CHAPTER I

INTRODUCTION

1.1 Background

Blue carbon ecosystems are critical natural systems that sequester carbon, enhance coastal and marine biodiversity, and provide protection against shoreline erosion, extreme weather events, pollution, and sea level rise (Choudhary, Dhar, and Pawase, 2024) . Mangroves are one of the blue carbon coastal ecosystems known for their significant long-term carbon storage capacity and strong potential to reduce greenhouse gas emissions and atmospheric carbon dioxide levels (Choudhary et al., 2024). Among coastal ecosystems, mangroves have the most well-defined carbon budget, globally absorbing approximately 700 million tons of carbon per year through gross primary production, while releasing about 525 million tons (75%) back into the atmosphere as carbon dioxide through respiration (Alongi, 2014). Mangroves absorb large amounts of carbon dioxide through photosynthesis, making them vital for climate change mitigation and requiring regular monitoring (Paramanik, Varghese, Behera, Barnwal, Behera, and Bhattyacharya, 2022).

Accurately measuring, mapping, and monitoring of mangrove forests are essential for the sustainable management of blue carbon in mangrove forests (Dutta, Pitumpe, Watt, Kale, Davies, Heng et al., 2024). Only a limited number of studies have focused on estimating their carbon stocks, mainly because of the technical challenges and the limitations of traditional methods. These challenges encompass financial limitations, workforce availability, time requirements, and the processing of data inventories (Mariano, Da, and De, 2024). Moreover, the difficult accessibility of mangrove habitats has led most studies to be restricted to small areas and reliant on a limited number of field samples (Wang, Wan, Liu, Su, Guo, Qiu, and Wu, 2020). These constraints emphasize the need to develop more advanced methods to improve mangrove carbon stock assessment.

Remote sensing (RS) provides effective methods for accurately estimating carbon stocks in mangrove forests, addressing the difficulties posed by conventional methods. Conventional methods rely exclusively on field surveys for estimation, limiting their effectiveness to small-scale areas (Nguyen and Nguyen, 2021). In contrast, RS provides a solution to the challenges of fieldwork, especially through passive RS, which is both cost-effective and easy to interpret, while providing comprehensive information (Shangari, Shams, Azari, Shamshirdar, Baltes, and Sadeghnejad, 2017). Satellite-based research is becoming more prevalent due to the increasing availability of satellite data, enhanced image resolution, time-series datasets, and reduced time and computational costs (Tassi and Vizzari, 2020). Vegetation indices (VIs) can demonstrate a strong correlation with mangrove aboveground biomass (AGB), as demonstrated by models achieving R^2 values of 0.81 using Sentinel-2 (Farzanmanesh, Khoshelham, Volkova, Thomas, Ravelonjatovo, and Weston, 2024), and 0.90 using Lansat-8 (Mariano et al., 2024). However, Unmanned Aerial Vehicles (UAVs) can carry multiple sensors, allowing for the collection of various data types at different resolutions (Rina, Ying, Shan, Du, Liu, Li, Deng, 2023). The advancement of RS methods is essential for estimating mangrove biomass, especially in large-scale areas that are difficult to access. UAVs should be employed to estimate the biomass and carbon stocks of mangroves using VIs due to their exceptionally high spatial resolution and the ability to take off at any time, on the other hand, satellites have limitations such as revisit time, lower resolution, and atmospheric distortion.

Thailand, located in Southeast Asia (SEA), has a substantial wealth of mangrove forests. Between 1989 and 2020, the mangrove area in the Lower Mekong Region (LMR), encompassing Myanmar, Thailand, Cambodia, and Vietnam, there was a dramatic increase (Bajaj, Sasaki, Tsusaka, Venkatappa, Abe, and Shrestha, 2024). In Thailand, the mangrove area nearly doubled, rising from 339,613 hectares to 601,642 hectares during that period (Bajaj et al., 2024). This emphasizes the need to explore carbon storage in the expanding mangrove areas, particularly in regions where carbon levels have not been examined.

The Banlaem mangrove forest is a promising area that should deserve consideration for its role as a carbon sink. It is located within the Banlaem community of Tha Sala, Nakhon Si Thammarat, in Southern Thailand. Based on a personal interview with the community tourism coordinator (Minmun, personal communication, June 23, 2024), the area underwent an ecological transition from a sandy beach to a muddy-soil wetland approximately 30 to 40 years ago (1984–1994). Following this transformation, various mangrove planting initiatives were implemented, particularly the introduction of loop-root mangroves (*R. mucronata*), which facilitated the rapid expansion of the mangrove ecosystem. However, regarding carbon assessment efforts, this community lacks statistical data on carbon storage, which would facilitate impact assessments and monitoring efforts in this mangrove area.

To address these gaps, this study aimed to 1) evaluate AGB and AGC stocks in the Banlaem mangrove forest located in Nakhon Si Thammarat, Thailand, and 2) generate AGB models from an UAV in the mangrove forest. Furthermore, this study represents the first effort to identify the biodiversity of mangrove trees within the Banlaem mangrove forest. A ground truth assessment was conducted to establish baseline measurements AGB and AGC stocks for validation against RS data. Regression analysis was employed to develop models for estimating AGB in relation to VIs and the canopy height model (CHM). The results of this research will provide a valuable tool for estimating carbon storage in the Banlaem mangrove forest, assisting land managers in making informed decisions regarding harvesting, tree planting, and habitat conservation in this promising area, thereby fostering community engagement in sustainable management and carbon offset initiatives

1.2 Research Objectives

1.2.1 To evaluate AGB and AGC stocks in the Banlaem mangrove forest located in Nakhon Si Thammarat, Thailand

1.2.2 To generate AGB models from an UAV in the mangrove forest

1.3 Scope of the Study

The scope of this study is to assess the AGB and AGC stock of the mangrove forest, followed by the development of an AGB model utilizing RS and regression techniques. The research was carried out in the mangrove forest (ecotourism zone) of the Banlaem community, Moo 7, Tha Sala Subdistrict, Tha Sala District, Nakhon Si Thammarat Province, Southern Thailand (**Figure 1.1**). The study was conducted from April 2023 to July 2024.

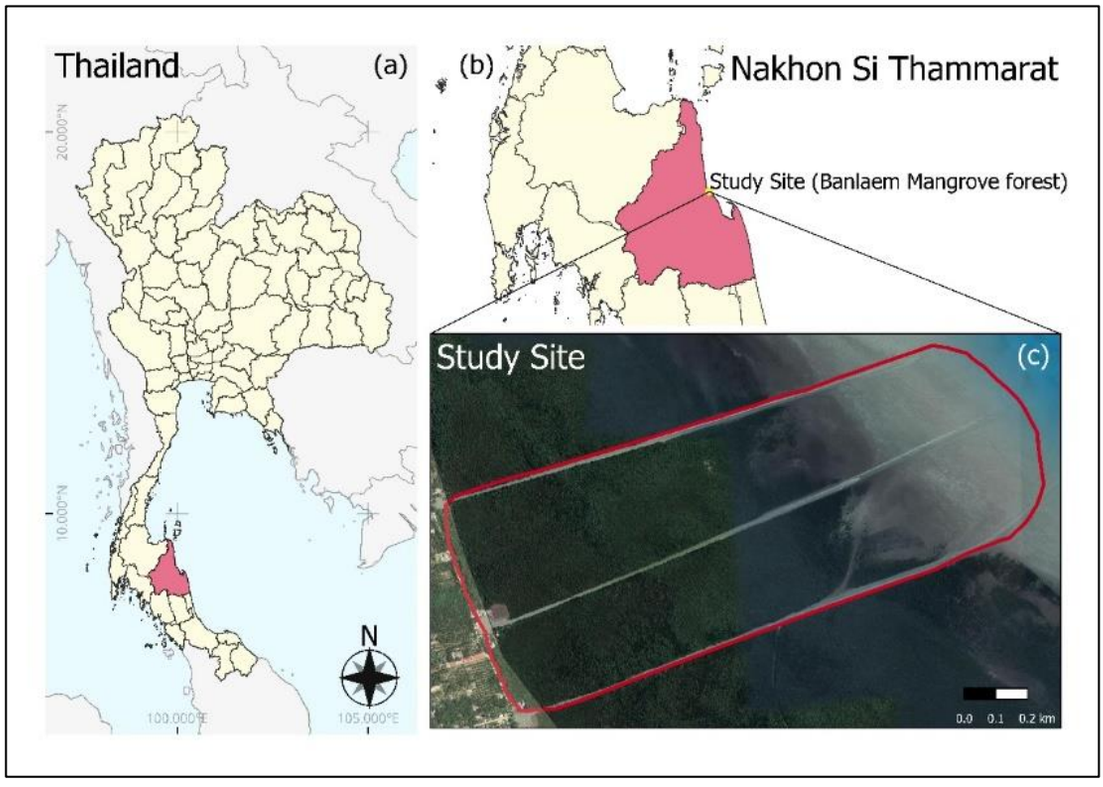

Figure 1.1 The study area: a) Thailand map; b) Nakhon Si Thammarat province; and c) the study site in Banlaem mangrove forest.