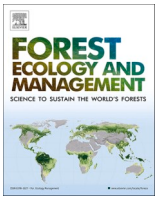
Forest Ecology and Management 527 (2023) 120611

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco



Total ecosystem blue carbon stocks and sequestration potential along a naturally regenerated mangrove forest chronosequence

Mohd. Safwan Azman [a], Sahadev Sharma [b,*], Maya Liyana Hamzah [c], Rozainah Mohamad Zakaria [a,b], Kishneth Palaniveloo [b], Richard A. MacKenzie [d]

[a] Institute of Biological Sciences, Faculty of Science, Universiti Malaya, Kuala Lumpur, Malaysia
[b] Institute of Ocean and Earth Sciences, Universiti Malaya, 50603 Kuala Lumpur, Wilayah Persekutuan, Kuala Lumpur, Malaysia
[c] Institute for Environment and Development, University Kebangsaan Malaysia, Selangor, Malaysia
[d] Institute of Pacific Island Forestry, USDA Forest Service, Hilo, HI, USA

ARTICLE INFO

Keywords:
Global climate change
Restoration
Forest age
Nature-based solutions
Environmental settings
Greenhouse gas emissions

ABSTRACT

Naturally regenerated (NR) mangroves offer an excellent passive approach for climate change mitigation and adaptation under UN decade of restoration program. However, the support of NR mangroves on total ecosystem carbon (TEC) stocks and sequestration potential remained unclear across forest stand development process that can significantly vary spatially and temporally due to regeneration age. Using the 'space for time' approach, this study quantified the TEC stocks along the Merlimau - Kuala Sebatu fringing mangrove habitat expansion chronosequence that comprised of 3, 6, 12, 18, 25 years age and intact stands. We also estimated the carbon (C) sequestration potential of each stand-age by comparing with un-vegetated mudflats as control. We collected aboveground tree, belowground root, downed woody debris, litterfall and soil core up to 2 m for TEC quantification and C sequestration. Mean TEC stocks ranged from 232 ± 69 to 296 ± 49 Mg C/ha for NR3 and NR25 respectively at the study area. TEC stocks from different aged NR and intact mangroves were not significantly different from each other and therefore did not affect by age. Aboveground trees C and downed wood C pools were significantly affected by stand-age. In contrast, sediment C stocks (representing up to 80 %) remained generic over many years, driving the constant of TEC stocks in this study. Equally affected by age, the NR mangroves sequestered total C of 2.28 to 17.38 (mean ± SE: 7.36 ± 1.88 Mg C/ha yr^{-1}), with younger stands (NR3) holding almost six times higher total C sequestration rates than older mangroves (NR25). Our study suggests that highly suspended sediments driving from upstream, especially in the younger mangrove stands at a lower elevation, supports higher bulk density and C accumulation rate in the sediment as they expand seaward. This study proves that NR mangroves comprised primarily of younger mangrove stands can be a C sequestrator powerhouse that promises nature-based climate solutions through avoidance and management. Though, future research is needed to understand how better management and conservation practices can affect or towards increasing trend of TEC especially sediment carbon stock that holds almost 80 % of total TEC.

1. Introduction

Increasing atmospheric greenhouse gases that drive global climate change have far more detrimental environmental and health effects over decades, it is often overshadowed by the catastrophic threat of term climate change itself. Conservation, management and restoration of mangrove forests under the blue carbon (C) initiative (alongside seagrasses and saltmarshes) (Nelleman et al. 2008, Pendleton et al. 2012) have received immense international attention that can help in climate change mitigation and adaptation. Mangrove forests have been well documented for keeping up with sea-level rise (Alongi 2008, Kirwan and Megonigal 2013, Lovelock et al. 2015) and storing a large amount of C in the form of biomass and detritus (Hamilton and Friess 2018, Kauffman et al. 2020, Sharma et al. 2020). Mangrove blue C stocks and sequestration capability get the most attention now in the fight to reduce C emissions as they have been discovered to store 3–5 times more C in the long-run, especially in soil and sequester a lot more C per unit area compared to other temperate or tropical forest ecosystems (Donato et al.

* Corresponding author.
E-mail addresses: ssharma.shell@gmail.com, ssharma@um.edu.my (S. Sharma).

https://doi.org/10.1016/j.foreco.2022.120611
Received 29 July 2022; Received in revised form 26 October 2022; Accepted 27 October 2022
Available online 10 November 2022