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ANALYSIS OF ECONOMIC AND MANAGEMENT OF CLIMATIC CHANGE MITIGATION NETWORKS AND THEIR BUSINESS ALLIANCES INVESTMENT RETURNS: THE CASE STUDY OF KARAGWE DISTRICT, TANZANIA

Aurelia N. Kamuzora

Mzumbe University, Tanzania
ankamuzora@mzumbe.ac.tz

ABSTRACT

The institutional arrangements and return on investing in climatic change mitigation require international economics and management of the networks actors involved in the sector. As trees remove carbon dioxide from the atmosphere (carbon sink), planting trees is one of carbon sink economic management of green economy. Planting trees not only seize carbon but also gives tree planters other economic benefits for current and future generation. The smallholder farmers in Karagwe district have been receiving carbon credits from Green Choice Company (Green Choice , 2019) to plant trees for a decade through Green for Education and Poverty Alleviation Trust (GEPAT, 2019) which organizes the smallholder farmers who are carbon credit receivers. receive carbon credit funds from the carbon credit provider (Green Choice). Green Choice give They receives carbon credit through Wakk Foundation through GEPAT. In this case Green Choice company is the buyer of carbon dioxide. Green Choice and other buyers of carbon credit buy tons of emitted carbon dioxide equivalence (tCO2e) in terms of supporting farmers in Karagwe district to invest in tree planting. This is a current green investment model succeeded to plant more than 1,500,000 trees annually with expectation of reaping more return among the current and future generations. However, reaping high returns, requires current investment supported by good economic and management strategies. GEPAT participatory action research, as a case, demonstrates in its findings the economic organization, management and networking

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structure needed to manage climatic change investments. The Economic and management of the networks of green investment actors has revealed a high return on investment in Karagwe district in terms of climatic change resilience in terms of the lowered temperatures in the area relatively compared to the previous periods. Similarly, the number of planted trees has resulted into high returns measured in terms of carbon dioxide equivalent removed from the atmosphere by GEPAT members through a forestation (carbon sink) at low transaction costs. Mixed research methodology (triangulation) methods including qualitative and quantitative research methods have been used to address the phenomenon. The major research designs used are explorative, descriptive, and explanatory have been used in this case study. This new network of green business alliance taking place among the carbon credit providers and carbon trade markets. The investment return of tree planting has been articulated in this paper and recommended for sustainable economic development is discussed.
Key words: Economic Management, value chain, business alliances, investment return, carbon inventory

1 INTRODUCTION

The United Nations Sustainable Development Goal number 13, "Climate action" advocates the importance of strengthening adaptive capacity and resilience of communities to climate related hazards. However, the goal did not explain the managements and networks relevant to mitigate climatic changes. Through this paper we explain the networks and the impact of interventions. Before the project, the deforestation levels in Karagwe projected possible desertification due to heavy deforestation, a thing that could have led to spells of drought and famine. The GEPAT project advocated for tree planting in the affected communities whilst educating them on climate change and its effects.

The expected outcomes of the implementation of the GEPAT project were increased income due to carbon credits and carbon sequestration by forestation. However, there exists cross cutting issues that might have influenced dynamics of project implementation and

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subsequently its impact to the society. Some of these factors included gender equality, farming systems and education levels. Assessing how these factors influence implementation of the projects' activities is a key to reduce risk of underachievement's. Women form 51% of the labour force in agriculture even though most of the land is usually owned by men. Their participation in the project is paramount if it is to succeed and be sustainable.

The magnitude of carbon sequestration in the project area by its related forestation activities is determined by the potential of the chosen tree species to retain carbon stock from the atmosphere (qualitative factor) and amount of land allocated for planting them (quantitative factor). Reasons why less land might be allotted to forestation activities was thatmost of the smallholder farming used the land for crop farming.Also, there was a condition of not using heavy pesticides and heavy metal inorganic fertilizers that could defeat the purpose of climate change mitigation of the project activities since the artificial fertilizers would affect the soil.

This research-basedpaper establishes the level of GEPAT project success by measuring its impact on resolving these cross-cutting issues and GEPATproject contribution to reduction of CO2 asthe carbon sink strategy. It establishes the baseline for scaling up and explains the future indicators that can be adopted to quantify long term success among carbon migrant's management networks.

2 PROBLEM STATEMENT

Currently there is a global debate focusing on how to mitigate the climate change by controlling greenhouse gases (GHGs) emissions from industries. Controlling GHGs emission is embedded in the 1992 United Nations Framework Convention on Climate Change (UN-FCCC) and 1997 Kyoto protocol (UN,1998) which set the emission target for the developed countries (Annex B of these protocol, in the Kyoto protocol to the United Nations Framework Convention on Climate Change, 1998) sets the limit of each country on emmision of carbon. Therecent Paris Agreement came up with new strategies of carbon credit and carbon offsetting credit because these allow different countries to contribute in UNFCC without reducing industrialization.

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Polluter pays the right to emit pollution. The paid money is directed to pay to different strategies relevant to climatic change mitigation such as carbon sinks e.g. forest preservation. Among UNresolutions one of them is to combat climatic changes for climate resilience. Since climatic change affects different tradable goodsdirectly from industry production to consumption behavior, different network actors have established carbon trade markets for carbon producers buy their carbon footprint. Most industrialized countries in Europe and other parts of the world have well developed markets. Buying carbon footprint means paying for decarbonation of industries because industrialization is the major source of Green House Gases (GHGs) and carbon dioxide (CO2). GEPAT projects outcome indicators isindirectly industrial decarbonation strategies.

During industrial revolution, developed countries were not prepared to control the excessive emission of GHGs emission. To solve this problem, the world has passed through different declarations. The current one is the Paris agreement of 2015 (UN, 16). This agreement encouraged the developed countries to reduce emission of GHGs. Emphasis were on carbon credit that is buying the right to emit the specified amount of carbon. It also came with the following mitigation measures:

1) Carbon market (carbon credit)
2) Reduction of emission
3) Forestation as the carbon sink
4) Helping developing countries using alternative energy like solar energy.
5) Transparency. Each country has to record the amount of emission and declare it.

A lot of efforts have been done to reduce carbon emission from industries. The industries in the economic point of view are engines for development as manufactured goods add to export gainfrom trade to foreign currency. From environmental protection point of view, industries are great polluters which lead to climatic changes. Developed industrialized countries are great polluters which pay to buy the carbon sequestrated by forests mostly grown in developing countries. The grown trees in turn absorb carbon in the form of carbon dioxide (CO_2) from the

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atmosphere through the process of photosynthesis. Hence treesreduce the amount of carbon from the atmosphere. Some studies reveal that credit payment scale was decided to follow carbon inventory methodology. Different authors have written about different methodologies required to estimate tradable carbon. Akhlaq, (2012) studied on Carbon Inventory Methods in Indian Forests. They found outthat, there was the different in carbon volume between the areas with forests and the areas without forests. This necessitated credit market makers networks to give more pecuniary and non-pecuniary incentives to carbon mitigants to plant more trees which are carbon sequencers.

Charles, (2013) evaluated the contribution of provision of carbon credit incentives for combating climate change through tree plantation. She used both qualitative and quantitative methods in her study. she found that the provision of carbon credit incentive which are seeds, seedlings, and cash paid to farmers have positive impact in increasing the rate of tree planting for combating climate change.

2.1 GENERAL OBJECTIVE AND SPECIFIC OBJECTIVES OF THE STUDY

Generally, the study evaluated success of social economic carbon sink GEPAT projects management networks in mitigating climate change, specifically the study aimed:

i. To identify socio-economic factors influencing forestation activities within the projects sphere of influence.

ii. To elucidate farm related issues causing variation in contribution to carbon inventory.

iii. To estimate the carbon stock sequestered by the forestation initiatives of the project.

iv. To examine the weather patterns before and after the project implementation as a justification of climatic change mitigated by GEPAT Project management networks in the area, ceteris peritus.

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2.2 HYPOTHESES

i. H1: Gender equality, good education, and food security boost homestead forestation activities.

ii. H2: Agronomic practices in intercropping systems conform to climate change mitigation strategies.

iii. H3: Forestation activities in the GEPAT project study area capture a significant portion of CO_2.

iv. H4: The GEPAT project has mitigated climate change in its project area

3 REVIEWING THE LITERATURE

According to Ravindranath (2008), carbon inventory is the process of estimating the stock and fluxes of carbon from different land uses systems in a given area under a given management system. This involves removal of estimated CO2 from the atmosphere. Estimation compares the baseline CO2 concentration before the mitigation project implementation and the concentration after the mitigation project implementation havebeen established. U.S. Geological Survey (2008), defines Carbon sequestration as both natural and deliberate process by which CO2 is either removed from the atmosphere or diverted from the emitter and stored in terrestrial environment (vegetation, sediments, and soils), oceans and geological formation. Terrestrial carbon sequestration is also called biological sequestration in which forests are used to capture atmospheric carbon in the form of CO2. Mitigating CO2 emission and hence climate change, requires reducing emission from the sources and increasing uptake from the atmosphere. Reducing emission means reducing industrial activities which are vital for economic development. But increasing the uptake of CO2 from the atmosphere can be done through different approaches like reforestation and forestation.In year 2000 countries members of United Nations came out with eight Millennium development goals to eradicate poverty by 2015, they are also known as Agenda 2030. The seventh goal was about ensuring environmental sustainability (Todaro, 2014). According to the seventh millennium development goal, forests

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are the safety nets especially for the poor. But they are disappearing at an alarming rate due to deforestation and poor forestation programs. Sustainable development goals came into effect since January 2016 following the success of millennium goals with the aim of ending poverty, protecting the planet, and ensuring that all people enjoy peace and prosperity. These goalsare also known as Agenda 2030 because they will be evaluated in year 2030. Among those goals is SDG number 13 which is about climate change issues. The goal stands as; Take urgent action to combat climate change and its impacts. This argues that, climate change is currently affecting all countries on economy and lives of people and it endangers the current and the future generation ofall countries. It further outlines the observable effects of the change of climate as change in weather patterns, rising in sea level and other fatal weather events. The change in climate is caused by greenhouse gas emission from human activities. It emphasises that if no action is taken, the world's average temperature was projected to rise and cause much effect with some areas being affected even more. The poorest people were stated in the goal as the most vulnerable ones.

Climate change is not limited by borders it is the global challenge. Emission anywhere in the world affects people everywhere. Its solution requires international cooperation to be effective. Developed countries have to help the developing countries to move towards the low-carbon economy.

It came with three strategies which have to be implemented to get rid of this situation. This has to be taken by developed country parties of National Framework Conversion on Climate Change (NFCCC), by mobilizing jointly $100 billion annually by 2020 known as Green Climate Fund (GCF) to address the need of developing countries to act on mitigation measures as soon as possible. This fund should be used to implement projects to mitigate climate change such as forestation, use of clean energy in order to reduce carbon emission to the atmosphere (UN, 2016)

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3.1 CARBON CREDIT

Charging carbon credit and carbon offset follows the polluter pays principle. This is the acceptable practice of which those who produce pollution should bear the costs for managing it to prevent the damage to human health and environment. This principle has mainly been used to the emission of greenhouse gases which cause climate change (Hicks 2014).

Callan (2013) explains that, pollution is the negative externality which causes negative effect to human beings and environment that are not directly involved to the source of the pollution. The polluter should bear the costs to keep the environment in acceptable quality level. (Todaro 2014) argues that, developed countries are the main polluters of air and sea; therefore, they must commit themselves in cleaning environment. If they do not it will be difficult for them to convince developing countries to reduce emission of GHG since their per capital emission levels are far below those of the non-industrialized countries.

Carbon credit is found in the article 6 of Paris agreement (UN, 2015). The proposed article addresses the need to reduce GHGs emissions which cause global climate change through charging carbon credit and carbon offset which is equivalent to the reduction of one metric ton of CO_2 from the atmosphere through promoting use of clean energy like solar and wind energy. Another way is through funding projects on reforestation and nature conservation.

This method is mainly used by highly industrialized developed countries by funding kind of projects in developing countries, (Gupta, 2011). The article orders the commercial entities emitting CO2 not to exceed the allowed limit or to cut down emissions to the required level. Otherwise it should buy carbon credit offset certificates tradablein the market. Another recommendation is charging the commercial entity the carbon tax.

3.2 THE CONCEPTUALIZATION OF THE THEORY OF CHANGE

"Theory of change is a tool for developing solutions to complex social problems such as climatic change mitigation project evaluation. A basic theory of change explains how a group of early and intermediate accomplishments set the stage for producing long-range results" Harris

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(2017). Theory of change creates a picture of steps required to reach a goal. According to Anderson (2005) in Harris (2017), steps for creating theory of change are;

i. Identifying the long-term goal (The outcome)

ii. Conducting the backward mapping to identify the pre-conditions necessary to achieve that goal.

iii. Identifying the interventions that your initiatives will perform to create these preconditions.

iv. Develop indicators for each precondition which will be used to assess the performance of the intervention.

v. Write a narrative that can be used to summarise the various moving parts of the theory.

Theory of Change map looks a bit slight like a driver diagram or a logic model. It differs from these by offering a nonlinear map of a project or programme approach, which shows how different components are expected to interact, and the multiple pathways through which change is expected to happen. It terms these components as intermediate outcomes; the specific changes expected because of the project or programme being implemented. These are linked together by causal pathways, which determine the direction of the relationship between these changes and show how they lead to the long-term outcomes and impact to which the project or programme intends to contribute. Between these intermediate outcomes, interventions (the concrete activities undertaken as part of the project or programme), rationale (the justification or existing evidence that suggests that a specific approach is likely to work in this context), assumptions (the uncertainties to be tested through formative research or implementation) and indicators (metrics of change linked to each intermediate outcome, determining whether and how much change has been achieved towards reaching this intermediate outcome) are plotted. (Silva, 2014)

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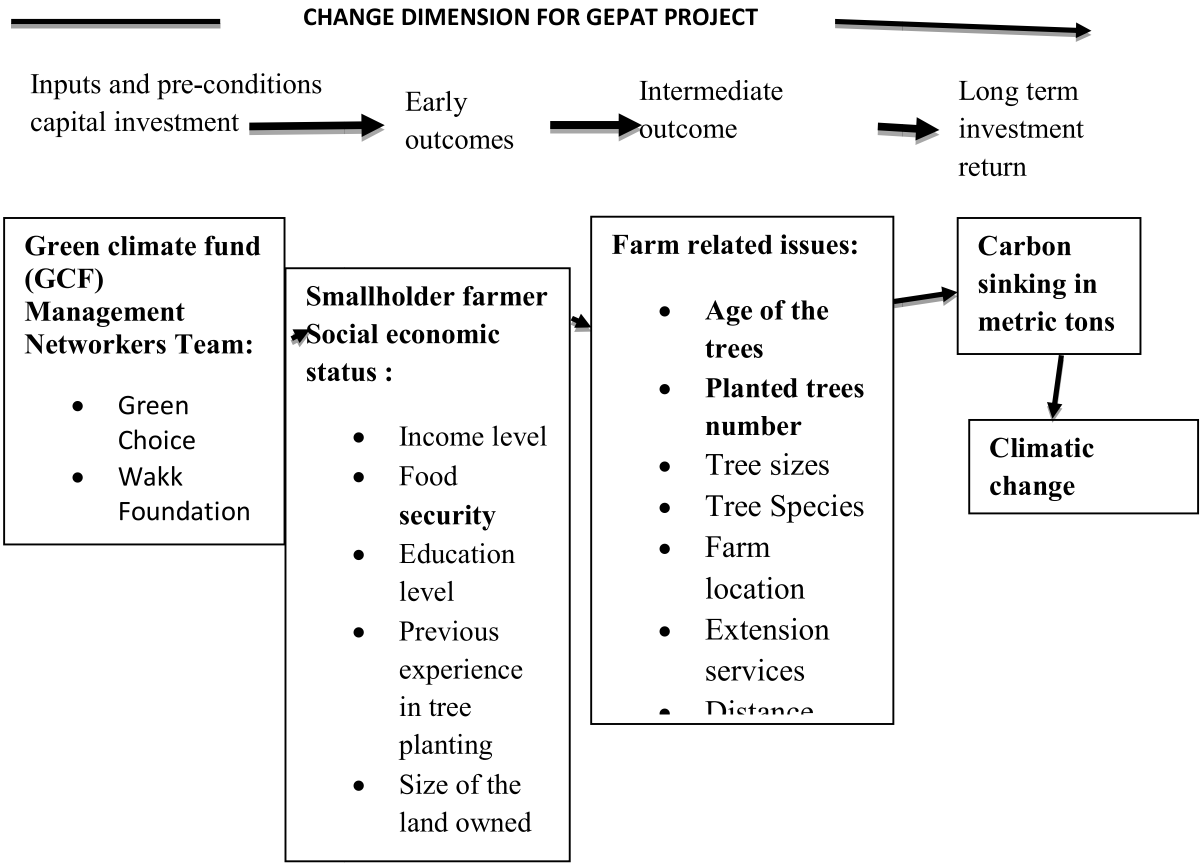

Figure 1 - Theory of Change Conceptual frameworkfor GEPAT Climatic Change Mitigation Project in Karagwe district

This conceptual framework is derived from the theory of change following important steps stated by Anderson (2005) in Harris (2017) applied to in GEPAT project dimension of change to achieve the long-term goal of climatic change mitigation. The change consists of four steps to attain the long-term outcomes shown in the figure. The pre-condition necessary to attain the long-term outcome is the existence of Green Climate Fund (GCF) Management Networkers Team. The networkers are voluntarily investing in climatic change mitigation. The Carbon sequestrated in trees planted is the second priority the GCF funds to give incentives to the

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smallholder farmers to plant trees in their areas. The carbon sequestrated is the results of the farm related issues the smallholder farmer addressed. These issues influenced the amount of carbon to be removed from the atmosphere through forestation. Theearly outcomes are writing a proposal to receive support from Global climate fund after organizing smallholder farmers in Karagwe and Kyerwa districts though the GEPAT project evaluation was conducted in Karagwe district. The second step was implementation, At the same time socio-economic status of the farmers influenced the implementation farm related issues as indicated in figure 1. The farm related issue were directly influencing the carbon sink levels or the capacity of planted trees in carbon sink leading to influence on the impact of GEPAT project management networks on climatic change mitigation.

4 RESEARCH METHODOLOGY

Gajasen (2011) conducted a comparative study of carbon sequestration potential in above ground biomass in primary and secondary forests at Khao Yai national park. They used allometric method to estimate above ground biomass and carbon stock. They found that these two types of forests had common species but the primary forest had more carbon content which was 342.99 tons C/ha compared to secondary forest which had only 99.10 tones C/ha. They concluded that this was because of the plant density difference between the forests. Primary forest had low tree density i.e. 919 trees /ha while secondary forest had high plant density i.e. 2192 tree/ha. This caused the primary forest to have large trees with higher density at breast height (DBH) compared to those in secondary forest which were small with low DBH. GEPAT projects impact was evaluated based on this methodology.

Ministry of natural resources and tourism (MNRT) of Tanzania, through its organ called Tanzania forestry services (TFS) with collaboration with the government of Finland and Food and Agriculture Organization (FAO) conducted national forest resources monitoring and assessment (NAFORMA) in Tanzania mainland from 2009 to 2014 and came up with the report in 2015 (MNRT, 2015). They also used allometric method to analyze biophysical data which are

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number of stems per plot, diameter at breast height, and the height of the tree. This evaluation used the same approaches.

This study was conducted at Kituntu, Kanoni and Igurwa wards which are found at Karagwe District in Kagera region. These are among areas where GEPAT project is implemented. GEPAT activities started in 2005 and it was formally registered in 2008 and it has been implementing its project activities from humble beginning until when Green Choice started supporting GEPAT in 2014. GEPAT has been receiving support from Green Choice through Wakk Foundation for the past 11 years as we started working closely with Wakk Foundation in 2007 and the interventions started in Kituntu Village.1The area is 1500-1800 m.a.s.l and experience bi-modal rainfall with peak rains from September to December and from March to May.

The evaluation used both probability sampling and non-probability sampling.Probability sampling helped to obtain the number of Tree farmers implementing the project, Plots and trees for carbon inventory estimation through simple random sampling. Non-probability sampling was purposive sampling since the study focused only to the tree farmers of GEPAT project. Green Choice and Wakk Foundation who have been carbon credit donors supported the study, they were not among the respondents as they were also interested in the study.

The evaluation had two populations to sample from (1) Sampling from farmers who plant trees (Tree Growers) and (2) trees sampling for carbon measurement. One village of Kituntu was selected purposively since all farmers who were registered with GEPAT as Tree Growers i.e. GEPAT Tree Growers ((GTG). Purposively involved 45 (4 %) out of more than 1000 (> 100%) GEPAT members planting trees in Karagwe and Kyerwa districts. The population of Kituntu village is about 600 households. Since the sample was selected from Kituntu Village as a case, the sample size was stratified from 600 Kituntu villagers. All 600 households had planted trees ranging from 1 tree to a big forest.Smallholder farmers samplingincluded Seven point five 7.5% of 600 (100%) Kituntu villagers who were involved in planting socio-economic forest (SEF).

[1] However these estimates are based on 2016 census.

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The research team visited the household using snowballing techniques.Visiting the first farmer's plot lead to obtain information on the next neighboring farmer's plot (snow balling sampling techniques). Through snowballing, 40 households dwelling in Kituntu Village were included in the sample However, each household owned different numbers of tree in their farms or a certain land parcel occupied by trees and/or social-economic forest (SEF). Hence, 70 farms owned by the visited 40 farmers were included in the sample purposively. The number of forests differed in number of tree farms because some of farm owners possess more than one tree farm we measured.

We sampled trees in the farm to be measured for carbon sequenced (carbon content or carbon sink) absorbed from the atmosphere. The more the trees in the farm with a relatively big stem the more the carbon absorbed from the atmosphere and the more the contribution of GTG who owns those big trees to climatic change mitigation efforts. To monitor the efforts of GEPAT members, measuring of the amount of carbon in the social-economic forests planted by GTG were measured in the period of March 2018. We employed the sampling techniques similar to that the forestersused to measure carbon in Tanzania in 2014 (Malimbwi, 2014). However, our techniques were somehow different. The foresters measured CO2 of reservedforests while GEPAT project measured socio-economic forests owned by stallholder farmers

For relatively high trees density farms, we measured farms ranging from 0.0758 to 4.4919 hectares on average. The range was about 4.4 hectares, GEPAT farm at Kituntu Head Office was not measure yet. The total number of trees were estimated from the permanent plots. To create permanent plots, we started with creation of temporarily plots. Sampling temporary plots (like piloting) per farms, the researcher (operator) walked around each tree farm holding the Global Positioning System (GPS)[2] to estimate the farm area measured in hectares. The farm

[2]The GPS (Global Positioning System) is a "constellation" of approximately 30 well-spaced satellites that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location. The location accuracy is anywhere from 100 to 10 meters for most equipment.

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size was recorded in the inventory form. The researcher (operator) identified strata in the individual stallholder tree farm based on the farm characteristics: indicated in the conceptual framework (figure 1). The second step was to demarcate the farm into strata. Within the strata, the temporary plots were also demarcated as figure 2 below.

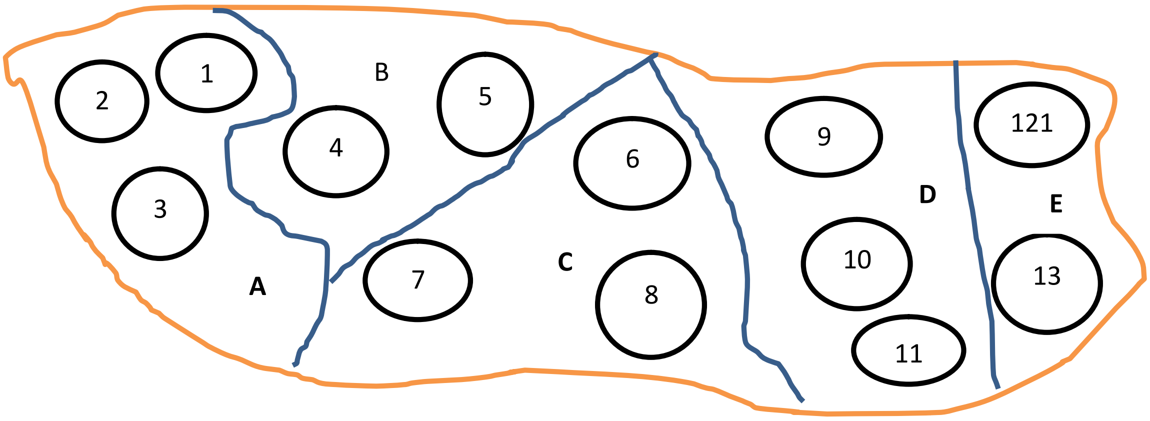

Figure 2 - Illustration of a randomly assigned plots within a strata (stands) in tree farm

Figure 2 illustrated the example of the stratification sampling plan and techniques used to identify strata in the relatively tree concentrated heterogeneous SEF tree farm. This example in the figure 2 shows that five strata from A to E where to be demarcated based on age, species, and density of the trees in the farm. Furthermore, within the strata, the temporary plots were also demarcated. The number of temporary plots to be assigned in a stratum also followed density, age, species, and landscape. Within a stratum, circular five (5) meter radius plots were randomly cruised (selected in cruising fashion). Following the example in figure 2, the researcher (operator) assigned 1 up to 13 plots based on the density, age, landscape, and species of the trees in a stratum. We further used relascope to determine the trees with different sizes to measure. The telescope was used to estimate the Basal Area (BA) 3 of which different temporary plots used to estimate severalpermanent plots to be selected in a farm. We made a wooden

[3]Basal area is the common term used to describe the average amount of an area(usually an acre) occupied by tree stems. It is defined as the total cross-sectionalarea of all stems in a stand measured at breast height, and expressed as per unit of land area (typically square feet per acre).

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relascope together with the carpenter of Kituntu Village. It has two square holes at the beginning and at the end. We directed on how to make it to be used as a metaphor of a reflection glass based on angles reflected from the chick of one eye open and another closed. The relascope was 50 cm long and the side by side two holes to look through were equal. They were 1 cm square.The operator stood at the center of the 5 m radius (10 m diameter) circular plot to categorize IN, INTERMEDIATE and OUT trees. Where the eye was placed on the releascope to see the density of pointed trees in a plot was smaller than the other side of the hole facing the tree, that tree was categorized as OUT. When the eye could see through the relascope, a tree which is barring one of us (operator) tosee through, the tree was categorized as INTERMEDIATE. The trees which could cover the hole and be seen outside the hole was categorized as IN tree.

The permanent sampling plots were obtained from the temporary sampled plot explained in Figure 1 above. Counting all IN-trees and INTERMEDIATE trees (HALF) gave the number of two categorical sets of both types of trees to be measured. The trees categorized as IN a selected plot within a stratum were counted. The IN_Treeswere counted as 1 while INTERMEDIATE trees were regarded as half of IN-trees because IN-trees are larger than INTERMEDIATE trees.

Through three types of trees we estimated of Total Number of Trees of the same size in the temporary plot. IN-trees andINTERMEDIATE (HALF) –trees were counted to determine the total number of trees with the same size of IN (big) trees within a plot as follows:

SMALL (OUT) -TREE ATTRIBUTES

Figure 3 demonstrates the trees which is very far or near but cannot fill-in the relascope hole. It is too small to fill in the hole. it subtends an angle small than that of the relascope and it was not to be selected. That is regarded as OUT-trees.

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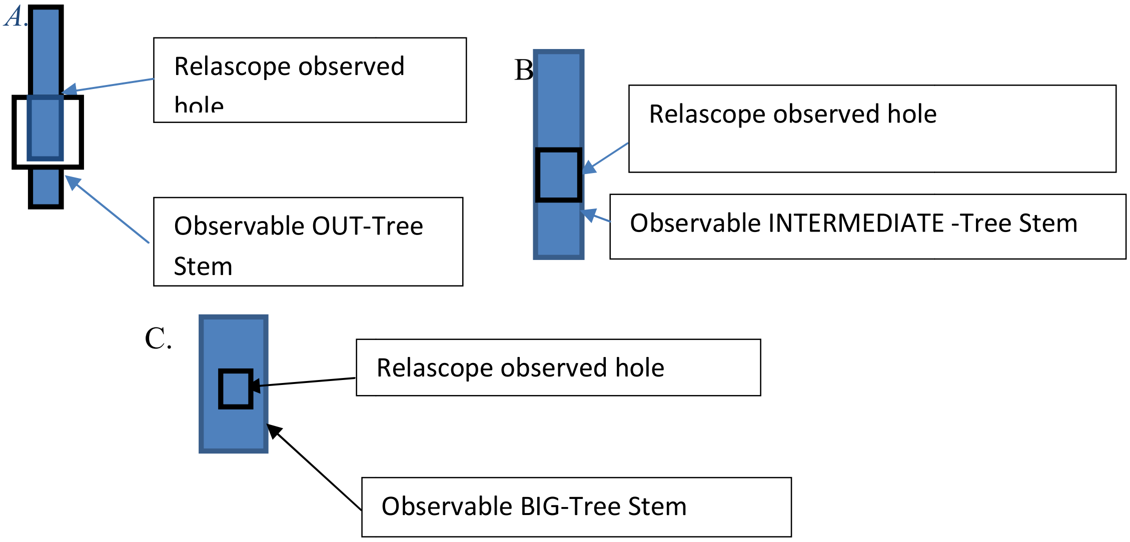

Figure 3 - OUT-Tree and Observing to select INTERMEDIATE trees

Figure 3A is an example of smalltrees stem size observed through the relascope. We ignored such small (out) trees and we did not include them in the sampled plots during estimation of Standard Deviation of Basal Area of the plot. These trees were regarded as too small to be included in estimation of the sample. The INTERMEDIATE demonstrated by 3B figure showing that they were trees had crowns extending into the lower part of the highest canopy of the forest. They made lower mid-story canopy below the highest canopy of the forest (the middle-counted trees). Figure 3B is an example of IN-Trees which were selected after aligning two holes of relascope made of wood (Malimbwiet.al, 2012) observable from the center of the circular temporary plot (standing point), the researcher could see the tree which could fill in the hole and categorized it as INTERMEDIATE Tree. INTERMEDIATE trees characteristics. They were selected when they could best fit filling-in the hole of wooded-made relascope. Figure 3C were IN-Treewhich observable trees that could fill in the relascope hole and observed being bigger than the hole. They demonstrate the trees which were observable to be bigger than the

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hole regardless of being closer or somehow far from the center. They subtended the angle greater than relascope hole. They were selected to be counted as IN -Trees.

To calcula**te Stocking Rate (**stems/ha), Tree Stems in plot/ plot area) we summed up both the total number of IN and had Intermediate trees to get the number of trees with the same size in a plot (all with NI-tree sizes).

Hence,

$$NT_{total} = \sum_{i_{,,}j=1}^{n} \left(X_i + 0.5Y_j\right) \quad (1)$$

Whereby:

$NT_{total} = Total\ number\ of\ treesina\ plot$

$X = NumberofIN - treesina\ \ temporary\ plot$

$Y = Number\ of\ INTERMEDIATE\ treesina\ temporary\ plot$

$i = i^{th}IN - trees$

$j = j^{th}tree\ of\ INTERMEDIATE\ Tree$

$n = n^{th}of\ either\ IN - Treesand\ INTERMEDIATE\ trees$

$i, j \neq 0$

Using the total number of IN trees, we measurement the diameter at breast height (DBH) to be used in estimation of Basal Area. To measure the Diameter at the Breast Height (DBH) required the Master Tree Growers Diameter Tape (MTGD-Tape). On one side it measured the distance from the ground the breast height which is equal to 1.3 m. On the other side it measures DBH directly. The operator needed to observe the inclination angel of the tree. Further below, we demonstrate the standing position of the operator in measuring different trees.

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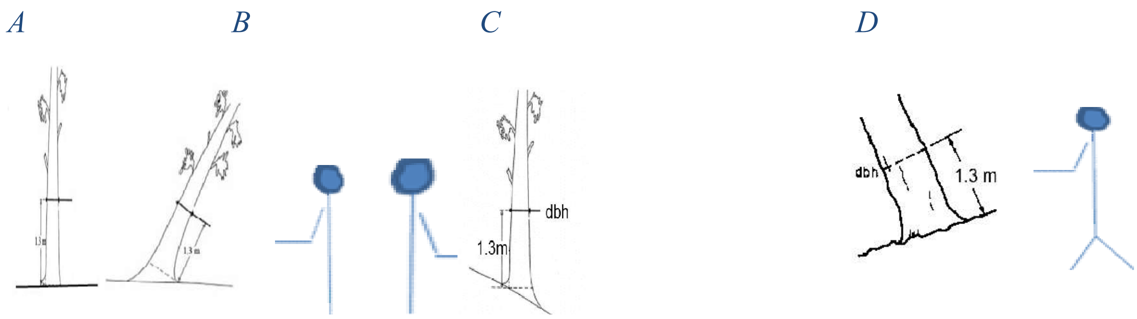

Figure 4 - Position of operator and the shape and inclination of a tree

Figure 4 shows the position of the operator and the tree position. The tree indicated by A is a straight positioned while tree B is inclined. The operate was measuring the DBH from the side when the tree is inclined. In A the operator is standing straight following the tree position.

In C is the position when the tree is at the hill or a steep slope. Figure 5 is DBH measurement process.

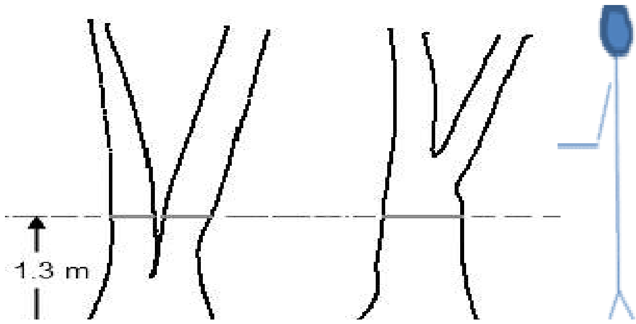

Figure 5 - The DBH measured points for forked tree

Figure 5 shows how to measure the DBH of a forked tree. The operator originates at 1.3 m or above that measurement, the tree considered as a single tree, therefore the diameter measurement was carried out below the fork. When the fork originated below 1.3m, the two measurements was taken. Such tree was considered as two trees.

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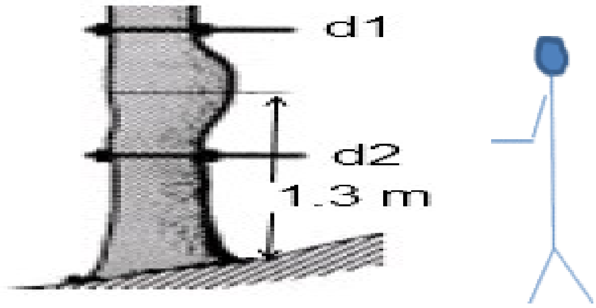

Figure 6 - Diameter measurement of deformed trees

Figure 6 is measuring DBH of the tree with a protruded shape. Two measurements were required below the breast height and above and then the average DBH was recorded.

$$DBH = (d_1 - d_2)/2 \qquad (02)$$

When the total number of trees in a plot (NT_{total}) was known per plot (see Eq.1), the Basal Area of the plot was estimated by multiplying by the Basa Area factor. Basal area is the common term used to describe the average amount of an area occupied by tree stems. Basal area is the area of a given section of land that is occupied by the cross-section of tree trunks and stems at the base. The term is used in forest management and forest ecology.The same was adopted to measure Basal Area (BA) of trees in the temporary plots. The total cross-sectional area of all stems in a stand (when the operator stands at the center and gauge the stems through relascope). Then, measured the stem areas of the trees at breast height using DBH to calculate the areas of the tree stems. The Basal area was expressed as per meter squared (m^2) of land area. It was measured in area in a plot occupied by stems per hectare. The basal area was regarded as the measurement of the cross-sectional area of tree trunks at 1.3 m above the ground and inclusive of the bark. We had not special pocket knife to measure reduced value of the back. The basal area was sought to give an idea of the stocking of trees in a stand of 10 m diameter circular plot (standing at the center and look around back to the starting point of the circular plot} which we used. The basal area was reported in square meter per hectare.

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Hence,

$$BA = NT_{Total}/[\frac{\pi d^2}{200^2}] \quad (3)$$

Where by:

$NT_{Total} = Total\ number\ of\ trees\ in\ a\ plot$ (m²)

$BA = Basal\ area\ (m^2)$

d = diameter of a trees with IN -size trees within a plot (DBH) in cm.

In further analysis, BA was given by:

$$BA(m^2\ /ha) = {NT_{Total}/[\frac{\pi d^2}{200^2}]} \Big/ {10{,}000}$$

This simple method was used to estimate trees per hectare in a small farm, but for large farm estimation of Stand Basal Area was estimated per plot. The Stand Basal Area of the plot were established to eliminate the errors that could be caused by sampling methods. The Stand Basal Area was measured in ($m^2/hectare$).The operator stood at the centre of a plot to spin clockwise or anticlockwise to circumvent a sickle of 10 cm diameter and 5 cm radius. From optical methodology point of view, he created an angle while gauged at the relescoope of 1cm width and 50 cm length from the point of an eye to the circumference of the circle. The angle gauged createda Basal Area Factor to multiply by BA for expansion purposes (generalization from the plot pint of view).

Optical method was developed by foresters in Europe in the 1930's and was introduced to Australia in 1952. Although it was developed to use a prism. In our context we used the relascope as an alternative tool for using a glass prism which subtends the angle although the gauge method because it was cheap to use. We used the Master Tree Growers Diameter-Tap (MTG D-Tap) we received from Face The Future, anNGO in the network, in January 2018. The MTG D-Tap was not good enough to gauge the angle a relescope was better to use than the MTG D-Tap. We knew that since we used a relascope of 50 cm length from the gauging eye to the hole

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of relascope and the size of the hole was 1 cm, while the radius of the plot was 5 , The optical method estimates the radius of the plot to be equal to:

$$Plot\ Radius\ = tree\ diameter(DBH)x50) \quad (4)$$

Henceforth the BA of the plot is equal to the number of trees in a plot. Each IN tree contribute 1 m^2/ha to the Stand Basal Area. Using this principle, we devised the appropriate dimensions of a 1-Factor optical gauge which was the number of "IN" trees when we spinin a full circle within a plot and this was equal to the Stand Basal Area. Such a gauge must subtend an angle that allowed us to "test" if any tree was "IN" or "OUTt" of a plot (centred where we stand) that has a radius equal to 50 m xTree Diameter. Principally, the optical method gave us the rationale of accepting the ratio of [Gauge Width]: [Distance from Eye] being equal to the ratio of [DBH]: [Radius] i.e. 1:50 in our case as we used 1-centimeter width and 50 cm long of the reloscope made of wood. However, we choose factor of four (4) as we adopted it from Malimbwi (2012) and Department of Environment, Climatic Change and Water (2010).

Therefore, the Stand Basal Area of demarcated plots was obtainedas:

$$SBA = (\sum_{i=1}^{n} BA_i) \times 4 \quad (5)$$

Whereby:

$SBA = Stand\ Basal\ Area\ of\ the\ demarcated\ (selected)\ temporary\ plot\ in\ a\ stratum$

$BA = Basal\ Area$

$4 = Prism\ (relascope) expansion\ factorfor\ parallax\ error$

To establish permanent plots required a random plot selection (sampling) techniques using stratified sample within the above illustrated strata (ref. figure 7). To determine the stratified sample size (Kothali,2012, REDD, +, 2017), the following formula was used. Firstly we found maximum number of plots by dividing Area of the farm in hectare to the area of a single plot. The following formula was used ;

$$N = \frac{A}{AP}\ ;\ N_i \frac{A_i}{AP_i} \quad (6)$$

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Where,

N = maximum possible number of sample plots in the project area (stratum) [dimensionless];

A = total size of all strata, e.g. the total project area [ha];

N_i = maximum possible number of sample plots in stratum [dimensionless];

i = index for stratum [dimensionless];

A_i = the size of each stratum [ha].

Secondly we estimated the minimum number of the plots to include in the stratified sample as follows:

$$n = \frac{\left(\sum_{i=1}^{L} N_i S_i\right)^2}{\frac{N^2 E^2}{t^2} + \left(\sum_{i=1}^{L} N_i S_i^2\right)} \quad (7)$$

Where,

n = total number of sample plots (total number of sample plots required) in the forest area [dimensionless];

i = project strata number from 1 up to n_ [dimensionless];

L = total number of strata [dimensionless];

N_i = maximum possible number of sample plots in stratum [dimensionless];

S_i = standard deviation for each stratum plots [dimensionless];

N = maximum possible number of sample plots in the project area [dimensionless];

E = desired level of precision;

t = sample statistic from the t-distribution for the 95% confidence level: is usually set at 2 since sample size is unknown [dimensionless].

By using the equation number in 5 and 6 above, the total number of sample plots of each different stratum was calculated by the using the Eq. 8 bellow as follows;

$$n_i = n \cdot \frac{N_i S_i}{\left(\sum_{i=1}^{L} N_i S_i\right)^2} \quad (8)$$

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where,

n_i = number of sample plots per stratum [dimensionless];

i = project strata number from 1 until n [dimensionless];

n = total number of sample plots (total number of sample plots required) in the forest area [dimensionless];

N_i = maximum possible number of sample plots in stratum [dimensionless];

S_i = standard deviation for each stratum [dimensionless]; and

L = the total number of strata [dimensionless].

This formula was applied in the relatively huge forests as GEPAT members have relatively small tree farms.When the farm was found to be small , all trees were to be counted and measure (treated as a single plot).After obtaining the number of plots , the operator (researcher) estimated the distance between transect :

$$\text{Dm} = \frac{Aha \times 10{,}000}{n} \quad (9)$$

$Dm = distance\ between\ transect\ in\ meter(m)$

$Aha = Area\ of\ the\ treefarmsin\ hectare$

$n = number\ of\ the\ plots$

Further, the we established the number of transect in a farm as follow:

$$\text{T} = \frac{\text{D}_{\text{ls}}}{Dm} \quad (10)$$

Whereby,

$T = number\ of\ transect\ per\ farm$

$D_{ls} = Distance\ of\ the\ longest\ side\ of\ the\ farm$

Transect are parallel lines set across the slope of the hill-side tree farms following the contour fashion of the hills. Permanent plots were allocated within the transect aligned in the tree farm by maintaining a certain bearing within a transect, distance between transect and distance between permanent plots. The alignment of transect was done by using a GPS through taking the bearing together within a specific distance.

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Generally, the operators set the first plot at 10 meters from each tree farm boundary. Forward and backward bearings were set following the number of transect aligned in a tree farm. When the farm was assigned only one transect, only forward bearings were taken while the tree farm with more than one transects, both forward and backward bearings were taken and recorded. The distance between the transectswere the same from one transect to another transects. Each transect was parallel to each other within a farm.

All permanent plots were demarcated within the transects using marking plastic papers. The demarcated plots were marked using GPS. The operators also recorded the coordinates and elevations of each permanent plots.

5 DATA COLLECTION WITHIN PERMANENT PLOTS

During data collection, theoperators same tools used to estimate BA, SBA, plot areas and DBH were used in collecting data from demarcated permanent plots. Those were :

- **Master Tree Growers Diameter-Tape (MTG D-tape)** donated by Face The Future at GEPAT centre. The tape was used to measure DBH of the tree from 1.3M above the ground.
- **Swords** as a pocket knife: In GEPAT context, sword were used to cut climbers and sometimes swords were used to reduce the ununiform back of the trees which could obstruct measurement of DBH.
- **Relascope** : It was used to determine IN and INTERMEDIATE (HALF) trees used to measure the Stand Basal Area (see also Section 3.6.1 above).
- **Reddish coloured Plastic marked papers** donated by Face The Future used to demarcate the plots.
- **Normal Tape Measure** for measuring the distances and height
- **Pen, Pencils, rule and notebooks** used to record the measurements. And filling in the questionnaire relevant to get information used to understand farmer and farm characteristics stated in section 3.4 and section 3.5 above.

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- **Clinometer** was used in measuring the height of the trees in the plot as shown in the figure 15 below.

Figure 7 show how operators measured tree heights in the permanent plots. The heights of the trees in permanent plots were measured using the clinometer.

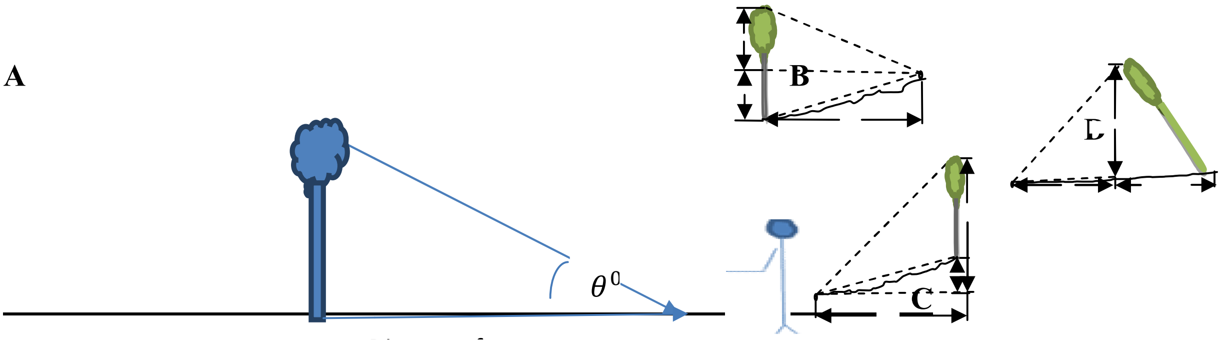

Figure 7 - An example of using the θ^0clinometer to measure the height of the tree grown in the flat surface in A.

The operator (enumerator) measured a distance of 10 meters from the trees base to where he stood. Through the clinometer, he focused at the top to take the readings shown in the clinometer-scale which entailed the tree height. That scale showed the height of the tree in case the tree top was at the same vertical line and the line connected the point where he stood to the base of the tree was straight line without any elevation. This method of determining the height of the trees was commonly used when the farm was in the valley (plain area) for Kituntu case. Therefore , we used trigonometric theories to determine the height as follows :

5 DEVELOPMENT

We estimated the tree height , let say X-value, in this triangle (which represents the portion of the height from eye-level up) by using some basic trigonometry, specifically the tangent ratio of the triangle:

tan (θ) = x / distance

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Multiply by the distance on both sides and you get:

x = tan(θ) x distance

We used a calculator to multiply these together and get a decimal value (be sure your calculator is in 'degrees' mode, rather than 'radians'!).

In our example if the angle is 35^0 gauge:

tan(35°) = x / 15.6

x = tan(35°) x 15.6

x = 10.92 meter

If the trees grew on non-flat land,the addition or reduction of the difference between the real height gauged in the clinometer and they consider base line will be considered as shown in figure 7A, B, C and D above/

$H = \sqrt{(10^2 + 5^2)} = 11.2\ m$

Figure 7 shows the tree position and the deduction of distorted height due to elevation and inclination of the tree.

GPS used to align the transect and plot location. It was also used to set up the grid reference for the farm location (latitudes and longitude -Eastings and Northings), elevation and distance. As shown in Figure 8, each farm’s map was saved in the GPS but the operators had no access to ACMAP software program to download it.

Figure 8 - MrTirasias Paulo Farmin Kituntu area

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Figure 8 is an example of the maps saved in GPS showing the maps of different tree farms of GTG.

6.1 DATA ANALYSIS

Green Choice donated two latops and those were used for data entry and analysis. However due to the complexity of the work , GPS applications was not compatible to the old fashioned computers. We used other laptop which was also old and we also face a problem of new versions Microsoft excel , SPSS or STATA software program . They are expensive to buy the licenses.

The preliminary information was entered in Microsoft Excel of office 2007. The data included names of names of the tree farm owner, area of the forest farm, coordinates, elevation, species, bearings (Forward and Backward), the plot size and tree species. Also, it included the DBH together with their few heights of the tree.

6.2 ESTIMATION OF TREE HEIGHTS

The operator measured three trees' heights. As we measured the DBH of all trees in a plot, we measured the heights of one OUT (small tree, one INTERMEDIATE tree (medium size tree) and IN tree (the largest tree) per selected permanent. We repeated the same procedure per every permanent plot in a farm. All heights were recorded in spread sheet. Two columns were generated, one for Y-variables and another for X-variables to generate a regression equation following that Height of a tree is a function of its DBH and therefore the following specific regression equation per farm was estimated:

$$\hat{y}_i = \hat{b}_0 + \hat{b}_i x_i \quad (11)$$

Whereby,

$,\hat{b}_0, \hat{b}_1 = coefficients\ of\ regression\ model$

$\hat{y}_i = estimated\ height\ of the\ trees$

$x_i = measured\ DBHs\ of\ different\ chosen\ three\ trees\ from\ each\ plot$

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From simple linear regression modal, the height of the tree was independent variable "x"and the DBH of the tree was treated as dependent variable "Y". Therefore the few heights of the tree with their respective DBH measured in permanent plots were regressed so as obtain the parameter b_0 andb_1 of which was substituted into estimated simple linear regression equation in order to obtain the rest of the tree heights.

6.3 ESTIMATION OF CARBON VOLUME

All steps used above in estimation of STAND BASAL AREA (SBA) of temporary piloted plots) in section above was employed repeatedly in the temporary plots to estimate SBA of all permanent plot. After estimation of the SBA, tree volume equations were employed to estimate the volume of the commonly planted trees species such as eucalyptus, pinus spatula/radiata and other tree species. The analysis used standard accepted volume equation used in Tanzania in 2012 (Malimbwi, 2012) as follows:

Standard equation for estimation of the carbon volume of the following species was adopted for GEPAT use:

- Eucalyptus species: $V = 0.000065 \times DBH^{163} \times H^{1137}$

  (Malimbwi and Mbwambo , 1990)

- Pinus species: $V = 0.00002117 \times DBH^{18644} \times H^{13246}$

  (Malimbwi and Mbwambo , 1990)

- Other species: $V = SBA \times H \times 0.5$

  (adopted from Malimbwi and Maya ,2012)

Where by,

$V = Tree\ Stem\ volume\ (m^3)$

$DBH = distance\ at\ the\ breast\ height\ (the\ DBH\ was\ measured\ at\ 1.3\ m$

$from\ the\ ground\ level\ tothe\ top\ oftree\ (see\ also\ section\ 3.6.1)$

$H = Height\ of\ the\ tree\ in\ m$

$SBA = Stand\ basal\ area$

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6.4 ESTIMATION OF BIOMASS

The biomass was estimated from a stem with a new improved biomass allometric equation by assuming 50% of biomass is carbon (Chave et al., 2014). The biomass was calculated in metric tons including heights of the trees to avoid an overestimation when using the DBH only. (Marshall et al.,2012).Forest Carbon was estimated by taking Above Ground Biomass (AGB) in tons per hectare (tones/ha), Below Ground Biomass (BGB)and Total Biomass (TB).

Where by

A. ABOVE GROUND BIOMASS (AGB) (TONES/HA)

$$AGB = (V \times WD)/1000 \quad (12)$$

$V = Stemvolumemeasuredinm^3/ha$

$WD = Wooddensityinkgs/m^3$

$1000 = forconversionof$ from kg to tones

Therefore,

$$AGB = \frac{\left(\frac{m^3}{ha} \times \frac{kgs}{m^3}\right)}{1000}\ in\ metric\ tonnes\ of\ carbon\ per\ hectare \quad (13)$$

However, wood density is already estimated by different foresters whereby is defined by Chave (2012) as Oven-dry weight is measured from the same sample by drying it in a well ventilated oven until it achieves constant weight (this usually takes 48 to 72 hours). Drying depends on the quality of the drier, and it is necessary to test the constant weight hypothesis by weighing the samples at regular intervals. The samples should be weighed immediately after being taken out of the drying oven, because tropical air is often water-saturated. We used the constants of oven dry weight used by Malimbwi (2012) since GEPAT have no such oven to use.

The constants are as follows:

i. Pinus species =390 kg/m3
ii. Eucalyptus species =517 kg/m3
iii. Grivelliarobusta =470 kg/m3

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i. Other species wood densities = 500 kg/m3

B. BELOW GROUND BIOMASS (BGB) (TONES/HA)

To get BGB, the AGB estimated in A above was used as follows:

$$BGB = AGB \times 0.25 \quad (14)$$

Eq.14 is below ground biomass expression which means the content of above ground biomass of trees in a farm contain 100% biomass while below ground biomass contains 25% of AGB.

Henceforth,

$$TB = AGB + BGB \quad (15)$$

Whereby ,

$TB = Total\ biomass\ the\ trees\ in\ a\ particular\ farm\ contain$

6.5 ESTIMATION OF CARBON

To estimate tons ofCarbon dioxide equivalent KituntuGEPAT Tree Growers (GTG) have mitigated from the atmosphere, TB was multiplied by 0.47 as a ratio of carbon among other materials making a tree.

$$Carbon = TB \times 0.47 \quad carbon\ in\ metric\ tonnes$$

6.6 ESTIMATION OF TONNES OF CARBON DIOXIDE EQUIVALENCE MITIGATED BY SMALLHOLDER FARMERS OFKITUNTU VILLAGE

The ratios of Carbon in Carbon dioxide were considered in estimation. Since the fraction of carbon in carbon dioxide depends on their weights. Twelve (12) mass unit of atomic weigh of carbon is found in carbon dioxide (CO_{2}) compound, while the weight of carbon dioxide is 44 as it includes two oxygen atoms. Each Oxygen atom ((O_2) has the weightof 16 atomic mass unit.

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Hence,we deduced that since carbon attracts oxygen for form carbon dioxide existence of one ton of carbon atom in the tree attracts two oxygen atoms to form carbon dioxide compound, one atom of carbon is equals 44/12 = 11/3 = 3.67 tonnes of carbon dioxide.

Therefore. Carbon dioxide equivalent was obtained by;

$$tCO_2eq = CT \times 3.67 \; in\ metric\ tonnes\ of\ carbon\ dioxide$$

Whereby,

$tCO_2eq = tonnes\ of\ carbon\ equivalence$

$CT = carbon\ metric\ tonnes$

$3.67 = carbon\ dioxide\ compounds\ available\ per\ carbon\ atoms\ among$
$the\ trees\ in\ a\ farm\ of\ GTG$

6.7 CONVERTING METRIC TONNES INTO TONS OF tCO_2eq

The literature has two types of tons, short tons (tonnes) and metric tons. We have shown how the operators estimated short tons (tonnes) in 3.12 above. Ton is a unit of mass in different measurement systems and usually mistaken with each other. The short ton (also known as net ton) equals to 2000 pounds and used in North America (United States and Canada), the long ton (also known as weight or gross ton) is used in imperial system (UK and some of the other English-speaking countries).

If you are tradingtCO_2eq internationally, you must know what type of ton as a weight unit is used in that country to avoid the surprises.

To convert tonnes (UK metric system) into tons (US system),we converters as follows: .

- 1Short Ton [US] = 0.90718474 Metric Tons [Tonnes]
- 1 Metric Ton [Tonnes] = 1.10231131 Short Tons [US]

Since we used metric tonnes , to convert them into short tons , 0.9072 was used as a multiplying factor.

$tCO_2eq = metrictonsofCO_2\ eq.x0.9072$ short tons (net tons) used in US -system.

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6.8 GENERALIZATION OF PLOT SAMPLES TO THE WHOLE FARM

As we entered the farm, we measured **the area . After determining the** tCO_2eq, there was a need for generalizing the amount at the farm level. We asked ourselves the question: If the estimated tCO_2eq was accumulated from the selected plots , how much was the amount of the same in a farm? Them we used the following cross -multiplication ratios to establish the amount in a specified farm of GTG:

$TPA = tCO_2eq$

$FA =$ TFC

Hence,

$$TFC = (\frac{FA \times tCO_2eq}{TPA}) \quad (16)$$

Whereby,

$TFC = Total\ Farm\ Carbon\ \ measured\ in\ tCO_2eq\ in\ the\ whole\ farm\ \ area\ \ in\ hectare$

$FA = The\ whole\ Farm\ Area\ \ in\ hectare$

$tCO_2eq = tons\ of\ carbon\ estimated\ from\ the\ permanent\ \ plots\ of\ the\ farm\ hectare$

7 FINDINGS PRESENTATION

After measuring all smallholder farms, the amount of Carbon dioxide in metric tons obtained among seventy (70) farms measured at KituntuVillage were showed the carbon volume equivalent in metric tons were **3571.686.** Subsequently, there was an investment return in terms of climatic change resilience shown by Tanzania Metrological agency represented in figure 9.

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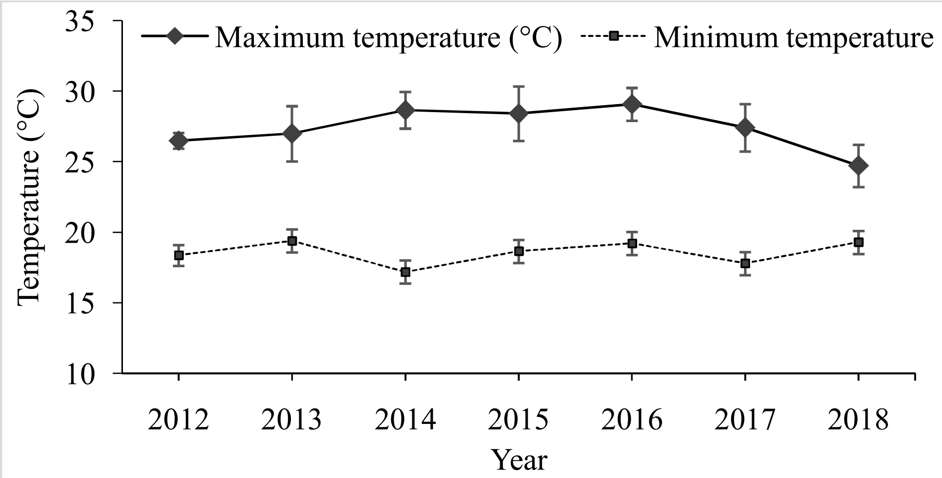

Figure 9 - Temperature fluctuations for five years within the GEPAT project areas

Figure 9 shows the way the temperature have slowly gone down in Karagwe districts since when Green Choice started supporting GEPAT in 2014 through impliedly carbon trade . The carbon trade market created by Green Choice among the four partners of GEPAT, Wakk Foundation And Face the Future was voluntary and collegial . There was no strict enforceable contract, Green Choice send fund to Wakk Foundation. GEPAT has been receiving Euro 10 ,000 to support nursery raising and seedling distribution. GEPAT sends annual report to Wakk Foundation which in turn submits to Green Choice, Green Choice supports smallholder farmers who are members of GEPAT to plant only indigenous trees.

Most of the farms planted many eucalyptus trees. GEPAT has invest a lot of time and money to create awareness to the people to plant indigenous trees. Many indigenous trees are still too young to be measured when one considered that indigenous trees take long time to reach 2.5 cm Diameter at Beast Height (DBH) contrary to eucalyptus and pine which reached that size within two years. Our DBH threshold was 2.5 cm that is why we did not measure the Kituntu GEPAT farm. Many trees were planted in 2014 and they are still young to measure. We will measure them as soon as the majority grow to reach 2.5 cm DBH) as our research is a Participatory Action Research (PAR).

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"We *need firewood, timber and money from pine and eucalyptus. Indigenous trees take long time to grow and they compete with good land we plant banana and other crops. Eucalyptus and pine grow on waste land, kindly tell Green Choice to support planting eucalyptus and pine"* said one of the farmers in the research. However, eucalyptus and pine worsen the waste land while indigenous trees improve it. GEPAT will continue creating awareness.

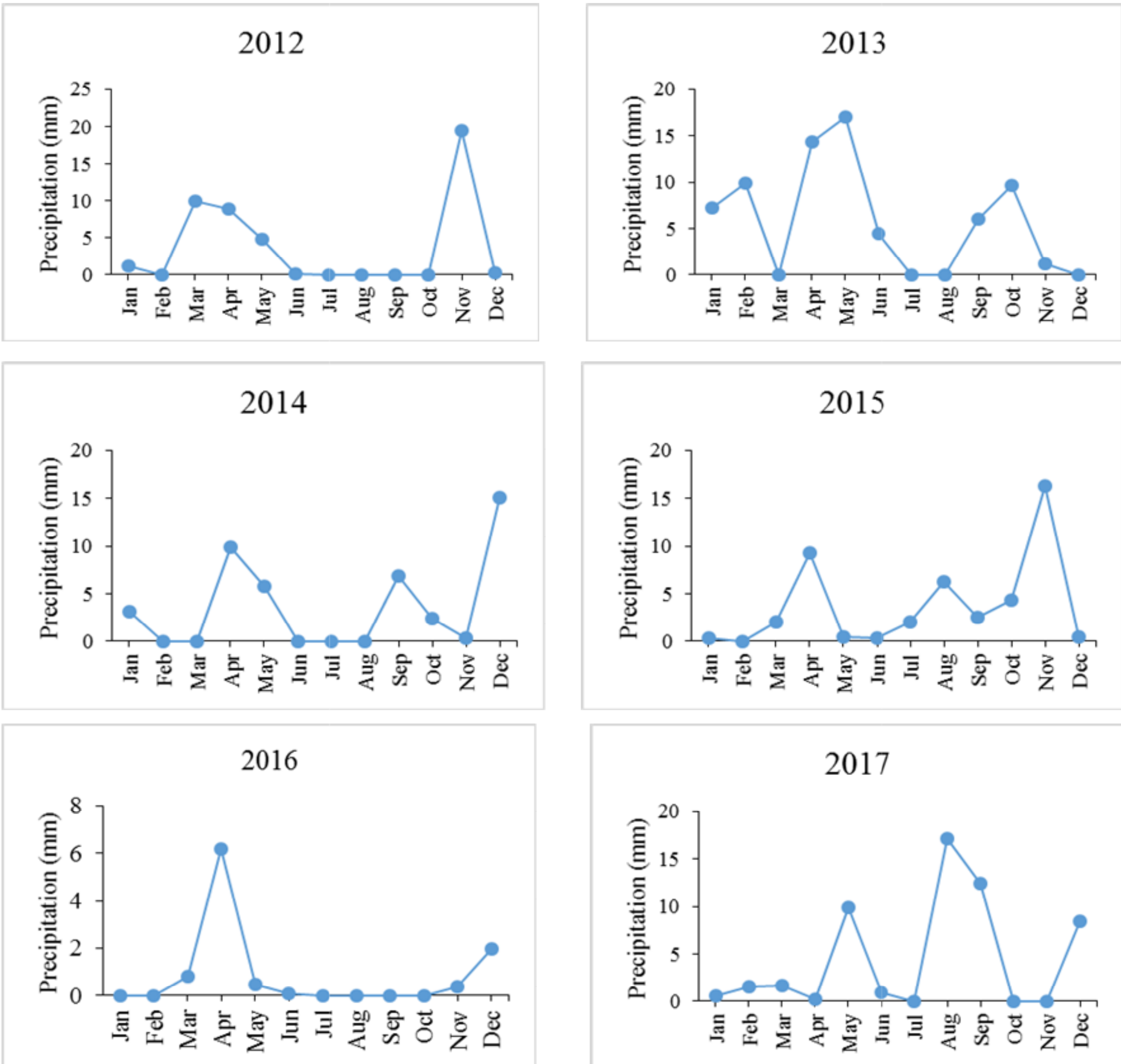

Figure 10 - Charts depicting mean precipitation per month throughout the year from 2012 to 2017 in the project area

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The rainfall pattern has fluctuated from bimodal in 2012 to trimodal for the next two years. In 2016 the area experienced a unimodal rainfall pattern. The rainfall pattern in 2017 was also trimodal (Figure 10).

8 CONCLUSION

The paper has presented the data, analyzed and discussed the investment in carbon credit and the return on investment. The return on investing in Social Economic Forest (SEF) is climatic change resilience in Kituntu village, Karagwe district. The project was and is still being implemented in Karagwe and Kyerwa district.

The carbon which has been removed is the cause of mitigation of the climate in the area under study which is the long-term goal of the project. The tree species *Eucalytpus grandis* has been extensively studied by environmental scientists over the course of years. It's one of the most widely cultivated trees in tropical and subtropical areas (Eduardo *et al.,* 2004). *Eucalyptus grandis* is known for its high potential in carbon sequestration (Kiyingi*et al* 2016) and its dominance in the study area was a positive outlook for success. The *Pinuspatula*trees have many economic benefits such as gum and resin extraction, furniture production, paper and pulp manufacturing. Studies by Oeba *et al.,* (2016) show that *Pinus patula* has a sequestration rate of 145.6 ± 44.4 MgC ha-1 for trees with the age of six years. This is in conformity to the results in this study (10 years) and shows great sequestration potential of the trees. The choice of trees was influenced by the GEPAT project coordinators and their technical judgment was keen and sound. Therefore the management of inivation networks among Green Choice andWakk Foundation was well aligned with GEPAT and Face The future actors to enable equivalent in metric tons were 3571.686 sink which lead to climatic change resilience in Karagwe district as return on carbon credit provision investment.

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9 REFERENCES

[1] Akhlaq, A., Wani, P. K., Joshi, O. S., Rajiv, P. (2012). Carbon Inventory Methods in Indian Forests - A Review. International Journal of Agriculture and Forestry, 2 (6), 315-323.

[2] Callan, J.S., Thomas, J.M. (2013). Environmental Economics & Management. Theory, Policy And Applications (6 ed.). South - Western, United States of America: Bentley University.

[3] Charles, J. (2013). Analysis of Green Investments for Combating Climatic Changes through Carbon Credit in Tanzania. A Case Study of Gepat in Karagwe. A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Economics . Morogoro, Tanzania: Mzumbe University.

[4] De Silva, M. J., Breuer, E., Lee, L., Asher, L., Chowdhary, N., Lund, C., & Patel, V. (2014). Theory of Change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions. Trials, 15(1), 267.

[5] Folner,H., Gabal, H.L., Gerking, S., Rose, A. (2001). Frontiers of Environmental Economics. UK: Glensanda Hause.

[6] Gizachew, e. a. (2016). Mapping and Estimating the Total living Biomass and Carbon in Low - Biomass woodlands Using Landsat 8CDR Data. Carbon Balance And Management .

[7] Gupta, Y. (2011). Carbon Credit: A Step Towards Green Environment. Global Journal of Management and Business Research, 11 (5).

[8] Hovi, J., Sprinz, D, F., Bang, G. (2010). Why the United States did not become a party to the Kyoto Protocol: German, Norwegian, and US perspectives. European Journal of Internation relation, 18 (1), 129-150.

VOLUME 2, NÚMERO 3, MARÇO DE 2019
ISSN: 2595-8402
DOI 10.5281/zenodo.2629436

[9] Jensen, J. (2014). Remote Sensing of the Environment an Art Resource Perspective. UK: Pearson Education Limited.

[10] Kothari, C.R., Garg, A.V.,. (2014). Research Methodology, Methods and techniques. New Delhi: New age Internation (P) Limited, Publishers.

[11] MalimbwiR.E. and Zahabu, E. (2009). The analysis of sustainable fuelwood production systems in Tanzania. In FAO 2009. Criteria and indicators for sustainable woodfuels. Case studies from Brazil,Guyana, Nepal, Philippines and Tanzania, Edited by Simmone Rose, Elizabeth Remedio and Miguel A.Trossero. http://www.fao.org/docrep/012/i1321e/i1321e09.pdf

[12] MalimbwiR.E., (1987). A growth and yield model for Pinuspatula at Sao Hill, Southern Tanzania. Ph.D. Thesis. University of Aberdeen, U.K.

[13] Malimbwi, R. E. and Philip, M. S.,. (1989). A growth and yield model for P. patula at Sao Hill, Southern Tanzania. Paper presented at IUFROS4.01 Mensuration, Growth and Yield.ViennaSept1989.

[14] Malimbwi, R.E., Eid, T., Chamshama, S.A.O.,. (2016). Allometric Tree Biomass And Volume Models In Tanzania. Tanzania.

[15] MNRT. (2015). National Forest resources Monitoring and Assessment. Ministry of Natural Resources and Tourism , Tanzania Forestry Services. United Republic of Tanzania.

[16] Ostrom, E. (2011). Governing The Commons. Indiana University, CombridgeUniversity Press.

[17] Panday, P.N., Mahato, B., Singh,R.K., Singh, L.K., Pandey, B.N. (2010). Environmental Pollution. India: Narendra Publishing House.

[18] Ravindranath, N.H., Ostwald, M. (2008). Carbon Inventory Methods.Handbook for Greenhouse Inventory, Carbon Mitigation and Roundwood Production Projects.

ISSN: 2595-8402
DOI 10.5281/zenodo.2629436

[19] Stake, R. (1993). The Art of CAse Study. New Delhi, India: Narendra Publishing House.

[20] Todaro, M.P., Smith, S.C. (2014). Economic Development (12 ed.). United States of America: New York University, The George Washington University.

[21] Tomppo, E., Malimbwi, R., Katila, M., Makisara, K., Henttonen, H., Chamuya, N., Zahabu, E., Otieno, J.A. (2014). Sampling design for a large area forest inventory - case Tanzania. Canadian Journal of Forest Research, 10.1139/cjfr-2013-0490.

[22] UN. (2015, April 07). United Nations Framework Convention on Climate Change:A Field Manual. Measurements for Estimation of Carbon Stocks in Afforestation and Reforestation Project Activities under the Clean Development Mechanism . Bnn, Germany: UNFCCC.

[23] UN. (2016). Transforming our world. Retrieved 2016, from The 2030 Agenda for Sustainable Development: http/www.sustainabledevelopment.un.org

[24] Underson, D. (2014). Environmental Economics and Natural Resource Management (4 ed.). Milton Park, New York: ox 14.

[25] Yin, R. (2003). Case Study Research Design and Methods. New Delhi, India: SUGE publication.