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Research Article

Estimation of CO_2 Absorption, Biomass, and Carbon Deposit the Trees on the Street City of Malang

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Abstract
Climate change increases the concentration of the greenhouse effect, this was caused by the lack of trees as a function of carbon sequestration. Therefore, this study aims to map the vegetation distribution in the streets of the city of Malang and to measure its carbon stocks. The used method was vegetation analysis, to calculate the estimation of biomass, carbon storage and CO_2 absorption using the allometric equation Brown; Brown and Lugo; and Morikawa. The study was conducted at the street lots of traffic activity, there are six stations representing the city of Malang, those are Tlogomas Street, North of Ahmad Yani Street, Letjend Sutoyo Street, Panglima Sudirman Street, Sudanco Supriadi Street and Kolonel Sugiono Street. The results of this study are that the most carbon-absorbing tree is *Albizia saman* with a value of 287,656 kg and the region that absorbs the most carbon is Panglima Sudirman Street, that located in the middle of the city.

Keywords: allometric equation, carbon-stock, climate change, Malang

1. INTRODUCTION

Climate change is the impact of logging that causes the greenhouse effect. Increasing the concentration of greenhouse effect gases in the atmosphere resulted from inadequate forest management, planting of land, draining large amounts of peatlands over a short period of time [1]–[3]. To reduce the impact of current changes that can be done is to increase carbon and reduce carbon emissions [4]. The main purpose of planting shade trees can absorb CO_2 in the air. CO_2 is absorbed through photosynthesis, converted into insulin and then transferred to carbon (C) in the organs of plants. CO_2 measurements can be measured in the atmosphere absorbed by plants [5][6].

There is significant interest in the role of terrestrial ecosystems in the global carbon (C) cycle. It is estimated that about 60 Pg C is exchanged annually between terrestrial ecosystems and the atmosphere, with a net terrestrial absorption of (0.7 ± 1.0) Pg C. The tropical forests covering 17.6 x 10^6 km^2 in vegetation and soils containing 428 Pg C [7]. Important net sources of CO_2 are however, land use change and forestry (LUCF) operations, primarily tropical deforestation, accounting for 1.6 Pg/a of total anthropogenic emissions of 6.3 Pg/a [8][9].

The process or mechanism which removes carbon dioxide (greenhouse gas) from the atmosphere is known as a carbon sink [10]. Based on variables such as growth rate, tree species, size at maturity, and life span, carbon is sequestrated and deposited in tree tissue at varying concentrations and amounts [11]–[13]. There is a major opportunity for urban trees and woodland to serve as carbon sinks. However little study on urban forest carbon dioxide sequestration and urban tree biomass allometry has been undertaken in relation to natural forests and there is a general lack of knowledge on urban tree species in this regard [14][15]. In a Malang city background, a literature review revealed no details on urban forest carbon dioxide sequestration and urban tree biomass allometry that puts additional importance to this presented study.

75% of global anthropogenic carbon dioxide (CO_2) emissions are due to cities [16][17]. An significant research subject is the quantification and comprehension of the function of the storage or increase of carbon (C) deposited in urban areas itself in city-generated anthropogenic CO_2 emissions compensation. Most analysis has been undertaken in recent decades to measure the sequestration of urban forests by the carbon [18][19]. For instance, Davies et al. noticed that in Leicester, United Kingdom, a significant amount of carbon was deposited in aboveground vegetation, and that trees account for more than 95 percent of this carbon reservoir [20]. In some regions especially arid areas, as a result of tree planting and urban greenspace management, urban forests can store more carbon than adjacent suburban and rural areas [21]. A few research also show that the carbon density of plants and the rate of carbon deposition in urban forests could be higher than that of contiguous natural forests [22]. In order to enhance our perception of the position of urban green space in the urban carbon balance, precise quantification of C accumulation in different urban forests is therefore important. In addition, towns undergo high temperatures, CO_2 and nitrogen accumulation (i.e. urban "heat island" warming) and are typically intensively controlled compared to rural environments. This dramatic variations between urban and natural systems indicate that a significant component of carbon cycle research is the characterization of C dynamics in urban forests [23].

In this research, based on data from the Central Statistics Agency for Malang City 2019, the population of Malang City has increased, in 2014 there were 845,973 people and in 2019 there were 870,672 people. Meanwhile, the data on the increase in motorized vehicles of Malang City as of July 2017, recorded 441,123 motorcycles in 2015. A year later it increased by around 15,559 to 456,693 units [24]. The purpose of this study was to map the vegetation distribution in the streets of the city of Malang and to measure its carbon stocks. This research is expected to provide information that can be used to evaluate management plans for Malang town's environmental growth.

Figure 1. Malang City Map and Research Location (Scale 1:20.000 km) [24].

2. MATERIALS AND METHODS

2.1. Materials

The tools used in this study include a tape measure, rope, lux meter, GPS, writing instruments, identification books, digital cameras.The material used is a shade tree along the arterial road which is the object of research and the organ of the shade tree.

2.2. Inventaritation

The inventory in this study aims to determine tree conditions, composition and dominance. The inventory is carried out through a vegetation

Table 1. Biomass; Stock Carbon; and CO_2 absorption of plants in Malang city roads.

Type	Biomass (kg)	Stock Carbon (kg)	CO_2 absorption (kg)
Albizia saman	156888,85	78444,43	287655,71
Annona muricata	72796,40	36398,20	133472,20
Artocarpus elasticus	47208,69	23604,35	86557,14
Barringtonia asiatica	45834,25	22917,13	84037,10
Aridelia sp.	41124,16	20562,08	75401,14
Leucaena leucocephala	37273,03	18636,52	68340,1
Felicium decipiens	36942,79	18471,4	67734,61
Cerbera manghas	13235,72	6617,86	24267,69
Mangifera indica	7835,56	3917,78	14366,50
Sterculia foetida	6911,027	3455,51	12671,37
Chrysophyllum cainito	3894,22	1947,11	7140,05
Polyalthia sp.	3264,58	1632,29	5985,62
Ficus benjamina	3147,21	1573,61	5770,42
Bauhinia purpurea	2969,67	1484,84	5444,90
Ficus vens	2803,66	1401,83	5140,52
Hibiscus tiliaceus	1872,50	936,25	3433,22
Dimocarpus longan	1389,50	694,75	2547,64
Lagestroemia speciosa	1254,99	627,50	2301,039
Morinda citrifolia	772,56	386,28	1416,49
Spathodea campanulata	735,05	367,53	1347,72
Mimusops elengi	659,01	329,50	1208,2
Mangifera ordonata	539,06	269,53	988,36
Psidium guajava	506,82	253,41	929,26
Pterocarpus indicus	445,53	222,76	816,88
Terminalia catappa	409,67	204,83	751,14
Persea americana	381,56	190,78	699,59
Pinus merkusii	216,54	108,27	397,03
Roystonea regia	124,10	62,05	227,54
Peltophorum pterocarpum	93,69	46,84	171,78
Melaleuca leucadendra	50,01	25,00	91,71
Swietenia macrophylla	45,34	22,67	83,15
Erythrina cristagalli	37,38	18,69	68,53
Syzigium sp.	30,41	15,20	55,76
Tamarindus indica	30,41	15,20	55,76
Gliricidia sepium	24,68	12,344	45,27

analysis, the following is an outline of the vegetation analysis procedure:

1. Determined the location of the sampling using the principle of purposive sampling, which is based on the spacing.
2. This study uses 6 stations. Each station has a length of 1,000m × 2m based on the Guidelines for the Provision and Utilization of RTH in Urban Areas.
3. Each station has 5 substations with a size of 200 m × 2 meters.
4. The coordinates of each station are determined by GPS.
5. Shade tree species are identified, if the species name is not known, identification is carried out in the laboratory.

6. Measuring the circumference of the stem Diameter at Breast Height (DBH) is carried out.
7. Criteria for road shade trees to be used include a minimum trunk diameter of 15 cm and a fork of at least 2 meters from the top of the ground.
8. Measuring the temperature, light intensity, and air humidity.
9. Enter all field data into the observation form and then analyz vegetation data [25][26].

2.3. Estimation of CO_2 Absorption, Biomass, and Carbon Deposit

Calculation of CO_2 absorption, Estimation of Biomass and Carbon Deposits. Estimation procedure for CO_2 sequestration and carbon storage based on Ning et al. [27]:

1. Record the local name and Latin name of the tree to be measured.
2. The diameter of the shade trees is measured along with the vegetation analysis measurement procedure (to make it easier to use a 1.3 meter long wooden stick). If the ground surface and trunk are uneven, it can be seen in the DBH measurement rules.
3. The biomass of shade trees was measured using the allometric equation.
4. Measurement of CO_2 absorption, biomass and carbon deposits is carried out by entering the biomass value of shade trees in the equation.

3. RESULTS AND DISCUSSIONS

The results of carbon calculations on Arterial Road in Malang showed in the Table 1. Based on the result showed that the plant that had the highest absorption and carbon storage was *Albizia saman*. The *Albizia saman* plant has a wide cover and wide tree diameter. This was confirmed in the research that said the greater base area, that the greater carbon stock. This carbon deposit will make the tree bigger [22].

Based on experiment results by Setiawan [24]. St. Tlogomas has carbon absorption 269.837 kg and carbon stock 73.585 kg, St. Ahmad Yani has carbon absorption 352.727 kg and carbon stock 96.189 kg, St. Jendral Sutoyo has carbon absorption 263.262 kg and carbon stock 71.792 kg, St. Panglima Sudirman has carbon absorption 285.642 kg and carbon stock 77.895 kg, St. Sudanco Supriadi has carbon absorption 284.318 kg and carbon stock 77.534 kg, St. Kolonel Sugiono has carbon absorption 118.007 kg and carbon stock 32.181 kg. By compare with data we got on the below, carbon absorption and carbon stock on every street has decreased cause many trees are cut down for road repair, construction and land conversion for industry.

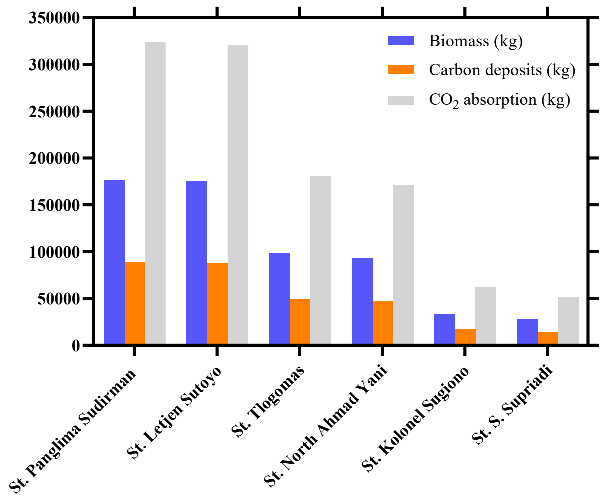

Figure 2. Regional observation result.

The highest carbon deposits and uptake is in the St. Panglima Sudirman (Figure 2). This is because this area has high density vegetation. According of the literature states that the amount of carbon stored between land varies, depending on the diversity and density of existing plants, soil types and how they are managed [28]–[30].

4. CONCLUSIONS

From this research, we conclude that carbon stocks and uptake in Malang city has increased because there are many new plants planted. The largest carbon stocks and uptake are in the Panglima Sudirman road area and the plants that store the most carbon stock and absorption are *Albizia saman*.

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