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Tree Inventory Assessment in Religious Institution Compound and its Benefit for Environmental Management in the Case of Addis Ababa, Ethiopia

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Abstract— Tree inventory plays a crucial role to work out the number of trees by measuring the various trees attributes like tree height, tree DBH, tree canopy, and tree age. The study was accompanied to estimate the carbon stock using above and below-ground biomass of tree by identifying the tree species exists in the religious institutions and also its variation along the environmental gradient. The amount of total carbon stock in all religious institutions was 223.72 tons, the carbon stock range of Above-ground biomass was 124.1 – 1.4 tons and the range of carbon stock of below-ground biomass was also 24.84-0.28 tons. The current study shows that the number of trees, types of trees, and carbon stock value of all religious institutions were highly affected by human and environmental factors such as deforestation, altitude, and slope. The implication was religious institutions have deforested a lot of tree species for different purposes such as infrastructure expansion, income source, and firewood. The consequences of these decreased the number of tree species and carbon biomass in religious institutions may have influenced the environment of climate change.

Keywords— Above-Ground biomass, Below-Ground biomass, Carbon Stock, Diameter at Breast height, and Tree height

I. INTRODUCTION

World people suffer regarding the temperature change because of the increase in world warming and exaggerated the natural hazards like flooding, wild fireplace, and land degradation. Even though, the most issue that is that the temperature change occurs within the world is giant the quantity greenhouse emission by anthropocentric activities. Within the last century, varied human activities like land-use changes and therefore the burning of fossil fuels has increased the atmospheric phenomenon inflicting international temperature change [1]. Even though still this international amendment is continued powerfully ever-changing the composition of inexperienced house gases because of emotional the greenhouse gas, inhalation general anesthetic and Alsace series from the industries' production. The greenhouse emission is presently at 385.2 components per million (ppm), N2O at 321.8 components per billion (ppb), and CH4 is at 1797(ppb) that square measure all above from preindustrial times [2]. carbon dioxide emission in the atmosphere is a major cause of global warming The one mechanism that produces to mitigate for reducing the quantity of greenhouse gas in the atmosphere multiply the variety of tree in the given space and keeping to their surround for recording all information's regarding the tree by tree inventory methodology as a result trees square measure play vita role capture a store the quantity of greenhouse gas for the process of chemical change. Measures for environmental control in modern coal-fired thermal power plants may be useful in reducing SO2, NOx, and particulate matter emissions [3].

Expressed the advantages of trees give from social, communal, environmental, and economic views Trees alter the setting within which we have a tendency to live by alleviatory climate, up air quality, reducing storm-water runoff, and harboring life. Native climates square measure tempered from extreme sun, wind, and rain by trees [4]. So energy from the sun is absorbed or deflected by leaves on deciduous (broad-leaves) trees within the summer and is just filtered by branches of deciduous trees in winter. The investigated the larger the tree, the bigger the cooling result [5]. Because these trees have a large variety of cover that covers the massive surface of Earth? By mistreatment trees within the cities, they'll moderate the heat-island result caused by industries and buildings in business areas. This vital tree function provides for living organisms by trees that will be preserved within their surround (in-situ) and outdoors of their surround (ex-situ) and additionally implement the tree inventory system in the completely different places for the tree plant exists.

A tree inventory is that the systematic gathering data of knowledge regarding the urban forest and organizing it into usable information for tree management [6]. The knowledge regarding the species tree, its health, size and placement square measure recorded for every tree. a listing is a crucial and infrequently unnoted step, in effectively managing urban forests, or any resource for that matter

grahm et al (1992); [7]. Inventories give a baseline to figure from, facilitate management choices, and supply a basis for future analysis of management efforts.

Tree inventories specialize in the options of individual trees, as compared to a Forest inventory that asks for to assess timber attributes on forest stands. Tree inventory enclosed the knowledge like what percentage trees square measure there, what their species square measure and their condition are additionally gathered. A community forest can't be effectively managed unless its condition is thought. A tree inventory ought to be conducted for several reasons, like to see if a community must implement environmental management, so as to rate forest management, and to supply a basis for the implementation of tree management arrange. Tree population is very wide in their species composition, age, size, potential worth, longevity, and growth of all factors that will influence the planning of tree inventory [8]. tree inventory ought to give tree species, ideally in binomial nomenclature (Latin names), size, like DBH (diameter at breast height) and tree height, tree cover, tree age, crown dimension, overall condition like health and maintenance desires, overcrowding, attainable issues, presence or absence of insects or diseases. Characteristics of the positioning ought to even be listed like soil sort and condition, root space, and safety.

There square measure some researchers in the Federal Democratic Republic of Ethiopia were worked on the forest inventory that is just targeted on known the plants square measure herbs, shrubs or trees and determined the areas that forests exist. The Federal Democratic Republic of Ethiopia is lacking periodic inventory knowledge of forests and carbon stocks, and this makes the country fail to develop property forest management designing that draws climate finances through enhancing the environmental services of forests for the aim of finance forest development through forest carbon finance. Even the researchers haven't been studied tree inventory before they did carbon stock estimation and forest inventories in specific areas [9]. The tree or the forest inventory enclosed like Mensuration of diameter at breast height, canopy, and therefore the height of trees. However, the distinction is that the forest inventory means typically known as the world, the dimensions and with quantities mensuration the expansion of various varieties of plants. Forest inventory may be a tool that has the data regarding the size and form of the world in addition to qualitative and/or quantitative information of the growing stock [10]. However, the tree inventories square measure recorded or collected knowledge to live the peak tree, tree age, tree cover, and tree diameter at breast height. albeit, the analysis not used tree inventory once they ought to create the research of forest inventories in order that they aren't live used the standards like age and dimension tree in forest inventories because of high price needed the method, it takes an extended time and giving the low values for the needs. And researchers in the Federal Democratic Republic of Ethiopia haven't done tree inventory methods in religious institutions compound or alternative places.

This study is organized and presented in six chapters. The first chapter concerned introduction/background of the study. The second chapter presents the review of related literature, and the third chapter is materials and methods, whereas the fourth, fifth and sixth chapters brought to an end of the study with the results, discussion, and conclusion and recommendation respectively.

II. LITERATURE REVIEW

2.1 Overview of climate change and causes of climate change

Climate change is a change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average. Climate change may be limited to a specific region or may occur across the whole Earth [11].

The average temperature of the earth's near-surface and the ocean has increased dramatically as compared to the historical data. During the last decade which is referred to as global warming, Greenhouse gases including water vapor, carbon dioxide, methane, nitrous oxide, and ozone, are believed to have played an important role in global climate change [12].

2.2 Tree inventory

There are many different types of inventories that the researcher should select an inventory type to consider precisely what the research study wants to accomplish. Data gathered on the religious institution compound trees must have practical value. Davey Resource Group has investigated to guarantee that the study tree management program will be effective and an appropriate inventory based on the objectives for use the most common types are the specific problem inventory, partial inventory, complete inventory, and cover type survey [13]. So that this research study uses complete (it means surveys the entire tree population but it is time-consuming and expensive) inventory because of the religious institution compound have large number of trees around them.

Tree inventory will carry out based on the measuring tree species using various devices that can be measured such as tree size (DBH), tree height, tree age, and tree canopy. Stem diameter at breast height (DBH) and tree height (*H*) are commonly used measures of tree growth [14]. The relationship between trunk diameter at breast height (DBH) and tree height (T*H*) is the most commonly used measurement of tree size. The allometric equation is important to describe the total growth of trees based on measuring of the size trees such as tree height, diameter at breast height and crown height. The development of allometric equations for urban open-grown trees has been sporadic. Measured trees in New Jersey having full healthy crowns to develop linear relationships between D.B.H.,

height, crown spread, and age [15]. Measured only healthy trees (12 species, 221 trees total) growing in Minneapolis and St. Paul, Minnesota, to predict linear size relationships [16].

1) 2.2.1 Tree size (DBH) measuring

Diameter at breast height (DBH) is usually measured in inches or centimeters around the tree at 4.5 feet from the ground. Analyzing the diameter size class distribution (measured as diameter at breast height [DBH]) provides an estimate of the relative age of a tree population and lends insight into maintenance practices and needs [17]. The inventoried trees were categorized into the following diameter size classes: young trees (0–8 inches DBH); established trees (9–17 inches DBH); maturing trees (18–24 inches DBH); and mature trees (greater than 24 inches DBH). These categories were chosen so that the population could be analyzed following [18]. The tree size value provides for the status of the tree which is also determined the age of the tree qualitatively would be new, young and mature. Trunk diameter at breast height (approximately 4.5 feet above the ground) was measured to the nearest inch. DBH is the most commonly used measure of tree size and age, it is not an absolute measure, however, as relationships between DBH and canopy spread or DBH and tree age varies by species.

DBH is used in estimating the amount of timber volume in a single tree or stand of tree utilizing the allometric correlation between stem diameter, tree height and timber volume [19]. It can be also be used in the estimation of veteran (old) trees, given that diameter increment is the only "constant non-reversible features of tree growth" [20]. The diameter of a tree provides a measure of tree performance and is a useful starting point for estimating tree volume. By convention, the diameter of forest trees is measured in cm at 4.5ft above the ground and is termed the "Diameter at Breast Height" (DBH) [21].

2) 2.2.2 Tree age measuring

Tree age can be measured using counting the rings of the tree which is determined by the new, the young, and the old tree. The young trees are performed fast metabolic activities for developing the new tissues and growing the various organ parts than the old trees. Tree age and longevity Old trees, while having significant emotional and aesthetic appeal; have the limited physiological capacity to adjust to an altered environment, Young trees are better able to generate new tissue and respond to change [22]. Tree age is used to predict species diameter at breast height (D.B.H.), and D.B.H. is used to predict tree height, crown diameter, crown height, and leaf area. Diameter at breast height is also used to predict age of trees [23].

2.2.3 Tree height measuring

Tree height is measured as a vertical distance between the ground immediately next to the stem base approximating the germination point and the highest point on the main stem (terminal bud or needles). Tree height is sometimes measured when there are utility wires overhead and used for scheduling future pruning needs. Tree heights can be obtained by using clinometers, Abney level, hypsometer, or an altimeter. The most significant attribute for determining accurate tree volume is tree height.

2.2.4 Tree Canopy

Tree canopy means width, an important attribute of the size of the tree that influences the benefits (e.g. cooling of the environment) that a tree provides. To measure the canopy width, we measure the diameter of the tree's crown (i.e. canopy) i.e. the distance from one edge to the other. Measurements of urban tree canopy cover are crucial for managing urban forests and required for the quantification of the benefits provided by trees, and Scientists classify forest canopies as open (10-39% of the sky is obstructed by tree canopies), moderately closed (40-69% of the sky is obstructed by tree canopies) or closed (70-100% of the sky is obstructed by tree canopies) [24].

3) 2.2.5 Tree Species

There are several different ways of naming tree species. Using the scientific name genus and species as well as the variety or cultivar is essential because it will eliminate any confusion that common names may have because of regional variations. However, it is also important to include a listing of often used common names. These common names will assist in communicating with local residents and in various educational endeavors. The ability to accurately identify cultivars is very difficult to even with experienced crews [25].

2.3 Tree Inventory Uses

2.3.1 Environment and tree Management program

Trees inventory play an especially important role in enhancing our quality of life in the urban environment and this is acknowledged in the Governments Sustainable Development Strategy. Tree inventory is important to collect data about tree species in specific area. So that Trees improve air quality by acting as natural air filters removing dust, smoke and fumes from the atmosphere by trapping them on their leaves, branches and trunks. As well as Trees reduce the 'Greenhouse' effect by removing carbon dioxide from the air and releasing oxygen in the process of photosynthesis is called carbon sequestration. The idea of storing the carbon dioxide in underground tanks for a long time is termed sequestration of CO2 [26].
Tree inventories can be used to determine the need for a tree management program. Trees that are publicly or religious institution owned must be properly maintained to avoid hazardous conditions. Data can be organized and presented in a neat and concise manner illustrated with graphics, to indicate the importance of a well maintained urban tree population.

III. MATERIALS AND METHODS

3.1 Location of the Study Area

Ethiopia is located at 3 degrees and 14.8-degrees latitude, 33 degrees and 48-degree longitude in the Eastern part of Africa lying between the Equator and the Tropic of Cancer.

It is bounded on the Northeast by Eritrea and Djibouti, on the east and Southeast by Somalia, on the south by Kenya and on the west and Northwest by Sudan**.** Since 1995, Ethiopia has been divided into 10 administrative regions based on ethnic lines. These are Tigray, Afar, Amhara, Oromia, Somali, Benishangul, Southern Peoples' State, Gambella, Harar and Addis Ababa Ethiopian Orthodox 43.5%, Muslim 33.9%, Protestant 18.5%, traditional 2.7%, Catholic 0.7%, and others 0.6%.

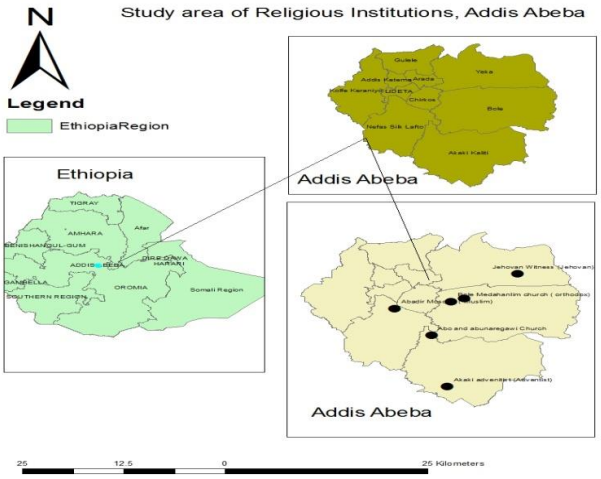

Figure 1: Map of the study Area

3.2 Geography

Addis Ababa lies at an elevation of 2,300 meters (7,500 ft) and is a grassland biome, located at 9°1′48″N 38°44′24″ECoordinates:9°1′48″N 38°44′24″E. The city lies at the foot of Mount Entoto and forms part of the watershed for the Awash. From its lowest point, around Bole International Airport, at 2,326 meters (7,631 ft) above sea level in the southern periphery, the city rises to over 3,000 meters (9,800 ft) in the Entoto Mountains to the north.

3.3 Climate condition

Addis Ababa has a Subtropical highland variety. The city has a complex mix of highland climate zones, with temperature differences of up to 10 °C (18 °F), depending on elevation and prevailing wind patterns. The high elevation moderates temperatures year-round, and the city's position near the equator means that temperatures are very constant from month to month. As such the climate would be maritime if its elevation was not taken into account, as no month is above 22 °C (72 °F) in mean temperatures.

3.4 Demographic and location of Addis Ababa

Addis Ababa is the capital city of Ethiopia, which has totally of 10 sub-cities that comprises 6 zones and 28 woredas. The city is divided into 328 dwelling associations (Kebeles) of which 305 are urban and 23 rural. The city council is made up of 18 bureaus, offices and authorities. Addis Ababa is located in the heart of the country surrounded by Oromia. Addis Ababa covers about 540 Km^2 of which 18.2 Km^2 are rural. According to the 2007 census, the population of Addis Ababa is 2.739 million of which of the total population 51.6% are females while 48.4% are male. According to the Addis Ababa Administration website, regarding religion, 82% of the populations are Orthodox Christians, 12.7% Muslims, 3.9% Protestants, 0.8% Catholics, and 0.6% followers of other religions.

3.5 Field Data Collection

The methods and procedures to be used to estimate tree abundances, tree measurements such as tree height, tree DBH, tree canopy, and tree age and carbon stocks in trees species were simple step-by-step procedures using the standard tree and carbon inventory guidelines and techniques. The following procedures were used.

1. Preliminary Field Data Collection

A. Determine Plot vegetations

Plot vegetations in all religious institutions are determined by the GPS coordination's points and This GPS coordination's points are needed to calculate the areas in Gis software used the coordination's points which are indicated the exact placed on trees species in the areas.

B. Shape and size of plots vegetations

Tree inventory and its measurements and also carbon stock measurement can be carried out in different shapes and sizes of plot vegetations based on the GPS coordination points. The coordination points are taken based on the largest number of trees species existed together in the areas. So that the largest area of plot vegetation in all religious had Abo church, it was 0.49 ha (the parameter of the area was 10 km) and the lowest area of plot vegetation also in Abo church, it was 0.007 ha (the parameters of this plot was 4 km). These and other plot vegetations were chosen to conduct field data collection.

C. Number of Plots vegetation

The number of plots vegetation can be determined a few trees species found in groups of particular areas in the religious institutions. But the homogeneity species was considered as a single plot of vegetation due to it was very easy for counted the abundances and measured the tree attributes such as tree height, tree circumference, and tree canopy. There were fifteen plots vegetations selected from five religious institutions compound based on the GPS coordination points. Only Misrak Mesert Kristos had two plots of vegetation and the rests had three plots in each of them.

2. Field Data Collection

I. Tree inventory

The main tree inventory method in this research used plot vegetations (Complete tree inventory) and, supported by mobile software was Inventory management for Tree inventory system. This software was used to count each tree species after identification took place by the botanists in the Gulele botanic garden of the research department. The main reason for using this method for tree inventory was some of the religious institutions have paved around of their compounds and the trees species are obtained as

dispersed in groups of different areas in the religious. Even if some religions have a few or none trees species in their religious compounds. However, it was very difficult to use other methods without this method for tree inventory.

The procedure that counted Tree species (tree inventory) in the six religious institutions used plots vegetations as follows:

1. Determined each religious institution from plot vegetations 1 up to 15, each plot has different areas in religious institutions.
2. Tree species were identified by the local name and the scientific name used pictures of the camera.
3. Each tree species were coded by letters of the religious name and put them into the inventory management mobile application to ready for counted
4. Counted every tree species used the mobile application.

II. Tree height Measurement

One of the Tree inventory technique that the information is gathered from the tree based on Tree height measuring and the tree height was measured in the research used the stick methods by the ruler and the angle of elevation with used the protractors instrument and the first and the main method in this research for measured the tree height was used the stick methods that can measure as plan geometry to compute the corresponding leg of a large triangle of similar shape to a smaller one [25]. The other method was the protractors of the height measuring technique is required for the tangent angle which is between the tree and the person who stand in front of the tree certain distance.

The procedures for measuring the height of a tree using the stick method as followed

1. Hold a ruler or yardstick vertically at arm's length. Move forward or backward from the tree until the part of the stick from the top of your hand to the top of the stick just covers the tree.
2. Measured the length of the stick above your hand to get the side **b** of the small triangle **abc**.
3. From this position measure the distance from your eye to the top of your hand. This was the distance **a.** we have got this distance by extended a string from your eye to your hand and measured the string length.
4. We used tape, measured the distance from your eye past the top of your hand and on to the base of the tree. This was distance A.
5. We have used the following formula to calculate B, the tree's height.

$$B = \frac{A*b}{a}$$

B is Tree height, A is the distance between people and Tree, a is small triangle horizontal side, b is small triangle vertical side and c is small triangle hypotenuse side**.**

III. Tree of circumference

Diameter at breast height of the tree can be measured using a mid-slope rule for the circumference measurement. This method was important for measuring a single trunk tree were 4.5 feet above the ground at the mid-slope is above the location where the trunk touches the ground on the uphill side or level of the ground. The method involves measuring the tree circumference by the Tape instrument measurement in centimeter or inch and measured the tree around of its trunk above 4.5 feet from the ground.

The procedures of measured the diameter of the tree using the mid-slope rule as follows:

1. Located and marked the point 4.5 feet above where the trunk touches the ground on the uphill side.
2. Located and marked the point 4.5 feet above where the trunk touches the ground on the downhill side.
3. Taken the midway between these points (measured the distance between the uphill and the downhill) then mark this midpoint was 4.5 feet above the ground and measured the circumference of the trunk
4. Be sure the tape was perpendicular to the axis of the trunk.

$$C=2\pi r,$$
$$\text{Or } C=D\pi$$

C is the circumference of the tree, π is 3.1416, and r is the radius of the tree, D or DBH is the diameter of the tree.

$$D = C/\pi \text{ or } r = C/2\pi$$

IV. Tree Age Measurement

This research was used to measure determined the estimation of tree age is to calculate the growth factor of tree multiplied by the diameter of the tree. the other method and the previously the researchers were used to determine the age of the tree was to count the rings of the stem when the increment borer is entered in the trunk of the tree to form the large hole in the stem for count the rings of a tree but this method is very dangerous for tree to exposed diseases and injury.

[1] Tree Age = the growth factor of Tree * the diameter of the tree

The procedures that followed to measure and calculated from the age of tree species:

1. Measured the circumference of the trunk in inches or centimeters. Used the trunk width at 4.5 feet (1.3 m) off the ground.
2. Calculated the diameter (circumference divided by pi).
3. Multiple the diameters and the tree species' average growth factor. This will give us the approximate age of the tree in years. But the growth factors of trees were obtained by searching online or divide the longevity of the tree by the growth rate in inches or centimeters per annual.

V. Tree canopy

This research study is used to measure the Tree canopy by the crown spread method (Leaves cap). Crown spread method is difficult to measure the accuracy of Tree canopy.

There are three different techniques or methods use to measure the tree canopy by Tree crown, but individual Tree of Tree canopy can be measured based on the Axis method of crown spread.

If the ground is not level, the canopy of the tree can be calculated using the formula below.

$S = \frac{E_1 + E_2}{2}$ $E_1 = X\text{Cos } A_1$ and $E2 = Y\text{Sin } A_2$

'X' is P_1, P_2 and 'Y' is P_3, P_4 if 'S' is the average crown spread. But the ground is level or normal we use to calculate the tree canopy: S = X+Y\2, whereas, X is the distance between P_1-P_2 and Y is the distance between P_3-P_4.

VI. Carbon estimation of Tree (Above the ground biomass)

This research study used amount of carbon biomass can be estimated the non-destructive methods, this method is important to measure the amount of carbon stock in the trees or plants based on measuring of tree height and tree dbh with out of tree cutting or tree dead. According to the online Globallometry database, at least 63 allometric equations are specific for Ethiopia [26]. All allometric equations taken from globallometric database are important for the estimation of carbon stock biomass but the difference of all are the parameters of that used in the equations such as tree height, tree diameter, tree dbh, and others. So that this research study is used below the allometric equation to estimate the carbon stock of a single tree or group based on the parameters of tree DBH. The allometric equation is suitable for rainfall less than 1500mm and the DBH > 5 cm. The literature revealed that this method is nondestructive and is the most suitable method [27-29]. The equation taken for the present study was shown as follows:

$Y= 34.4703 - 8.0671(DBH) + 0.6589(DBH^2)$…… (Equation 1)

Where: Y is above-ground biomass: DBH is Diameter at Brest Height

The amount of biomass in each species using the above equation was calculated. They were sum up to get total carbon stock in each plot and then putting in hectare and the size of the area was determined by the GPS coordination's points.

VII. Below the ground biomass (BGB)

Below ground biomass estimation is much more difficult and time-consuming than estimating aboveground biomass [31]. Roots play an important role in the carbon cycle as they transfer considerable amounts of Carbon to the ground, where it may be stored for a relatively long period of time. As indicated standard method for estimation of below ground biomass can be obtained as 20% of above ground tree biomass i.e., root to shoot ratio value of 1:5 is used [32].

The equation is given below:

BGB = AGB × 0.2 …… (Equation 2)

VIII. Populations or Universe of the study area

According to the Addis Ababa Administration website, the area cover of Addis Ababa is 540 km^2.The number of churches and mosques have taken consider the percentages of religious existence in the City based on the official website of Addis Ababa described about the religious status (regarding religion, 82% of the populations are Orthodox Christians, 12.7% Muslims, 3.9% Protestants, 0.8% Catholics, and 0.6% followers of other religions.

In this case, in Addis Ababa, the total churches and mosques are above 450 available at the religious institution's official websites. The total number of mosques in Addis Ababa is above 140 [33].

3.6 Data analysis and interpretation

The collected data was organized and recorded on the excel datasheet. The quantitative structure analysis was made using Microsoft excel of 2007 and SPSS software 16 version from data DBH, height, canopy, age, and carbon biomass of above and below-ground tree. The relationship between different parameters was tested by linear regression and descriptive statistics. The height and diameter data were arranged in classes for applying the appropriate model of biomass estimation equation. It includes many techniques for modeling and analyzing several variables when the focus is on the relationship between a dependent variable and one or more independent variables (or 'predictors').

Regression Equation (y) = a + bx

Slope (b) = $\frac{N\sum XY - (\sum X)(\sum Y)}{N\sum X^2 - (\sum X)^2}$

Intercept (a) = $\frac{\sum Y - b(\sum X)}{N}$

Where,

x and y are the variables.

b = the slope of the regression line is also called a regression coefficient

a = intercept point of the regression line which is in the y-axis

The other methods of data interpretation are the tables, graphs, figures and others. The study of this research data gathered using the primary and secondary data sources that will organize the data based on the research objectives.

IV. RESULTS

4.1 Tree species identification

There were 18 different trees species that have been identified in 16 plots from six religious institutions and the identified trees species were exotic and indigenous for the communities. Most of the religious institutions have contained more than five tree species individually and one religious institution had no tree in the Compound due to the compound has small area and the area that totally paved, furthermore, the religious institution using the most of its area was build houses.. Even if some religious institutions have more than seven trees species and the highest number of trees species contained in the Seventh-day Adventist religious institution that was 10 and the

lowest number of tree species typically found in Misrak Mesert Kristos that was 5. Out of 18 trees species, the Eucalyptus globules tree is found in most religious institutions compound and the next were Juniperus procera and Grevillea robusta.

Table 1 identified trees species

No.	Species Name (Scientific Name)	Family	Local Name
1.	***Eucalyptus globulus*** Labill.	**Myrtaceae**	**Bahir zaf**
2.	***Olea europaea*** L. subsp. cuspidata (Wall. ex G.Don)	**Oleaceae**	**Weyra**
3.	***Juniperus procera*** Hochst.ex A.Engl.	**Cupressaceae**	**Yehabwsha Tsed**
4.	***Cupressus lusitanica*** Mill.	**Cupressaceae**	**Yeferenj Tsed**
5.	***Grevillea robusta*** R.Br.	**Proteaceae**	**Grevillea**
6.	***Cordia africana*** Lam.	**Boraginaceae**	**Wanza/ዋንዛ**
7.	***Borassus aethiopium*** Mart.	**Arecaeae**	**Palm**
8.	***Prunus africana*** Hook. F.kalkm.	**Rosaceae**	**Tikur Enchet**
9.	***Acacia abyssinica*** Hochst. Ex Benth.	**Fabaceae**	**Bazra Gerar**
10.	***Dodonaea viscose*** auct. mult., non Jacq	**Sapindaceae**	**Dedho**
11.	***Callistemon citrinus*** (Curtis) Skeels	**Myrtaceae**	**Bottle brush**
12.	***Croton macrostachyus*** Del.	**Euphorbiaceae**	**Bisana**
13.	***Ficus sur*** Forssk.	**Moraceae**	**Shola**
14.	***Persea aemericana***	**Lauraceae**	**Avocado**
15.	***Vernonia amygadlina*** Del.	**Asteraceae**	**Girawa**
16.	***Casimiroa edulis*** La Llave	**Rutaceae**	**Casimiroa**
17.	***Millettia ferruginea*** (Hochst.) Bak.	**Fabaceae**	**Birbira**
18.	***Casuarina equisetifolia*** L.	**Casuarinaceae**	**Shewshewe**

4.2 Measuring Biodiversity

A total of 4683 trees representing 18 species and 15 families were identified from the total area (3. 067 ha). Myrtaceae, Cupressaceae and Fabaceae were the dominant families in the Religious institutions with 6 species and 3616 tree Species. Based on annex 4 and table 3, plot 1 had only one tree species (*Eucalyptus globulus**)*** which was the dominant tree (0.8238) in Abo church, and the plot 2 had the highest abundances of trees species or more species diversified than other plots, Therefore There were some plots that had largely identified trees in the lower area coverage like Plot 8 and 11 had the equal number of trees species which was 0.08 ha for both.

Table 2 Biodiversity indexes in religious institutions

	Abo Church	7th day Adventist Church	Mesert Kristos Church	Bole Medhan-alem Church	Mekanis Abadir Mosque
Taxa_S (Number of Species)	8	10	5	7	9
Individuals	3270	445	474	346	148
Dominance_D	0.8238	0.2065	0.5481	0.3128	0.1917
Simpson_1-D	0.1762	0.7935	0.4519	0.6872	0.8083

4.3 Tree inventory and its characteristics measurement

4.3.1 Tree inventory

A total of eighteen different species of tree plants were identified in religious institutions at western Addis Ababa, Ethiopia. A total number of 4683 trees were collected from eighteen species of plants in the study area. Among such species, Eucalyptus globules was the dominant species counting 3330 trees, and Cordia africana and Junipers procera were the second and third dominant species recorded with 346 and 178 trees respectively. Six species also recorded namely *Grevillia robuusta*, *Acacia abyssinica*, *Olea europaea*, *Callistemon viminalis*, *Veronia amygadlina*, and *Prunus africana* with an equal coverage of which were the least of the whole species.

The five religious institutions have various tree species around their compounds. So that the highest abundances of trees existed in Abo church, and the 2nd, 3rd, 4th and the least were found, in Misrak mesert Kristos, 7th Day Adventist, Medhan-alem church, and Mekanisa Abadir Mosque respectively.

4.1 Measurement of Trees

4.3.1 Tree height Measurements

There were 67 total trees species in all sixteen plots of the religious institutions have been measuring their estimation height in each species. The tree height measurements were necessary to compare the amount carbon stock in trees and related to tree age and diameter of the tree in the various areas of the religious compounds.

The tree's heights in all plots were ≥ 3.5 m. The smallest height trees' was found in Abo church (plot two); the tree species name was Olea europeae. The largest tree height was Juniperus procera, 29 m from 7th Adventist Church (plot four). The other tree species heights ranged between 29 m and 3.5 m.

4.3.2 Tree DBH Measurements

$$C = \pi D, \text{ and } D = C/\pi$$

Before determined the tree DBH, trees species in different religious institutions have been measuring their circumference of the trees in all plots.The largest DBH of the tree in selected areas were *Cordia africana* (51cm) from 7th Day Adventist Church in plot four and the smallest tree was both *Olea europaea* (5.0 cm) and *Vernonia amygadlina* (5.0 cm) from the 7th Day Adventist

Church in plot 12 and 11 respectively**.** The DBH for the other species ranged between 51 cm and 5 cm.

Table 3: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Tree DBH	***67***	5	51	17.45	10.562
Tree canopy	***67***	1.30	12.6	4.1597	2.39083
Valid N	67				

The standard deviation of the tree DBH was 10.5, the value gives that the sets of different data of the tree DBH from 51 cm- 5 cm distribution was dispersed.

Figure 2 Tree Circumference measuring (Yohannes, 2018)

4.3.3 Tree Canopy Measurements

The largest Canopy of the tree in a six selected area was *Casimiroa edulis* tree (12.6 m^2) from plot twelve in Mekanisa Abadir Mosque, the next larger tree canopies were *Acacia abyssinica* (9.8 m^2) from plot fourteen in Misrak Mesert Kirstos and *Cordia Africana* (8.5 m^2) from plot seven in Bole Medhane Alem Church. The smallest tree canopies were *Eucalyptus globulus*, *Casurina equisetifolia*, *Vernonia amygadlina* and *Callistemon citrinus* (1.3 m^2) from plot one in Abo Church, plot four in Adventist Church, plot twelve in Mekanisa Abadir Mosque and plot fifteen in Misrak Mesert Kirstos Church respectively**.** The rest of the trees species Canopy ranged between 12.6 m^2 - and 1.3 m^2. The total Average tree canopies of all plots in six religious institutions have covered the area of 38.8% (considered the total area coverage of all plots in religious institutions). The largest and the lower average tree canopies has found in plot one and plot fourteen from Abo Church (0.36 ha) and Misrake Mesert Kirstos Church (0.016 ha) respectively.

4.3.4 Tree Age Measurements

This research study, tree age was measured the growth factor of tree multiple by tree diameter in order to that the diameter of the tree is increased and the tree age also increased. The trees age distribution of religious institutions classified into four classes. Most tree plants were located in the first and second classes, on the other hand the rest of least number of plants was found in the third and fourth classes respectively. The lowest tree age classes showed the highest densities of species than the middle and higher classes (Fig. 3).This condition indicates that as the tree age decreases the number of plants declined due to deforestation and other human interruption. The tree age class 0 ≤ 50 years was dominant, followed by 51- 100 years, 101- 150 years, and 151 – 200 years respectively. As mentioned in the Figure 3, the largest age of tree in all plots of sample selected area was *Prunus africana* tree (179 years) from plot two in Abo Church and the smallest tree of Age was *Croton macrostachyus* (9 years) from plot Eleven in Mekanisa Abadir Mosque. The rest trees species Age was between 179 years – 9 years. Above 60% of the tree's age were found between 9-50 years.

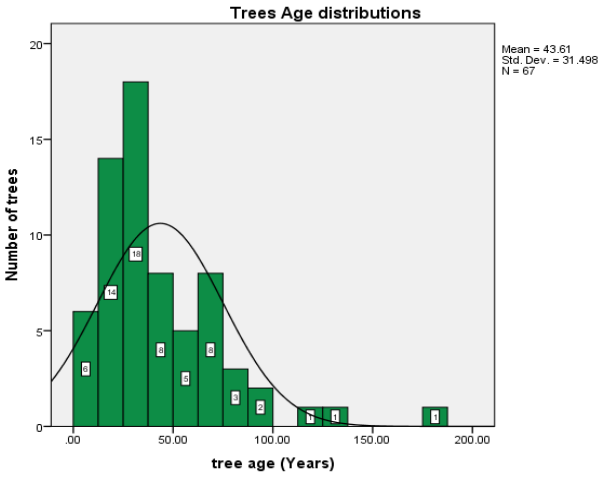

Figure 3 Tree age

The p-value in the tree age and tree dbh was indicated that there was the significance of the relationship between the two independent variables (tree dbh and tree age) ((p < 0.05). However, the age of the trees should be more influenced the trees dbh to increase.

4.4 Carbon biomass estimation of Tree

4.4.1 above the ground biomass (AGB)

The carbon stocks of trees are estimated through the field inventory in which all the trees in the vegetations plot above a minimum diameter or DBH (5 cm) are measured. Biomass and carbon stock are estimated from Diameter at Breast Height (DBH).

$AGB = 34.4703 - 8.0671(DBH) + 0.6589(DBH^2)$

AGB = above the ground biomass, DBH = Diameter at breast height

The average carbon biomass in all species was 0.164 tons per tree. The maximum and minimum average carbon biomass content in a single tree was 0.83 tons and 0.021 tons. From each tree's carbon stock, the average of each species was calculated from above the ground biomass and 0.42 tons of the largest carbon stock was observed in *Persea americana* species. 0.335 tons, 0.26 tons, 0.076 tons of next largest average carbon stock were observed in species of *Cordia africana***,** *Cupressus lusitanica* **and** *Eucalyptus globulus* tree species respectively. *In Callistemon citrinus was* the lowest average carbon biomass contained a value of 0.0097 tons was observed.

The total amount of carbon biomass and carbon stocks above the ground in six religious institutions was 372.98 tons and 189.69 tons respectively.

4.4.1 Carbon biomass estimation in regression

4.4.1.1 Tree height Vs Carbon biomass estimation (ton) per individual in regression

The regression (R^2) of the tree height and carbon biomass can predict the value of the dependent variable by the percent.

The carbon stock of tree

The carbon stock of the tree can be determined using the combination of the number of carbon stocks above the ground and below the ground. The largest carbon stock of trees in all plots was *Cordia Africana* from plot four; the carbon stock of the tree was 0.81 tons. The lowest carbon stock in all plots was *Olea europaea* from plot Twelve; the tree carbon stock was also 0.00587 tons.

The total carbon stock in all plots of religious institutions was 111.9 tons per hectares. The largest and the lowest carbon stock were plot two and plot sixteen, the carbon stocks of those plots was 12.2 tons and 0.0 tons respectively

V. DISCUSSION

Tree inventory should be used to develop the management of tree and policy recommendations for conservation trees to the contribution to reduced environmental degradation and impacts of climate change Moreover, recent research finding shows that populations of the tree species in the religious compounds are small and decreasing in extent over time [36-38]. Consequently, many of the trees associated with churches are very old and include *Juniperus procera, Podocarpus falcatus, Ficus Vasta* and other indigenous tree species [39]. This research, there are 18 different tree species that existed in various religious institutions and some religions have the old trees like Juniperus procera, Olea abyssinica, and Eucalyptus globules trees. But this research was not found the old trees such as *Podocarpus falcatus, and Ficus Vasta.*

According to different literature, global aboveground carbon stock in tropical dry and wet forests ranged between 13.5-122.85 t ha^{-1} and 95- 527.85 t ha^{-1}, respectively [40]. Above ground carbon in Amazonian Brazil forests ranged between 130- 223 t ha^{-1} (Alves *et al*., 1997). Similarly, Using the non- destructive method of carbon biomass estimation in present study report in six religious institutions non-forest compound have stored the biomass of above the ground tree was 134.8 tons ha^{-1} and the carbon biomass can be measured from the biomass of tree (AGB) So the carbon biomass is half of the biomass of tree which is 67.4 tons ha^{-1}. This amount of biomass and carbon biomass is obtained from the total number of trees was 4683. The average carbon stock in the church forest is 122.85 tons ha^{-1} [41]. Above-ground carbon stock estimated in this study was less to the amount of carbon stock estimated in selected church forests around in Addis Ababa. This implication was religious institutions have deforested a lot of tree species for different purposes such as infrastructure expansion, income source, and firewood. The consequences of these decreased the number of tree species and carbon biomass in religious institutions may have influenced the environment of climate change.

The tree canopy, tree DBH, tree height, tree age and carbon biomass measurement in this research study can be determined a single selective tree in religious institutions not for all species in the plots. but at the future, I will get chance to do my PH.D. or other research studies around of this topics I would try to measure Canopy and age of tree for better tools and methods to obtain the good results.

VI. CONCLUSION AND FUTURE SCOPE

The study conducted in religious institutions showed that the trees contain less diversified plant species. The total trees species from the selected religious institutions was 4683, out of this, above 70% was occupied by Eucalyptus tree species. Most of these trees have existed in the Abo Church and only fewest numbers of trees species found in the Mikanisa Abadir Mosque. There were 18 trees species identified in the six religious institutions compound, most of them were indigenous and endemic trees and a few were exotic.

In the field trees measurement such as tree height, canopy, DBH, and tree age were important to make out the benefits of each tree to provide the environment and the climate change impacts. Additionally, the field measurement of all tree attributes indicated that the trees were very young and early time planting in the compound. As a result, the tree's height in all plots was ≥ 3.5 m, Tree DBH in all sample area was greater than 12.6 cm, and the large Canopy of the tree in all trees were *Casimiroa edulis* tree (12.6 m^2), and the smallest were Eucalyptus globules, *Casurina equisetifolia, Vernonia amygadli*na and *Callistemon citrinus* (1.3 m^2). The trees species Age ranged was between 179–9 years.

Trees have a great role to stored the carbon biomass for the photosynthesis process and the amount of carbon storage in the tree was different due to the tree DBH and tree height was also varies. below and above the ground tree of the carbon biomass storage tree was 447.58 tons and the amount of total carbon stock in all religious institutions was 223.72 tons, the carbon stock range of Above ground biomass was 124.1 – 1.4 tons and the range of carbon stock of below-ground biomass was also 24.84-0.28 tons. The recent findings indicated that the carbon stock can be determined to consider the area in the forests, not for a number of trees in the forest. The number of carbon stocks in different species was varied and the average total carbon stock was small. Carbon stock amount increases with the DBH of the tree also increase but this could be the tree species stayed to grow healthy in their lifespan. The amount increased from 1984 to 2005 within 21 years with

an average increment value of 5,417 tons /ha/yr. but now the amount of carbon stock is decreased in the religious institutions due to deforestation by religious infrastructure expansion and the human activities highly increased for use firewood and homebuilding. This study and further research on this topic helps to indicates trees have the potential for emission reduction to tap climate finance opportunities that would support government development plans.

RECOMMENDATIONS

- The abundances of tree species in all religious institutions except Abo church, the Eucalyptus tree (the local name of this plant is Behar zef) are so young so that the amount of carbon biomass of this tree, tree canopies and tree ages were very low. This can give the implication of the tree species have cut as soon as grow up.
- Some religious compound of the tree species growth is blended in with other tree species. This blended trees ranch of trees has great advantages for the environment. Blended species manors are much of the time prescribed and used to meet these capacities. Blended species estates, notwithstanding, can have high paces of over the ground biomass production and carbon sequestration than monocultures

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