Correlation of Carbon Stock and Biodiversity Index at the Small Scale Agroforestry Landscape in Ciliwung Watershed

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Abstract. Pekarangan is part of a complex of small-scale agroforestry landscape. Pekarangan have 3 functions i.e. ecological, economic, and social. ecological function, for providing landscape services such as carbon stock and biodiversity; economic function, can supplies foods and nutrition; and social function, for building low carbon communities and increasing the environmental awareness. Therefore, this research aims to correlate carbon stocks and biodiversity index of Pekarangan in Ciliwung Watershed. This study has measured 48 samples which were divided in three stream, namely upstream, midstream, and downstream. The samples were divided into four groups, G1 (pekarangan size less than 120 m² and doesn’t have other agricultural land - OAL), G2 (<120 m² with OAL < 1000 m²), G3 (120-400 m² with no OAL) and G4 (120-400 m² with OAL < 1000 m²). The results show that correlation between carbon stock and biodiversity index value is $R^2 = 0.05$. The results showed no correlation between carbon stocks and biodiversity index could be due to the amount of Pekarangan owners who prefer potted plants than plant a tree, so that the carbon sequestered in the Pekarangan only slightly.

1. Introduction

Pekarangan or home garden is a part of a complex small scale agroforestry landscape, usually located around the house and its range is only about 0.1 to 0.3 hectares [1]. Pekarangan have 3 functions i.e. ecological, economic, and social [1]. Ecological function is for providing landscape services such as carbon stock and biodiversity; economic function can supplies foods and nutrition; and social function is for building low carbon communities and increasing the environmental awareness. The biodiversity index of area has a great contribution to the preservation and the diversity of ecosystems, thus pekarangan as agroforestry systems provide a significant contribution to carbon storage area while also enhancing rural livelihoods [2] [3]. This research aims to determine correlation between carbon stock and biodiversity index at pekarangan in Ciliwung Watershed. In addition, to figures out whether biodiversity index inside pekarangan can influences of carbon stock value and vise versa. Both carbon stock and biodiversity index are type of landscape services which also be considered as the asset and ecosystem sharing value to improve rural community welfare [1].
2. Methods

2.1. Location, Tools, and Materials
This study is located in Ciliwung Watersheds (Figure 1). The tools used in this study consist of hardware and software, such as digital camera, stationery, measuring tools, laptop, and spreadsheet software. Materials used in this study is formula of carbon stock and biodiversity index (Table 1) and other materials obtained directly in the field.

![Figure 1. Ciliwung Watersheds Location](image)

| Table 1. Carbon stock and Biodiversity Indeks Formula |
|-----------------------------------------------------|
| **Carbon stock formula**                             |
| Allometric                                          | *(Tabel 2)* |
| Biomass [4]                                         | \( W_{tc} = Y \times 0.5 \) |
| **Biodiversity formula**                             |
| Shannon-Wiener [5]                                  | \( H = -\sum p_i \ln p_i \) |
| **Correlation**                                     | \( y = ax + b \) |

| Table 2. Allometric Equation for Biomass            |
|-----------------------------------------------------|
| **Plant**                                           | **Allometric** |
| *Tectona grandis* [6]                               | \( Y = 0.153 \ D^{2.39} \) |
| *Musa sp* [5]                                       | \( Y = 0.0303 \ D^{2.1345} \) |
| Multispecies D <5 [7]                               | \( \ln(\text{AGB}) = -3.50 + 1.65 \ln(D) + 0.842 \ln(H) \) |
| Another tree [3]                                     | \( Y = 42.69 - 12.8 \ D + 1.242 D^2 \) |

2.2. Methods
The method used in this study using survey and measurement on the field to get carbon stored and heterogeneity. There are 48 samples *pekarangan* and each 16 samples are in upstream, midstream, and downstream. Samples were taken by purposive random sampling (Figure 2). *Pekarangan* group were divided into four groups, namely as G1 (*pekarangan* size less than 120 m² and doesn’t have other agricultural land - OAL), G2 (120-300 m² with OAL < 1000 m²), G3 (120-400 m² with no OAL) and G4 (120-400 m² with OAL < 1000 m²).
3. Result and Discussion

3.1. Correlation of Carbon Stock and biodiversity index
Based on the formula in Table 1 and Table 2, carbon stock at pekarangan in Ciliwung watershed are around 0.13 Mg C/ha up to 27.15 Mg C/ha, the highest average in midstream reach to 7.71 Mg C/Ha, then up stream is 1.51 Mg C/ha and downstream 1.83 Mg C/ha (Table 3). The biodiversity index (Shannon Wiener Index) can be categorized from low to medium and ranges from 0.77 to 2.51, the highest average in downstream with 2.00, then upstream is 1.69 and midstream 1.77 (Table 4). Pekarangan in the downstream could be has higher biodiversity because the household tend to plant the ornamental plants for the aesthetic purposes [3].

Table 3. Carbon Stock (Mg C/ha)

| V1: Megamendung | MIDSTREAM | V1: Kedunghalang | V1: Pasar Minggu | V2: Cisarua | V2: Nanggewer | V2: Tebet |
|-----------------|-----------|-----------------|-----------------|------------|--------------|----------|
| KP. Pondok      | G1 2.76   | RW 03 G1 1.14   | RW 07 G1 0.68   | G1 0.32    | RW 01 G1 13.07 | RW 05 G1 1.97 |
| Gede            | G2 0.76   | G2 0.31         | G2 2.09         | G2 2.80    | G2 22.06     | G2 3.31  |
|                 | G3 0.58   | G3 3.73         | G3 1.42         | G3 1.03    | G3 10.43     | G3 0.72  |
|                 | G4 0.18   | G4 1.36         | G4 1.83         | G4 1.27    | G4 27.15     | G4 0.65  |
| KP. Pasir       | G1 6.58   | RW 05 G1 2.13   | RW 11 G1 1.24   | G1 0.19    | RW 07 G1 24.61 | RW 03 G1 0.85 |
| Muncang         | G2 0.13   | G2 0.39         | G2 6.44         | G2 0.40    | G2 4.34      | G2 1.19  |
|                 | G3 4.51   | G3 6.76         | G3 1.71         | G3 0.26    | G3 1.88      | G3 0.47  |
|                 | G4 4.53   | G4 1.15         | G4 1.27         | G4 0.39    | G4 2.81      | G4 4.04  |
| Average         | 1.51      | Average         | Average         | Average All|              |          |
| Max             | 27.20     |                 |                 | 3.68       |              |          |
| Min             | 0.13      |                 |                 |            |              |          |
Based on the data Table 3 and Table 4 the correlation were obtained is $R^2 = 0.058$ (Figure 3). Based on this value the correlation of carbon stock and biodiversity index was positively related even though the value of which is derived relative small, this is because biodiversity index is very diverse while the carbon stock obtained relative small. Things like this happen as more plants were grown in pots as houseplants than trees which incidentally have more carbon stock. Tropical homegardens or pekarangan with high agrobiodiversity have high potential for carbon (C) sequestration, especially under changing environments [8], and particularly in West Java [9] [3].

![Figure 3. Correlation carbon stock and biodiversity index](image)

| UPSTREAM       | MIDSTREAM       | DOWNSTREAM      |
|-----------------|-----------------|-----------------|
| V1: Megamendung |                 |                 |
| KP. Pondok Gede | G1: 1.73        | RW 03 G1: 1.79  |
|                 | G2: 1.58        | G2: 1.31        |
|                 | G3: 2.49        | G3: 1.37        |
|                 | G4: 2.01        | G4: 1.91        |
| KP. Pasir Muncang | G1: 2.31      | RW 05 G1: 2.06  |
|                 | G2: 1.95        | G2: 1.21        |
|                 | G3: 2.48        | G3: 1.97        |
|                 | G4: 2.11        | G4: 0.77        |
| V2: Cisarua     |                 |                 |
| KP. Tugu Utara | G1: 1.29        | RW 01 G1: 1.99  |
|                 | G2: 1.17        | G2: 1.28        |
|                 | G3: 2.13        | G3: 2.43        |
|                 | G4: 1.24        | G4: 2.47        |
| KP. Tugu Selatan | G1: 1.09      | RW 07 G1: 2.28  |
|                 | G2: 1.05        | G2: 1.87        |
|                 | G3: 1.27        | G3: 1.87        |
|                 | G4: 1.13        | G4: 1.75        |
| Average         | 1.69            | Average         |
| Max             | 2.51            | 1.77            |
| Min             | 0.77            | Average All     |
| Average All     | 1.82            | 2.00            |

**Table 4. Biodiversity index (Shannon Wiener Index – H’)**
4. Conclusion

Based on this study, it can be concluded that the correlation of carbon stock and biodiversity index in Ciliwung Watershed is still relatively low. This is due to increased levels of development in Ciliwung Watershed which impacted to the open space area and the household prefer to potted their plant on pekarangan. The land use change in Ciliwung Watershed is believed to reduce the carbon stock and at the same time degrade the biodiversity condition [10] [11]. This condition should be overcome by integrated landscape approach [12] for increasing the community awareness [13]. The community should improve their understanding about the important of home garden or pekarangan. Pekarangan can provide ecological, economical and social function, thus it can be determine as the household capital [14]. Furthermore, pekarangan can be utilized not only for production but also provide landscape services asset [15].

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6. References

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