LenteraBio
Berkala Ilmiah Biologi

LenteraBio, 2025; Volume 14, Issue 2: 266-272

p-ISSN: 2252-3979 e-ISSN: 2685-7871
https://journal.unesa.ac.id/index.php/lenterabio/index

Quantitative Estimation of Carbon Stock Reserve in Angsana (*Pterocarpus indicus*): Study of Unesa Lidah Wetan Campus Forest

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Article History:
Received:
19-May-2025
Revised:
31-May-2025
Available online:
31-May-2025
Published regularly:
31-May-2025

Abstract
Angsana (*Pterocarpus indicus*) is a plant with a high carbon sequestration rate, which dominates in the Unesa Lidah Wetan Campus Forest. Carbon sequestration by plants can minimize microclimate changes caused by increasing greenhouse gases (GHGs). This research needs to be done because the calculation of carbon stocks in angsana in the research location has not been recorded. The purpose of this study was to describe the biomass, leaf chlorophyll content, and leaf surface area of angsana, evaluate carbon stocks in angsana, and analyze the relationship between biomass, leaf chlorophyll content, and leaf surface area of angsana with the amount of carbon stock stored by angsana in Unesa Campus Forest Lidah Wetan. This research used non-destructive carbon stock estimation methods, and the Kettering allometric equation. Based on the research conducted, it was found that angsana in the Unesa Lidah Wetan campus forest had an average biomass of 213.47 Kg, an average chlorophyll content of 22.52 mg/L, and an average leaf surface area of 38.83 cm2, with carbon storage of 100.33 Kg C / tree. There is a positive correlation between biomass of angsana, chlorophyll content of angsana leaves, and leaf surface area of angsana with carbon stock, namely the greater the biomass, chlorophyll content, and leaf surface area of angsana, the higher the carbon stock stored in angsana.

Keywords: Biomass; Chlorophyll; Leaf area; Climate Change

How to Cite: Andriani B, Rachmadiarti F, Kuntjoro S, 2025. Quantitaive Estimation of carbon Stock Reserve in Angsana (*Pterocarpus indicus*): (Study of The Unesa Lidah Wetan Campus Forest). LenteraBio; 14(2): 266-272

DOI: https://doi.org/10.26740/lenterabio.v14n2.p266-272

INTRODUCTION

An increase in surface temperature due to global warming has been recorded in various regions, especially in Indonesia. The increase in surface temperature in Surabaya City shows an average temperature increase of 1-1.4% in the last five years (Jatayu and Susetyo, 2018). One of the main contributing factors to gas (GHG) emissions is anthropogenic activities such as fossil fuel combustion from the transportation and industrial sectors (Setyo & Handriyono, 2021). This increase in carbon emissions puts significant environmental pressure, so appropriate mitigation measures are needed to reduce greenhouse gas (GHG) concentrations in the atmosphere.

One approach that is considered effective in mitigating climate change is through increasing carbon stocks through carbon sequestration by plants (Hasibuan *et al.*, 2020). Plants, especially woody trees, play an important role in the process of absorbing carbon dioxide from the atmosphere through photosynthesis and storing it in the form of biomass (A'la and Winarsih, 2021).

Green open space (RTH) planted with vegetation with a high ability to sequester carbon is an integral part of climate change adaptation and mitigation strategies in urban areas. Surabaya State University campus forest is one of the green open spaces (RTH) in Surabaya City, with a total area of 4.64 hectares. Green open space (RTH) is an area that is left open without buildings that have a certain size, shape, and geographical boundaries, in which there are *perennial woody plants*, and other types of plants, as well as other objects that can support the function of green open space (Maryadi *et al.*, 2019). The campus forest is one of the efforts made to maintain the stability and balance of the urban environment, especially in the campus environment. In addition, the trees in the campus forest function as a carbon storage area that will accumulate in biomass through a sequestration mechanism (Hasibuan *et al.*, 2020).

Plants that are commonly found in the Unesa Campus Forest are angsana (*Pterocarpus indicus*). Angsana has a tree height of up to 40 meters, with a diameter of up to 3.5 meters (Ingeswari, 2016). addition, angsana (*Pterocarpus indicus*) has a large shape, sturdy structure, and dense crown. Trees with large diameters and sizes have the potential to store larger carbon stocks (Sribianti *et al*., 2022). Several studies have been conducted on the potential of angsana (*Pterocarpus indicus*) in absorbing carbon, including research by Rosianty *et al*., (2021) which states that angsana (*Pterocarpus indicus*) in Ilir Barat District, Palembang has the ability to absorb carbon reaching 49.793 Ton/C/Ha. Then, research by Samsu (2019) in the green spaces of Jompie District stated that angsana (*Pterocarpus indicus*) was able to absorb carbon as much as 27.141 Ton/C/Ha.

Biomass assessment is one of the steps that can be taken to quantitatively assess the role of a tree species in absorbing gases, especially greenhouse gases. Until now there has been no specific study on the estimation of the amount of biomass and carbon stock of angsana in the Unesa Campus Forest Area Lidah Wetan. This study aims to describe the amount of biomass, chlorophyll content, and leaf surface area of angsana (*Pterocarpus indicus*), analyze the carbon stock of angsana (*Pterocarpus indicus*), and evaluate the relationship between the amount of biomass, chlorophyll content, and leaf surface area to the amount of carbon stock in angsana. (*Pterocarpus indicus*) in the Unesa Lidah Wetan Campus Forest. The results of this study can be used to create a more effective reforestation strategy to mitigate the impacts of climate change, and its relation to the SDGs.

MATERIALS AND METHODS

This research was an descriptive study with an observational method. The data collected include primary data such as the diameter at breast height of angsana (*Pterocarpus indicus*), chlorophyll content, and leaf surface area of angsana (*Pterocarpus indicus*). While secondary data include wood specific gravity obtained from *global wood density* (Dryad, 2015). This research was conducted in July-September 2023, and October-November 2024. Sampling was conducted in the Unesa Campus Forest Lidah Wetan (Figure 1), while the analysis of chlorophyll content and leaf surface area was carried out in the IsDB Biology Research Laboratory, FMIPA, Unesa.

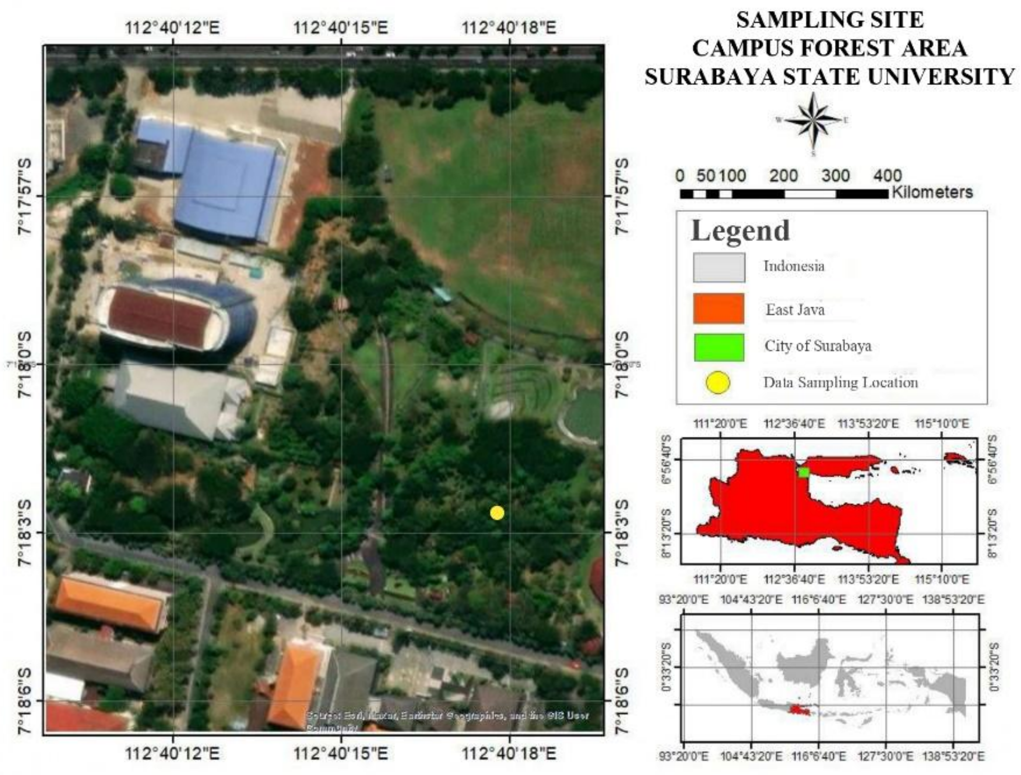

Figure 1. Map of sampling site

The research procedure consisted of collecting growth data on all angsana (*Pterocarpus indicus*) at the research site to calculate biomass, carbon content, and carbon sequestration values, sampling angsana (*Pterocarpus indicus*) leaves, and measuring physical and chemical factors of the environment.

Measurement of angsana (*Pterocarpus indicus*) biomass was carried out using the following Kettering allometric equation (Kettering *et al*., 2001).

$$W = 0.11 \times \rho \times DBH^2$$

W = Plant biomass (Kg)
ρ = Wood density (g/cm^3)
DBH = Diameter at breast height (cm)

Then the carbon content of angsana (*Pterocarpus indicus*) was calculated using the following formula (Analuddin *et al*., 2020).

$$CS = W \times 0.47$$

CS = Carbon stock (Kg/C/Tree)
W = Total biomass (Kg)

And continued with this formula to calculate the ability of angsana (*Pterocarpus indicus*) to absorb carbon (Baderan, 2017).

Absorbtion (CO2) = Mr Co2/Ar C x carbon stock

Samples of angsana (*Pterocarpus indicus*) leaves were taken from 3 trees at 3 stations randomly to measure chlorophyll levels, by mixing 1 gram of crushedleaves with 100 ml of 96% alcohol, then filtered, and measured using a spectrophotometer. Total chlorophyll content in angsana (*Pterocarpus indicus*) leaves was calculated using the following Wintermans and De Mots formula (Pratiwi & Rachmadiarti, 2021).

Chlorophyll a (mg/L) = $13.7 \times (OD665) - 5.76 \times (OD649)$
Chlorophyll b (mg/L) = $25.8 \times (OD649) - 7.7 \times (OD665)$
Chlorophyll total (mg/L) = $20 \times (OD649) - 6.1 \times (OD665)$

The measurement of angsana (*Pterocarpus indicus*) leaf surface area was carried out by scanning the leaves on the leaf area meter until the leaf surface area value appeared on the monitor screen, and measuring the physical parameters of the environment. The data obtained were then analyzed using the Pearson Correlation Test. This aimed to see the relationship between biomass size, leaf chlorophyll content, and leaf surface area to carbon content in angsana (*Pterocarpus indicus*).

RESULTS

Based on the research conducted, 74 angsana individuals were successfully identified. Thus, the biomass stored in angsana at the research site was 196.68 kg, and the carbon stored in it was 92.44 kg/C/tree, as presented in Table 1.

Table 1. Biomass and carbon stock calculated from Angsana trees

Number of Individuals	DBH (cm)	Biomass (Kg)	Carbon Stock (Kg/C/Tree)	Carbon Absorption
74	20.52 ± 7.35	213.47 ± 196.68	100.33 ± 92.44	368.22 ± 339.25

In addition, the average chlorophyll content in angsana leaves at the research site was 22.52 mg/L (Table 2), and the average leaf area of angsana leaves was 38.83 cm² (Table 3), as well as measurements of environmental physical and chemical factors at the study site, including soil and air physical and chemical factors (Table 4).

Based on the results of the Pearson correlation test, the relationship between biomass parameters, leaf chlorophyll content, and leaf surface area to carbon stocks in angsana shows a unidirectional relationship. Where the greater the three parameters, the greater the value of carbon stock in angsana. While the parameters of physico-chemical environmental factors showed insignificant results, where there was no relationship between the two parameters (Table 5).

Table 2. Chlorophyll content of Angsana

Station	Chlorophyll Content (mg/L)			Mean (mg/L)
	Chlorophyll a	Chlorophyll b	Total Chlorophyll	
1	1.06	24.89	19.22	20.11 ± 0.93
	1.91	32.80	20.02	

	1.47	24.71	21.08	
	1.90	34.36	23.97	
2	1.65	28.80	22.24	22.33 ± 1.60
	1.04	23.81	20.78	
	2.68	30.27	23.37	
3	2.51	34.48	26.62	25.12 ± 1.64
	1.49	32.87	25.38	

Table 3. Leaf area of Angsana

Station	Leaf area (cm²)	Mean (cm²)
	27.75	
1	32.53	36.30 ± 10.93
	48.61	
	48.93	
2	44.79	39.72 ± 12.54
	25.44	
	34.93	
3	45.79	40.48 ± 5.43
	40.72	

Table 4. Environment physical factors in Unesa Lidah Wetan campus forest

Station	Physical factors (Air)				Physical factors (Ground)		
	Temp (°C)	Humidity (%)	CO_2 content (ppm)	Ligth Intensity (lux)	Humidity (%)	pH	Temp (°C)
1	33	61	421	717	20	8	29
	32	57	438	737	25	8	30
	30	52	455	562	15	8	34
2	33	49	459	333	20	7	30
	32	50	447	364	20	7	35
	31	60	430	730	17	8	30
3	32	62	479	440	30	7	31
	33	55	477	345	20	7	30
	31	52	476	455	20	7	32
Mean	32 ± 1	55 ± 4.9	453.56 ± 21.31	520 ± 170.4	21 ± 4.38	7 ± 0.53	31 ± 2.05

Table 5. Result of Pearson's correlation test

Parameters	Correlation Coefficient	Significant Value
Biomass	1	0,000
Leaf Chlorophyll Content	0.733	0.025
Leaf Area	0.728	0.026
Environmental Physical Factors	-	> 0.05

DISCUSSION

Based on the research that has been carried out, the average value of angsana biomass in the Unesa Lidah Wetan Campus Forest 213.47 kg. Hence, the value of carbon stock in angsana can also be obtained, which is 100.33 kg/C/Tree, and the value of carbon absorption is 368.22 kg/C/Tree (Table 1). Angsana is a plant that has a sturdy structure, with growing stems reaching a diameter of up to 3.5 meters. Plants with large stem diameters have the potential to store abundant carbon reserves, because carbon in plants is stored in their biomass. In other words, the larger the diameter of the stand, higher the biomass and carbon content. This result is in accordance with the research of Sari *et al*., (2022) which shows that the large or small diameter of a stand will also affect the size of its biomass and carbon storage. Mutmainna *et al*., (2024) also mentioned that the average diameter of a stand has a positive relationship with its biomass content. During photosynthesis, CO_2 in the atmosphere will be absorbed and bound by plants. In addition to being a source of chemical energy for plants in photosynthesis, carbon also functions as a provider of carbon skeletons to form organic molecules that make up the structure of plants. According to Nedhisa and Tjahjaningrum (2020), in general 96% of the total biomass is the result of the assimilation of carbon, hydrogen, and oxygen in the photosynthesis process. The level of biomass produced from photosynthesis is directly proportional to the rate of plant growth, both primary and secondary growth. Plant diameter growth is the result of secondary growth that occurs due to the activity of lateral meristems that produce secondary vascular tissue and periderm (Kimball, 1996). Thus, plant diameter can be used as an indicator used to estimate the amount of biomass and carbon stock of a plant.

Biomass in angsana has a positive correlation with the carbon stock it contains (Table 5). The greater the biomass value in angsana, the value of carbon stock it stores will also increase. This is in accordance with Sari *et al*. (2022) which states that high biomass values indicate high carbon content as well. This is because carbon stock is half of the total tree biomass and carbon uptake is three times the carbon stock. Research by Nedhisa and Tjahjaningrum (2020) also mentioned that an increase in biomass is followed by an increase in carbon, and carbon sequestration. Where both aspects are the result of CO_2 absorption from the atmosphere through photosynthesis, which is accumulated and allocated to leaves, twigs, roots, flowers, fruits, and stems. Tree biomass includes all parts of tree, both above ground and below ground. Tree biomass also reflects the tree's overall ability to store carbon. Trees with large biomass generally have thicker trunks, sturdy and strong root systems, and a large number of branch leaves that can store larger amounts of carbon. Generally, the carbon content of tree biomass ranges from 40-50% of the dry weight of the biomass. Most the carbon is stored in the hardwood tissue of the trunk, which has a high density. Therefore, trees with high density tend to have higher carbon stocks including angsana (*Pterocarpus indicus*) which has a density of 0.520 g/cm^3. There are several factors that influence the amount of carbon stock in angsana (*Pterocarpus indicus*), including the age of the stand. Larger and older trees tend to have a biomass, thus storing more carbon. In contrast, younger trees have smaller carbon stocks because their biomass is not yet fully developed. In addition, the size of the stem diameter and height, as well as environmental conditions also affect the amount of carbon stock in angsana (*Pterocarpus indicus*).

Based on the calculation of chlorophyll values in angsana leaves, the chlorophyll content values for angsana are presented in Table 2. There is a positive relationship between the chlorophyll content of angsana leaves and the carbon stock they contain. The higher the chlorophyll content in angsana, the carbon stock stored in it will also increase significantly. Chlorophyll levels in angsana leaves will affect photosynthetic efficiency that contributes to biomass formation. High chlorophyll levels will increase the rate of photosynthesis and will produce a larger biomass, as a result the carbon stock it contains will also increase in line with the increase in biomass. This is supported by the results of research from Uthbah *et al*., (2017) which states that carbon stored in a stand is influenced by tree physiological factors, especially photosynthesis which is the main process in the process of making food from inorganic materials into organic materials. Where high chlorophyll content increases the capacity of plants to absorb light and carry out photosynthetic reactions (Rasyidi *et al*., 2024), so that photosynthetic productivity increases and will increase the accumulation of photosynthetic products stored in stems, branches, leaves, and roots in the form of biomass. So that it will contribute directly to the total carbon stock of angsana trees (*Pterocarpus indicus*) (Siregar *et al*., 2020).

Measurements of leaf surface area in angsana obtained the results presented in Table 3. There is a positive relationship between leaf surface area and carbon stock in angsana. Where the more extensive the leaf surface of the angsana, the greater the carbon storage in the plant. According to Asner *et al*. (2001) high leaf surface area is correlated with increased biomass productivity and carbon stocks in tropical forests. Field *et al*. (1995) stated that *Leaf Area Index* can be used as a key indicator of resource use efficiency in carbon accumulation. Trees with large leaves have a higher ability to absorb carbon dioxide (CO_2) from the atmosphere than trees with a small leaf surface area. Thus, the photosynthesis process will produce more photosynthate and can increase biomass production. Biomass produced from the photosynthesis process will be stored in the form of tissues in plants such as stems, branches, twigs, roots, and leaves (Drupadi *et al*., 2021). Leaf surface area has an important role in determining the ability of trees to capture sunlight and absorb carbon dioxide (CO_2). The larger the leaf surface area, the more sunlight is absorbed so that the photosynthesis process becomes optimal and the formation of greater biomass which synergizes with chlorophyll substances in the leaves. Leaf chlorophyll levels and leaf surface area have a mutually influential relationship in the context of photosynthesis and light absorption efficiency. High chlorophyll level and large leaf surface area are two important factors that increase photosynthetic efficiency, allowing plants to absorb and store large amounts of carbon.

Angsana (*Pterocarpus indicus*) has a high ability to absorb and store carbon, especially through its large biomass, making it a strategic tree for climate change mitigation. In the Surabaya State University Campus Forest, angsana is the dominant species due to its ecological, aesthetic and economic advantages. Its wide canopy supports optimal CO_2 absorption and helps reduce ambient temperature. Maintenance such as regular pruning is essential to keep the angsana healthy and functional as a carbon store. Although the campus has not met the national minimum green open space (RTH) standard, the contribution of campus RTH remains significant to Surabaya City's RTH. Angsana (*Pterocarpus indicus*) can be used in reforestation and afforestation programs, especially in tropical areas. This initiative supports the achievement of SDGs 13 targets related to climate change through its role in absorbing carbon which aims to increase resilience and as an adaptation to the impacts of climate change (SDGs 13.1), reduce air temperature and maintain hydrological cycles and increase biodiversity (SDGs 13.2), and increase public awareness and capacity in mitigating, adapting, and reducing the impacts of climate change (SDGs 13.3).

CONCLUSION

Angsana (*P. indicus*) found in Unesa Campus Forest of Lidah Wetan has an average biomass of 213.47 Kg, chlorophyll content of angsana leaves as much as 22.52 mg/L, and leaf surface area of 38.83 cm^2. Angsana in the research location is able to store carbon in the form of its biomass of 100.33 Kg/C/Tree, with the ability to absorb carbon 368.22 Kg/C/Tree. There is a positive relationship between biomass, chlorophyll content, and leaf surface area of angsana, the carbon stock value of angsana will increase along with the increase in biomass, chlorophyll content, and leaf surface area.

ACKNOWLEDGEMENTS

The authors would like to thank the "Laboratorium Merdeka" biodiversity research team at the Universitas Negeri Surabaya for their help during data collection and writing of this article. Our deepest gratitude to the reviewers and editors hence this manuscript improved.

CONFLICT OF INTEREST

There is no conflict of interest

REFERENCES

A'la M, Winarsih W, 2021. Pengurangan jejak karbon (C) pada serasah daun angsana (*Pterocarpus indicus*) dan Daun trembesi (*Samanea Saman*) melalui metode pengomposan lubang resapan biopori inovatif. *LenteraBio: Berkala Ilmiah Biologi*; 10: 234–244.

Analuddin K, Kadidae LO, Haya LOMY, Septiana A, Sahidin I, Syahrir L, Rahim S, Fajar LOA, Nadaoka K, 2020. Aboveground Biomass, Productivity and Carbon Sequestration in *Rhizophora stylosa* Mangrove Forest of Southeast Sulawesi, Indonesia. *Biodiversitas*; 21: 1316–1325.

Asner GP, Townsend AR, Riley WJ, Matson PA, Neff JC, Cleveland CC, 2001. Physical and Biogeochemical Controls Over Terrestrial Ecosystem Responses to Nitrogen Deposition. *Biogeochemistry*; 54: 1–39.

Baderan DWK, 2017. Kerapatan, Nilai Biomassa, dan Serapan Karbon Spesies *Ceriops tagal* (Perr.) C. B. Rob di Wilayah Pesisir Tabulo Selatan Provinsi Gorontalo, in: Nurcahyanto G, Kartikasari S, (Eds.), Seminar Nasional Pendidikan Biologi dan Saintek. Prodi Pendidikan Biologi FKIP UMS, pp. 180–187.

Drupadi TA, Ariyanto DP, Sudadi S, 2021. Pendugaan Kadar Biomassa dan Karbon Tersimpan pada Berbagai Kemiringan dan Tutupan Lahan di KHDTK Gunung Bromo UNS. *Agrikultura*; 32: 112.

Dryad, 2015. Global Wood Density Database. Retrieved from http://datadryad.org/handle/10255/dryad.235

Field CB, Randerson JT, Malmström CM, 1995. Global Net Primary Production: Combining Ecology and Remote Sensing. *Remote Sensing of EnvironmentI*; 51: 74–88.

Hasibuan RR, Kardhinata EH, and Riyanto R, 2020. Analisis Kandungan Karbon pada Daun Mangrove *Rhizophora Apiculata* di Kampung Nipah Kecamatan Perbaungan Kabupaten Serdang Bedagai Sumatera Utara. *Jurnal Ilmiah Biologi UMA (JIBIOMA)*; 2(2): 78–82.

Jatayu A, and Susetyo C, 2018. Analisis perubahan temperatur permukaan wilayah surabaya timur tahun 2001-2016 Menggunakan Citra Landsat. *Jurnal Teknik ITS*; 6(2).

Ketterings QM, Coe R, Noordwijk MV, Palm CA, 2001. Reducing uncertainty in the use of allometric biomass equations for predicting above-ground tree biomass in mixed secondary forests. *Forest Ecology and Management*; 146: 199–209.

Kimball JW, 1996. *Biologi Edisi Kelima Jilid 2* (Vol. 2, pp. 571–572). Erlangga.

Maryadi A, Rafdinal R, and Linda R. 2019. Kajian biomasa tegakan atas permukaan (aboveground biomass) dan cadangan karbon di Beberapa Taman Kota Pontianak. *Jurnal Protobiont*; 8(3).

Mutmainna N, Umar M, Salam MA, 2024. Estimasi simpanan karbon tegakan *Rhizophora* spp., dan sedimen ekosistem mangrove di Kecamatan Belopa, Kabupaten Luwu. *BIOMA: Jurnal Biologi Makassar*; 9: 145–159.

Nedhisa PI, and Tjahjaningrum IT, 2020. Estimasi biomassa, stok karbon, dan sekuestrasi karbon mangrove pada *Rhizophora mucronata* di Wonorejo Surabaya dengan Persamaan Allometrik. *Jurnal Sains dan Seni ITS*; 8.

Pratiwi RY, and Rachmadiarti F. 2021. Keanekaragaman jenis-jenis tumbuhan akumulator Kadmium (Cd) di Sungai Sudimoro Mojokerto. *LenteraBio: Berkala Ilmiah Biologi*; 10(1): 125–133.

Rasyidi AF, Sulistiani R, and Bin JSI, 2024. kadar klorofil daun bibit kelor (*Moringa oleifera* L.) pada berbagai dosis kompos. *AGRIUM: Jurnal Ilmu Pertanian*; 27(1): 32-43.

Rosianty Y, Waluyo EA, and Himawan MSG, 2021. Potential of carbon storage in angsana plant (*Pterocarpus indicus* Willd) in Ilir Barat I District, Palembang City. *Sylva: Jurnal Ilmu-Ilmu Kehutanan*; 10(1): 6.

Samsu AKA, 2019. Pendugaan potensi simpanan karbon permukaan pada ruang terbuka hijau di hutan kota Jompie Kecamatan Soreang Kota Parepare. *Jurnal Envisoil*; 1(1): 34–43.

Setyo GA, and Handriyono RE, 2021. Analisis penyebaran gas karbon monoksida (CO) dari sumber transportasi di Jalan Tunjungan Surabaya. *Prosiding Seminar Nasional Sains dan Teknologi Terapan*; 9(1): 360–369.

Siregar SR, Irwan SNR, and Putra ETS, 2020. Kandungan logam berat timbal (Pb) dan pengaruhnya pada angsana (*Pterocarpus indicus*), tanjung (*Mimusops elengi*), dan asam jawa (*Tamarindus indica*) di Jalan Lingkar Alun–Alun Yogyakarta. *Vegetalika*; 9(1): 316.

Sribianti I, Daud M, Aziz AA, and Sardiawan A, 2022. Estimasi biomassa, cadangan karbon, produksi O_2 dan nilai jasa lingkungan serapan CO_2 tegakan hutan di Taman Hutan Raya Abdul Latief. *Jurnal Hutan dan Masyarakat*; 14(1): 12–26.

Uthbah Z, Sudiana E, and Yani E, 2017. Analisis biomasa dan cadangan karbon pada berbagai umur tegakan damar (*Agathis dammara* (Lamb.) Rich.) di KPH Banyumas Timur. *Scripta Biologica*; 4(2): 119.