Escalating the small-sized community green spaces’ role as the carbon storage in the coastal town

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Abstract. The community green space type is well-known as a public place with a superior aesthetic value. In contrast, this green space type can also have the principal ecological value because of the vegetation cover. This study was estimated the above-ground biomass and carbon stock of each tree species within the community green spaces in both coastal and terrestrial habitat to select some potential species to be more developed within both community green spaces in order to escalate the ecological value of the green spaces (carbon storage in a town area). All woody plants with a diameter at breast height (dbh) ≥ 20 cm were identified by the census method within three sampling plots in both Laman Brenda Park (Site 1) and Pamedan Ahmad Yani Park (Site 2). This study found that the tree community in Site 2 stores a higher carbon stock (15,433 kg/ha) than in Site 1 (1,744 kg/ha). The number of individual trees is the main driving factor of the amount of carbon stock on both sites. Some species from Lauraceae, Fabaceae, and Meliaceae that are incredibly tolerant of small mineral content soils, salinity, and lack of water content should be more developed in Site 1, specifically.

1. Introduction

Green spaces’ capability to remove carbon from the atmosphere by absorbing it and form it as carbon biomass is one of the ecological benefits found within the green spaces [1]. Some previous studies about the estimation of carbon biomass (carbon stock) already undertook within urban forests cover and the other conservation green spaces type, greenway green space type, community green space type and amenity green space type. These studies confirm the importance of green spaces as the carbon stock shed within an urban area. Specifically, to the community green spaces type, the aesthetic benefits frequently dominate the ecological benefits that cause the medium level of ecological benefits of this type of green space [2–13].

Due to the medium level of ecological benefit that is frequently discovered in the community green spaces type, this study was undertaken to select some tree species with a high ecological benefit, especially the amount of carbon stock per species to be more developed within the community green space. The goal is to escalate the community green spaces’ ecological value as the town area's carbon storage. This study also analyzed the diversity, dominance, and richness of the trees species in the community green spaces to obtain information about the tree community's structure in the community green spaces (supporting data).
The previous studies already took place in a community green space type within the residential area or an immediate urbanized area in the medium to large size based on the size classification of urban parks [9,10,14]. Therefore, this study took place in the small-sized community green space type in a small-sized coastal town to enrich the existing information about carbon stock in an urban green space from the different areas of the previous studies.

2. Methodology

2.1. Study sites
This study was undertaken at Laman Boenda Park (Site 1) and Pamedan Ahmad Yani Park (Site 2). Site 1 and Site 2 were set to be the study area of this study because they are the two largest urban parks in Tanjungpinang. Site one is a public park at the coastline with 9,780 m² (0.97 ha). Meanwhile, Site two is a downtown public park with 14,885 m² (1.49 ha) [15]. Initially, the location of Site 1 was a coastal area but had been reversed into the pavement area as one of the most popular recreational sites of Tanjungpinang. This site is surrounded by the government's and private's buildings and other green spaces, but the local area is not too dense. This site is also nearby to the highway of this town and Sri Bintan Pura International Ferry Terminal as the main gate for Indonesians and foreigners to visit some tourist destinations in Bintan Island (generally) and Tanjungpinang (specifically). Unlike Site 1, Site 2 is far away from the coastline and surrounded by densely built-up areas (predominated by commercial and government's buildings) and the highway. Both sites have the condition of sandy soil that tends to lack mineral content.

![Figure 1. Location of: (a) site 1 (0°55'46.8" N 104°26'26.9"E) and (b) site 2 (0°54'30.1"N 104°27'49.4"E). (Source: Google Earth Satellite Data, 2019)](image)

2.2. Trees species identification
This study's population is all trees in sites, while plants with ≥ 20 cm stem diameter are considered samples. The size of DBH is basically classified into 4 classes: Class 1 (7-20 cm), Class 2 (20-40 cm), Class 3 (40-60 cm), and Class 4 (> 60 cm) [16]. Since both study areas are categorized as small size park (the park size is < 4 acre or < 1.61 ha), the total of sampling plots for this study is only between 1-3 plots [14,17]. The entire sampling plots in Site 1 were three plots with the size 100 m x 20 m, while the total of sampling plots in Site 2 were three plots with size 30 m x 30 m. Vegetation inventory was undertaken using the census method by recording each discovered vegetation in the sub-plots area [18].

2.3. Analysis of data from the field observation
Shannon-Wiener diversity index (H') was utilized to analyze the diversity of the trees [19]. The larger Shannon-Wiener's index value implies the higher species diversity in the samples [20]. The species
dominance was analyzed by Simpson’s dominance index (D). The more considerable D index value implies the reduction of species diversity [21]. This study was also utilized Species Richness Index to obtain information about the number of species in the tree community of both study areas [19,21]. These analysis results would provide information about the tree community's structure in each site as the supporting data of this study. The above-ground tree biomass was estimated by multiplying the specific gravity of each tree (g/cm³), the dbh (cm), and the total height of each tree (cm) [22,23,24]. The above-ground biomass value was multiplied with 0.47 as the carbon fraction's coefficient to obtain each tree's carbon stock [25].

2.4. Statistical analysis
This study utilized SPSS Statistics software version 22 to execute Product Moment correlation to analysed the association between an independent and a dependent variable [26] with significance (α = 0.05). The total number of individual trees, the above-ground biomass, tree diversity, and dbh size are the independent variables while the amount of carbon stock per species is the dependant variable. The association between the variables is extremely strong if 0.90 ≤ r < 1 or -0.90 ≤ r < -1; sufficiently strong if 0.70 ≤ r < 0.90 or -0.70 ≤ r < -0.90; moderately strong if 0.50 ≤ r < 0.70 or -0.50 ≤ r < -0.70; sufficiently weak if 0.30 ≤ r < 0.5 or -0.30 ≤ r < -0.50; and extremely weak if 0.0 ≤ r < 0.30 or -0.00 ≤ r < -0.30 [27]. This study also utilized Independent Samples T-test to analysed the difference of the amount of carbon stock in both sites.

3. Results and discussion

3.1. Results

3.1.1. Site 1. There were 128 individual trees (Species Richness = 8; 4 introduced species and four native species; classified into five families) filled the vegetation cover in Site 1. The species diversity of tree community in Site 1 was recorded (H’ = 1.47) while the tree community (D) in Site 1 was 0.27. The tree community in Site 1 was dominated by Terminalia mantaly (48%), followed by Alstonia scholaris (16%), Tabebuia area (12%), and Wodyetia bifurcata (12%). Terminalia catappa was considered the biggest tree in Site 1 (117 cm DBH size), while Mimusops elengi was considered the smallest tree (20 cm DBH size) site. Class 2 trees (DBH = 41-60 cm) dominate the vegetation cover in Site 1 (64%), followed by Class 1 trees (DBH = 20-40 cm) (23%), and Class 3 trees (DBH = > 60 cm) (13%).

3.1.2. Site 2. There were 104 individual trees discovered in Site 2 (Species Richness = 14; 6 introduced species and eight native species; classified into 13 families). The tree community (H’) in Site 2 was 5.14, while the dominance value (D) was 0.14. Swietenia macrophylla dominates 30% of the tree community in Site 2, followed by Wodyetia bifurcata (15%), Terminalia catappa (11%), and Alstonia scholaris (10%). Acacia auriculiformis is the biggest tree (DBH size = 185 cm), while Polyalthia longifolia is the smallest tree (DBH size = 30 cm) in Site 2. Class 3 trees (DBH = > 60 cm) fill the 82% of tree community in Site 2; followed by Class 1 trees (DBH = 20-40 cm) (11%), and Class 2 trees (DBH = 41-60 cm) (7%). The dominance value (D) indicated the reduction of species diversity in an area [22]. Based on the findings, the tree community in Site 1 had a higher D value than the tree community in Site 2, indicating that the tree community in Site 1 was less diverse than Site 2.

There is a difference between the amount of carbon stock in Site 1 and Site 2 (α = 0.02 < 0.05). Site 2 (terrestrial habitat) shows a higher carbon stock amount than Site 1 (coastal habitat). Class 3 trees store the highest amount of carbon stock (1,076 kg) in Site 1, followed by Class 4 trees (512 kg) and Class 2 trees (18 kg), respectively. Unlike Site 1, Class 4 trees store the highest amount of carbon stock (15,170 kg) in Site 2, followed by Class 3 trees (182 kg) and Class 1 trees (69 kg), respectively. This study found that Terminalia mantaly was estimated to store the most carbon stock while Cerbera odollam store the
least carbon stock in Site 1. *Swietenia macrophylla* was estimated to store the most carbon stock while *Ficus elastica* stores the least carbon stock in Site 2. Further findings are shown in table 1.

**Table 1.** The amount of carbon stock of trees species in the study area.

| Site (coastal habitat) | Species       | Local name     | Family           | TI*   | Leaf color* | DBH* (cm) | AGB* (kg) | Carbon Stock (kg/ha) |
|------------------------|---------------|----------------|------------------|-------|-------------|-----------|-----------|----------------------|
| T. mantaly             | Ketapang      | Kencana        | Combretaceae     | 62    | 1           | 47        | 1,620     | 761                  |
| A. scholaris           | Pulai         | Apocynaceae    |                  | 21    | 2           | 57        | 683       | 321                  |
| T. aurea               | Tabebuya kuning | Bignoniaceae  |                  | 16    | 2           | 45        | 606       | 285                  |
| W. bifurcata           | Palem ekor tupai | Arecaaceae    |                  | 15    | 2           | 45        | 311       | 146                  |
| T. catappa             | Ketapang      | Combretaceae   |                  | 2     | 1           | 108       | 267       | 125                  |
| C. Nucifera            | Kelapa        | Arecaaceae     |                  | 6     | 1           | 56        | 163       | 77                   |
| M. elengi              | Tanjung       | Sapotaceae     |                  | 4     | 1           | 27        | 54        | 26                   |
| C. odollam             | Bintaro       | Apocynaceae    |                  | 2     | 2           | 22        | 6         | 3                    |
| Total                  |               |                |                  | 128   |             | 1,620     | 761       | 1,744                |

| Site (terrestrial habitat) | Species       | Local name     | Family           | TI*   | Leaf color* | DBH* (cm) | AGB* (kg) | Carbon Stock (kg/ha) |
|---------------------------|---------------|----------------|------------------|-------|-------------|-----------|-----------|----------------------|
| S. macrophylla            | Mahoni        | Meliaceae      |                  | 32    | 2           | 102       | 11,891    | 5,589                |
| T. catappa                | Ketapang      | Combretaceae   |                  | 12    | 1           | 116       | 7,875     | 3,701                |
| A. scholaris              | Pulai         | Apocynaceae    |                  | 10    | 2           | 125       | 4,635     | 2,179                |
| C. burmanii               | Kayu manis    | Lauraceae      |                  | 9     | 2           | 111       | 2,595     | 1,220                |
| A. auriculiformis         | Akasia daun kecil | Fabaceae     |                  | 1     | 1           | 185       | 1,826     | 858                  |
| T. grandis                | Jati          | Lamiaceae      |                  | 2     | 1           | 150       | 1,147     | 539                  |
| M. leucadendra            | Kayu putih    | Myrtaceae      |                  | 6     | 1           | 82        | 1,054     | 495                  |
| W. bifurcata              | Palem ekor tupai | Arecaaceae    |                  | 16    | 2           | 62        | 825       | 388                  |
| P. longifolia             | Glodogan tiang | Annonaceae    |                  | 6     | 2           | 66        | 730       | 343                  |
| M. elengi                 | Tanjung       | Sapotaceae     |                  | 3     | 2           | 47        | 107       | 50                   |
| S. aqueum                 | Jambu air     | Myrtaceae      |                  | 1     | 1           | 60        | 71        | 33                   |
| P. orientalis             | Cemara kipas | Cupressaceae   |                  | 3     | 1           | 43        | 38        | 18                   |
| F. benjamina              | Beringin      | Moraceae       |                  | 2     | 2           | 46        | 22        | 10                   |
| F. elastica               | Karet kebo    | Moraceae       |                  | 1     | 2           | 40        | 18        | 9                    |
| Total                     |               |                |                  | 104   |             | 3,711     | 15,433    | 15,433               |

*Note: TI: Total Number of Individual Trees per Species; Leaf color: (1: light green, 2: dark green); DBH: the average size of the tree’s diameter per species; AGB: Above-Ground Biomass per Species; CS: Carbon Stock per Species*

### 3.2. Discussion

According to the average size of dbh per species in table 1, the tree community in Site 2 was dominated by Class 4 trees (> 60 cm dbh) while Class 3 trees (40-60 cm dbh) dominate the tree community in Site 1. This study also found that these classes store the highest amount of carbon stock in each site. The dbh size \( r = 0.39; \alpha > 0.05 \) has an insignificant moderate, weak association with the amount of carbon stock per species in Site 2. The insignificant association between dbh size \( r = 0.07; \alpha > 0.05 \) and the carbon stock is also found in Site 1, even weaker than in Site 2. This finding contradicts the previous study that found a significant positive correlation between dbh and the carbon stock in urban parks [28]. Instead of the dbh size, this study found that the total number of individual trees \( \alpha > 0.05 \), species diversity \( \alpha > 0.05 \), and the carbon biomass per species \( \alpha > 0.05 \) provide a more significant positive association to the amount of carbon stock in both sites.
Terminalia mantaly (Combretaceae), Alstonia scholaris (Apocynaceae), Tabebuia aurea (Bignoniaceae), Wodyetia bifurcata (Arecaceae), Swietenia macrophylla (Meliaceae), Terminalia catappa (Combretaceae), Cinnamomum burmannii (Lauraceae), and Acacia auriculiformis (Fabaceae) are some species that are capable of storing carbon stock in a high amount in each site. Another study also found that Lauraceae, Meliaceae, and Fabaceae store the higher carbon concentration than the other families, similar to this study's finding. The variability of carbon stock/concentration among species could be affected by carbon fixation's capability among each tree [29]. Concerning carbon fixation, the leaf has a considerable contribution to carbon fixation because chlorophyll and stomata on the leaf are well-known to be the most influential factors in photosynthesis [30,31], which unfortunately did not analyze this study.

4. Conclusion
This study concluded that the number of individual trees is the main driving factor of the amount of carbon stock on both sites. Some species from Lauraceae, Fabaceae, and Meliaceae that are incredibly tolerant of small mineral content soils, salinity, and lack of water content should be more developed in Site 1, specifically.

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