

ASSESSMENT OF TROPICAL BLUE CARBON
RESERVES IN THAILAND

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B.SC. (SECOND CLASS HONOURS) & M.SC. (ECOLOGY)

2015

A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN SCIENCE

SCHOOL OF LIFE SCIENCE

PLANT FUNCTIONAL BIOLOGY AND CLIMATE CHANGE CLUSTER

UNIVERSITY OF TECHNOLOGY SYDNEY

CERTIFICATE OF AUTHORSHIP / ORIGINALITY

I certify that the work presented in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree, except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Pemika Apichanangkool

ACKNOWLEDGEMENTS

I would first and foremost like to thank my supervisors: Professor Peter Ralph for his patience, insight, guidance and involvement, and all the opportunities he has provided me during my candidature; Hilary Kennedy for her comprehensive knowledge, encouragement and patience dealing with the physical distance of separation from United Kingdom; Dr Peter Macreadie who has supported me throughout my thesis with his patience, knowledge, and motivation.

I would like to thank the funding support that I received for my thesis project from the Total Foundation and the International Union for Conservation of Nature (IUCN), UTS: International Research (IRS) and the UTS: Faculty of Science. Thank you to Dorothée Herr and IUCN team who have supported and assisted me throughout the research and media production.

I am also appreciative of the field study assistance and laboratory space provided by members of the: UTS: Plant Functional Biology and Climate Change Cluster (C3); the Marine Ecology Group, Northern Fisheries Centre, Queensland Australia (TropWater, James Cook University); and the Seaweed and Seagrass Research Unit, Prince of Songkla University and Faculty of Science, Suratthani Rajabhat University.

Thank you to all members of the Aquatic Processes Group (APG) in C3, and special thanks to Stacey Ong, Marlene Fretz (Zbinden) and John Moore for their assistance. I would specifically like to thank Stacey Trevathan-Tacket, Sutinee Sinutok, and Ponlachart Chotikan and all friends in the coastal plant research program for their support and friendship. Thank you to my family for being supportive and for always

believing in me. Special thanks to my partner Sunil Gurung for encouraging and inspiring me.

PUBLICATIONS

Peer reviewed journal articles arising directly from this thesis:

Chapter 2:

P. Apichanangkool, P.I Macreadie, H. Kennedy, D. Herr & P.J Ralph. The Impacts of Tropical Seagrass Loss on Blue Carbon Sink Capacity. Submitted to Scientific Report.

Chapter 3:

P. Apichanangkool, H. Kennedy, P.I Macreadie, D. Herr & P.J Ralph. The influences of species-specific seagrass canopy structure on Blue carbon sink capacity. In preparation.

Chapter 4:

P. Apichanangkool, P.I Macreadie, H. Kennedy & P.J Ralph. Artificial seagrass: the alternative way of Blue Carbon restoration. In preparation.

TABLE OF CONTENTS

| | |
|---|-----|
| Certificate of Authorship/Originality | i |
| Acknowledgements | ii |
| Publications | iii |
| List of Figures | vii |
| List of Tables | xii |
| Abbreviations | xiv |
| Abstract | xv |
| CHAPTER | |
| 1. General Introduction | 1 |
| 1.1 Black and brown carbon: their impact on global climate change | 2 |
| 1.1.1 Black carbon | 3 |
| 1.1.2 Brown carbon | 4 |
| 1.2 Green and blue carbon: carbon captured through biosequestration | 5 |

| | | |
|-------|---|----|
| 1.2.1 | Green carbon | 5 |
| 1.2.2 | Blue carbon | 6 |
| 1.3 | The ocean carbon cycle | 6 |
| 1.3.1 | Ocean vegetated “blue carbon” habitats | 7 |
| 1.4 | Seagrass ecosystems: vital carbon sinks | 10 |
| 1.4.1 | General introduction to seagrass | 10 |
| 1.4.2 | Seagrass meadows are a key blue carbon sink | 14 |
| 1.4.3 | Isotopic composition: the blue carbon “fingerprint” | 18 |
| 1.5 | Loss of blue carbon sink capacity | 21 |
| 1.6 | Recovering and improving coastal blue carbon sink capacity | 22 |
| 1.6.1 | The potential role of seagrass restoration to enhance blue carbon sinks | 25 |
| 1.6.2 | Artificial seagrass: an alternative way to restore a seagrass habitat capacity | 25 |
| 1.7 | Knowledge gaps and research priorities | 26 |
| 1.7.1 | Estimates of carbon loss following different levels of habitat degradation | 26 |
| 1.7.2 | Species-specific canopy structure and the blue carbon | 27 |

| | |
|---|------------|
| capacity | |
| 1.7.3 The effective way to recover blue carbon sink capacity | 28 |
| 2. The impacts of tropical seagrass loss on blue carbon sink capacity | 29 |
| 3. The influences of species-specific seagrass canopy structure on blue carbon sink capacity | 59 |
| 4. Recovering local blue carbon stocks with artificial seagrass | 88 |
| 5. Conclusion and future work | 105 |
| 5.1 Conclusion | 105 |
| 5.1.1 Loss of sediment C_{org} stock following seagrass degradation | 106 |
| 5.1.2 Spatial variability of sediment C_{org} stock in seagrass ecosystem | 109 |
| 5.1.3 Blue carbon restoration using artificial seagrass | 110 |
| 5.2 Summary of research findings: key findings for tropical blue carbon reserves | 111 |
| 5.3 Implications for future research | 114 |
| Bibliography | 118 |
| Appendix | |
| Seagrass degradation at Khao Bae Na, Haad Chao Mai national park, | 143 |

LIST OF FIGURES

- Figure 1.1** Atmospheric warming and surface cooling (in $W m^{-2}$) due to light absorption by organic brown carbon aerosol (Feng et al., 2013).
- Figure 1.2** Mean long-term rates of carbon sequestration ($g C m^{-2} yr^{-1}$) in soils in terrestrial forests and sediments in vegetated blue carbon habitats (saltmarsh, mangrove and seagrass). Error bars indicate maximum rates of accumulation (Mcleod et al., 2011).
- Figure 1.3** The morphological features of seagrass (McKenzie, 2008).
- Figure 1.4** Seagrass meadow on Green Island reef flat, offshore Cairns, North Queensland, Australia (Apichanangkool, 2012).
- Figure 1.5** The conceptual diagram of sediment C_{org} stocks and fluxes in seagrass meadows. a) Seagrass meadows tend to be autotrophic communities because they uptake more carbon than they produce from respiration. b) Leaf litter is a part of sediment C_{org} and is exported to the nearby ecosystem. c) The autochthonous carbon (source) is derived from sources within seagrass meadows such as leaf litter and below-ground tissue. d) The seagrass canopy can trap and filter allochthonous C_{org} sources, such as mangrove materials and suspended organic carbon. The diagram was produced by the Integration and Application Network

(IAN), University of Maryland Center for Environmental Science, Cambridge, Maryland.

Figure 2.1 Sediment Dry Bulk Density (DBD) and sediment organic carbon (C_{org}) content. Sediment DBD (a) and sediment organic carbon (b) content measured at three different depths (0–3, 3–10, and 10–15 cm) in a pristine meadow, a denuded site and in unvegetated sediment in the Haad Chao Mai National Park, Trang Province, Thailand. Mean \pm S.E.M, n=10.

Figure 2.2 Comparison of sediment C_{org} stock in the upper 15 cm of sediment. Sediment C_{org} stocks were measured in the upper 15 cm of sediment in a pristine meadow, a denuded site and in unvegetated sediment in the Haad Chao Mai National Park, Trang Province, Thailand. The upper plot shows the average stock over 1 cm using data from the whole core, while the lower plot shows the average stock over 1 cm using data from three different depth ranges. The letters, a, b and c indicate significant differences between conditions as determined by the Tukey post hoc test (95% confidence level). The same letters given for different conditions indicates that no significant difference (95% confidence level) was detected. Mean \pm S.E.M, n=10.

Figure 2.3 Comparison of sediment carbon stock between three sediment depths (0–3, 3–10, and 10–15 cm) in a pristine meadow, denuded site and in unvegetated sediment. Sediment C_{org} stocks were measured at three depths in the upper surface of sediment (0–3, 3–10, and 10–15 cm) in a pristine meadow, a denuded site and in unvegetated sediment in the Haad

Chao Mai National Park, Trang Province, Thailand. The letters, a, b and c indicate significant differences between conditions as determined by the Tukey post hoc test (95% confidence level). The same letters given for different conditions indicates that no significant difference (95% confidence level) was detected. Mean \pm S.E.M, n=10.

Figure 2.4 N/C vs. $\delta^{13}\text{C}$ in ternary mixing diagrams of the potential sediment C_{org} sources including seagrass, mangrove and SPM. The potential sources are expanded according to the standard deviations of the end members to account for natural variability and analytical error. Samples that fall within the ternary diagram were collected from a pristine meadow, a denuded site and in unvegetated sediment at three depths from the sediment surface: 0–3 (white), 3–10 (grey), and 10–15 cm (black).

Figure 2.5 Benthic community production. Benthic community production – net community production, respiration and gross primary production – were compared among a pristine meadow, a denuded site and in unvegetated sediment in the Haad Chao Mai National Park, Trang Province, Thailand. The letters, a, b and c indicate significant differences between conditions as determined by the Tukey post hoc test (95% confidence level). The same letters given for different conditions indicates that no significant difference (95% confidence level) was detected. Mean \pm S.E.M, n=3.

Figure 3.1 Comparison of seagrass shoot densities in seagrass meadows with 75% and 12% covers of *T. hemprichii* and *E. acoroides*. The letters, a, b and c, indicate significant differences between treatments as determined by

Tukey post hoc tests (95% confidence level). The same letters given for different treatments indicates that there was no significant difference detected (95% confidence level). Mean \pm S.E.M, n=10.

Figure 3.2 Comparison of seagrass above- and below-ground biomass in seagrass meadows with 75% and 12% covers of *T. hemprichii* and *E. acoroides*. The letters, a, b and c, indicate significant differences among treatments as determined by Tukey post hoc tests (95% confidence level). The same letters given for different treatments indicates that no significant difference (95% confidence level) was detected. Mean \pm S.E.M, n=10.

Figure 3.3 Comparison of sediment C_{org} stock in seagrass meadows with 75% and 12% covers of *T. hemprichii* and *E. acoroides*, and unvegetated sediment across three sediment depths (0–3, 3–10, and 10–15 cm). * indicate significant difference between seagrass species and between percent cover (95% confidence level). The letters a, b and c indicate significant differences among 5 meadows as determined by the Tukey post hoc tests (95% confidence level). Mean \pm S.E.M, n=10.

Figure 3.4 The carbon content of each potential source (seagrass, mangrove and SPM) in sediment depth 0-3 (a), 3-10 (b), and 10-15 cm (c) from 75% and 12% cover of seagrass species; *T. hemprichii* and *E. acoroides* meadow and unvegetated sediment.

Figure 3.5 Comparison of benthic community production (NCP, R and GPP) among 75% and 12% cover of seagrass species; *T. hemprichii* and *E. acoroides* meadow and an unvegetated sediment. The letters, a, b and c, indicate

significant differences among treatments as determined by the Tukey post hoc tests (95% confidence level).

Figure 4.1 Comparison of deposition of a) particle and b) C_{org} among 1) denuded with artificial seagrass and 2) denuded site at Khao Bae Na and 3) pristine with artificial seagrass; 4) pristine meadow, and 5) unvegetated sediment with artificial seagrass. The letters, a, b and c, indicate significant differences among treatments as determined by the Tukey post hoc tests (95% confidence level). Mean \pm S.E.M.

Figure 5.1 Summary of key findings for tropical blue carbon reserves.

LIST OF TABLES

- Table 2.1.** Repeated-measures ANOVA of sediment C_{org} stocks in a pristine meadow, a denuded site and in unvegetated sediment in the Haad Chao Mai National Park, Trang Province, Thailand, at three upper sediment depths (0–3 cm, 3–10 cm, and 10–15 cm). $n = 10$.
- Table 2.2.** The percentage volume of sediment grain sizes (mm) in a pristine meadow, a denuded site and in unvegetated sediment at three depths (0–3 cm, 3–10 cm, and 10–15 cm) in the Haad Chao Mai National Park, Trang Province, Thailand. Mean \pm S.E.M., $n = 10$.
- Table 3.1.** Comparison of sediment dry-bulk density (DBD) and organic carbon (C_{org}) content in seagrass meadows containing two seagrass species (*T. hemprichii* and *E. acoroides*) at 75% and 12% covers and in unvegetated sediment at 3 depths (0–3 cm, 3–10 cm, and 10–15 cm) below the sediment surface (Mean \pm S.E.M; $n=10$).
- Table 3.2.** Summary of repeated-measures ANOVA of sediment organic carbon (C_{org}) stocks in seagrass meadows with a 75% cover of *T. hemprichii*, 75% cover of *E. acoroides*, 12% cover of *T. hemprichii*, 12% cover of *E. acoroides* and in unvegetated sediment at three depths (0–3 cm, 3–10

cm, and 10–15 cm). * indicates a significant difference among treatments (95% confidence level) (n = 10).

Table 3.3. Mean, minimum and maximum of the source contribution (%) (Statistic output from IsoSource) of carbon at three sediment depths (0–3, 3–10, and 10–15 cm) in seagrass meadows with 75% and 12% covers of *T. hemprichii* and *E. acoroides* and in unvegetated sediment.

Table 3.4. Comparison of community metabolism (NCP, R and GPP) between two seagrass species (*T. hemprichii* and *E. acoroides*) in seagrass meadows with 75% and 12% covers and in unvegetated sediment. Data was analysed using the one-way ANOVA for NCP, R, and GPP. * indicates a significant difference among treatments (95% confidence level) (n=3).

Table 4.1. Comparison of particle deposition rate and C_{org} deposition rate in five experimental sites: denuded with artificial seagrass; denuded site; pristine with artificial seagrass; pristine meadow; and unvegetated planted with artificial seagrass. Data was analysed using the one-way ANOVA of particle deposition rate and C_{org} deposition rate. * indicates a significant difference among five treatments (95% confidence level).

Table 4.2. Mean, minimum and maximum source contribution (%) (Statistic output from IsoSource) of carbon deposited at different experimental sites: denuded with artificial seagrass; denuded site; pristine with artificial seagrass; pristine meadow; and unvegetated with artificial seagrass.

ABBREVIATION

| | |
|------------------|------------------------------|
| C _{org} | Organic carbon |
| df | Degrees of freedom |
| DO | Dissolved oxygen |
| GPP | Gross primary production |
| MS | Mean square |
| NCP | Net community production |
| POC | Particulate organic carbon |
| R | Respiration |
| SPM | Suspended particulate matter |

ABSTRACT

Carbon dioxide (CO₂) emission through human activities is one of the most critical issues affecting the entire globe. Among the solutions, carbon sequestration is an important way to reduce atmospheric CO₂. Vegetated coastal habitats – seagrasses, saltmarshes, and mangroves – are among the most effective carbon sinks of the world. These habitats capture and store (sequester) large quantities of organic carbon (C_{org}), termed ‘blue carbon’. The rapid decline of seagrass in many areas around the world, especially in Southeast Asia has motivated us to study the carbon-sink capacity of tropical Blue Carbon habitats, as well as the impact of the loss of seagrass. This study comprised of three major aims: 1) to investigate the impact of seagrass loss on blue carbon sink capacity; 2) to investigate the influence of seagrass species-specific canopy structure on blue carbon sink capacity; and 3) to investigate the feasibility of using artificial seagrass for blue carbon restoration.

Seagrass meadows at Haad Chao Mai National Park, Trang, Thailand trap allochthonous (externally-produced) carbon into sediment reaching up to 90% of C_{org} stored. At a pristine meadow, seagrass densities play a major role in determining the sediment C_{org} stock. Seagrass canopy height was found to be not important when comparing C_{org} sink capacity between *Thalassia hemprichii* (medium-sized species) and *Enhalus acoroides* (large-sized species) in this study. On the other hand, seagrass densities influenced the trapping capacity of allochthonous carbon. The sediment

organic carbon sources of *T. hemprichii* and *E. acoroides* beds for all densities tested were similar (dominated by suspended particulate matter and mangrove for the top 15 cm of sediment). High shoot densities of seagrass could promote the settlement of suspended particles by increasing the chance of particle to contact directly with leaf blade. Seagrass biomass influenced the community metabolism. The Net Community Production (NCP) of seagrass meadows was higher with increased above-ground biomass. NCP measured in meadows with 75% cover of *T. hemprichii* (104.59 ± 21.72 mmol C m⁻² d⁻¹) and *E. acoroides* (166.92 ± 12.32 mmol C m⁻² d⁻¹) were higher than these of NCP measured in meadows with 12% cover of *T. hemprichii* (63.54 ± 5.53 mmol C m⁻² d⁻¹), *E. acoroides* (78.09 ± 4.63 mmol C m⁻² d⁻¹) and unvegetated sediment (53.36 ± 4.11 mmol C m⁻² d⁻¹). Seagrass loss following elevated sedimentation and increasing water turbidity lead to the loss of 89% of sediment organic carbon (C_{org}) stock. Loss of seagrass resulted in the loss of allochthonous carbon trapped by the seagrass canopy. Loss of seagrass also altered the sediment grain size distribution. Elevation of coarse grains was found in a denuded site compared to a pristine meadow. About 50% of sediment grain size from the pristine meadow consisted of fine sand (0.125 – 0.25 mm), while 50% of sediment from the pristine meadow consisted of very fine sand (0.0625 – 0.125 mm). The evidence of a weakened blue carbon sink due to seagrass loss was also found as a reduction of carbon sequestration. The level of Net Community Production (NCP) at a denuded site (21.13 ± 8.30 mmol C m⁻² d⁻¹) was lower than the NCP measured at a pristine meadow (53.36 ± 4.11 mmol C m⁻² d⁻¹).

While the negative impact of seagrass loss on blue carbon sink capacity was evaluated, artificial seagrass was shown to be an innovative technique to enhance particle- and organic carbon deposition. The particle deposition measured at the denuded site with artificial seagrass was 3-times higher than the particle deposition rate measured at the

denuded site without artificial seagrass. The organic carbon trapped by artificial seagrass was 12-times higher than occurred at these denuded sites without artificial seagrass. There was no significant difference in the particle deposition rate and organic carbon deposition rate between an artificial seagrass experiment and the natural pristine seagrass meadows. Thus, artificial seagrass is an effective tool to recover blue carbon sink capacity where the allochthonous carbon is a major carbon source, artificial seagrass is an effective tool in the recovery of blue carbon sink capacity – it enables a more rapid recovery and requires less effort than other restoration techniques. For better estimates of blue carbon sink capacity, seagrass abundance was recommended as an appropriate monitoring indicator because it influences the sediment C_{org} stock, while species-specific canopy height did not play an important role determining sediment C_{org} stock in this particular study.