resorts and ports.

In addition to the important role mangroves play in climate change adaptation, there is a growing recognition of their importance in mitigating climate change. Coastal blue carbon is the carbon stored by coastal and marine ecosystems such as mangroves, tidal marshes and seagrasses. Of the carbon stored in these systems, 50–99% is located in the soils below ground and sequestered at significantly higher rates, per unit area, than terrestrial forests. When coastal ecosystems are degraded, lost or converted to other land uses, the large stores of blue carbon in the soils of these ecosystems are exposed and released as CO_2 into the atmosphere and/or ocean. Recent estimates from the International Panel on Climate Change suggest that the emissions from conversion of mangroves to aquaculture ponds in the Philippines over the last 50 years have resulted in approximately 50 million megagrams of carbon to be released into the atmosphere. Conservation and restoration of mangrove areas is therefore a significant climate mitigation action.

WHY MEASURE CARBON STOCKS

Oceans and coastal ecosystems play vital roles in controlling greenhouse gases. They help mitigate climate change by sequestering and storing significant amounts of carbon, known as coastal blue carbon, from the atmosphere and

oceans (Duarte et al. 2005, Bouillon et al. 2008, Lo Iacono et al. 2008, Duarte et al. 2010, Kennedy et al. 2010, Donato et al. 2011, Mcleod et al. 2011, Fourqurean et al. 2012a, Pendleton et al. 2012, Chmura 2013, Lavery et al. 2013). Although their historical extent is difficult to determine due to dramatic losses that occurred before accurate mapping was possible, it is estimated that up to 67% of the historical global mangrove range, 35% of tidal salt marshes, and 29% of seagrasses have been lost. 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 (Pendleton et al. 2012).

Coastal ecosystems are being recognized increasingly for their important role in carbon sequestration and, when degraded, for their potential to become sources of carbon emissions. Progress has been made to include these systems in international and national policy and finance mechanisms, but full integration of coastal management activities, as part of countries' portfolio of solutions to mitigate climate change has not yet been realized. This opportunity to incorporate coastal blue carbon into policies and management could lead to additional coastal ecosystem conservation (restoration and protection) worldwide, which would preserve and enhance the multiple benefits these ecosystems provide to humans.

WHAT IS BLUE CARBON?

Blue carbon is the carbon stored in mangroves, salt tidal marshes and seagrass meadows within the soil, the living biomass aboveground (e.g. leaves, branches and stems), the living biomass below ground (e.g. roots), and the non-living biomass (e.g. litter and dead wood) (Mcleod et al. 2011). Similar to the carbon stored in terrestrial ecosystems, blue carbon is sequestered in living plant biomass for relatively short time scales (years to decades). Unlike terrestrial ecosystems, carbon sequestered in coastal soils can be extensive and remain trapped for very long periods of time (centuries to millennia) resulting in very large carbon stocks (Duarte et al. 2005, Lo Iacono et al. 2008). The difference in soil carbon accumulation in terrestrial versus coastal systems is that potential carbon storage in upland soils is limited by high availability of oxygen, allowing for aerobic microbial carbon oxidation and release back into the atmosphere (Schlesinger & Lichter 2001). In blue carbon systems, however, the soil is saturated with water keeping it in an anaerobic state (low to no oxygen), and it continually accretes vertically at high rates resulting in continuous build-up of carbon over time (Chmura et al. 2003). Some of the largest examples of carbon stocks in coastal sediments include the Posidonia oceanica seagrass meadows in Portlligat Bay, Spain, and mangroves in Belize which have accreted carbon-rich soils more than 10 m thick and are more than 6,000 years old (McKee et al. 2007, Lo Iacono et al. 2008, Serrano et al. 2014). Similarly, tidal salt marsh sediments in northern New England are 3–5 m thick, 3,000–4,000 years old, and are composed of up to 40% organic carbon (Johnson et al. 2007).

MANAGING BLUE CARBON

Plants naturally sequester carbon and transfer it into the sediment and it is shown that coastal ecosystems such as mangroves and seagrasses have high sequestration rates (Fig. 1). Coastal habitats also store significant amounts of carbon (Fig. 2). However these ecosystems are rapidly being lost to numerous causes of degradation and destruction as mentioned such as aquaculture, agriculture, coastal development and pollution. It is estimated that up to 67% of the historical mangrove range, 35% of tidal salt marshes, and 29% of seagrasses have been lost. 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 (Pendelton et al. 2012). Given this situation, can coastal "blue" carbon leverage better management, conservation and restoration of coastal ecosystems? The answer is yes if government, civil society, conservation organizations and communities increasingly recognize the mitigation value of coastal ecosystems, if steps are taken to improve management and regulation, and if the government provides basis for incentives to conserve or restore coastal "blue" carbon. Currently, at the global level and in the Philippines, numerous policies, coastal management strategies, and tools designed for conserving and restoring coastal ecosystems have been developed and implemented. Policies and finance mechanisms being developed and implemented for climate change mitigation may offer an additional route for effective coastal management. Blue carbon now offers the possibility to mobilize additional funds and revenue by combining best practices in coastal management with climate change mitigation goals and needs.

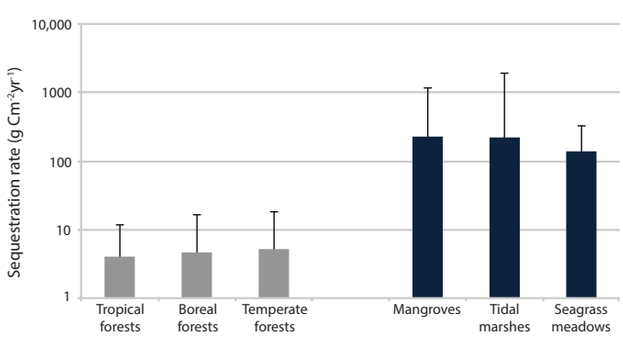

Figure 17. Sequestration rates of mangrove and seagrass ecosystems

INTERNATIONAL BLUE CARBON INITIATIVE

At the global level, ongoing dialogue on blue carbon exists. The International Blue Carbon Initiative (http://thebluecarboninitiative.org/) is a coordinated, global program focused on mitigating climate change through the conservation and restoration of coastal and sustainable management of coastal marine ecosystems). The Blue Carbon Initiative currently focuses on carbon in coastal ecosystems – mangroves, tidal marshes and seagrasses. It brings together governments, research institutions, NGOs and communities from around the world. The Initiative is coordinated by Conservation International (CI), the International Union for Conservation of Nature (IUCN), and the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization (IOC-UNESCO).
The Blue Carbon Initiative works to:

- Develop management approaches, financial incentives and policy mechanisms for ensuring the conservation, restoration and sustainable use of coastal blue carbon ecosystems;
- Engage local, national and international governments to promote policies that support coastal blue carbon conservation, management and financing;
- Develop comprehensive methods for assessing blue carbon stocks and emissions;
- Implement projects around the world that demonstrate the feasibility of blue carbon accounting, management and incentive agreements; and
- Support scientific research into the role of coastal blue carbon ecosystems for climate change mitigation.

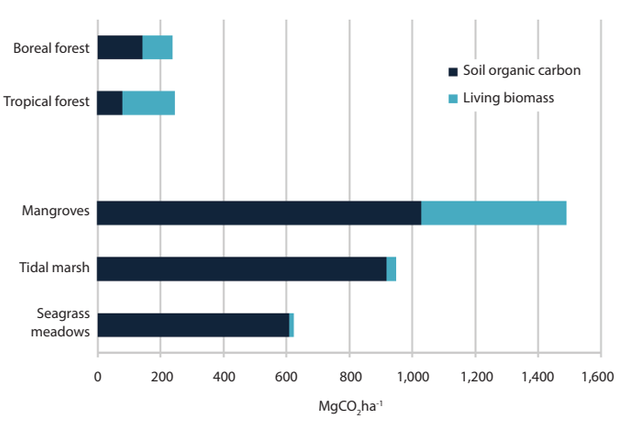

Figure 18. Sequestration rates of coastal vs. forest ecosystems

To achieve these goals, the Blue Carbon Initiative has formed Science and Policy working groups. The International Blue Carbon Scientific Working Group identifies priority research areas, synthesizes current and emerging blue carbon research and provides the robust scientific basis for coastal carbon conservation, management and assessment. The International Blue Carbon Policy Working Group supports efforts to integrate blue carbon in existing international policy frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC), and the Convention on Biological Diversity (CBD) among others. Members of both working groups routinely collaborate to ensure that qualified science forms the basis of sound policy.

CONSERVATION INTERNATIONAL INITIATIVES ON BLUE CARBON

In support of the global dialogue, Conservation International (CI) is supporting site level mangrove restoration and blue carbon initiatives. In the Gulf of Nicoya in Costa Rica, CI is developing and supporting to develop policy and management options that conserve and promote sustainable use of the mangroves. This will include assessment of fisheries and blue carbon value, community mangrove restoration and capacity building in sustainable fisheries and alternative livelihoods.

CI-Indonesia hosted the International Blue Carbon Scientific Working Group in 2011, and formed the Indonesian Blue Carbon Working Group in 2012. Since then it has organized field trainings on carbon measurement, and hosted the Multi-sectoral Blue Carbon conference (December 2013). Currently, Indonesia has developed its National Science Plan of Action on Blue Carbon, expanded its science program, and initiated field projects. The next priority of the Working group is on capacity building and national policy assessment.
CI-Philippines is raising awareness on blue carbon among stakeholders and partners in the Philippines, apart from implementing an Ecosystems-based Adaptation to climate change project through mangrove rehabilitation and protection in vulnerable coastal areas. There are opportunities and challenges in organizing a Philippine Blue Carbon Working Group so much like Indonesia. However, steps are already being undertaken to engage national government agencies and promote discussion on coastal blue carbon. The National Mangrove Workshop organized by Ateneo de Manila University is one such opportunity to engage stakeholders and partners to look at opportunities to develop a national policy on blue carbon

and identify incentives through carbon finance. Among the other activities CI-Philippines is working on with partners are:

- Support the National Mangrove Committee to initiate agenda setting on blue carbon and co-convene the Philippine Blue Carbon Working Group in coordination with the Philippine National REDD+ Strategy. The working group shall include representatives from the Forest Management Bureau; the Biodiversity Management Bureau; Ecosystems Research and Development Bureau of the Department of Environment and Natural Resources; local governments, relevant scientists, industry, NGOs and international observers. This group would (1) lead development of a Philippines National Blue Carbon Strategy, (2) advise the government on critical Blue Carbon issues, (3) support formation of a Blue Carbon network of scientists and practitioners across the country, (4) support capacity building, and (5) lead collaboration with International Blue Carbon programs such as the Blue Carbon Initiative.
- Identify key pilot actions on Blue Carbon based conservation or restoration of coastal ecosystems.

CONCLUSION

The proceedings are meant to provide the participants an overview of ecosystems services values of coastal wetlands and the importance of protecting mangroves and seagrasses. CI-Philippines hopes that the presentation shall generate a better understanding of blue carbon and the role of blue carbon in climate change mitigation. It also hopes to generate interests among participants from local government, national government agencies, academe and civil society.

The remainder of this document is concerned with describing coastal ecosystems as critical to maintaining human well-being and biodiversity. It shall also discuss the threats to coastal ecosystems and the status of mangroves and coastal wetlands in the Philippines. These proceedings shall discuss the opportunities and initiatives of the blue carbon working groups at the global and regional level. At the end of the presentation, participants of the Summit were encouraged to identify challenges and opportunities in initiating projects on blue carbon in the Philippines.
Finally, these proceedings were partly excerpted from the recently published manual, *Coastal Blue Carbon: Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrasses*.

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V. WORKSHOP OUTPUT

The Summit culminated with a planning workshop wherein the three groups (Group 1: Bulacan, Bataan, SBMA, Zambales and Masinloc; Group 2: Ilocos Norte, Ilocos Sur, La Union, Pangasinan and Bani; Group 3: NGAs, NGOs, and Academe) were asked to specify the issues and problems in mangrove management; the specific objectives that may respond to these; as well as the activities, resources needed, persons-in-charge and the proposed timeline for the activities. Below are the tables and the outline that summarizes these.

The recurring issues in mangrove management include the following: (1) the lack or inconsistency of data, (2) the lack or redundancy of laws and problems in its implementation and (3) the lack of awareness on the importance of mangroves on the ground. For the lack or inconsistency of data, a similar activity enumerated was the development of a comprehensive and central data bank that will consolidate existing, current and future information on mangroves. Capacity building of the managers and other technical efforts such as ground truthing and mapping of mangrove areas also need to be undertaken.

As for the lack or redundancy of laws and problems in its implementation, it was suggested for the agencies involved to develop close coordination. There is also a need to revisit existing laws and to refine these into clear-cut policies that may aid mangrove management. A national framework for mangrove management was also identified to address the issue of governance and implementation.

Lastly, even with the decades-long mangrove management in the country, it seems that there still seems to be a lack of awareness on the importance of mangroves on the ground. To address this, IEC campaigns and the strengthening of public participation through volunteer activities were suggested.

All the activities identified and discussed below are to be implemented within 6 months to 2 years from the date of the summit.

Workshop Output: Group 1
(Bulacan, Bataan, SBMA, Zambales, Masinloc)

Issues/Problems	Objectives	Activities	Resources Needed	Person(s)-in-charge	Timeline
1. Lack of Comprehensive Mangrove Management and Protection Plan					
a. Incomplete baseline data (mangrove species, old growth, etc.)	Develop comprehensive baseline data	• Personnel selection • Capacity building • Mapping of area • Field validation • Formulation of survey form • Conduct survey • Consolidation of collected data • Encoding	• Personnel • Funds • Trainings/capacity building • Office equipment	GOCC/ LGU (PGU, MGU)	2 years
b. Conflict on boundary delineation	Establish clear boundaries	• Coordinate with responsible offices (NAMRIA, DPWH, etc.)	• Personnel • Office equipment	PPDO, MPDO, PDO	1 year
2. Weak law enforcement/ implementation of existing laws/rules/ regulations	Strengthen Law Enforcement Team/ Implement All Pertinent Laws	• Capability building • Procurement of equipment (patrol boats, communication, etc.) • Formulation of clear-cut policies/ ordinances/Executive Orders	• Hire consultant/ trainors • Budget	PNP, PCG, BFAR, NGOs, DENR	6 months
3. Lack of awareness on mangrove ecosystem	Increase awareness on importance of mangroves	• IEC (utilize print, radio and tv) • Hold regular programs aimed on enticing public participation in the maintenance of mangrove areas	• Budget/funds • Materials	Public Affairs Office, Local/ national media, Public Relations Department	6 months
4. Declining Mangrove Cover due to:					
a. Encroachment	Relocate informal settlers/remove physical structures	• Identification of suitable relocation site • Formulation of plans and programs for sustainable livelihood of relocatees • Demolition of illegally erected structures	• Personnel • Budget • Ordinance/policy formation	DPWH, PPDO, MPDC, PDO, Legal Office	2 years
b. Reclamation	Ensure that all provisions regarding reclamation is followed	• Info Dissemination • Strict Implementation • Monitoring/ Reporting	• Personnel • Budget	-	
c. Conversion	Revert all AUU into mangrove areas	• Identify AUUs • Obtain complete legal documentary requirements • File Appropriate Legal Action for Reversion	• Personnel • Budget • Records	Legal Office, Provincial Agriculture Office, MAO, BFAR	2 years
d. Solid waste management	Implement RA9003	• IEC • MRF/ Sanitary Landfill	• Budget • Personnel	PSWMB, PGSO, MGSO, Public Affairs Office	1 year
5. Lack of national framework for mangrove initiative	Develop a national mangrove monitoring/ reporting framework	• Workshop/training • Establish a social network Group • Establish an efficient/effective system of reporting • Cross Visit • Organize a mangrove conservation society	• Budget • Personnel • Consultant	all	2 years
6. Lack of direct economic values for mangrove ecosystem goods and services	Develop the Blue Carbon accounting	• Training on blue carbon • Establish guidelines and standards	• Budget • Personnel • Consultant	all	2 years
	Conduct economic valuation study	• Training • Survey • Analysis • Dissemination	• Budget • Personnel • Consultant	all	2 years

Workshop Output: Group 2
(Ilocos Norte, Ilocos Sur, La Union, Pangasinan, Bani)

Issues/Problems	Objectives	Activities	Resources Needed	Agencies-in-charge	Timeline
Technical					
Data Gap	To establish accurate and reliable data bank	• Field validation and ground truthing (PRA) • Conduct consultation/ dialogue • Identification/potential reforestation areas and mangrove stands.	• Budget • GPS, GIS training	DENR, BFAR, LGUs, Academe, NGOs	2 years
Lack of technical know-how: a. Mangrove propagation b. Monitoring and assessment using technical tool c. Pest and diseases control management	To capacitate concern LGUs/stakeholders	• Skills Hands-On training and exposures trips	• Budget • Training supplies/ IEC materials/ film showing	DENR, BFAR, LGUs, Academe, NGOs	2 years
Governance					
Overlapping implementation of mangrove program from different agencies (NGOs, NGAs-BFAR, DENR, Academe and LGUs)	To establish harmonious/ systematic program implementation	• Close coordination among agencies concern	• Budget	DENR, BFAR, LGUs, Academe, NGOs	2 years
Reversion of unproductive FLA to mangrove state		• Organize MPA network	• Budget	DENR, BFAR, LGUs, Academe, NGOs	2 years
Social					
Lukewarm attitude on the benefits/Illegal cutting of mangroves	To disseminate the importance of mangrove to the community	• Massive IEC, FGD • Mangrove Reforestation • Adopt a mangrove project • Establishment of mangrove nursery	• Budget • Training supplies/IEC materials/Media Advertisement	DENR, BFAR, LGUs, Academe, NGOs	2 years

Workshop Output: Group 3 (NGAs, NGOs and Academe)

1. Mapping

- Standardized methodology in mapping mangroves
  - * Streamline mangrove classification through satellite images
  - * Complimented by field validation

2. Data Availability and Central Management

- Where to plant? Is data accessible?
- No central repository
  - * No consolidation
  - * Plans only (for all coastal ecosystems)
  - * Should be a permanent office (plantilla)
- Data management and consolidation per region, for now

3. Incentive Rates for Reforestation

- Different rates of incentives
  - * BFAR through SUCs: P2.5-/propagule planted, +P3.50 if __m height is reached
  - * DENR: 23, 000/ha [ICRMP]; NGP: 14000/ha
  - * Standardized rate
  - * Implementation rules

4. Mangroves in A/D lands

- Related to forestland Cadastre
- Major challenge: partnership with stakeholders
  - * Case to case
    - Gonzaga, private owners transferred management to LGU
    - Buguey, Sta. Ana etc. – conflicts with land owners

5. Bantigue

- Policy enforcement to address issue on use of Bantigue Bonsai plant
  - * Improvement/ additional provision
  - * "Do what you preach"
  - * LGU ordinance on harvesting/possession/selling of Bantigue

6. Mangrove Bill

- Initially proposed as separate bill from OCM Bill
- Then moved to combined with ICM Bill
- Latest, decided to have it separate

7. Mangrove Bill (2)

- National mangrove conservation and Rehabilitation Act: 460 (Rep. Guanlao) and 3525 (Rep. Reyes)
- Almost have the same provision on mangrove on mangrove protection zone and production
- National Coastal Greenbelt Bill (Sen. Aquino)

8. Existing Laws

- Amendments
- Totally banning of mangroves
  - * Case of nipa

Time Frame

2014	2015	2016
Mangroves in A/D Lands	Mapping	Central Data Repository and Management
	Standardization of Incentives	Mangrove Bill
	Strict Implementation on Harvesting of Bantigue	Amendments on Existing Bill

Photo by SSalmoll

VI. WHERE WE STAND: A SYNTHESIS OF STATUS REPORTS OF MANGROVES IN NORTHWESTERN LUZON

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I. Biophysical and Socio-economic Setting

Northwestern Luzon has over 8,600 km of the Philippine shoreline, and is composed of 8 cities, 73 municipalities and 909 barangays. It is part of the northern section of the West Philippine Sea biogeographic region and is home to over 14.5 million individuals (14,240,907), around 10% of whom live in coastal areas (**Table 26**).

Northwestern Luzon's coastal ecosystems – which have significant ecological, socio-cultural and economic importance – include coral reefs, seagrass beds and mangrove forests. Mangrove forests are primarily seen as a critical spawning and breeding ground for various terrestrial and aquatic species. They function as shoreline protection and erosion control, and also provide sources of food and livelihood. Among the raw materials/products that coastal residents gather from mangroves and sell for income are wood, nipa (shingles, vinegar, syrup and wine), fish and shellfish. The propagules used in seedling production for mangrove planting programs are from existing mangrove forests. Mangrove forests are also recognized as important sites for research and ecotourism in some localities.

Table 26. Provinces in northwestern Luzon showing the total (and % coastal population) per province

Province/ Municipality/Zone	Total Population	Coastal Population (% of total)
Bataan	687,482	292,390 (42.5)
Bulacan	2,924,433	43,005 (1.5)
Cagayan	1,124,773	173,257 (15.4)
Ilocos Norte	568, 017	85,363 (15.0)
Ilocos Sur	658,587	132,098 (20.1)
La Union	741,906	185,083 (23.5)
Pampanga	2,014,019	61,598 (2.6)
Pangasinan	2,779,862	809,990 (29.1)
Subic Bay Freeport Zone	99,437	nd
Zambales	534, 443	190,120

All provinces reported fishing as the main source of income of coastal communities, followed by fish vending, fish processing and farming. Other livelihoods mentioned are the gathering and selling of seaweed, seagrass and mollusks; livestock production; merchandising; salt and bagoong making; sea urchin culture; aquaculture; food processing; welding and metal craft; charcoal making; and tourism (specifically for Bani and Masinloc).

Many of the provinces reported poverty as the most pressing social issue experienced by their coastal communities. Poverty is further aggravated by increasing populations, with an annual growth rate of 1.04–3.37% (National Statistical Yearbook 2013), limited livelihood opportunities, inaccessibility of schools and health service providers, and lack of social safeguards. Another issue is the decrease in fish catch. A notable example is the province of Bataan, which claims 1.08 tons per hectare per year as the estimated reduction of fish catch for every hectare of mangrove loss. The decline in fish catch is further worsened by the presence of illegal fishers and poachers. The pollution and overfishing of coastal areas by informal settlers were also identified among the social and environmental issues. These issues are compounded by weak law enforcement. There are also concerns about poor waste management, the lack of sustainable resource practices and the unpreparedness of coastal communities for natural disasters.

II. Mangrove Status

Data on the extent of mangroves in northwestern Luzon (**Table 27**) are notably insufficient and often with inconsistencies. The extent of mangroves widely varies across the region - from less than a hundred hectares (Ilocos Norte) to around 4,000 ha (Cagayan). Most provinces have no data on the remaining old growth stands. The extent of new planted mangrove stands also varied widely. All provinces however reported a steady increase of mangrove plantation areas in the last ten years resulting in approximately 838.6 ha of new plantations. Except for Cagayan, most provinces declared around 10% as mangrove protected area.

Mangrove areas in northwestern Luzon add up to 6,010.1 ha, with old stands, secondary growth and new plantations at 504.7, 870.3 and 838.6 ha, respectively. A large expanse of old stands is found in the province of Pangasinan, followed by Bulacan and Subic Bay Freeport Zone. New stands are mostly distributed in Cagayan, Bataan and Bulacan. These figures and description of distribution need to be verified, considering the lack of data for other provinces. All provincial reports provided higher estimates of mangrove forest cover compared to estimates derived from spatial analyses of remote sensing data by Long et al. (2011, 2013) and Pagkalinawan (see his report in this Proceedings).

Table 27. Summary of mangrove information per province showing the total, old and new stands as well as the coverage of mangroves declared as protected areas.

Province/ Municipality/ Zone	Total Area (ha)	Old Stands (ha)	Secondary growth	Plantation (ha)	Protected Areas (ha)
Bulacan	585.14	72.43	318.71	194	24.64
Bataan	121.08	nd	nd	120.2	0
Subic Bay Freeport Zone	65.57	61.63	nd	3.94	62
Zambales	326.5	nd	211	nd	115.5
Masinloc, Zambales	109	37.75	39.25	32	0
Pangasinan	615.02	283	332.02	nd	52.25
Bani, Pangasinan	66.91	nd	nd	nd	42.25
La Union	140	nd	nd	80	60
Ilocos Sur	122.95	26.88	8.58	87.49	5
Ilocos Norte	66	23	nd	43	nd
Cagayan	3,967.87	nd	nd	278	nd
Total	**6010.1**	**~504.7**	**~870.3**	**~838.6**	**319.4**

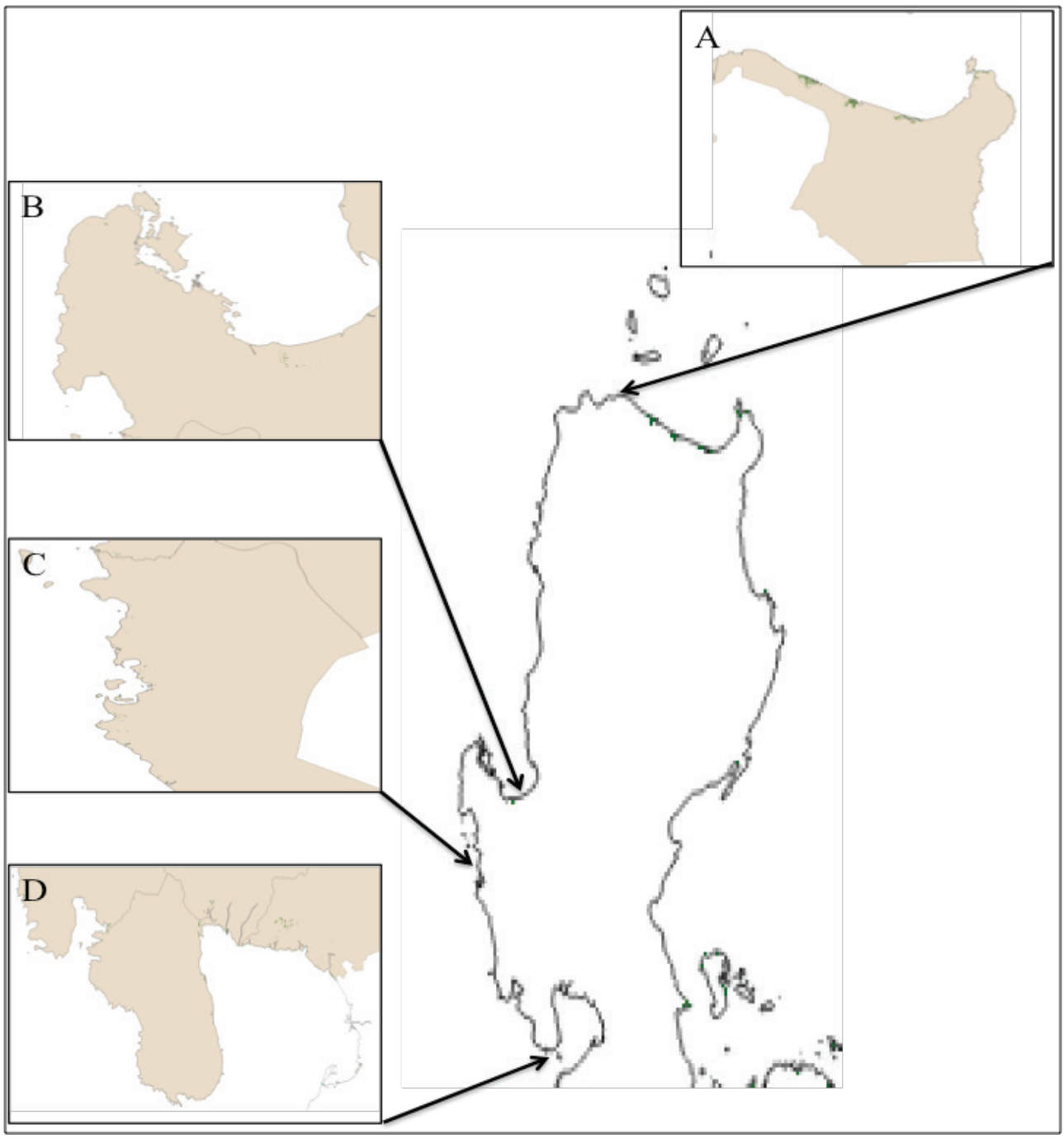

Figure 19. Mangrove distribution in northwestern Luzon (extracted from Long et al. 2013): (A) Cagayan, (B) Pangasinan, (C) Zambales, and (D) Bataan peninsula. Other provinces have very minimal mangrove forest.

Figure 19 shows the mangrove distribution in northwestern Luzon based on the most recent satellite image (extracted from Long et al. 2013). The total mangrove area is estimated at 5,655 ha and is mostly found in Cagayan and Zambales. The mangroves of northwestern Luzon constitute 2.34% of the total mangrove forest in the Philippines.

Table 28 provides a list of the mangrove species found in northwestern Luzon. There are 33 true mangrove species and 23 associate species reported in the region. Pangasinan has the highest species richness with 25 species, followed by SBMA and Zambales both with 21 species. Ilocos Norte has the least species number of species (7). The species that are present in most provinces are *Avicennia marina, Nypa fruticans, Rhizophora apiculata, R. mucronata, R. stylosa* and *Sonneratia alba*. Species that are less common across the region are *Acanthus sp., Acrostichum aureum, Avicennia alba, Bruguiera parviflora, Osbornia octodonta, Pemphis acidula* and *Sonneratia ovata*. The rare species *Camptostemon philippinense* known to have limited distribution (mainly in the central Philippines) was also reported in Pangasinan and Zambales. These information, however, need further verification.

Table 28. List of true (A) and associate (B) mangrove species in Northwestern Luzon

Species/Province	Local Name	Bataan	Bulacan	Cagayan	Ilocos Norte	Ilocos Sur	La Union	Pangasinan	SBMA	Zambales
A. True species										
Acanthus ebracteatus	*tigbau*								X	
Acanthus ilicifolius	*tigbau*		X	X						
Acanthus volubilis	*diluario*		X							
Acrostichum aureum	*lagolo*		X		X					
Aegiceras corniculatum	*saging-saging*	X				X		X	X	X
Aegiceras floridum	*tinduk-tindukan*			X				X		X
Avicennia alba	*bungalon-puti*							X		
Avicennia lanata	*piapi*		X					X		X
Avicennia marina	*bungalon*	X	X	X	X	X	X	X	X	X
Avicennia officinalis	*api-api*	X	X	X		X		X	X	X
Bruguiera cylindrica	*pototan-lalake*	X	X			X		X	X	X
Bruguiera gymnorrhiza	*busain*	X	X	X		X		X	X	X
Bruguiera parviflora	*angarai/langarai*							X	X	
Bruguiera sexangula	*pototan*	X				X		X	X	X
*Camptostemon philippinense**	*gapas-gapas*							X		X
Ceriops decandra	*malatangal*	X		X		X		X	X	X
Ceriops tagal	*tangal*	X						X	X	X
Excoecaria agallocha	*buta-buta*		X	X		X		X	X	X
Heritiera litoralis	*dungon late*			X		X		X	X	X
Kandelia candel	*candel*			X						
Lumnitzera littorea	*tabau*								X	X
Lumnitzera racemosa	*kulasi*					X		X	X	X
Nypa fruticans	nipa/*sasa*	X	X		X	X	X	X	X	X
Osbornia octodonta	*taualis*					X				X
Pemphis acidula	*bantigi*					X	X			
Rhizophora apiculata	*bakauan-lalake*	X	X	X	X	X		X	X	X
Rhizophora mucronata	*bakauan-babae*	X	X	X	X	X	X	X	X	X
Rhizophora stylosa	*bakauan-bato*	X	X	X	X	X		X	X	
Sonneratia alba	*pagatpat*	X	X	X	X	X		X	X	X
Sonneratia caseolaris	*pedada*	X		X		X		X		
Sonneratia ovata	*pagatpat baye*							X		
Xylocarpus granatum	*tabigi*			X				X	X	X
Xylocarpus moluccensis	*piagau*							X	X	
Total		**14**	**14**	**15**	**7**	**18**	**4**	**25**	**21**	**21**

Table 28 (continued)

B. Associate species									
Acacia fernasiana	*aroma*	X							
Barringtonia asiatica	*botong*		X	X			X		
Barringtonia racemosa	*botong*						X		
Caesalpinia nuga	*sapinit*	X							
Calophyllum inophyllum	*bitaog*			X					
Casuarina equisitefolia	*agoho*		X						
Cerbera manghas L.	*banato*		X						
Derris trifoliata	*tuble*			X					
Dolichandrone spathacea	*tui*	X			X				
Euphorbiacea 1			X						
Hibiscus tiliaceus	*malubago*		X			X	X		
Intsia retusa	*ipil laut*						X		
Ipomea pes-caprae	*lambayog*	X		X					
Morinda citifolia	*bangkoro*	X							
Myristicaceae									
Myrtaceae			X						
Terminalia catappa	*talisai*	X	X	X			X		
Thespecia populnea	*banalo*	X					X		
Pandanus tectorius	*pandan dagat*		X	X			X		
Pongamia pinnata	*bani*		X	X					
Rubiceae	*nino*		X						
Sesuvium ilicifoliu	*dampalit/diluario*	X							
Sesuvium portulacastrum	*dampalit*			X					
Total		**8**	**10**		**8**	**1**	**1**	**7**	

* for verification

III. Issues and Threats

All provinces reported declines of mangrove forests but the rates of losses are unclear, given the insufficient available information. For 73% of the region, the primary cause of mangrove decline is the conversion of mangroves into aquaculture ponds and residential or commercial areas. Also contributing to mangrove decline are extensive cutting for firewood and housing materials; water contamination from pollution and siltation; soil erosion and sedimentation; and floods caused by extreme rainfall events.

In addition to typhoons and storm surges, other reported threats to the coastal communities of northwestern Luzon are sea level rise, algal bloom, coastal erosion, saltwater intrusion, liquefaction, land subsidence, the swelling of foreshores and the occurrence of sinkholes. Human-induced threats include improper solid waste management, organic loading (due to the absence of adequate sanitation and sewage facilities), industrial pollution, oil spills, mine tailings, black sand mining, groundwater extraction, deforestation, the mismanagement and overexploitation of natural resources, and the extraction of aquatic and mineral resources. Some inter-municipal administrative concerns include boundary disputes in municipal waters, encroachment and unwarranted development of coastal areas into residential or commercial areas, and weak coastal law enforcement.

The main problems can be generally categorized into two: (a) conversion of mangrove habitat to aquaculture ponds and residential areas, and (b) vulnerability to natural disasters (**Fig. 20**). The provinces of Pangasinan, Zambales and Bulacan attributed high mangrove loss due to conversion to aquaculture ponds. Most of the massive conversion of mangrove areas happened in the 1970s, opening spaces for building residential, commercial and even industrial areas (**Fig 20A**). Notable examples are the provinces of Bulacan and Bataan, which became hotspots for high human migration and urban centers because of several industries that were established.

Localities reported as highly vulnerable to natural disasters were consistently the same localities that had massive losses of mangrove areas. The most serious threats are typhoon damage, erosion, land subsidence and sea level rise. Cagayan is known to be a passageway of most strong typhoons in the country. Coastal erosion, combined with quarrying activities, further aggravates land subsidence. Aside from typhoon, the provinces of Pangasinan, Zambales and Ilocos Sur also reported storm surges. Some of these catastrophic typhoons happened in the last ten years. These provinces also documented evidences on shoreline change attributed to sea level rise. Some coastal areas drop ~0.5–1 m of elevation and lost ~100 m of shoreline.

There are some conflicting and unclear policies on mangrove management in the region. It involves bureaucratic conflicts on setting priorities on mangroves – either viewed as a forest protection/rehabilitation zone, or as a fisheries production zone. The LGUs, by virtue of the Local Government Code (R.A. 7160) may also assert their rights on implementing mangrove management programs. But in some cases, mangrove areas are classified as Alienable and Disposable Lands, which can be interpreted as an area that can be designated for other uses aside from conservation and preservation. The absence of a comprehensive land and coastal use plan for most provinces in the region complicate mangrove management.

The loss of mangroves affects both the safety and livelihoods of coastal residents. With fewer mangroves serving as barriers, communities are further exposed to dangers posed by tidal flooding, sea level rise, and high events of erosion and siltation. The loss of mangroves has also been observed to result in a decrease in fish catch, biodiversity and coastal habitat productivity – directly affecting thousands of people whose main source of income depends on mangrove-derived fisheries.

IV. Management

A Brief History of Mangrove Management in the Philippines

As the third longest coastline in the world, the Philippines is expected to have considerable mangrove resources. Brown and Fisher (1918) reckon that the country had over 500,000 ha of mangrove cover in the 1900s. However, by 1995, this number had dwindled to 117,700 ha. Most of the mangrove loss occurred from the 1950s to the 1990s (Primavera 2000) – a period of mangrove deforestation for firewood collection or for conversion into aquaculture ponds. Other coastal ecosystems were similarly exploited, resulting in a serious decline in fish catch.

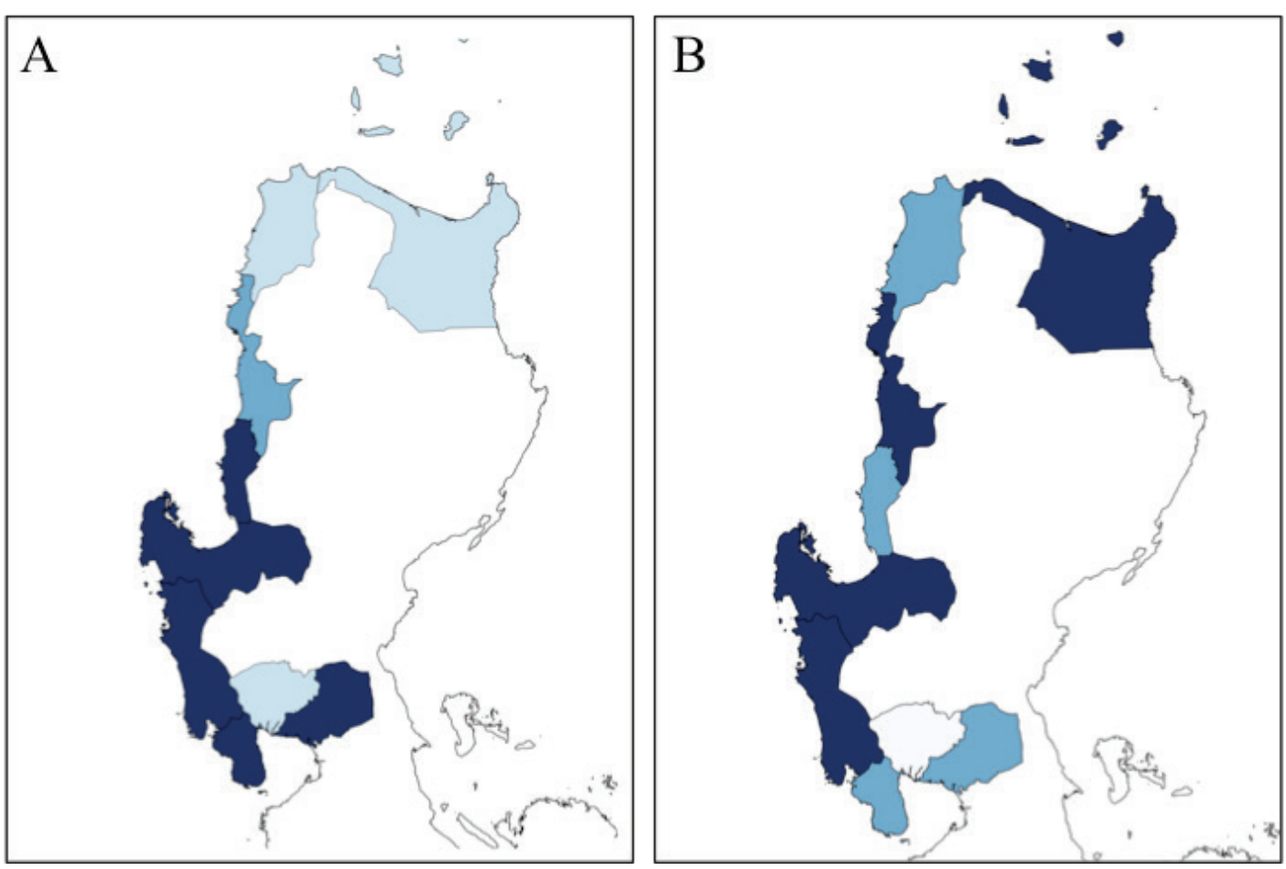

Figure 20. Provinces with severe concerns on (A) conversion of mangrove into aquaculture ponds and residential areas, and (B) areas exposed to natural hazards (e.g. erosion, land subsidence and sea level rise). Darker shades indicate more severe problems.

In the late 1970s, as concern over aquaculture resources grew, the national government created the National Mangrove Committee to formulate policies and recommendations for sustainable mangrove management and conservation. The Mangrove Forest Research Center was also established to generate technologies for mangrove management.

In the 1980s, the government appeared to take mangrove health more seriously and steps were taken to more concretely protect mangrove resources. For instance, in 1981, Presidential Proclamation No. 2151 declared several islands "containing an aggregate area of 4,326 hectares, more or less, subject to future delineation and survey for foreshore protection, maintenance of estuarine and marine life, including special forests for the exclusive habitats of rare and endangered Philippine flora and fauna and for such other purposes."

In the same year, Presidential Proclamation No. 2152 declared Palawan as a Mangrove Swamp Forest Reserve "containing an aggregate area of 74,267 hectares, more or less, subject to future ground survey and delimitation, for conservation and protection purposes by reason of their ecological, scientific, educational and recreational values, including flora and fauna and marine life found therein and other values."

By the 1990s, more widespread coastal management initiatives such as the Coastal Environment Program (1993) and the Coastal Resource Management Project (1996) were initiated. By this time, stakeholder engagement was already recognized as an integral part in the success of coastal ecosystem management.

While the (re)planting of mangroves has been a standard practice in coastal resource management, there is still a dearth of data regarding their success, status and impacts. A common critique of traditional mangrove planting activities is the use of inappropriate species and planting in inappropriate areas (i.e., highly saline and inundated shoreline). For example, propagules of *Rhizophora* were commonly planted near the shoreline even if this species is naturally found in mid-forest or middle intertidal zone (Samson & Rollon 2008). This practice often led to dismal survival rates and, in rare cases where the propagules did survive, converting the previous mudflats or seagrass beds along the shoreline resulted in detrimental effects such as loss of habitat and feeding grounds for shorebirds and some species of fish. Thus, there is a need to improve and enhance mangrove replanting strategies. In addition, more and more mangrove managers are beginning to see the advantages of stronger community involvement.

In the past decade, mangrove restoration and conservation has become a prominent adaptation and mitigation strategy against the impacts of climate change. For instance, among the most recent initiatives include Executive Order 26, series of 2011, or the National Greening Program (NGP) and the Philippine National Aqua-Silviculture Program (PNAP). The NGP declares that "It is the policy of the State to pursue sustainable development for poverty reduction, food security, biodiversity conservation, and climate change mitigation and adaptation." As such, it requires the planting of 1.5 billion trees by 2016 in suitable lands, which include mangrove and protected areas.

The PNAP, the MOA of which was also signed in 2011, is geared towards mangrove rehabilitation and livelihood provision as a measure to address food security and poverty, and climate change. The Bureau of Fisheries and Aquatic Resources (BFAR), the primary implementing agency, has identified the following strategic interventions:

1. Replanting of destroyed mangrove resources;
2. Establishment of community-based multi-species hatcheries; and
3. Provision of aquasilviculture livelihood projects to fisherfolk-beneficiaries

In addition to these, the Reducing Emissions from Deforestation and Forest Degradation (REDD+) program of the United Nations Framework Convention on Climate Change (UNFCC) is now thought to be a possible mechanism that can arrest further mangrove degradation. The Philippine National REDD+ Strategy aims to determine the drivers of greenhouse gas emission arising from both deforestation and mangrove forest degradation (Ramos & Osorio 2013).

Mangrove Management in Northwestern Luzon

In northwest Luzon, mangrove management has long been part of the region's history. One of the earliest mangrove management programs can be traced with the declaration of Hundred Islands National Park (HINP) in Alaminos City, Pangasinan as protected area by virtue of Presidential Proclamation 667 by then President Manuel Quezon in 1940. The HINP covers the foreshore areas, including mangroves. Ironically, most foreshore areas are also the same site where massive conversion to aquaculture ponds happened until 1980s. In the late 1980s to early 1990s, the Municipal Government of Bani initiated the first mangrove rehabilitation program in the region. The mangrove plantation was eventually enacted as a marine protected area. This program garnered several provincial, regional

and national environmental management recognitions. Its success inspired the other neighboring municipalities and provinces such that by mid- to late-1990s, massive mangrove rehabilitation programs were implemented in the region. Most of these programs received funding mainly from the national government (e.g. the Coastal Environment Program, and Integrated Coastal Resources Management Program of DENR), and, in some cases, from local and international NGOs. It also becomes a norm that the remaining natural mangrove stands are declared as mangrove protected area.

All provinces in northwestern Luzon have reported implementing mangrove reforestation projects through multi-sectoral partnerships and/or through their respective Integrated Coastal Resources Management Plans. There are approximately 838.6 ha of planted areas in Northern Luzon. This figure does not include plantations from Pangasinan and Zambales, whose plantation data were not specifically identified. Most projects used *Rhizophora sp.,* although Pangasinan has initiated multispecies planting. The survival rate of planted seedlings average at 58% with regular weekly to quarterly monitoring (Table 3).

All provinces, with the exception of Bataan, have mangrove plant monitoring systems in place. Provinces that mentioned an established monitoring system, whether by the municipal government or by fisherfolk/POs are Bulacan (40–50% survival rate) (90% survival rate based on BFAR data), La Union (100% survival), Pangasinan (53% survival in river banks, 43% survival in intertidal flats), Bani, Pangasinan (34-64% survival rate), Subic Bay Freeport Zone, and Zambales (65–100% survival rate). Ilocos Norte did not provide details of their monitoring system but reported evaluation data. There were no reported values for growth rate. These reported figures, however, need to be verified and standardized as the survival rates are inconsistent with the mangrove status in each province. For example, if these survival rates are indeed accurate, then, the mangrove cover should have increased by at least 200 to 300 ha.

There is no systematic and standard monitoring systems in place despite the fact that most of these provinces have been doing mangrove planting programs for at least 15 to 20 years. There is also no monitoring data, except for Bani, Pangasinan. In addition, the metrics and methods used for monitoring are not clear. Most provinces reported visual observations and did not have actual growth and survival measurements. Similarly, there is no systematic impact monitoring system. If the planted mangrove trees grown and survived for 15 years, it is interesting to know what have been the actual contribution of these mangroves in terms of fisheries production, in stabilizing the shoreline, in protecting the coast as buffer against typhoons, and in performing other ecosystem functions. Only the municipality of Bani reported that rehabilitation projects helped increase their municipality's fish catch from 2.0 kg in 1995 to 3.25 kg in 2000 and then to 6.68 kg in 2007.

Problems encountered in the planting programs include natural impact from tidal and wave actions during typhoons; high salinity; high inundation; extreme sunlight exposure; infestation of barnacles and tussock moths, algal blooms; poor management practices such as improper care and maintenance, improper timing of planting, planting of poor quality propagules; and disturbances or damages from fishing, gleaning, trampling of boats, stray animals and entanglement with garbage or debris.

In addition to mangrove planting, other provinces have also taken steps to improve the health of their coasts by dredging rivers, planting trees in upland areas to prevent erosion, prohibiting the building of illegal structures along riverbanks, sustaining activities of Marine Protected Areas, regulating fishing activities, providing livelihood projects, and strictly implementing Municipal Fisheries Ordinances. Some provinces also have active partnerships with local fisherfolk and POs, which strengthen community-based management.

Summarized in **Table 29** are the mangrove planting programs and projects reported by the provinces, and the municipalities of Masinloc and Bani. The SBMA has no mangrove projects as no increase or decline in mangrove forests have been observed in recent years.

V. Experiences and Lessons

The mangrove management programs in northwestern Luzon can be traced back as early as 1940s. Mangrove rehabilitation programs started in late 1980s. There have been some measurable and considerable successes as well as difficulties. Several facilitating (and constraining) factors can be learned from these experiences.

Institutional networking and linkaging facilitates continuous technical assistance, both in technical and financial concerns. Most provinces are recipients of grants and projects from various funding institutions showing that the region was recognized for its accomplishments in mangrove management. The provision of incentives, such as annual recognition awards, has long been practiced in Region 1, but are more prominent in the provinces of Pangasinan and La Union. The awards, aside from the

financial incentives, will give recognition on the role of mangrove managers. Hence it provides regular challenge and inspiration among mangrove managers to sustain their projects.

Mangrove management projects will be sustainable in area where there is a pro-active participation from the local communities, and more importantly, if the communities are organized. In most cases, members of POs are the ones doing the actual planting, replanting and maintenance of the plantation. An enabling mechanism to sustain community participation is the stipulation of community empowerment provisions in integrated land/coastal development plan. A policy on long-term (at least ten years) mangrove management plan should be enacted. This aspect was clearly shown in Pangasinan, Zambales and Bataan.

The declaration of remaining natural mangrove stands as protected areas serves as a good strategy to help ensure that there will be no further mangrove loss through cutting. Eco-tourism, though only currently practiced in the municipalities of Bani and Masinloc, hold promise in providing economic incentives to mangrove managers. These two municipalities were able to package mangroves with bird watching and snorkeling activities.

Most provinces in the region still widely practice monospecific planting and putting plantations in the wrong sites despite the fact that it has been discouraged since mid-1990s. Fortunately, the provinces of Pangasinan and Zambales slowly did away with monospecific planting and actually already attempted to practice multispecies planting. For optimal results, mangrove managers are encouraged to consider the natural species zonation pattern in choosing the mangrove species to plant. If possible, mangrove planting in intertidal zone should be avoided, and instead prioritize planting in abandoned, undeveloped and underutilized (AUU) aquaculture ponds.

VI. Future Directions, Gaps and Recommendations

The role of mangroves in disaster risk reduction has never been as acutely recognized in the Philippines as in recent years. Reports of the impacts of Typhoon Haiyan with respect to mangrove cover have highlighted the critical role that proper mangrove management plays in mitigating sea level rise, storm surges and string wave action, among others. However, more stringent monitoring systems must be set in place to collect better quantitative and qualitative data that will inform policies and management strategies.

While the legal framework of mangrove management remains problematic due to overlapping roles and responsibilities, several options already exist to incentivize mangrove protection beyond the legal framework. Lasco et al. (2011) reported that local interest to participate in the carbon market is increasing. There is potential in exploring the value of carbon sequestered by mangrove forests and the ability to offset the opportunity costs of aquaculture might pave the way for better mangrove protection. Thus studies investigating the value of stored carbon, which will not be fruitful without extensive monitoring data, are critical.

A lack of data on the extent and survival of mangroves is evident from the information provided by the provinces. This lack of information contributes to the difficulties of mangrove evaluation, monitoring and management. A thorough evaluation of current mangrove areas will be useful in obtaining baseline data, which can be used in the creation of comprehensive and effective mangrove monitoring and management plans. The data can also be used in making guides for future mangrove planting projects to ensure the success of mangrove management programs.

Crucial to the success of any project is the strict implementation of policies as well as the empowerment of communities in participating in mangrove management. Furthermore, implementation must always have clearly defined goals. Each individual, agency or group should also be clear on their respective role in the implementation to avoid unnecessary confusion and encourage accountability.

A regular venue and network for sharing status reports and best mangrove management practices across the region is needed. From this, a comprehensive national mangrove database can be created and used to produce information and recommendations for improved and updated practices that keep up with our changing climate and coasts.

Table 29. Provincial/municipal mangrove planting projects

Province/ Municipality/ Zone	Name of Project	Duration	Implementing Agencies/Groups	Hectares Planted	Project Location/s	Monitoring Rate	Survival Rate	Factors Affecting Survival
BATAAN	Bataan Integrated Coastal Management Program (BICMP)	2001-2012	LGUs, POs, NGOs, Private Corporations, NGAs, Academe, Bataan Coastal Care Foundation	30.2	Municipality of Abucay (Brgy. Mabatang) Municipality of Orion (Brgy. Daan Pare, Camachile, Capunitan, Balut, Sta. Elena) Municipality of Limay (Brgy. Alangan) Municipality of Pilar (Brgy. Wawa South, Balut II) Balanga City (Brgy. Sibacan, Brgy. Tortugas)	-	70%	-
	Bakawanan sa Bataan	Annual	-	-	-	-	-	-
	BFARs Enhancement Planting	2011	-	18	Orani to Limay	-	-	
	DENR-PENRO Initiative	2007-2010	DENR-PENRO	72	Kabalutan, Orani; Wakas, Pilar; Pto. Rivas, Balanga; Orion; Pilar; Balanga; Abucay; Samal; Orani	-	-	-
	Mangrove Nursery and Mangrove Reforestation Project	2010-2013	Samahan at Ugnayan ng Pangisdaan ng Orion	6	Brgy. Sta. Elena and Brgy. Balut	Monthly	70%	Typhoons, barnacles
	People's Organization Initiative	2003-2006	Sagip Likas Yamang Dagat ng Bataan, Inc. (SALBA)	130,000 propagules or ~13 ha	Orani and Pilar	-	-	-
		2009-2012	Samahan at Ugnayan sa Pangisdaan ng Orion Inc. (SUGPO)	120,000 propagules or ~12 ha	Brgy. Balut, Camachile and Sta. Elena, Orion Bataan	-	-	-
	Private Sector Initiative	2014	Jollibee Group Companies, Rotary Club of Metropolitan Cubao, Association of Safety, Practitioners of the Philippines, Inc., ASSPI and Phil Resins Industries Inc (PRII)	~9, 000 propagules or ~0.9 ha	Sta. Elena and Camachile, Orion	-	-	-
BULACAN	Bulacan Fisheries Resource Management Program (FRM for Improved and Sustainable Harvest) Fish Component II	October 2008 to Present	Provincial Agriculture Office	6	Wawang Capiz, Taliptip, Bulakan, Bulacan	Weekly/ monthly	40%	Trampling by fishing boats, strong waves caused by typhoons
	Philippine National Aquasilviculture Program (PNAP)	May 2012 - December 2013	Bulacan State University and Obando School of Fisheries	130	Malolos, Paombong, Hagonoy, Obando, Meycauayan	Weekly/ monthly	40-70%	Tidal and wave action during typhoon, extreme sunlight exposure, garbage, quality of the propagules or planting materials
	Save Manila Bay Project (BFAR Regular Target)	January 2011 - December 2013	BFAR-RO 3, KMBI	33	Calumpit, Paombong, Hagonoy, Meycauayan and Obando	Weekly/ monthly	10-20%	
					Bulacan and Malolos		55- 60%	
	Mangrove Reforestation	December 2010 - December 2011	DENR - CENRO, Tabang, Guiguinto	25	Bulacan and Paombong	-	50%	Attachment of barnacles to the propagules
CAGAYAN	Integrated Coastal Resource Management Projects (ICRMP)	July 2009 - December 2012	DENR, BFAR	807	Abulug	Quarterly	60% Camiguin Island, 78% Pamplona, 80% Abulug	Force majeure
				39	Calayan			
				64.14	Gonzaga			
				4.25	Sanchez Mira			
				1,093.50	Aparri			
				121.44	Buguey			
				17.5	Claveria			
				702	Pamplona			
				639.24	Sta. Ana			
				340.1	Sta. Teresita			

Table 29 (continued)

Province/ Municipality/ Zone	Name of Project	Duration	Implementing Agencies/Groups	Hectares Planted	Project Location/s	Monitoring Rate	Survival Rate	Factors Affecting Survival
ILOCOS SUR	Mangrove Population Enhancement Program	January 2013-Present	BFAR, MMSU, PGIN, LGU, DENR, DECORMA	483	-	Monthly	100%	Floods, typhoons
ILOCOS NORTE	Establishment and Rehabilitation of Mangrove Areas in the Province of Ilocos Sur	1995-Present	BFAR-RO I, PGIS (OPAG-Fisheries/ ENRMO), LGUS, SUC, DENR	-	-	Monthly	-	Improper care, maintenance and management of the mangrove seedlings; stray animals; force majeure; improper timing of planting
LA UNION	BFAR Plantation	2011-2014	-	~175.75	-			
	Mangrove Population Enhancement Program	2011-2016	BFAR-I, OPAG, LGUs, DENR, Tanim Kalikasan and Fisherfolk Association	33.7	-	Quarterly	-	Barnacles, fungi, strong tidal waves
	Upland Development Program National Greening Program	2009-2016	DENR in partnership with LGUs and coastal communities, coastal barangays and POs	~40	Riverine/ estuarine and coastal areas from the municipalities of Sto. Tomas to Bacnotan	Quarterly	-	Barnacle infestation, tussock moth infestation, poor quality of propagules/ seedlings, stray animals, gleaning, trampling of boats, harsh tidal action, entanglement with debris
PAMPANGA	Enrichment Planting and Mangroves	-	-	5	Sasmuan, Pampanga	-	-	-
	Protection and Maintenance of Existing Mangroves through Enrichment Planting	-	-	38 10 21.7	Brgy. Consuelo Brgy. Batang I Brgy. Batang II	-	-	-
PANGASINAN	Mangrove Reforestation Project	2005-Present	PaGO and LGUs of project locations	62.44	Municipalities of Bolinao, Anda, Infanta, Dasol, Agno, Dagupan, Mangaldan, Sual, San Fabian, Lingayen, San Carlos City, Bugallon, Alaminos City, Labrador, Bani and Binmaley	-	53% along riverbanks, 45% along intertidal flats	In intertidal flats: Wave action, barnacle infestation, algal blooms, sedimentation. In riverbanks: Rapid currents, sedimentation, flooding
	Mangrove Rehabilitation through Enrichment Planting	2011-2012	DENR - Provincial Government of Pangasinan	15 10	Dasol Infanta	-	53% along riverbanks, 45% along intertidal flats	
	Mangrove Reforestation Project	2012-Present	BFAR	76.96	Municipalities of Binmaley, Bolinao, Alaminos City, Infanta, Dasol, Lingayen, Bani, Bugallon, San Fabian and Sual	-	53% along riverbanks, 45% along intertidal flats	
BANI	Riverine Mangrove Rehabilitation	2007-2013	Bigkis Lakas ng Brgy. Masidem, NAGKASAMA, Garrita Fisherfolks Assn., BFARMC, AFAI, LUFA,POFSA	70,845 propagules (32.41 ha)	Banog River, Don Cayo River, Bani River, Putot Lagoon, Garrita River, Embarcadero River, Ambabaay Creek	Annually	34%-64%	Toppling of plantation by *lumut*, heavy infestation of barnacles at the stems, typhoon; damage of defoliation of leaves by insects have also been observed
	Coastal Mangrove Rehabilitation	2007-2013	AFAI, NAGKASAMA, Bangrin Federation, PASS, Alaminos Students	184,802 propagules (37.5 ha)	Bangrin MPA			
SBMA	Mangrove Reforestation Project	2000	Woodward-Clyde (WCPI) Philippines	3.94	Nabasan, Triboa, Silangin and Ilanin	At least annually and at most quarterly (conducted by Ecology Center)	92% directly planted propagules, 90% nursery-raised seedlings	-

Table 29 (continued)

Province/ Municipality/ Zone	Name of Project	Duration	Implementing Agencies/Groups	Hectares Planted	Project Location/s	Monitoring Rate	Survival Rate	Factors Affecting Survival
			Small Fisherholds of the Municipality of Palauig				80-90%	
			LGU of Brgy. Sto. Tomas				82.12%	
			Mangingisda at Magsasaka sa Palauig				86.68%	
			Samahang Mangingisda ng Panglit				80-87%	
			United Palauig—MPC				83%	
			Samahang Magsasaka ng Libaba				86.63%	
ZAMBALES	Integrated Coastal Resources Management Project (ICRMP)	-	Samahang Mangingisda ng Candelaria	326.5	Sta. Cruz, Candelaria, Masinloc, Palauig, Botolan and Cabangan	-	85.37%	-
			Burador Fisherman's Association				87%	
			Samahang Pangkaunlaran ng San Salvador				82%	
			Panan Fisherfolks Movement Association				80%	
			Kalipunan ng Liping Cabangan				65.60%	
			Parel Union for Water Environmental Resources and Social				100%	
MASINLOC	Mangrove Rehabilitation Project	2012 - 2013	DENR, LGU	3	Brgy. Bani	3-month project monitoring and evaluation	80%	Disturbance due to fishing and gleaning, strong waves, soil erosion
				3	Brgy. Taltal			
				9	Brgy. San Salvador			
				41	Brgy. San Lorenzo, Bamban, Sto. Rosario			

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VIII. APPENDICES

Appendix A: Coastal Barangays of Bataan

Province: Bataan	
Coastal Cities/Municipalities	**Coastal barangays**
1st District	
HERMOSA	Pulo
	Almacen
	Saba
	Mabuco
ORANI	Pantalang Luma
	PantalangBago
	Kaparangan
	Balut
	Kabalutan
	Wawa
	Tapulao
	Puksuan
	Calero
SAMAL	Lalawigan
	Calaguiman
	Santa Lucia
	Daan Bago
	Sapa
	Tabing Ilog
ABUCAY	Mabatang
	Capitangan
	Calaylayan
	Wawa
	Omboy
MORONG	Sabang
	Nagbalayong
	Poblacion
	Mabayo
BALANGA	Sibacan
	Pto. Rivas Ibaba
	Pto. Rivas Itaas
	Tortugas
	Tuyo
	Lote
PILAR	Balut I
	Balut II
	Wawa
	Wakas
	Landing

Appendix A (continued)

Coastal Cities/Municipalities	Coastal barangays
2nd District	
ORION	Putting Buhangin
	Santa Elena
	Daan Pare
	Capunitan
	Lusungan
	Daan Bago
	Wawa
	Pag-asa
	Balut
	Camachile
LIMAY	Lamao
	Alangan
	Kitang II/Luz
	Kitang I
	Landing
	Townsite/Villafrancia
	Wawa
	Reformista
	St. Francis/Roxas
	St. Francis II
MARIVELES	Lucanin
	Cabcaben
	Townsite/Pinag-Apugan
	San Jose
	Alas-asin
	Sisiman
	Nasui
	Ipag
	Camaya
	Balon Anito
	Mt. View
	Batangas II
	Biian
BAGAC	Binuangan
	Pag-asa
	Quinawan
	Saysayin
	Paysawan
	Ibis
	Banawang

Appendix B: Mangrove Planting Initiatives for Bataan

MANGROVE PLANTING INITIATIVE OF BICMP, PMO

Year	Location	Area (ha)
2001	Mabatang Abucay	2
2002	Daan Pare, Orion	2
	Alangan, Limay	2
2003	Sibacan, Balanga City	2
	Mabatang, Abucay	2
	Wawa South, Pilar	2
	Sitio Sibul, Daan Pare, Orion	2
	Alangan, Limay	1
2004	Daan Pare, Orion	2
	Camachile, Orion	2
	Balut II, Pilar	2
2005	Camachile, Orion	1
2006	Capunitan, Orion	2
	Tortugas, Balanga	2
2007	Balut, Orion	1
	Balut II, Pilar	1
2009	Santa Elena, Orion, Bataan	2
2011	Balut II, Pilar	0
2012	Tortugas, Balanga	0
Total	**12 barangays in 4 Municipalities**	**30**
Other Data		
No. of propagules planted	More than 221,500	
No. of seedlings planted	More than 49,500 seedlings	
Survival rate	70%	
No. of volunteers involved in the activity	More than 6,500 volunteers from 2001	

DENR – PENRO INITIATIVE (2007-2010)

Year	Location	Area (ha)
2007	Kabalutan, Orani (BAKLAD)	8
2008	Kabalutan, Orani (BAKLAD)	5
	Wakas, Pilar (SALBA)	3
2009	Pto. Rivas, Balanga	5
	Orion	7
	Pilar	5
	Balanga	3
	Abucay	10
	Samal	10
	Orani	5
2010	Orani	5
	Orion	3
	Samal	3
Total		**72**

BFAR's ENHANCEMENT PLANTING (2011)

Year	Location	Area (ha)
2011	Orani to Limay	18

PRIVATE SECTOR INITIATIVE (2014)

Name	Location	Area (ha)
Jollibee Group of Companies	Santa Elena, Orion, Bataan	4,000 propagules
Rotary Club of Metropolitan Cubao	Camachile, Orion, Bataan	3,000 propagules
Association of Safety Practitioners of the Phil Inc		
ASSPI and Phil Resins Industries Inc (PRII)	Santa Elena, Orion , Bataan	2,000 propagules

PEOPLE'S ORGANIZATION INITIATIVE (under the UNDP, SGP Project)

Name of PO	Location/Year	No. of Propagules Planted
Sagip Likas Yamang Dagat ng Bataan Inc. (SALBA)	Orani and Pilar (2003 – 2006)	130,000
Samahan at Ugnayan sa Pangisdaannng Orion Inc. (SUGPO)	Brgys. Balut, Camachile and Santa Elena, Orion, Bataan (2009 – 2012)	120,000

Appendix C: Subic Bay Freeport Zone mangrove forest area coverage (in hectares)

Location	Closed Canopy	Open Canopy	Cleared/ Denuded	Total
Binictican	18	10	1	30
Boton	9	2	1	12
Nabasan	3	3	0	7
Triboa A	7	1	0	8
Triboa B	3	0	0	3
Ilanin	3	0	0	3
Total	**42**	**17**	**3**	**62**

Appendix D: List of Coastal Barangays per Municipality of Zambales

Municipality	Coastal Barangays	
Sta Cruz	Lucapon North	North Poblacion
	Lucapon South	Malabago
	Naulo	Gama
	Balitoc	Sabang
	Lipay	Pagatpat
	South Poblacion	
Candelaria	Uacon	Libertador
	Sinabacan	Dampay
	Malimanga	Binabalian
	Malabon	Lawis
	Panayonan	
Masinloc	Taltal	Inhobol
	Bani	Bamban
	Baloganon	Santo Rosario
	Collat	San Lorenzo
	North Poblacion	San Salvador
	South Poblacion	
Palauig	Pangolingan	Santo Tomas
	Lipay	East Poblacion
	San Juan	Liozon
	Gareta	Magalawa
	Libaba	Macarang
	Bato	Alwa
	Locloc	West Poblacion
Iba	Amungan	Palanginan
	Bangantalinga/Sta Rita	San Agustin
	Lipay Dingin Panibuatan	Sto Rosario
Botolan	Panan	Bangan
	Binoclutan	Beneg
	Porac	Danacbunga
	Capayawan	Parel
Cabangan	Laoag	Felmida Diaz
	Lomboy	Mabanglit
	San Isidro	Santo Niño
	Arew	Camiing
San Felipe	Santo Niño	Maloma
	Sindol	
San Narciso	Lapaz	
San Antonio	San Miguel	
	Pundaquit	
Subic	Baraca-Camachili	Calapandayan
	Wawandwe	Matain
	Calapacuan	Cawag
TOTAL	**75**	

Appendix E: Mangrove Seedling Production by Year in Pangasinan

Calendar Year	Annual Production
2008	20,000
2009	81,884
2010	71,886
2011	91,587
2012	105,613
2013	80,100
Total	**451,070**

Appendix F: Coastal Mangrove Reforestation of Bani, Pangasinan from 2007-2013

Year	Location	No. of propagules	Species	Area (ha.)	Alive	Survival Rate	PO Involved	No. of pax	Source of Funds/ Sponsor
2007	Bangrin MPA	4,951	*A. marina*	1	1,683	34%	AFAI, NAGKASAMA	25	UPMERF-Sagip LGP
		2,700	*R. mucrunata*	1	918	34%	AFAI	12	UPMERF-Sagip
2008	Bangrin MPA	10,000	*R. mucrunata, R. apiculata*	1.3	4,500	45%	Bangrin Federation	50	NEDA KR2
		2,500	*R. mucrunata*	1	375	15%	Bangrin Federation	13	PMA Class 72
		2,500	*R. mucrunata*	1	482	19%	AFAI	13	PGU Pangasinan
		2,000	*R. mucrunata*	1	40	2%	PASS, Alaminos Students	13	Hundred Islands Rotary Club
2009	Bangrin MPA	845	*R. mucrunata*	1	541	64%	NAGKASAMA	5	LGU-Bani
		1,459	*R. mucrunata*	1			AFAI	10	PMA Class 72
		725	*R. mucrunata*	1.3		43%	AFAI	15	LGU-Bani
		1,725	*R. mucrunata*	1		84%	AFAI	15	PGU Pangasinan
March 2012	Bangrin MPA near Wild Duck Avenue	14,250	*R. mucrunata*	0.3562	9,120	64%	NAGKASAMA	26	BFAR-DENR-Tanim Kalikasan-KASAMMBA-LGU
March 2012	Bangrin MPA near Heron Boulevard	15,240	*R. mucrunata*	0.381	10,973	72%	AFAI	34	BFAR-DENR-Tanim Kalikasan-KASAMMBA-LGU
18-May 2012	Bangrin MPA	355	*S. alba*	0.02	355	100%	AFAI, NAGKASAMA		PCV VEG
		445	*R. mucrunata*		445	100%	AFAI, NAGKASAMA		PCV VEG
23-Oct 2012	Bangrin MPA near Heron Boulevard	10,000	*R. apiculata*	0.25	7,400	74%	AFAI	65	BFAR-DENR-Tanim Kalikasan-KASAMMBA-LGU
4-Dec 2012	Bangrin MPA near Heron Boulevard	6,000	*R. apiculata*	0.15			AFAI	32	DENR National Greening Program
10-Dec 2012	Bangrin MPA near Heron Boulevard	11,000	*R. apiculata*	0.275			AFAI	32	DENR National Greening Program
14-15 Dec 2012	Bangrin MPA near Heron Boulevard	3,360	*R.mucrunata*	Replace-ment planting			AFAI	39	LGU-Bani
17-Jan 2013	Bangrin MPA	1,200	R.mucrunata	Replace-ment planting	5,200	100%	NAGKASAMA	10	LGU-Bani
28-29 Jan 2013	Bangrin MPA	4,000 s	R.mucrunata	Replace-ment planting			NAGKASAMA	10	LGU-Bani
13-Feb	Bangrin MPA	2,000	R.mucrunata	0.162			NAGKASAMA	10	BFAR-DENR-Tanim Kalikasan-KASAMMBA-LGU

Appendix G: List of Coastal Barangays with Their Population in La Union

Municipality/City	Number of Coastal Barangays	Population
Agoo	10	15,160
Aringay	5	11,911
Bacnotan	7	11,625
Balaoan	2	3,676
Bangar	4	5,601
Bauang	13	29,023
Caba	4	4,409
Luna	13	18,700
Rosario	3	5,137
San Juan	5	3,951
Santo Tomas	10	16,449

Source – Municipal Fishery Profile

Appendix H: Coastal barangays by municipality/city of Ilocos Sur

Municipality	Number of Barangays	Name of Barangays
Sinait	8	Dadalaquiten Norte, Dadalaquiten Sur, Cabangtalan, Katipunan, Sabangan, Paratong, Teppeng, Pug-os
Cabugao	7	Namruangan, Daclapan, Sabang, Dardarat, Salomague, Salapasap, Pug-os
San Juan	7	Surngit, Solot-solot, Dardarat, Camindoroan, San Isidro, Saoang, Sabangan
Magsingal	7	Pagsanaan Norte, Pagsanaan Sur, Namalpalan, Manzante, Miramar, Alangan, Puro
Sto. Domingo	5	Sived, Calay-ab, Casili, Suksukit, Nanerman
San Vicente	2	San Sebastian, Nagtupacan
Santa Catalina	4	Tamorong, Cabittaogan, Subec, Paratong
Caoayan	7	Tamurong, Puro, Caparacadan, Fuerte, Manangat, Villamar, Don Alejandro Quirolgio
Vigan City	3	Mindoro, San Pedro Sur, Pantay Laud
Santa	10	Magsaysay, Quezon, Bucalag, Tabucolan, Pasungol,Rancho, Calungboyan, Casiber, Dammay, Oribi
Narvacan	4	Sulvec, Bulanos, San Pedro, Pantoc
Santa Maria	5	Suso, Nalvo, Bia-o, Lingsat, Nagsayaoan
San Esteban	4	Villa Quirino, San Pablo, Apatot, Bateria
Santiago	6	Gabao, Sabangan, Guinabang, Butol, San Roque, Ambucao
Candon City	8	Patpata 1st , Patpata 2nd, Tamurong 1st, Tamurong 2nd, Calungboyan, Paypayad, Darapidap, Caterman
Santa Lucia	6	Luba, Vical, Paratong, Bao-as, Sabuanan, Nangalisan
Santa Cruz	14	Pattiqui, Gabor Sur, Las-ud, Villa Hermosa, Pilar, Dili, Villa Garcia, Capariaan, Casilagan, Sevilla, Mambog, Paratong, Pinipin, Mantanas
Tagudin	11	Becques, Pacac, Borono, Tampugo, Bimmanga, Libtong, Farola, Dardarat, Pudoc West, Sawat, Tarangotong

Appendix I: 1st State of the Mangrove Summit: Northwestern Luzon
Activity Design and Program

Activity Design

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 Need for a Mangrove Summit

Given the important role of mangroves, the lack of consolidated data, and some constraints in resources, there is an urgent need to have the first Mangrove Summit focusing on the provinces of Central and Northern Luzon. The provinces of Bataan, Bulacan, Cagayan, Ilocos Norte, Ilocos Sur, La Union, Pampanga, Pangasinan and Zambales still have a substantial number of mangroves but are highly vulnerable against anthropogenic and natural disasters.

The summit serves as a pioneering activity that envisions institutionalizing a national State of the Mangrove biannual workshop that consolidates monitoring data (growth, biodiversity, etc.). This information, collated in an accessible database, will also be useful in estimating the carbon sequestration of mangroves and its vulnerability against sea level rise. All this will be valuable in enhancing mangrove conservation and management strategies.

Summit Objectives

The 1st State of the Mangroves Summit: Northwestern 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 a venue 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

Outputs

5. Proceedings of the State of the Mangrove Summit: Northwestern Luzon;
6. Initial inputs for the development of a national mangrove database;
7. Formation of a mangrove management network for Northwestern Luzon; and
8. Draft action plan for mangrove management in Northwestern Luzon

1st State of the Mangroves Summit: Northwestern Luzon

23-24 October 2014
CTC 201, Ateneo de Manila University

In cooperation with:

Day 1

8:30 AM	Registration Prayer National Anthem
9:30 AM	Welcome Remarks Dr John Paul Vergara *Vice President for the Loyola Schools, Ateneo de Manila University* Mr Godofredo T. Villapando *Executive Director, Foundation for the Philippine Environment*
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 Mangrove Research in the Philippines Ms Anna Cubos *Research Assistant, APN Project, Marine Science Institute, University of the Philippines*
11:15 AM	Status of Mangrove Biodiversity Management Ms Nilda Baling *Section Chief, Coastal Marine Management Section, Biodiversity Management Bureau, Department of Environment and Natural Resources*
11:45 AM	Open Forum
12:15 PM	Lunch Break
1:00 PM	Presentation and Update of Mangrove Status per Province
6:00 PM	Welcome Dinner

Day 2

8:30 AM	Registration
	Day 1 Synthesis and Workshop Introduction Ms Abigail Marie T. Favis *Department of Environmental Science,* *Ateneo de Manila University*
9:30 AM	Mapping of Mangroves in Northwestern Luzon Engr. Homer Pagkalinawan *EnviSAGE Research Laboratory, Department of Geodetic Engineering,* *University of the Philippines*
10:15 AM	Understanding Climate Change Vulnerability Assessments: Application to Mangrove Forests Dr Laura T. David *Professor, Marine Science Institute, University of the Philippines*
	The need for institutional networking in Integrated Coastal Management: Interconnectivity among Coral Reefs, Seagrass Beds and Mangrove Forests Dr Porfirio M. Aliño *Professor, Marine Science Institute, University of the Philippines, Diliman*
11:00 AM	Open Forum
11:30 AM	Lunch Break
12:00 NN	Incentivizing Blue Carbon: Application to Mangrove System Mr Enrique Nuñez *Country Executive Director, Conservation International – Philippines*
1:00 PM	Workshop Proper Workshop Introduction: Action Planning and Recommendations
2:00 PM	Summit Synthesis and Closing Dr Severino G. Salmo III *Assistant Professor, Department of Environmental Science,* *Ateneo de Manila University*
5:00 PM	Dinner

Emcee: Ms Abigail Marie T. Favis
Department of Environmental Science, Ateneo de Manila University