ABOVEGROUND BIOMASS AND CARBO STOCK OF NECROMASS IN 200m^2 AT GUNUNG BASOR FOREST RESERVE

By

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A report submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Natural Resources Science) with honours

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APPROVAL

"I hereby declare that I have read this thesis and in our opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Natural resources science) with Honors"

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Date	:	………………………………..

DECLARATION

I declare that this thesis entitled "Aboveground biomass and carbon stock of necromass in 200m^2 at Gunung Basor Forest Reserve" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :...

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Date :

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ABOVEGROUND BIOMASS AND CARBON STOCK OF NECROMASS IN 200m2 AT GUNUNG BASOR FOREST RESERVE

ABSTRACT

Carbon stock of dead wood or necromass representss the quantity of carbon that in the pool of tree in the tropical forest. In this study were to calculate and evaluate the value of necromass of the the highland forest. There are no previous studies have been carried out to estimate the aboveground biomass of necromass in Kelantan. Therefore, this study was carried out to estimate the carbon stocks of necromass of tropical forest. Necromass and the carbon stock were measured in the two sampling plot of $200m^2$ in Gunung Basor, Jeli, Kelantan. The total necromass recorded within the study area was 7624.2 t/ha and the carbon stock was 3812.1 t/ha and it was estimated from 11 different classes. Out of 802 necromass samples, the highest value of carbon stock (1849.8 t/ha) was represented by 1% of fallen dead tree with dbh more than 50 cm. Another about 10% (n=402) of necromass contributed the second largest pool of carbon stock (370.9 t/ha). Meanwhile, the lowest necromass that contributed in the study area was below than (1%) (n=10) represented (82.21 t/ha) of carbon stock in the study area. Study area had significantly had a high value of necromass because it due to slow rate of decomposition of necromass stock of different necromass or species and suggested for the flux of carbon dioxide by the virtue to decomposition process that may contribute to 30% to 40% of carbon dioxide in the future. This study, it's important in providing data about carbon storage of tropical forest in Kelantan to sustain the forest management, especially in Kelantan.

BIOMASS DI ATAS TANAH DAN KARBON STOK NECROMASS PADA 200m^2 DI HUTAN SIMPAN GUNUNG BASOR

ABSTRAK

Stok karbon kayu mati atau necromass mewakili jumlah karbon yang di dalam kelompok pokok di hutan tropika. Dalam kajian ini adalah untuk mengira dan menilai jumlah necromass hutan tanah tinggi. Tiada kajian terdahulu yang dilakukan untuk menganggarkan biomas necromass di atas tanah di Kelantan. Oleh itu, kajian ini dijalankan untuk menganggarkan stok karbon necromass hutan tropika. Necromass dan stok karbon diukur di dua plot sampel 200m^2 di Gunung Basor, Jeli, Kelantan. Jumlah necromas yang direkodkan dalam kawasan kajian adalah 7624.2 t/ha dan stok karbon 3812.1 t/ha dan dianggarkan dari 11 kelas yang berbeza. Daripada 802 sampel nekromas, nilai tertinggi stok karbon (1849.8 t/ha) diwakili oleh 1% pokok mati yang jatuh dengan dbh lebih daripada 50 cm. Satu lagi kira-kira 10% (n = 402) necromas menyumbang stok karbon terbesar kedua (370.9 t/ha). Sementara itu, necromas paling rendah yang menyumbang dalam kawasan kajian adalah kurang daripada (1%) (n = 10) mewakili (82.2 t/ha) stok karbon di kawasan kajian. Kawasan kajian mempunyai nilai nekromas yang tinggi kerana ia disebabkan oleh kadar penguraian yang rendah pada necromas dari necromas atau spesies yang berbeza dan mencadangkan untuk mengalirkan karbon dioksida melalui proses dekomposisi yang boleh menyumbang kepada 30% hingga 40% daripada karbon dioksida pada masa akan datang. Kajian ini adalah penting dalam menyediakan data mengenai penyimpanan karbon hutan tropika di Kelantan untuk mengekalkan pengurusan hutan terutama di Kelantan.

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LIST OF ABBREVIATION

CO_2	Carbon dioxide
a.s.l	Above sea level
ha	Hectares
t	Tonne
H	Height
W	Biomass
AGB	Aboveground biomass
DBH	Diameter breast height
C	Carbon
CWD	Coarse wood debris
FWD	Fine wood debris

LIST OF SYMBOLS

%	Percentage
°C	Temperature (degree Celsius)
>	more than
<	less than
Π	constant 3.14
t/ha	Tonnes per hectares
cm	Centimetre
m	Metre
m^2	Metre square

CHAPTER 1

INTRODUCTION

1.1 Background of Study

In Malaysia, there are few types of forest that majoring in the the ecosystem are lowland dipterocarp forest, hill dipterocarp forest, upper hill dipterocarp forest, oak-laurel forest, montane ericaceous forest, peat swamp forest and also mangrove forest.

After a few decades, the growing threat of the world's tropical forests may affect the human civilization that will receive intention on public and political levels. The state of the global tropical forest reserve and on the ecological impacts of the utilization, the degradation and the destruction of the tropical forest has been increased consequently (Goldammer, 1992).

The attribution of forest ecosystems is rich in sources of biodiversity, how the forest ecology functioning toward the environment. There are much diversity of species are present in the ecosystem with their own interaction. For example, forest ecology has several trophic levels and lot of interaction between plant, animal and other diversity. Second, all the forest are working ecosystem in that they carried out of the ecological functions or processes of value to humankind. Forest ecology attributes in functioning in cycles of energy or carbon, nutrients, and water. The lastly, are the structure of the forest ecosystems which that elaborates about the architecture of an ecosystem with the physical features or other elements of the ecosystem and the spatial patterns in which they are an array. The structure of forest has special significance for the variety of an abundance of species and organisms structures for example animal, plants and all the other organisms that filled the space in the forest ecosystems (Franklin, 2018).

In a natural forest, necromass acts as carbon cycle in the forest that present of the value of carbon storage for about 20-40% from that 12% from total aboveground biomass (Palace et al., 2007). The rate of accumulation of carbon storage from the forest can affect by the change of land use that will degrade the tropical forest land and their biodiversity. Necromass plays important role parts that function as a carbon cycling to contributing the value of carbon stock in the forest area to maintaining sustainability or conservation.

The production of necromass stock can be determined based on several aspects that can be decrease number of the necromass. The factors are the history forest uses, duration of age forest and landscape of the forest that affects the death of the tree.

1.2 Problem Statement

Nowadays, there is a too serious and complex environmental problem that needs to solved through a scientific approach, technical and purely legal. While these forests undeniably result in increasing of carbon storage in above-ground biomass, consideration of other major effect is often unrestricted. The alterations in albedo and soil carbon storage reduced runoff and downstream water source, and effects on biodiversity have resulted in forest establishment (Whitehead, 2011). Major methods of study are by calculates their aboveground biomass of necromass and carbon stock. This study was analyzed for their value of carbon that was released by the necromass where the forest functioning on reducing the build-up of greenhouse gases in the atmosphere which is linked with the climate change.

1.3 Objectives

The objective of this research is:

1. To study of aboveground biomass and carbon stock of necromass at highland at Gunung Basor Forest Reserve.

1. 4 Scope of Study

The study was carried out in Gunung Basor Forest Reserve. The plot method was used to estimate the aboveground biomass. In this research, two plot sampling with size 5m x 20m each were constructed. The total area of study for was 0.02 ha. All the necromass in each plot were measured to measure the diameter of necromass by taking the circumference of tree and height at 1.3m from the breast height on just above the buttress for standing dead tree while for necromass we take the measurement in the middle of necromass sample. The DBH and height were collected for calculating the aboveground biomass (AGB) and carbon stock.

1.5 Significance of Study

The study was conducted to study above ground biomass of necromass such as fallen and standing dead tree at diameter breast height at Gunung Basor Forest Reserve. The amount of biomass considered as the percentage of carbon stock that are stored in the dead tree and can be used as a parameter to estimate the forest productivity.

CHAPTER 2

LITERATURE REVIEW

2.1 Biomass

Biomass is organic matter such as stems, wood, bark and leaves. It developed from the amount of living matter that included aboveground and belowground biomass. Biomass in the forest ecosystem plays in significant roles in the climate system. Its dead wood either fallen dead tree or standing dead tree such as woody debris, soil organic matter and fallen and standing dead tree that donating some amount of percentage of carbon storage into the environment.

There several carbon pools have been found in terrestrial ecosystem included aboveground biomass, belowground biomass, dead mass litter, woody debris and soil organic matter (Vashum & Jayakumar, 2012). The biggest carbon pools that contribute towards carbon were aboveground biomass and it can easily give the impacts to forest ecosystem if the forest has been cleared or degraded.

The biomass natural forest in Malaysia, biomass recorded total of aboveground biomass was 4780.91million tonnes while for belowground biomass was 1147.42 million tonnes and the lastly wood biomass recorded about 889.25 million tonnes at the end of 2005 (Leduning, 2014). In Malaysia, the resources from the forest have contributed to the socio-economy and tropical forest are the most diverse and complex ecosystems of the world. In Peninsular, the forest land encompasses approximately 95% from dipterocarps forest, 3.34% from peat swamp and 1.84% from mangrove forest (Osman et al, 2014).

2.1.1 Aboveground Biomass (AGB)

Aboveground biomass includes all the biomass such all biomass of living vegetation, above the soil included leaves, stem, bark and seeds and lastly evergreen foliage. The aboveground biomass related to many important components. For example, soil nutrient allocation, accumulation of fuel, habitat environment and the carbon cycle (Lu, 2005).

Tropical forest function acts as the carbon storage or reservoirs more than any other terrestrial ecosystem that contributes more carbon stock. They also act as the elevation atmospheric carbon dioxide (CO_2) concentration mitigation by an increase in forest area (Loade & Joeni, 2013).

Estimation of aboveground biomass for necromass was used allometric equation to obtain the inventory data for calculating the value of aboveground biomass and carbon stock in the forest by developed and applied the comparison with the several parameter of tree such as diameter of tree and height total height of tree, crown diameter (Vashum & Jayakumar, 2012). In this study, we used Brown et al, equation by calculating diameter breast height of dead tree and height of the tree.

$$AGB = 0.037\, D^{1.89}\, \mathrm{H}$$

2.1.2 Biomass studies

Table 2.1: Aboveground biomass in different forest type in Malaysia

Location	Above ground	Sources
UTM Secondary Forest	1094 t/ha	Nurun et al., 2015
Chini Watershed Forest Reserve	Inland: 408 t/ha Seasonal flood forest: 379.8	Khairil et al., 2012
Redang Island	Coastal: 491 t/ha Inland: 408 t/ha	Khairil et al., 2012
Bangi Permanent Forest Reserve	362.13 t/ha	Lajuni & Latiff, 2013

2.2 Carbon stock

Carbon stock defines as the amount of carbon that released or sequestered from the environment and was stored in the forest ecosystem. Carbon storage can be found in five carbon pools which from the aboveground biomass, belowground biomass, dead wood, litter and the lastly was soil carbon.

In Malaysia, it can be divided into several types of terrestrial such as mangrove forest, peat swamp forest, dipterocarp forest, montane forest and others. The most richness of carbon contributed into the environment (Zaki et al., 2014). The estimation of carbon stock in Malaysia (Table 2.2) was from 1990, 1995, 2000, 2005, 2006, 2007, 2008, 2009, 2010, 2011 and 2012, the numbers of aboveground biomass and carbon stock about 22 years backward were increased over the years. The changes of numbers of aboveground biomass and carbon stock probably affected by land use activities such as deforestation, development and construction effects that can affect the annual carbon storage in natural forest.

Table 2.2: An estimation of carbon stock in the natural forest (Ratnasingam et al., 2015)

Year	Forested land (million hectares)	Growing stock (million m^3)	Aboveground biomass (million tonnes)	Carbon stock (million tonnes carbon)
1990	19.62	4473.36	4249.69	1997.36
1995	18.9	4271.4	4057.83	1907.18
2000	18.56	4046.08	5259.9	2472.15
2005	18.3	3879.6	5043.48	2370.44
2006	18.32	3883.84	5048.99	2373.03
2007	18.23	3864.76	5024.19	2361.37
2008	18.08	3832.96	4982.85	2341.94
2009	18.93	4013.16	5217.11	2452.04
2010	17.99	3723.93	4841.11	2275.32
2011	17.98	3721.86	4838.42	2274.06
2012	17.95	3715.65	4830.35	2270.26

2.3 Forest stratification

The emergent layer is the topmost layer, composed of trees, woody climbers, and epiphytes. These strata can have trees reaching 70 metres to 80 meters high and is only found in tropical forests. This layer is absent from temperate forests. The next layer was forest canopy which continuous in a forest and is made of tree crowns. Forest canopy is will always be exposed to sunlight and thus the flowers and fruits will be bloom. Nevertheless, trees have to tolerate the high humidity and winds to survive. Trees have to compete for each other to acquire fully sunlight. This layer is usually found in both tropical and temperate forests. The maximum height of tropical forests can reach up to 60 meters high even though the average heights is only around 10 metre to 25 metres higher. While in the temperate forest these strata can only reach up to 90 meters.

Formerly, understorey layer of forest canopy blocks will receive much light will penetrate through it and consequently, the understory is dimly-lit, and calm without much wind due to the overhead shield. Thus, trees that found in this layer are those that have low requirement of light or are the cohort of young saplings of the canopy trees. This layer is not as densely packed as the canopy and reaches up to 5 metres to 10 metres.

Lastly, the undergrowth layer which the lowest floor. The shrub layer was usually 1 metre to 5 metres and is made of very short trees and seedlings of bigger trees. Shrubs are rarely found in untouched forests, as they usually need a great deal of sunlight, in tropical forests. In (Figure 2.3) shows that some deciduous temperate forests have a rich shrub layer. While the groundcover was a dark, damp and hot place. There only 2% of the sunlight that reached on a rainforest floor. The forest floor is home to many of the rainforest’s biggest animals like Tapir, Jaguar and Anteaters may be found wandering through the trees.

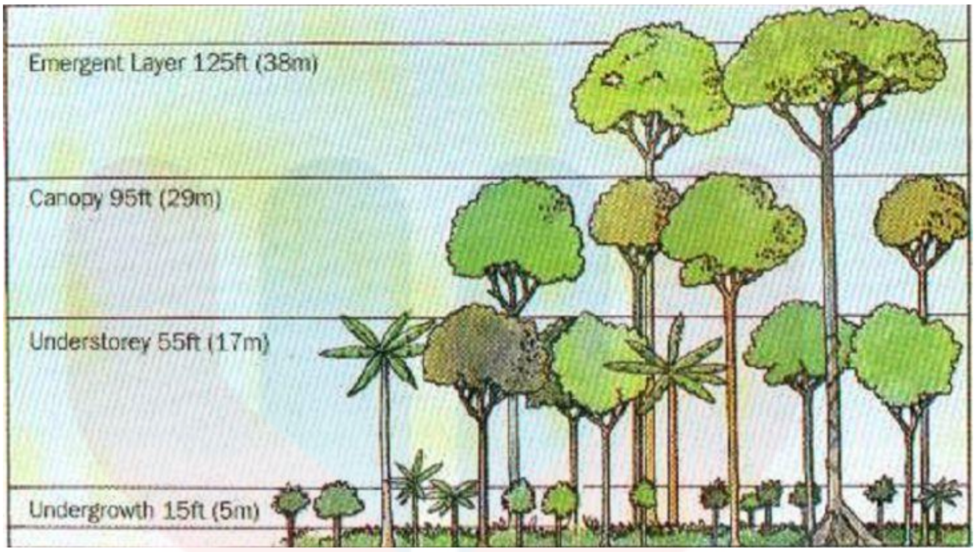

Figure 2.3: Stratification in a rainforest (Kinhal, 2016)

2.4 Diameter Breast Height (DBH)

Diameter Breast Height (DBH) defined as a method of measurement to obtain the diameter of trees. The measurement of DBH can be determined to calculate the circumference of the trees by using measurement tools called diameter tape, measuring tape and other else. In this study, we use measuring tape to calculate the length of the circumference of trees. Then, the DBH value was calculated by divided circumference value with pi (π) or 3.14. The measurement must be 1.3 m from the below of the standing dead tree and for the small necromass, we measure the circumference at the middle of necromass to get the average value of circumference.

2.5 Production of necromass

Necromass are the death whole tree that converts into necromass. The factor or mechanism that changes dead tree into necromass includes forest disturbances at various scale such as climate change, natural phenomena, logging activities and construction of roads. All the mechanism will disturb the tree growing process.

Tree mortality in tropical forests is driven on the individual tree level by competition, primarily for nutrients and light. As a tree dies and falls to the forest floor, a wide gap in the canopy will produce (Palace *et al*, 2012). These gaps are important in an ecological sense because they are involved in tree regeneration dynamics and species diversity and distribution (Denslow,1987), Gaps will increase light levels in the understory, release nutrients, and produce structural habitat for some species of flora, fauna, and fungi.

Weather and topography were one of the disturbances that influence the production of necromass. Tropical forest tree tends to have shallow root mass for nutrient exploitation and buttresses for structural support and have been shown to easily topple (Palace *et al*, 2012).

Approximately half of the studies we reviewed compared undisturbed forests with forests experiencing disturbance due to anthropogenic factors, such as selective logging. Selective logging is a practice that fells a few trees per hectare. This type of logging has been shown to affect substantial areas (Caviedes & Ibarra, 2017).

2.6 Decomposition of necromass

Decomposition is the first stage process in nutrient cycling that has been used by an organism. It is a process where the dead tissues broke down and converted onto simpler organic that can be as food sources toward the ecosystem. Decomposition of wood is a slow process that involves biological, chemical, and physical processes (Palace *et al*, 2008). Necromass decomposition rates and constants have been measured directly and estimated using Brown equations which that calculating the height and diameter breast height or dbh for fallen and standing dead trees in recent studies in Gunung Basor Forest Reserve (Basuki *et al*., 2009).

The decomposition of microbial necromass carbon (C) is, therefore, an important process governing the balance between terrestrial and atmospheric C pools (Crowther *et al*, 2015). The placement of wood that falls on the ground could dictate the rate of its decays process. Logs on hill tend to accumulate more soil on the uphill side. It also creates a wetter microclimate beneficial for many decomposing soil organisms. In the Gunung Basor forest, the rainfall season uses to be around Jun to November for this year. Unpredictable of weather condition give influence on its immediate and longer term of decomposition rates.

The estimation of necromass decomposition rates uses two major methods, chrono-sequences and time series (Harmon and Sexton, 1996). In a time series, the individual pieces of wood are followed over time (Harmon and Sexton 1996). In chrono sequence readings, inconstant ages of coarse dead wood are examined at a single point in time (Harmon *et al*, 1986). The rates of necromass production have been studied using disturbance records, living stumps, seedlings, dendrochronology, fall scars, and bent trees.

Rate decomposition of necromass was important biological metric. Rate decomposition was influenced by environmental condition, soil substrate quality and wood density. The rate of decomposition is very slow processes that take a long time, few studies have introduced into the variability in coarse wood debris (CWD) decomposition rates where decomposition process is the important and great source of uncertainty in the dynamic forest (Barbosa *et al*, 2017). For determining of the magnitude of carbon stock and residence time, providing a crucial data for accurate modeling of the effects of climate change on the stock and the global carbon fluxes, accuracy in measurement of coarse woody debris (CWD) decomposition rate are very important.

2.7 Classification of necromass

Necromass can be classified into five compartments. Firstly, coarse woody debris is branched logs with a bigger diameter that bigger than 15 cm. Then, small woody litter that having a diameter from 2 to 15 cm ranges. After that, fine litter which was leaves, fruits and twigs that have below than 2 cm in diameter and the lastly are soil organic matter (Pinnard and Cropper,2018).

2.7.1 Coarse woody debris (CWD)

Coarse woody debris (CWD) defined as the decomposition of trees in the forest floor that provides nutrition to live organisms, providing habitat for wildlife or animal in the forest, and source of food to insects and microorganisms.

Rotten wood or decay is a vital part of a healthy ecosystem in the forest. They afford nursery-like conditions for trees to regenerate, and dead wood plays a critical role in providing shelter for wildlife species that are important in maintaining a bio-diverse forest (Sullivan, 2017).

There are many important of coarse woody debris for our forest. The first one was important towards forest health. Coarse woody debris (CWD) provide a significant amount of organic matter to the soil which crucial toward the tree growth. The capability of coarse woody debris (CWD) in decaying matter to provide nitrogen, potassium and phosphate into the soil that also will be used by other plants and organisms. Coarse woody debris also helps in holding the moisture in the forest floor during the dry weather.

By having CWD in our forest, it also supports the healthy population of biodiversity in the forest as well as for the wildlife population. Coarse woody debris also providess habitat to the the animal. For example the woodpeckers, snowshoe and another small mammal as well as bigger mammals.

In this study, we can say that coarse wooody debris also plays their important role in carbon storage of the forest. Coarse wood and organic matter store carbon in the forest to prolonging the release of carbon dioxide into the atmosphere. Some of the species of the tree which are more resistant to rot or taking a long period for decay process. It could take hundreds to thousands of years to decompose, that which slower to release the store of carbon. This way was better than burns the wood that can pollute and give a negative effect on the environment.

2.7.2 Fine woody debris (FWD)

Fine woody debris defines as any pieces of dead wood that have greater than 0.5 cm and less than 10cm in diameter and usually represent as shrub and branches. FWD can be suspended in standing live and dead trees or become incorporated in duff and found within the soil such as roots. FWD also provide a source of fuel for catastrophic wildfires and as well as for food sources to invertebrate and fungi.

CHAPTER 3

MATERIAL AND METHOD

3.1 Material

3.1.1 Global Positioning System (GPS)

GPS stands for Global Positioning System. It is a tool that used to obtain position information. In (Figure 3.1) basic structure of GPS, it has three segment which is space segment or GPS satellites, the control segment and then lastly is user segment. Space segment defined as a number of GPS satellites that deployed on six orbits around the earth at altitudes around 20000 km and move around the earth at 12- hour interval.

Then, for the control segment its functioning in monitoring, controlling and maintaining satellite orbit to make sure that deviation of satellites from the orbit within the tolerance level. Lastly, user segment acts as GPS receiver.

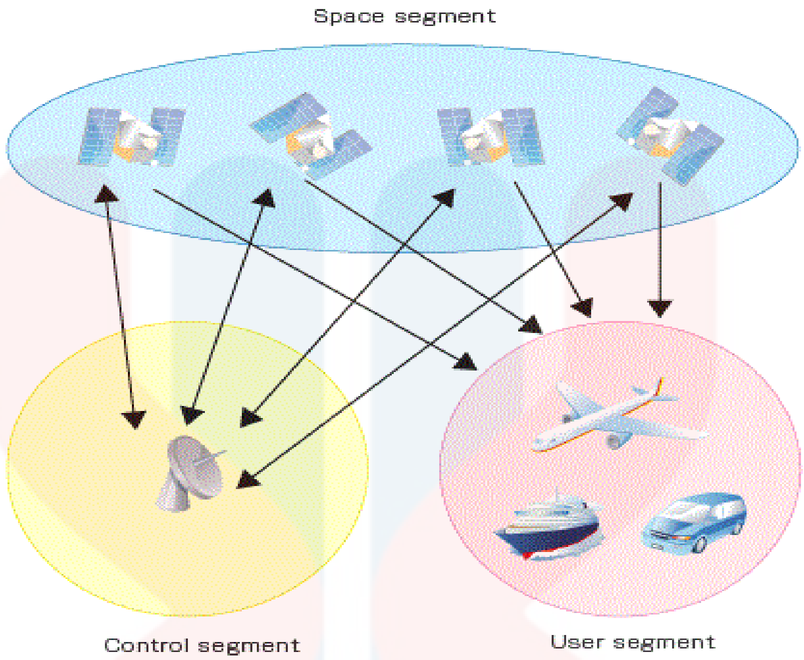

Figure 3.1: Element of GPS

3.2 Study Area

Figure 3.2: Maps of Gunung Basor (source: WWF, 2018)

The study site is located in an uphill forest in Gunung Basor (5.992 N, 101.8087 E) which was located at Dabong, Kelantan. The one is dominated by tropical dry forest and woodland. It covers an area approximately 40,613 ha and 34,763 ha were gazetted as the permanent forest reserve. Gunung Basor was restricted to the east portion of Malaysia.

Types of zoning vegetation for this study area are hill dipterocarp forest. The averages of annual rainfall of Gunung Basor are within 2750 to 3000 mm and the mean temperature of the year is 32°C and 25°C (Fauzi et al, 2017). The study area was located on the hill dipterocarp forest which 1045m from above sea level (a.s.l).

3.3 Plot Sampling

The Nested Plot Design was adopted for forest reserve. The randomly laid with an area 20m x 5m for 2 different plot which is same for 200m^2 (Figure 3.3). The size of each plot was 0.01 ha with a total area of two plots study was 0.02 ha. Line intercept sampling used a straight line where all pieces of necromass that intercept in the studied area were measured. From the plot, it can provide information about the forest.

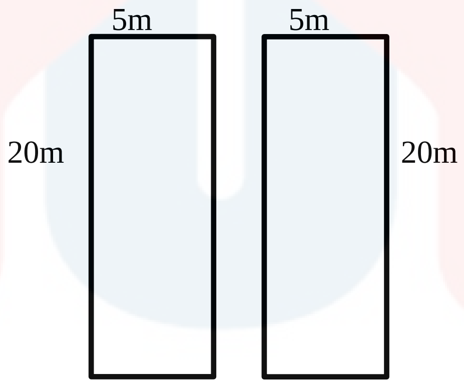

Figure 3.3: Size of the plot area

3.4 Data collection

In this plot area, the diameter at breast height of tree and tree stem that more than 5cm from the dead tree were measured to get DBH and height of the tree. Necromass or coarse woody debris was divided into two categories fallen and downed and standing dead woods or snags (Harmon *et al*., 1986). The technique that was used to get diameter value is by taking the diameter at 1.3 breast height in just on the buttress (Figure 3.4). To get the diameter of breast height, we measured the circumference by using this below formula were used.

$$\text{Diameter} = \text{Circumference} / \pi$$

After that, the data sample of necromass in the study area was calculated for aboveground biomass using Brown *et al* (1997) equation:

$$W = 0.037D^{1.89}\ H \text{ (Brown } et\ al\text{, 1997)}$$

Where D is diameter at breast height in cm and H for height for the dead tree.

Before the measurement, the aboveground biomass for coarse woody debris like an example of snags, logs and trumps were classified in several classes according to Chao et al. (2009). Then, the diameter of snags that diameter with length more than 5cm (>5) between 2cm and 5cm of equal length and the diameter of necromass was measured at the midpoint of necromass (Magalhaes, 2017) measured for the value of aboveground biomass and carbon stock percentage using Brown equation above and multiplying with 0.5 for estimation of carbon stock in this study.

3.5 Data analysis

3.5.1 Allometric equation

a) Measurement of Aboveground biomass

The measurement of aboveground biomass in the plot was derived from the equation by Brown, 1997. This formula uses the diameter of dead trees (D) and the height of the tree (H). In order to obtain the value of aboveground biomass of tree necromass, the allometric equation was used.

$$\mathbf{W = 0.037\, D^{1.89}\, H}$$

b) Measurement of carbon stock

Meanwhile, the carbon in the tree necromass was obtained from as half of the dry mass, so it was assumed that 50% of the dry mass was the value of carbon stock (Ngo *et al*., 2013).

CHAPTER 4

RESULT AND DISCUSSION

4.1 Diameter Breast Height (DBH) distribution

DBH value for all necromass was divided into 11 different classes. In the (Figure 4.1) the sequences of DBH classes was 0-4.9cm, 5cm-9.9cm, 10cm-14.9cm, 15cm-19.9cm, 20cm-24.9cm, 25cm-29.9cm, 25cm-29.9cm, 30cm-34.9cm, 35cm-39.9cm, 40cm-44.9cm, 45cm-49.9 and greater than 50cm. The tree composition in the two plot study sites were dominated with necromass of trees with diameter 0cm-4.49cm which recorded 633 from the total of necromass samples.

Table 4.1: DBH class of necromass

DBH classes (cm)	Total no of necromass
0-4.9cm	633
5-9.9cm	94
10-14.9cm	27
15-19.9cm	13
20-24.9cm	13
25-29.9cm	6
30-34.9cm	3
35-39.9cm	4
40-44.9cm	4
45-49.9cm	1
>50cm	4

The number of necromass decreases with the increased in DBH size classes. The number of trees from different classes decreased with the increase of diameter sizes class. The highest value of necromass for the 0-4.9cm sizes recorded 633 from the total number of individual necromass.

The data recorded was influenced by the topography of the study sites, fallen of the big size of the diameter of the tree that affects and broke the small necromass into small size. The presences of big size tree in a plot have contributed the most carbon stock in the forest. From this study, there are about 8 trees with diameter sizes more than 40cm of diameter.

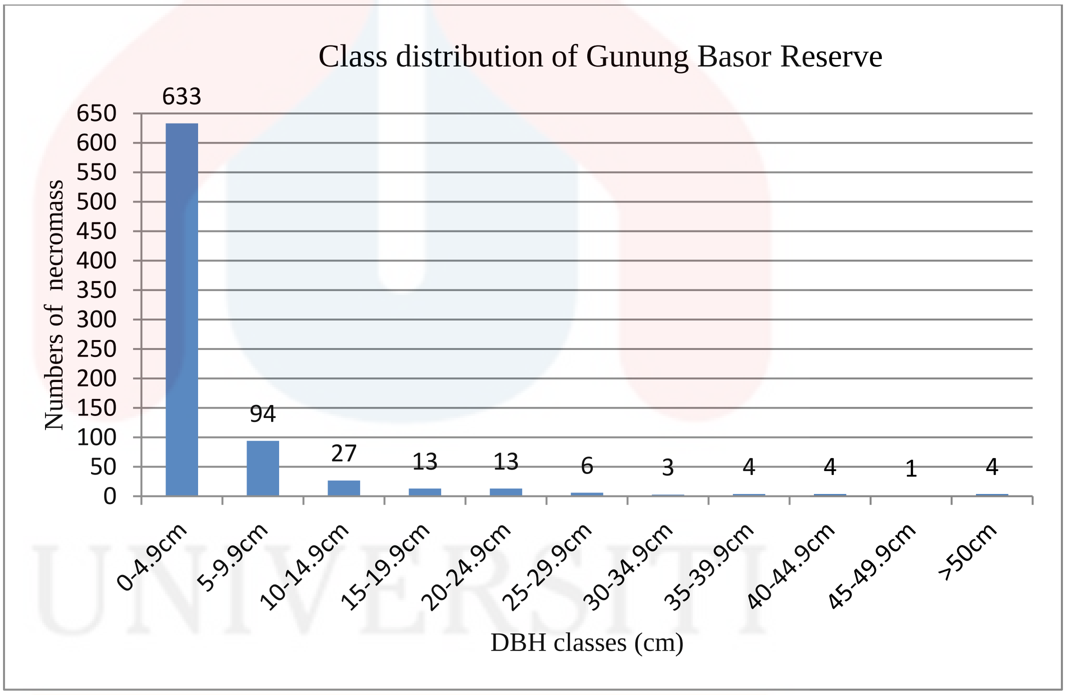

Figure 4.1: DBH distribution of a 0.02 ha plot in Gunung Basor Forest Reserve

4.2 Aboveground biomass (AGB)

The average value of biomass mostly used for calculations of carbon fluxes. The possibility of deforestation and degradation activities that occurred in the natural forest. The changes in land use in the forest by other disturbance with a geographically specific estimate of biomass could improve estimations of carbon flux (Houghton, 2005).

In this study, we use allometric equations which used variables such as the diameter of the necromass or dead trees and height of trees. This allometric equation was used to quantify the estimation of aboveground biomass. Based on the (Figure 4.2) total aboveground biomass derived from 802 sample necromass was 7624.227 t/ha. The least value of aboveground for based on different classes diameter of necromass that with 35cm-39.9cm recorded 157.115 t/ha while the highest number total aboveground biomass for classes that more than 50cm of the diameter was 3699.653 t/ha. Big trees with a diameter more than mostly contributed high of numbers of total aboveground biomass.

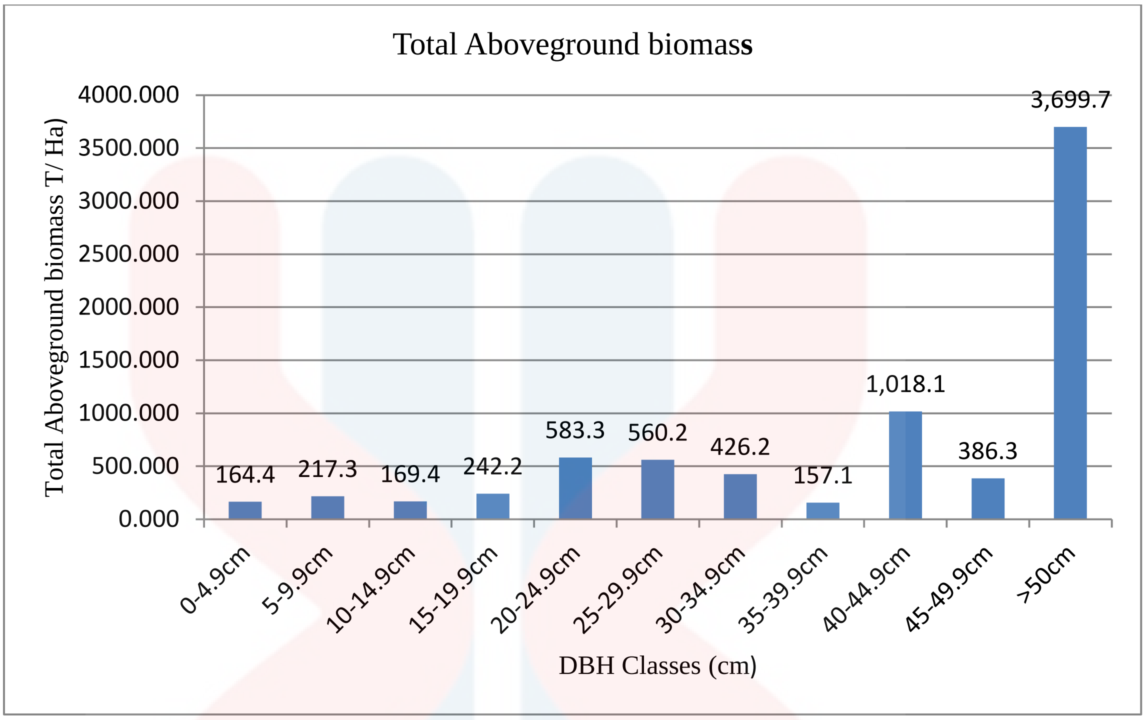

Figure 4.2: Graph of DBH and total above ground biomass distribution

4.3 Carbon stock estimation

In the (Figure 4.3), a total of 3821.2 tonnes/ha carbon stock was estimated from 11 different classes of DBH. Out of 802 necromass samples, the highest classes carbon stock was 1849.8Mg ha^{-1} was represented by 1% of fallen dead trees that dbh more than 50cm. the highest value of carbon stock (1849.8 tonnes/ha) was represented by 1% of fallen dead tree with dbh more than 50 cm. Another about 10% (n=402) of necromass contributed the second largest pool of carbon stock (370.9 tonnes/ha). Meanwhile, the lowest necromass that contributed in the study area was below than (1%) (n=10) represented (82.2 tonnes/ha) of carbon stock in the study area.

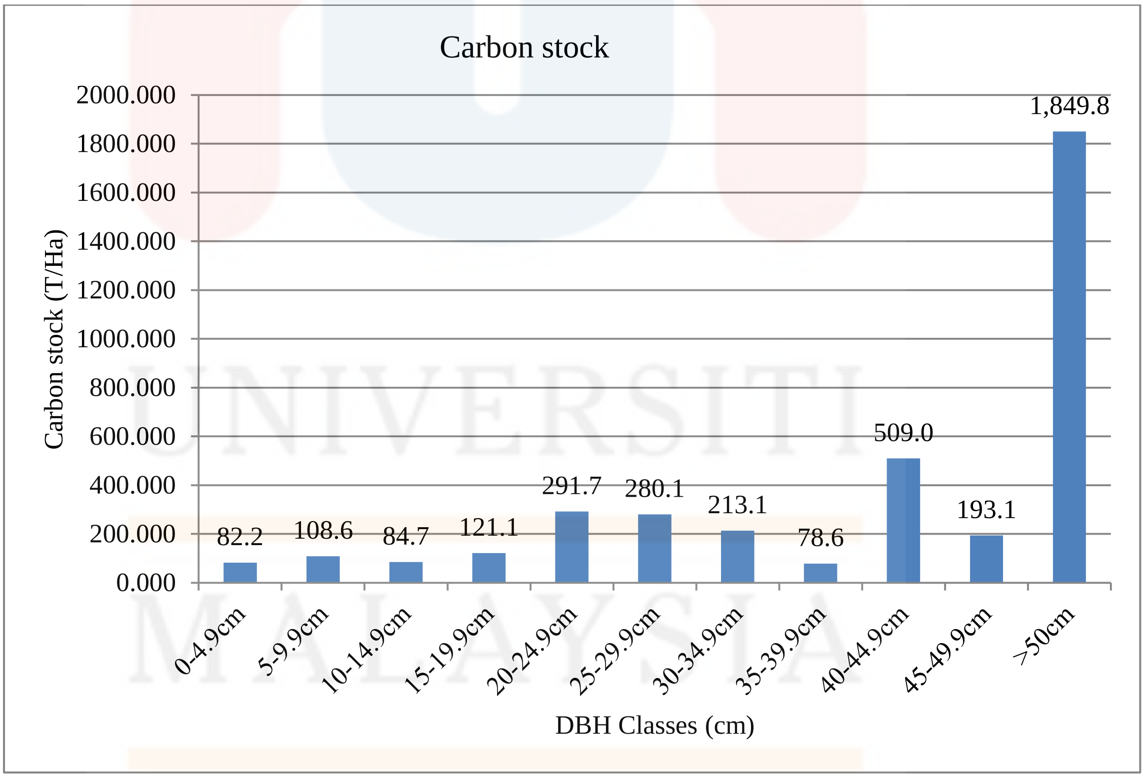

Figure 4.3: Graph of DBH and carbon stock

CHAPTER 5

CONCLUSION

5.1 Conclusion

This study was conducted in 0.02 ha plot at Gunung Basor Forest Reserve recorded a total of 802 necromass sample. The high value of necromass stock recorded in this forest reserve area reflected the low carbon storage in live trees. The value of the carbon stock of necromass only represents 50% of the dry mass of the trees. Human pressure has led to more necromass and carbon stock storage, a large value of necromass and carbon stock were observed and evaluated in the most anthropogenic factor that also can affect the number value of carbon stock percentage in this study. A high proportion of necromass carbon stock was found in the Gunung Basor Forest Reserve which was probably due to the high density of dead plants in Gunung Basor Forest Reserve and high amount of natural phenomenon occurred that destruct the tree forest in Gunung Basor Forest area.

The total aboveground biomass estimation in this study was 7624.2 tonnes/ha which derived from 802 necromass samples with 11 different classes while total carbon stock was 3812.1 tonnes/ha.

The data from this study about aboveground biomass and carbon stock can help to improve our knowledge on disturbance, deforestation, degradation and regrowth process of our natural forest by the monitor and manage for the sustainability in the future (Chave *et al*., 2014).

5.2 Recommendation

From this outcome of study and observation, I would suggest for the recommendation to improve the technique for estimating aboveground biomass and carbon stock by:

1) increase the number of the plot for the study area to obtain more accurate data and getting more necromass sample.
2) use of models that calculate from DBH only to obtain trees biomass which has a practical advantage (Segura & Kanninen, 2005).

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APPENDICES

Figure a: measurement of length or height of the big tree

Figure b: Record the data sampling

Figure c: measure small necromass

Table a: Project activity for Final Year Project 1 and 2

The table below show the planning of Final Year Project I and Final Year Project II

Final Year Project I	
Research Activities	Date
Proposal Wrinting	February 2018
Submission and Proposal Defence	May 2018
Completion of FYP I	July 2018
Final Year Project II	
Field Sampling	July – September 2018
Data analysis	September – December 2018
Completion of Chapter 4and 5	December 2018
Submission of Final Report	December 2018
Presentation of FYP II	December 2018
Hardbound Submission	January 2019