

PAPER • OPEN ACCESS

Total carbon stock in Langsa Urban Forest, Langsa City, Aceh Province

To cite this article: T Arlita *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **951** 012092

View the [article online](#) for updates and enhancements.

Total carbon stock in Langsa Urban Forest, Langsa City, Aceh Province

T Arlita*, L A Yanti, A Farida, A H Umam, A Anhar, S Maimunah, J H Samek, A M Muslih

Forestry Department, Universitas Syiah Kuala, Jalan Tgk. Hasan Krueng Kalee 3, Darussalam-Banda Aceh 23111, Indonesia

*Email: tarlita.syakir@unsyiah.ac.id

Abstract. The existence of forests as a life support system has provided benefits for human life, especially in the current era where environmental issues regarding climate change and global warming are starting to emerge. The existence of forest areas is called green open space or urban forest. The existence of urban forests is very important for the balance of the microclimate in urban areas. Langsa City Forest is an area with an area of about 10 hectares which functions for the preservation, harmony and balance of urban ecosystems which include environmental, social and cultural elements. Determination of the sample using purposive sampling method with random start. Sampling technique used 12 plots with an area of about 10 hectares, tree biomass calculation using allometric equations. Data obtained from the Langsa City Forest in the calculation of carbon in 12 plots, the plot that has the highest amount of carbon is 6 with a value of 225.74 tC/Ha and the plot that has the amount of carbon with the lowest value is 1 with a value of 16.54 tC/Ha. The average carbon value in Langsa City Forest is 119.07 tC/Ha. There are 5 plots that have the highest average value, namely plots 2, 6, 8, 9, and 10 also 7 plots have below the average value, namely plots 1, 3, 5, 7, 11 and 12. Total carbon plots in the forest Langsa City is 1428.84 tC/Ha with an average carbon in the area of 119.07 tC/Ha and a standard deviation of 65.35 tC/Ha. The information about carbon uptake on vegetation shows that the existence of urban forest is very important for the balance of the microclimate in urban areas of Langsa City.

1. Introduction

The existence of forests as a life support system has provided benefits for human life, especially in the current era where environmental issues regarding climate change and global warming are starting to emerge. In urban areas, the existence of forest areas is usually called green open space or urban forest. The existence of urban forests is very important for the balance of the microclimate in urban areas. Forest biomass is very relevant to the issue of climate change. Of the total forest carbon, about 50% of it is stored in forest vegetation. Reducing emissions from deforestation and forest degradation (REDD+) is a strategy for mitigating global climate change [1]. Langsa City Forest is an area of green open space with an area of about 10 hectares which functions for the preservation, harmony and balance of urban ecosystems which include environmental, social and cultural elements [2].

In urban areas, the existence of forest areas is usually called green open space (RTH) or urban forest. The existence of urban forests is very important for the balance of the microclimate in urban



areas. The shape and structure of urban forests can function as a counterweight to temperature, humidity, noise reduction, and air pollution absorbers [3]. Another benefit of the existence of urban forests is maintaining the sustainability, harmony and balance of urban ecosystems including environmental, social and cultural elements [4]. In practice, urban forest management is carried out in a simple management and really needs the participation and support of the community around the urban forest [5].

Forest biomass is very relevant to the issue of climate change. Forest biomass plays an important role in biogeochemical cycles, especially in the carbon cycle. Of the total forest carbon, about 50% of it is stored in forest vegetation. As a consequence, if there is forest damage due to fire, logging and so on, it will increase the concentration of carbon in the atmosphere [6]. Reducing emissions from deforestation and forest degradation (REDD+) is a strategy in mitigating global climate change [7].

Langsa City Forest is an ecotourism object that is quite famous even outside the Aceh area. Based on the Government Regulation of the Republic of Indonesia Number 63 of 2002 concerning Urban Forests, urban forest is a stretch of land that grows compact and dense trees in urban areas, both on state land and private land, which is determined by an urban forest by the authorized official.

Langsa City Forest is a green open space area with an area of about 10 hectares with about 300 species of plants and an attractive zoo and offers educational tours, the Langsa City Forest functions for the preservation, harmony and balance of urban ecosystems which include significant environmental, social and cultural elements. Broadly speaking, it functions as the lungs of Langsa City. The boundaries of the territory are west of Gampong Paya Dalam, east of Gampong Paya Bujok Seuleumak Utama, south of Gampong Lhok Kulam, and north of Gampong Birem Puntong.

2. Materials and methods

2.1. Creating plot sampling

Determination of the sample using purposive sampling method with random start. The sampling technique used 12 plots with an area of about 10 hectares. The number of plots is obtained based on the calculation of the sampling intensity, while the calculation of the sampling intensity (IS) uses a sampling intensity of 5% of the research area. The sampling intensity formula is as follows:

$$\begin{aligned} \text{Total Area} &= 10 \text{ Ha} \\ \text{IS} &= 5\% \end{aligned}$$

$$\begin{aligned} \text{Research Area} &= \text{Total Area} \times \text{IS} \\ &= 10 \text{ Ha} \times 5\% \\ &= 0,5 \text{ Ha} \end{aligned}$$

$$\begin{aligned} \text{Plot Area} &= 400 \text{ m}^2 \text{ or } 0,04 \text{ Ha} \\ \text{Number of Plot} &= \frac{\text{Research Area}}{\text{Plot Area}} \\ &= \frac{0,5 \text{ Ha}}{0,04 \text{ Ha}} \\ &= 12,5 \text{ or } 12 \text{ Plot} \end{aligned}$$

2.2. Carbon calculation

The formula used in the calculation of tree biomass uses the following allometric equation [8]:

$$\text{AGB} = 0,125 \times D^{2,533} \quad (1)$$

Where:

AGB : Aboveground tree biomass dry matter (kg/tree)

D : Diameter of the stem at chest height (cm)

Carbon stocks are calculated using the biomass approach. The C content in organic matter is used as the default value of 47%, so the estimated carbon stock per component can be calculated by multiplying the mass weight of each component of the C content [9].

Calculation of the estimation of stored carbon stocks according to the Intergovernmental Panel on Climate Change states that 47% of the biomass from forest vegetation is composed of carbon [10] so that stored carbon can be calculated using the following formula:

$$C \text{ carbon} = \text{AGB} \times 4,7\% \quad (2)$$

Where:

C : Tree carbon (kg)

AGB : Aboveground tree biomass dry matter (kg/tree)

4.7% : Constant

The carbon in the forest can be used to calculate the CO₂ absorbed by forest vegetation by means of a carbon biomass conversion factor. The total weight of carbon obtained was multiplied by the carbon-CO₂ conversion factor [11]

$$\text{CO}_2 = \text{Cn} \times 3,67 \quad (3)$$

Where:

CO₂ : Carbon Dioxide Uptake (ton/ha)

Cn : Carbon Content Unit Area (ton/ha)

3.67 : Equivalent Number or Conversion of Element C to CO₂.

(Atomic Mass of C = 12 and O = 16

CO₂ → (1 x 12) + (2 x 16) = 44

The conversion → 44:12 = 3.67

From the calculation results above, information will be obtained on how much potential carbon stock is in each tree species in one area.

3. Results and discussion

3.1. Composition types

The results of the study found several species that grow in the Langsa City Forest, based at the vegetation analysis found 159 trees with the most species being *Shorea platyclados* was 41 trees and *Agathis dammara* was 16 trees. While the least species is 1 individual were *Durio spp.*, *Garcinia parvifolia*, *Mangifera spp.*, *Vitex pubescens*, *Dipterocarpus spp.*, *Melachorrea spp.*, *Gardenia spp.*, *Murraya spp.*, *Shorea spp.* and *Magnolia grandiflora*.

The ability of meranti stands or called seumantok (Aceh) to soak up carbon as an attempt to reduce the results of greenhouse gases is influenced by means of the availability of biomass in it. According to [12] the tree component is the largest carbon storage on land. *Shorea platyclados* (hill meranti) is one of the plants from the red meranti type with very big and tall tree sizes and unbranched stems. The leaves are 6,1 cm - 13,1 cm long and 2,2 cm - 4 cm huge with a rounded leaf base and a pointed leaf tip. In dry circumstance, the top surface of the leaves is brown and slippery. It does not have domatia (small structures/ spaces on the lower surface of the leaf), tertiary bone is almost invisible and

secondary reinforcement is 12-25 pairs [13]. *Shorea plactyclados* is one of the species encouraged for enrichment planting and rehabilitation of logged over regions in tropical rainforests in Indonesia. that is due to the fact the take a look at outcomes of this species in central Kalimantan, that is 6,5 years old, has an incremental growth of 2,56 cm/year and an increase in height of 1,33 m/year [14].

3.2. Carbon at Langsa urban forest

Efforts to reduce the concentration of greenhouse gases in the atmosphere (emissions) is to reduce the release of CO₂ into the air. For this reason, the amount of CO₂ in the air must be controlled by increasing the amount of CO₂ uptake by plants as much as possible and suppressing the release of greenhouse gases as low as possible. The amount of stored carbon stock needs to be calculated so that we can find out the amount of carbon stock at a certain time and its changes if there are activities that increase or decrease the number of reserves [15]. The carbon stocks in the Langsa City Forest in the results of this study are as follows at Table 1.

Table 1. Results of analysis of potential carbon storage in Langsa City Forest.

No	Plot ID	tC / Ha
1.	Plot 1	16,54
2.	Plot 2	172,79
3.	Plot 3	73,20
4.	Plot 4	66,77
5.	Plot 5	90,17
6.	Plot 6	225,74
7.	Plot 7	110,11
8.	Plot 8	199,98
9.	Plot 9	155,52
10.	Plot 10	179,05
11.	Plot 11	74,97
12.	Plot 12	64,01
Average		119,07

Note: tC/Ha (ton C/Hectare)

Determination of the sample using purposive sampling method with random start. The sampling technique used 12 plots with an area of about 10 hectares, tree biomass calculation using allometric equations. Data obtained from the Langsa City Forest in the calculation of carbon in 12 plots, the plot that has the highest amount of carbon is 6 with a value of 225.74 tC/Ha and the plot that has the amount of carbon with the lowest value is 1 with a value of 16.54 tC/Ha. The impacts and threats that occur in forest areas are forest encroachment, forest fires, invasive plants or animals, as grazing places, and the presence of garbage or waste. The average value of carbon in the Langsa City Forest is 119.07 tC/Ha, there are 5 plots having the highest average value, namely plots 2, 6, 8, 9, and 10 also 7 plots have below the average value, namely plots 1, 3, 5, 7, 11 and 12.

Table 2. Process for quantitative analysis of carbon storage.

Total carbon plot	1428,84 tC / Ha
Average carbon plot at the area	119,07 tC / Ha
Deviation standard	65,35 tC / Ha
Total carbon stock (tC) – lower	261,88 tC / Ha
Total carbon stock (tC)	283,39 tC / Ha
Total carbon stock (tC) – upper	304,89 tC / Ha

The amount of plot carbon in the Langsa City Forest was 1428.84 tC/Ha with an average carbon area of 119.07 tC/Ha and a standard deviation of 65.35 tC/Ha. The total carbon stock (tC) at the lower

limit is 261.88 tC/Ha, the total carbon stock (tC) is 283.39 tC/Ha and the total carbon stock (tC) at the upper limit is 304.89 tC/Ha. The results showed that Langsa City Forest had good carbon storage and this is in line with the Langsa City Government's objectives in the Langsa City Qanun Number 7 of 2016 in reducing air pollution (carbon dioxide levels, carbon monoxide, nitrogen oxides, dust, sulfur and ozone depletion). The existence of the Langsa City Forest has benefits as a carbon store, besides that this Urban Forest can be said to be a green open space that has benefits as a means of recreation for the surrounding community. Langsa City Forest has an important role as a protector of environmental services, it also acts as a balancer for the water system [16].

4. Conclusions

Based on the research results, Langsa City Forest has a carbon storage of 119.07 tC/Ha, there are 5 plots that have the highest average value, namely plots 2, 6, 8, 9, and 10, and 7 plots have below the average value, namely plots 1, 3, 5, 7, 11 and 12. The amount of plot carbon in the Langsa City Forest was 1428.84 tC/Ha with an average carbon in the area of 119.07 tC/Ha and a standard deviation of 65.35 tC/Ha. The information about carbon uptake on vegetation shows that the existence of urban forest is very important for the balance of the microclimate in urban areas of Langsa City.

References

- [1] Forest Watch Indonesia 2001 *The State of Indonesia's Forests* Bogor Indonesia Forest Watch Indonesia and Washington D. C. Global Watch
- [2] Reksohadiprodjo S, and Brodjonegoro 2000 *Environmental Economics BPFE Yogyakarta* Second Edition Yogyakarta
- [3] Irwan Z D 2008 *Environmental Challenges and Urban Forest Landscapes* Jakarta Earth Literature
- [4] Purwasih H 2013 Estimation of Plant Carbon Storage Potential in Several Green Lines in Medan City Essay Faculty of Agriculture University of North Sumatra Medan
- [5] Muslih A M, Bintoro A, Duryat, Subhan, Arlita T, Ar Rasyid U H, Umam A H, Farida A, and Yanti L A 2021 The study of silvicultural aspects of community forest in Buana Sakti Lampung Province *IOP Conf. Ser. Earth Environment Science* **667** 012053
- [6] Sutaryo D 2009 *Biomass Calculation An Introduction to Carbon Studies and Carbon Trading Wetlands International Indonesia Programme* Bogor 39 pages
- [7] Resosudarma I A P, Atmadja S, Ekaputri A D, Intarini D Y, and Indriatmoko Y 2014 Does tenure security lead to REDD+ project effectiveness Reflections from five emerging sites in Indonesia *World Development* **55** 68-83
- [8] Manuri, Solichin, Cris B, Fatmi N, Teddy R, Shema M A, Helmut D, and Indra K 2016 Improve allometric equations for tree aboveground biomass estimation in tropical dipterocarp forest of Kalimantan Indonesia *Forest Ecosystems* **3** (1) 28
- [9] Kurniatun H, Sonya D, Fahmuddin A, Sandra V, Andree E, Subekti R, and Meine V N 2011 *Practical Guide to Carbon Stock Measurement: from land level to landscape* Second Edition Bogor World Agroforestry Centre 96 pages
- [10] Intergovernmental Panel on Climate Change 1995 Climate Change 1995 a Report of The Intergovernmental Panel on Climate Change <https://www.ipcc.ch/pdf/ipcc2ndassessment.com> accessed on 21 December 2021.
- [11] Dixon R K, Brown S, Houghton R A, Solomon A M., Trexler M C, and Wisniewskin J 1994 Carbon Pools and Flux of Global Forest Ecosystem *Science* **263** 185-190
- [12] Hairiah K, and Rahayu S 2007 *Pengukuran Karbon Tersimpan di Berbagai Macam Penggunaan Lahan* Book Bogor World Agroforestry Centre ICRAF SEA Regional Office University of Brawijaya Unibraw Indonesia 77 pages
- [13] Lestari C D 2013 Klasifikasi Jenis Shorea Berdasarkan Morfologi Daun Menggunakan Jaringan Syaraf Tiruan Propagasi Balik Levenberg-Marquardt *Skripsi* Bogor Institut Pertanian Bogor

- [14] Widiyatno, Soekotjo, Na'iem, Purnomo M S, Setiyanto P E 2014 Early performance of 23 dipterocarp species planted in logged-over rainforest *Journal of Tropical Forest Science* **26** (2) 259–266
- [15] Ministry of Environment and Forestry 2020 *Vademecum Forestry Indonesia Jakarta Research Development and Innovation Agency of the Ministry of Environment and Forestry* 627 pages
- [16] Sugianto S, Muslih A M, Ar-Rasyid U H, Anhar A 2021 Vegetation analysis of rawa singkil wildlife reserve in Rantau Gedang Village Singkil District Aceh Singkil Regency Aceh Province *IOP Conf. Ser. Earth Environment Science* **667** 012068