ASIA-PACIFIC NETWORK FOR
GLOBAL CHANGE RESEARCH

Project Report
ARCP2014-14NMY(B&ES)-Salmo

INFLUENCE OF MANGROVE BIODIVERSITY ON ACCUMULATION OF CARBON AND RESILIENCE TO SEA LEVEL RISE: A COMPARATIVE ASSESSMENT AMONG DISTURBED, RESTORED AND INTACT MANGROVE SYSTEMS

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Project Reference Number: ARCP2014-14NMY(B&ES)-Salmo

"Influence of Mangrove Biodiversity on Accumulation of Carbon and Resilience to Sea Level Rise: A Comparative Assessment Among Disturbed, Restored and Intact Mangrove Systems"

Progress Report for Continued Funding from the APN

Progress Report of APN Project

Part One: Overview of project work and outcomes

1. Introduction and Background

Mangrove forest is known to provide several ecological and socio-economic services. However, there has been severe degradation particularly in SE Asia, which ironically, is also the center of biodiversity and hosts the largest mangrove forest cover in the world. The loss of mangroves resulted to the decline the performance of its of ecosystem functions. Massive mangrove planting programs have been initiated since the 1990s in an attempt to restore the habitat functionality of mangroves. In lieu of the projected impacts of climate change (primarily sea level rise), the preservation and restoration of mangrove forest will play an important role in the adaptation and mitigation strategies for the stability of the coastline and in sequestering atmospheric CO2.

The project aims to establish a regional network by collecting biodiversity data, and through enhancing regional SE Asian collaboration. A series of regional workshops with local mangrove managers will be conducted to build international collaborations on the range of pressures on mangrove ecosystems over the SE Asian region. Specifically, the project will assess the vulnerability (or resiliency) of mangroves against sea level rise as a function of biodiversity (monospecific plantation vs. multi-species natural stands) and state of ecosystem health (as disturbed, restored and intact).

Keywords (Five Maximum Keywords): mangrove, biodiversity, sea level rise, carbon sequestration, coastal management

2. Participating countries

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3. Objectives

The project objectives are:

1. Share regional insights and key learnings into the state of mangrove biodiversity in each study site and the wide range of pressures on mangroves;

2. Increase the research capacity through the sharing of technical knowledge;

3. Train and educate partners from developing nations on values of intact mangroves and how to effectively sample them to determine resilience;

4. Establish new sites where vulnerability to sea level rise and carbon sequestration data has not previously been collected;

5. Assess the variability in the vulnerability of mangroves to sea level rise; and 6. Build a new regional picture of the capacity of mangroves to store carbon.

4. Funding secured from APN

USD 40,000.

5. Outcomes and products against original proposal objectives:

The first project meeting/workshop was held in Ateneo de Manila University (AdMU) on 16-21 September 2014, with a symposium held on 18 September 2014 as part of the workshop. The symposium was attended by at least fifty participants composed of faculty and students of the university as well as some representatives from other research institutions (from Philippine Nuclear Research Institute). Each collaborator presented their respective research that deals on carbon sequestration, vulnerability and adaptation against sea level rise, biodiversity assessment and mangrove ecology and management. The workshop helped enhanced the research capacity of partners, mainly from the Philippines and Malaysia) in doing research that will link mangrove biodiversity and sea level rise.

These sites compare surface elevation change between intact forest and a regenerating forest from a former aquaculture ponds (Indonesia; 8 plots), and between planted and natural mangrove stands (Philippines; 6 plots). The sites in Indonesia have higher species richness (12 to 20 species) as compared to that of the Philippine sites (< 10 species).

In Riau, Indonesia, rSET monitoring started since June 2015 in mangrove forests of the Riau University Research station, Dumai, Riau. A total of six plots were set up across two different environment settings located along the riverside and inside the forest. Soil surface elevation change was observed in 2-3 month interval. The surface elevation gains in the riverside (1.1 cm year-1) was found higher than inside the forest (0.55 cm year-1). We estimate that the change is likely to be determined by the sediment input, which is related to the water exchange through tides.

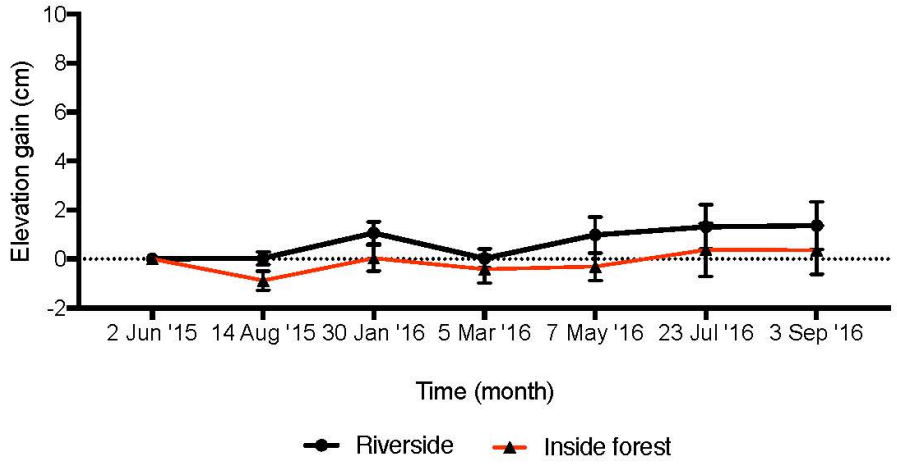


Fig 1. Surface elevation gain over 16 month of observation in Dumai mangrove forest

In Perancak, Bali, the site is characterized by the regrowth of mangroves dominated by native species of *Avicennia spp.* and *Sonneratia alba* and planted *Rhizophora spp.* These plots have 20 species of true mangroves and at least six species of mangrove associates. These sites were continued from previous monitoring efforts since 2013 and were acquired through the personnel and logistical support of Dr. Frida Sidik. Over two years of measurements shows that surface elevation has an increasing trend in both plots. The rates in the ponds are relatively higher than in the forests. Further assessment should be undertaken to determine the surface and subsurface processes that contribute to this change.

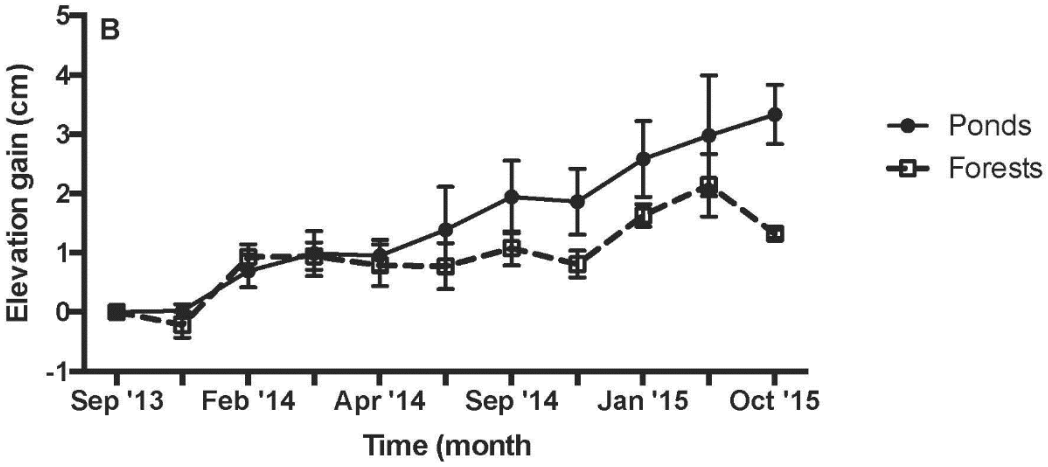


Fig 2. Difference in surface elevation change in regenerated mangroves vs intact forest in Bali, Indonesia

Six rod Surface Elevation Tables (rSETs) were completely installed in Bani, Pangasinan (northwestern Philippines) in November 2014. Within this site, three rSETs were installed in planted mangroves and three others were in natural mangrove stands. These are considered the first rSETs installed in the Philippines. This site is made up of a 25-year old planted

mangrove stands and declared as a 42-ha Mangrove Protected Area. These mangrove stands were damaged by Typhoon Chan-hom in May 2009.

This site is mostly composed of a mangrove plantation of *Rhizophora spp.* with remnants of natural mangrove stands made up of *Avicennia* and *Sonneratia spp*. In ca. 2.2-yrs of monitoring, the elevation lost was high at 6-8 cm in both natural and planted mangrove stands, respectively. The last monitoring period in April 2016 however shows a slower rate of elevation loss of 0.50 cm for the natural stands and 0.60 cm for the planted stands. The mean rate of elevation change for the entire site is computed at -1.56 ± 0.1 cm year-1. The site manifest further elevation losses because of the typhoon that hit the area in November 2016. Typhoons are known to cause significant amount of washout of the upper sediments.

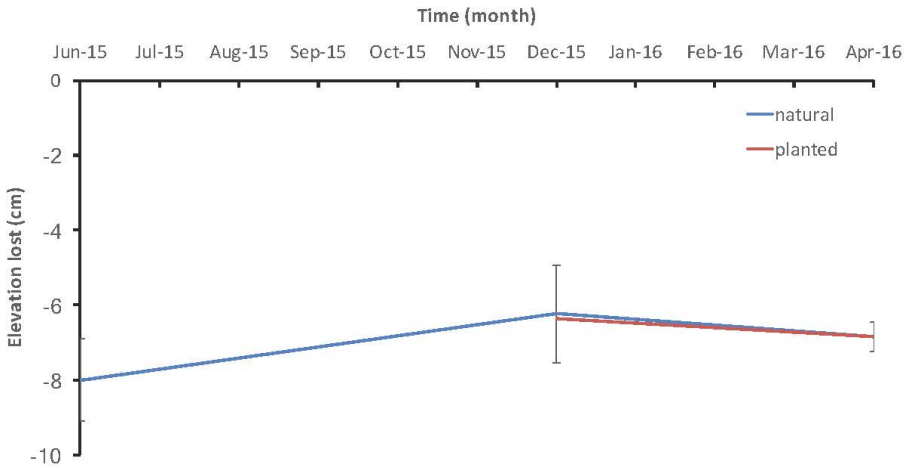


Fig 3. Surface elevation loss in natural and planted mangrove stands

Sediment carbon stocks were also measured near each rSET plot in the Philippines. Carbon stocks were compared between natural and planted stands from one-meter core samples of different depths. In the upper sediment layer (0-30 cm), the natural mangrove stands (61 ± 18 Mg C/ha) have at least 20-50% higher carbon stocks as compared to the planted mangrove stands (26 ± 3 Mg C/ha; Fig. 2). The sudden drop at 8-15 cm may be attributed to the washed out of fine sediments brought by the typhoon. There was a comparable carbon stocks at > 30 cm depth.

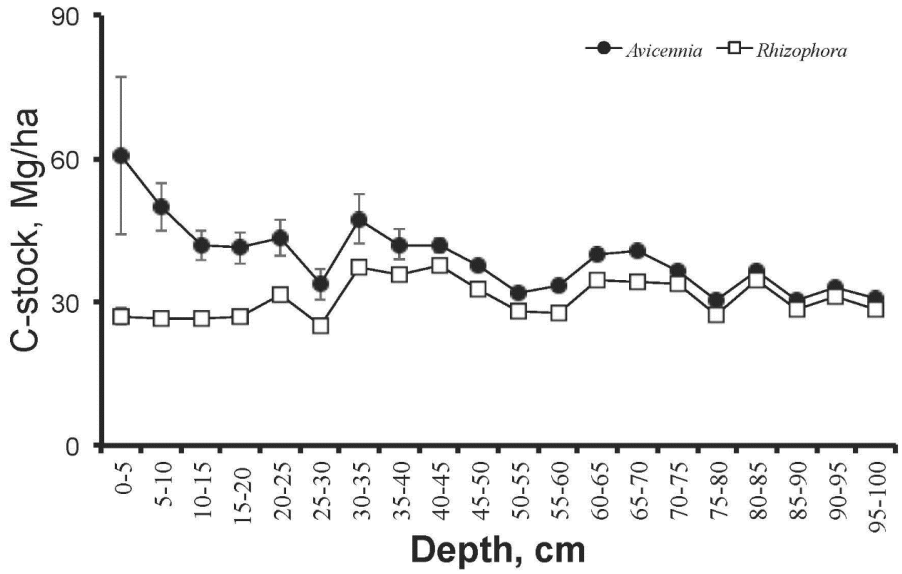


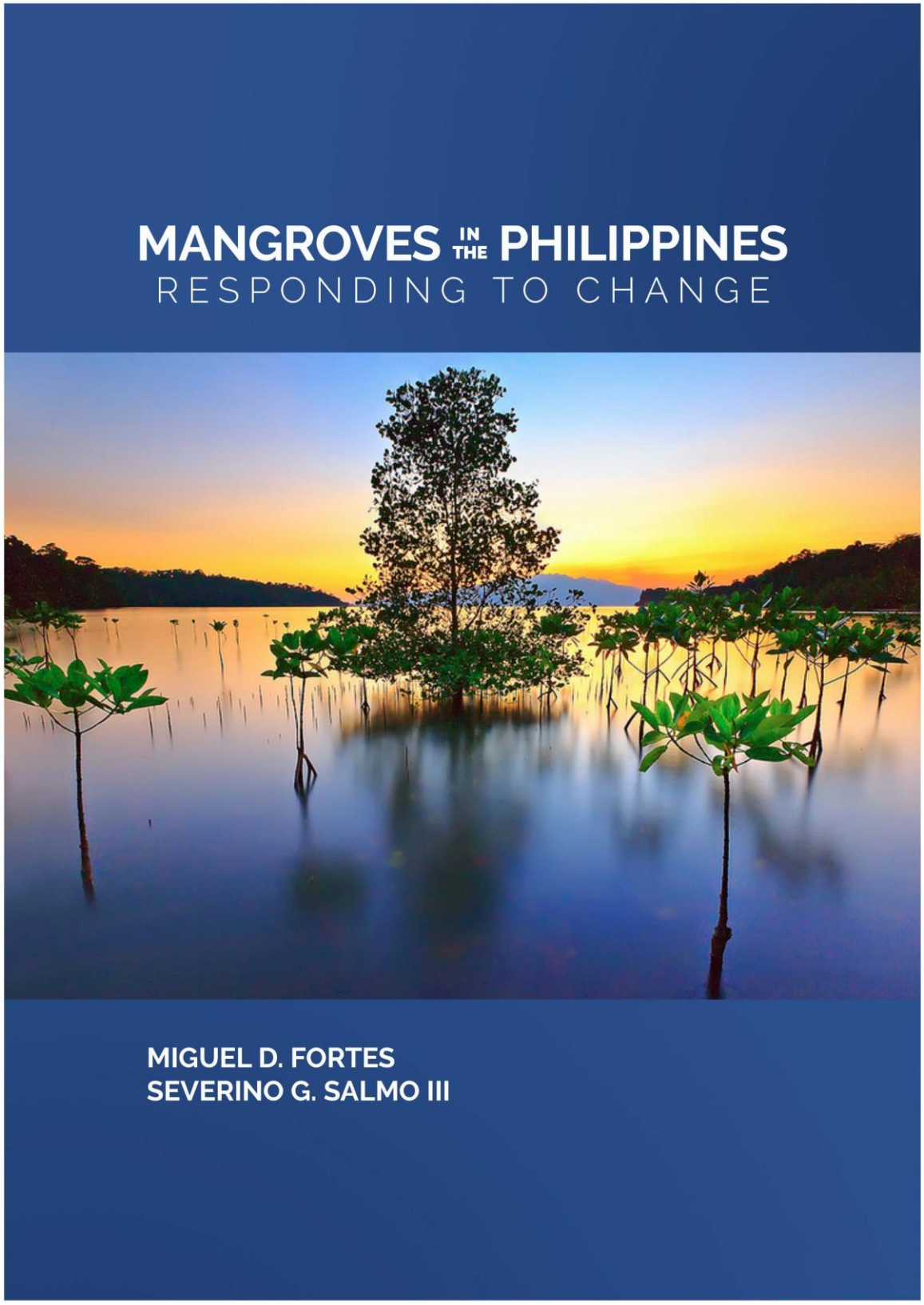
Fig 4. Differences in sediment carbon stocks between natural (Avicennia sp.) and planted (Rhizophora sp.) stands with depth

Our findings show spatio-temporal comparisons of surface elevation and carbon stocks on different types of mangrove settings. This information, especially if sustained in the long run, will contribute to update a regional trend as observed from different mangrove management regimes in SE Asia.

Although all mangrove sites appear vulnerable with rising sea level, our results show that the intact and more diverse natural mangroves will have higher resiliency as compared to the planted stands to the impacts of climate change. In addition, the data shows differences on the performance of regenerating mangroves (either through natural regeneration from aquaculture ponds or manual planting) as compared to an intact mangrove stands. This information will be needed to project the actual contribution of mangrove planting programs relative to climate change adaptation and mitigation strategies.

6. Appendices

Fortes, M. D., & Salmo, S., III. (2017). Mangrove in the Philippines: Responding to Change. (preprint)


MANGROVES IN THE PHILIPPINES
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MANGROVES IN THE PHILIPPINES

Responding to Change

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Severino G. Salmo III

Mangroves in the Philippines: Responding to Change

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Foreword

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Director & CEO, MangroveWatch
Facilitator of the Australian and Mangrove Network
Member of the IUCN Mangrove Specialist Group

Mangroves - love them or hate them - these quiet-achieving shoreline habitats deserve our full respect and understanding!

And, with such insights, mangroves are attracting growing admiration! It comes with an increasing realisation and appreciation of the many critical and profound benefits these places offer human societies – especially as shoreline environments feel the pinch with rising sea levels, more severe storms, along with other changes accompanying global climate change. Mangroves have the ability to dampen and moderate these impacts and the changes taking place – but only if we let them! With the latter point, there lies the dilemma faced by today's human societies! Community-owned natural resources like mangroves are under extreme and serious threats from expanding exploitation and ill-advised use, coupled with competing alternate uses leading to habitat degradation, replacement and loss.

These issues and more are addressed in this enlightened and refreshing new text by Professors Fortes and Salmo, titled "Mangroves in the Philippines: Responding to Change". Together, these locally-acknowledged international specialists have compiled a much needed, and invaluable authoritative resource about the special Philippine mangroves. The book is timely and it will be a most useful reference for hard-pressed, local environmental managers, community members, environmentally-aware industries, as well as researchers throughout the country - and elsewhere around the World.

In order to survive, mangrove habitats utilise their natural abilities to adapt and change. And, this has been largely successful for 50 million years! But now, there are serious questions as to whether they are able to cope with the unusually rapid pace forced on them by human development and climate change. By the accounts described, it appears that natural mangrove ecosystems have become less able to respond effectively to all the changes taking place. Does this mean that the added pressures and the rate of change has compromised the innate ability of these habitats to respond and adapt?

In raising awareness about this unique habitat in such a thoughtful way, Fortes and Salmo, present the necessary justification for immediate action - the 'why' and 'how' responsible societies need to act to preserve valued mangrove ecosystems by adding them into their longer-term aspirations for a healthy and prosperous future. It appears that the continued survival of these natural places and their benefits has now become dependant on the better care and management of a more well-informed community.

The authors provide that knowledge along with a practical roadmap signposted with many useful directions necessary for finding a way through current and emerging difficulties faced by communities throughout The Philippines. Local mangrove and tidal wetland ecosystems are at crisis point. While these habitats are degraded and in decline, and their survival window is rapidly shrinking – there may still be time to reverse the negative trend in the Philippines. This book by Fortes and Salmo helps a lot. It gives support to the many local community farmers, fishers, environmentalists, researchers and managers who see a future for mangrove habitats along with their special beneficial resources throughout The Philippines.

Acknowledgment

This book, *Mangroves in the Philippines: Responding to Change*, was completed with the valuable encouragement and support from several agencies, institutions, programs and projects, organizations, and individuals, who are all committed to the sustainability of mangroves and other coastal resources. They include the following:

Government and inter-governmental entities
- National Book Development Board (NBDB)
- Department of Geodetic Engineering, CE, University of the Philippines
- National Fisheries Research and Development Institute (NFRDI) of BFAR
- Biodiversity Management Bureau (BMB) of the DENR
- United Nations Educational, Scientific and Cultural Organization (UNESCO)

Academic institutions and organizations
- Marine Science Institute, College of Science, University of the Philippines (UPMSI)
- Department of Environmental Science, School of Science and Engineering, Ateneo de Manila University (AdMU)
- International Blue Carbon Scientific Working Group (CI, UNESCO-IOC, IUCN)

Programs, projects, organizations
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- Ms. Anna Francesca Cubos

…and our Research Assistants, students, and friends whose reliability and consistent help have made the chores so much bearable and whose presence and intelligent inquiry, more inspiring.

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Mangrove and Tropical Seagrass Ecology; Integrated Coastal Area Management; Environmental Impact Asssessment; Blue Carbon in Climate Change Mitigation

"Some say life is as murky as the mud in mangroves; I am thankful that life is as rich and full."

Severino G. Salmo III, PhD
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Mangrove Restoration Ecology; Disturbance Ecology; Integrated Coastal Management

"Pag-ibig sa tinubuang lupa!"
– Gat Andres Bonifacio, a national hero.
(Nationalism, above personal satisfaction and achievements, should propel research in the country).

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