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**Research Data Article**

# Carbon stock and $\delta^{13}C$ data of sediment samples collected from a tropical seagrass meadow in Malaysia

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**Abstract**

Seagrass ecosystems are considered as major blue carbon sinks, thus contributing directly to the mitigation of climate change by storing carbon in their habitats. However, empirical data for carbon stocks in Malaysia seagrass meadow sediment remain unreported in a standardised format. This paper presents data on organic (OC) and inorganic carbon (IC) stocks, and stable isotope signatures of carbon ($\delta^{13}C$) in bulk seagrass sediments collected from Sungai Pulai estuary (Johor, Malaysia). Within this estuary, seagrasses form shoals at Tanjung Adang and Merambong. Organic carbon and $\delta^{13}C$ values in bulk sediment were analysed by an elemental analyser and a continuous flow isotope-ratio mass spectrometer, respectively, while sediment IC data was derived from loss-on-ignition calculations of sample mass differences. The data from these samples are presented as downcore profile of OC (values range at 0.14% to 2.49%), IC (0.16% to 5.29%), $\delta^{13}C$ values of organic matter (-27.9‰ to -20.4‰), and cumulative carbon stocks (1.03-3.39 kg OC $m^{-2}$ and 0.76-2.84 kg IC $m^{-2}$) in the top 30 cm of sediments. This dataset is applicable for regional and local blue carbon studies, which would allow insights into carbon sink and carbon cycling capacity, in addition to gaining insights into the provenances of carbon stored in seagrass meadows.

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**Keywords:** blue carbon; estuary; organic carbon; $CaCO_3$; source provenance

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## Introduction

Seagrass ecosystem has been considered as efficient natural carbon sink (1) but a large variation in carbon storage capacity exists depending on the composition of the species and its habitat characteristics (2). One of the important ways to mitigate climate change is through the storage and retention of blue carbon in vegetated coastal ecosystem such as seagrass meadows. Carbon sequestration in seagrass meadow plays a vital role in the carbon cycle (3–5), and particularly, for long-term carbon storage (6). Blue carbon ecosystems are often threatened by anthropogenic causes, which lead to the losses of seagrass meadow and the reduction of carbon storage capacity. Increasing losses of the seagrass ecosystem worldwide weakens the carbon sink capacity (7) and will cause re-emission of $CO_2$ back to the atmosphere (8). In this article, data on the carbon characteristic of sediment is presented for the seagrass meadows of Sungai Pulai Estuary (Johor, Malaysia). The data provides a primary baseline in the ecosystem services for carbon storage, which would be useful in applying to studies related to understanding carbon cycling and the origin of the carbon at a meadow-wide scale.

## Materials and Methods

### *Sampling activity*

Samples were taken from three sampling sites: Tanjung Adang (N 010 19' 14.3", E 1030 33' 54.7"), West Merambong and East Merambong shoals (N 010 20' 17.5", E 1030 36' 11.3) (Fig. 1). These sites are located at Sungai Pulai estuary (Johor, Malaysia). Within the estuary, mangrove forests and seagrass meadows can be found (9,10). In recent times, this area had been disturbed through anthropogenic modifications such as coastal reclamation activities (10).

Sediment cores were collected from Aug 2015 to Jan 2016 to elucidate carbon characteristics in sediments of the seagrass meadow. Sampling was performed during low tides when the seagrass meadow was exposed from submersion. The sediment cores (n=22) were taken from different sediment patches of seagrass species by using PVC plastic pipes (50 mm internal diameter, 50 cm length). The ends of the coring pipes were sharpened and carefully hammered into the sediment to minimize core compression. Due to the relatively short cores sampled, compression was observed to be 10-15% relative to undisturbed sediments. This was factored in corrections of core lengths. In Tanjung Adang shoal, cores were collected from sediment patches colonised by *Enhalus acoroides, Cymodocea serrulata, Halophila ovalis,* and *Halodule pinifolia* growths. An additional unvegetated (bare) patch (11) was collected from the same meadow. From West Merambong shoal, cores were collected from *E. acoroides* and *T. hemprichii* patches, while only *E. acoroides* patches were selected for coring from East Merambong shoal.

### *Carbon stocks and δ$^{13}$C analysis*

Sediment cores were extruded from the core barrel and cut into 1 cm-wide slices up to 30 cm along the corrected core length. Samples were then dried in the oven at 60˚C to constant weight and the measurements were used to calculate for sediment dry bulk density following the equation:

Dry bulk density (g cm$^{-3}$) = dry weight of sample (g) / volume of core (cm$^{-3}$) (Eqn. 1)

These sediment samples were then ground to a fine powder using a ball-mill grinder. Each sample of the sediment was divided into inorganic carbon analysis (2 - 4 g) and organic

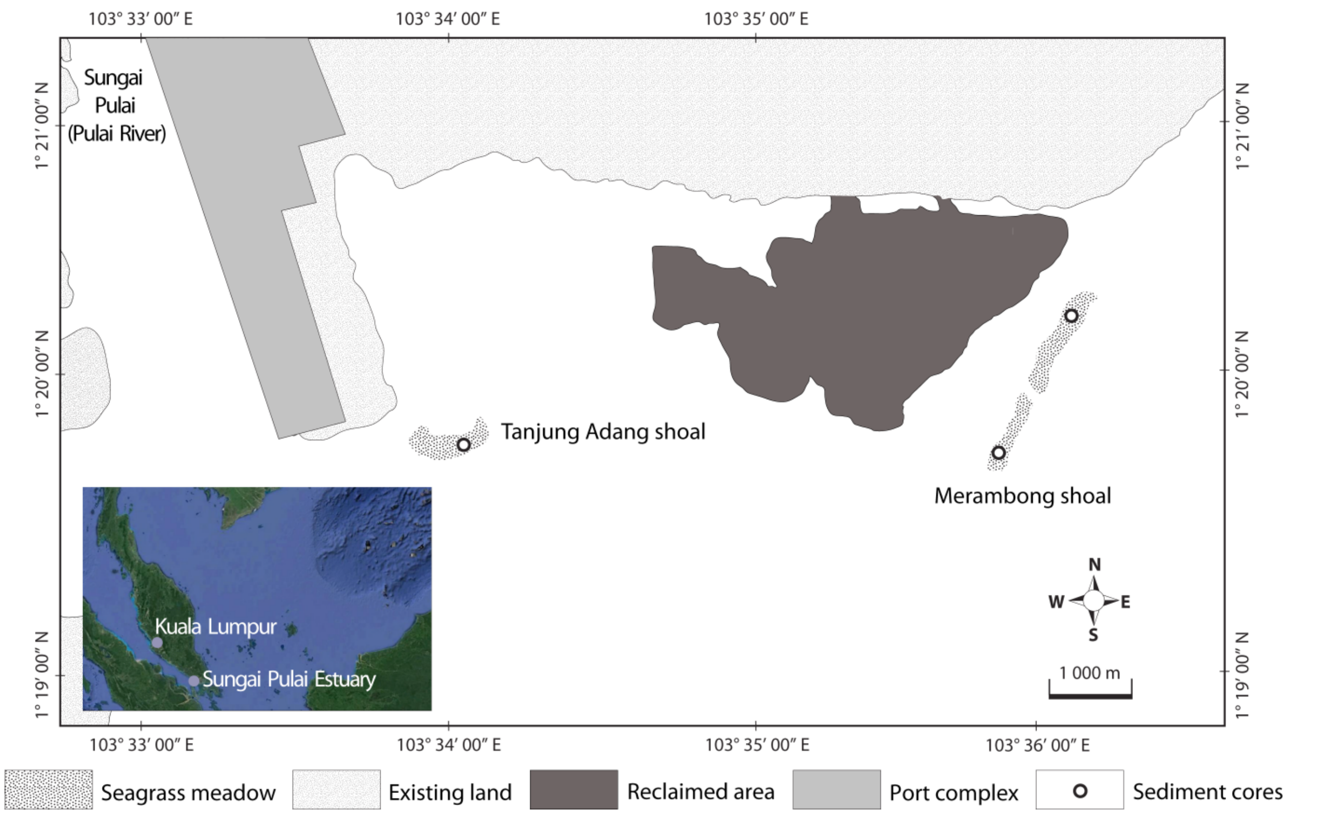


**Fig. 1.** Map of Sungai Pulai estuary core sampling locations. For Merambong Shoal, the lower half of the meadow represents West Merambong shoal and the upper half represents East Merambong Shoal.

**Table 1**: Data of organic and inorganic carbon stocks designated according to sediment patches (top 30 cm sediment depths) colonised by the different seagrass species and GPS coordinates of sediment cores from the sampling location.

| Location | Species patch | Core ID | OC stocks (kg m$^{-2}$) | IC stocks (kg m$^{-2}$) | GPS coordinates |
|---|---|---|---|---|---|
| Tanjung Adang shoal | *Cymodocea serrulata* | TA1 | 2.62 | 2.84 | N1° 19.835' E103° 34.097' |
| | | TA2 | 3.05 | 2.07 | N1° 19.835' E103° 34.095' |
| | | TA3 | 3.39 | 2.51 | N1° 19.835' E103° 34.091' |
| | *Halophila ovalis* | TA4 | 2.23 | 1.42 | N1° 19.842' E103° 34.075' |
| | | TA5 | 1.70 | 1.64 | N1° 19.840' E103° 34.072' |
| | | TA6 | 2.55 | 2.66 | N1° 19.838' E103° 34.068' |
| | *Halodule pinifolia* | TA7 | 1.20 | 2.75 | N1° 19.821' E103° 34.047' |
| | | TA8 | 1.03 | 2.02 | N1° 19.821' E103° 34.045' |
| | | TA9 | 1.72 | 2.06 | N1° 19.820' E103° 34.037' |
| | *Enhalus acoroides* | TA10 | 2.20 | 1.49 | N1° 19.851' E103° 34.087' |
| | | TA11 | 2.52 | 1.85 | N1° 19.853' E103° 34.084' |
| | | TA12 | 2.75 | 1.85 | N1° 19.857' E103° 34.080' |
| | Bare patch | TA13 | 1.45 | 2.44 | N 1°19.814' E103° 34.024' |
| West Merambong shoal | *Enhalus acoroides* | WM1 | 2.64 | 1.86 | N1°19.821' E103° 35.917' |
| | | WM2 | 1.35 | 1.70 | N1°19.868' E103° 35.990' |
| | | WM3 | 1.25 | 0.76 | N1° 19.88' E 103° 35.950' |
| | *Thalassia hemprichii* | WM4 | 1.38 | 1.73 | N1° 19.856' E103° 35.925' |
| | | WM5 | 1.45 | 1.09 | N1° 19.853' E103° 35.923' |
| | | WM6 | 1.49 | 2.03 | N1°19.851' E103° 35.922' |
| East Merambong shoal | *Enhalus acoroides* | EM1 | 1.33 | 1.49 | N1° 20.292' E103° 36.188' |
| | | EM2 | 1.23 | 1.03 | N1° 20.285' E103° 36.183' |
| | | EM3 | 1.55 | 1.62 | N1° 20.285' E103° 36.177' |

carbon analysis (1.5 g). For inorganic carbon (IC) analysis, 2- 4 g sediment samples were combusted in the furnace (550˚C, 5 h) to get the weights of organic matter and $CaCO_3$ by differences in combustion and re-combustion weight (12). The IC content of the $CaCO_3$ was then calculated through stoichiometric mass balances (6). For organic carbon (OC) analysis, 1.5 g of ground samples were acidified by using 1 M hydrochloric acid to remove $CaCO_3$ that was present in the sediments. After that, the sediment samples were centrifuged (3,000 rpm, for 5 min). The supernatant resulting from the centrifuging process was decanted, and the sample washed with distilled water to remove residual acid. Samples were then dried in the oven (60˚C) for 3 days until constant weight was reached. Subsequently, the sediment samples were encapsulated in tin capsules and combusted in an elemental analyser coupled to a continuous flow isotope ratio mass spectrometer (IRMS) to obtain the carbon elemental content and $\delta^{13}C$ signatures, respectively.

Organic carbon data was reported as the corrected mass after accounting for pre-acidified bulk sediments. The $\delta^{13}C$ values were reported relative to the Vienna Pee Dee Belemnite (VPDB) standard with accuracy up to 0.1‰, based on the equation:

$$\delta^{13}C\ (‰) = [(R_{sample} / R_{standard}) - 1] \times 10^3$$, where R refers to $^{13}C$ / $^{12}C$ values. (Eqn. 2)

Carbon stocks per unit area were calculated by multiplying the sediment dry bulk density (in g cm$^{-3}$) by the carbon content (either %OC or %IC) to obtain the carbon density (in g C cm$^{-3}$). Empirical data of OC and IC is presented as cumulative mass (in kg C m$^{-2}$). This was calculated based on the summation of carbon stocks within all the layers in a sediment core up to the distal end of the core sample (*i.e.* 30 cm).

## Result

### *Data*

Empirical data is summarised in the figures and tables. Fig. 1 shows the map of the study site. Table 1 represents the core sampling points in the seagrass meadow. Supplementary Table S1 provides data on the sediment biogeochemical analyses.

## Discussion

In this research data, we provide site-specific data on organic carbon and $\delta^{13}C$ signatures that represents the carbon storage characteristics in the seagrass meadow. The baseline data provides an understanding on carbon storage and organic carbon provenances in the study site. This is because isotope tracers have been widely used over the last few decades in understanding the sources and pathways of organic and oceanic materials (13–15). In addition, the data provides insights into variability of carbon storage with increasing sediment depths. Specific to this study, information on the carbon storage potential in the seagrass meadows, which are under pressure from anthropogenic disturbances, can be elucidated (15) and thereby demonstrating the contemporary carbon storage potential of the meadow. Other potential reuse of this dataset includes a comparison of carbon storage in other seagrass meadows, especially in Southeast Asia. Organic carbon provenances within the sediment can be determined through Bayesian mixing models by incorporating the $\delta^{13}C$ values presented here (e.g. 15), in addition to construction of trophic level connectivity for feeding guilds within the meadow (e.g. 16). As ongoing work to understand meadow dynamics under anthropogenic influences, further potential uses of the data include applications to modelling ecosystem-level carbon budgets. This model will demonstrate the net inflow or outflow of carbon into the meadows, which is directly pertinent to the management of the seagrasses, and habitats surrounding the meadow.

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## Competing Interests

The authors have no conflict of interests.

## Authors' contribution

NH, SAT and MF carried out fieldwork, laboratory work, and analysed the data. NH and MR drafted the manuscript. MR conceived the study, and participated in its design and coordination.

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