Potential Payment for Carbon Services for Community Managed Forests in Tanzania

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by

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Abstract

There is a hope that after 2012, Reduced Emission from Degradation and Deforestation could be credited under new Policy by UNFCC called "REDD". So, the study was conducted to assess the Potential for Community Managed Forest "Kimuyun" at Tanzania to qualify for credit under REDD. The Potential Carbon Stock at "Kimuyun" was found by Classifying and Comparing its forest cover Classes with adjacent unmanaged forest using stock difference approach, that gave a value of 46 hectare of forest land having Potential Carbon stock available for Payment under REDD. Household's interviews were Conducted to find the various forest uses by local communities and to estimate its equivalent amount in Cash where it has been found that Communities at Gwata Village were not taking any benefit from the managed forest "kimuyun", but rather, they were extracting wood from their allocated farms (unmanaged forest). The major reason for forest degradation and deforestation in the area was found as Clearing of the forest land (allocated farms) for agricultural crops, charcoal making and firewood usage that gave an annual income to the local communities at a rate of US$123 per hectare per household. As this amount of money can be received at a value (under REDD) of US$24 per ton CO2 which is within the bandwidth Value (US$5 per ton CO_2– US$45per ton CO_2) under REDD, So we can conclude that there is Potential for Community Managed Forest "Kimuyun" to qualify for Payment for Environmental Services (PES) under the Perspective of the REDD Policy.

Key Words: Deforestation; REDD; Community Managed Forest; Carbon Stock; Forest uses; Value under REDD

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1. Introduction

1.1. Background

The last century has brought more dramatic changes in human history of the world than any other of the past. Doubling in agricultural land,14-fold increase in economy, 15-fold increase in energy use, and 17- fold increase in carbon dioxide emission are some of the examples of these changes(Singh, 2007)

Deforestation in the tropics is a major source of carbon emissions and an active contributor to global warming. It has been estimated by the Intergovernmental Panel on Climate Change (IPCC) that there is a release of 1.7 billion tons of carbon annually due to land use changes, of which the major part is the tropical deforestation (IPCC 2001).This represents 20%–25% of current global carbon emissions(Banskota et al., 2007)

Much deforestation is the result of the planned activities such as expansion of area under cultivation to fulfil the livelihood needs of local people , although local communities are well aware of the consequences of these activities on the forest but they have no alternative means of income and also, most of the forest areas are unprotected and there is no rules for usage, So, each individual avail the most of his or her opportunity to use the forests (Esteve et al., 2008)

The concern to reduce concentrations of Greenhouses gasses and CO2 in order to mitigate global warming has led to the global agreement on the Kyoto Protocol. The Kyoto Protocol recognizes forest management activities in industrialized countries. The Non-industrialized countries can only participate in aforestation and reforestation activities to receive the incentive or payment for the described services under the specified terms and conditions (Banskota et al., 2007)

In recent years, there has seen considerable interest in using Payments for Environmental Services (PES) to finance conservation. PES programs are in operation in Latin America, Costa Rica, Colombia, Ecuador, Mexico(Pagiola et al., 2005)and Since 2003, the Kyoto: Think Global Act local(K:TGL) Research project has developed and tested procedures and techniques for carbon assessment and monitoring by local communities in different countries of the world like Nepal, Tanzania, India etc.

In Tanzania, there is a total of 34 million hectares of forestland, out of which 16 million hectares (47% of all forestland), are unprotected. Forests in General Land, that has an ‘open access’, characterized by insecure land tenure, shifting cultivation, annual wild fires, harvesting of wood fuel, poles and timber, and heavy pressure for conversion to other competing land uses, such as agriculture, livestock grazing, settlements and industrial development. The rate of deforestation in Tanzania, which is estimated at between 130,000 to 500,000 hectares per annum, is mostly in the General Land forests.(Zahabu et al., 2005)

Efforts towards forest reservation lead toward the initiation of Collaborative Forest Management (CFM) policy in this country that includes the involvement of local community in natural forest management in two ways i.e. Joint Forest Management (JFM) and Community based forest management (CBFM). Most of the CBFM areas are demarcated in village General Land that is also known as Village Forest Reserves (VFRs).

CFM provides for a promising forest management strategy to reduce deforestation and forest degradation in Tanzania. The statistics shows that between 2001 and 2006 CBFM activities have been increased and the unprotected forest land in General Land was reduced to about 16 million hectares from 18 million hectares. However, CFM do not provide cash benefits to the local communities nor the forests under CBFM have potential timber to merit harvesting as they are in the recovery stage, while JFM forest strategy restricts local use to a few non-wood forest products such as medicinal plants, thatching grass and honey. For effective participation of local communities in CFM activities on a large scale, they need to be provided with tangible incentives and preferably with cash benefits.(Zahabu, 2008)

In developing countries, forests Conservation in collaboration with local communities have been found an important component of overall climate strategy. But however, carbon sequestrations by existing forests, including those managed by local communities are not eligible for carbon trade under the Kyoto Protocol because under theses, only afforestation (plantations on land where forests did not exist) and reforestation (plantation on land which was cleared before1990) are eligible to qualify for this carbon trade.(Minang, 2007) However, avoidance of deforestation by conserving forests is more effective solution to the atmospheric rise of CO2. Although, plantations would bind carbon rapidly, but they may take 40-50 years to accumulate amounts equal to that are stored in the existing forests.(Singh, 2007)

Indeed it has been shown that the total cost of lost carbon due to deforestation is far greater, in dollar terms, than that of raising plantations. Plantations, although, may contribute to the prevention of deforestation and long-term carbon fixation in biomass, they certainly cannot substitute for the forest, which provides many services which a plantation cannot (Singh, 2007)

Under new policy that is under discussion by UNFCC called Reduced Emission from Degradation and Deforestation(REDD), there is hope that community forest management could be able to earn credit(Verplanke et al., 2009) Therefore, the need has been felt to develop a methodology to assess/verify that if under the new policy of REDD; CBFM could qualify for payment for Carbon Services at Tanzania

1.2. Research objectives

1.2.1. General objective

The objective of the research is to assess the potential for CBFM to qualify for PES (e.g. Carbon services) under the perspective of REDD Policy.

Assessing Potential for CBFM to qualify for PES is interdependent with Resource Potential (Carbon Stock) and Livelihood needs assessment because under REDD, payment for carbon services would be

made on the basis of existing carbon stock and if this payment would be sufficient enough to compensate the livelihood needs of the local people, then they would actively participate in the conservation of forests and would play positive role in achieving global target under REDD policy.

Here, our main focus of research is to assess the potential for CBFM on the basis of the two categories i.e.

1) With current uses (of CBFM) by local communities (where there is small rate of deforestation)
2) Without use by local communities (no deforestation)

We are interested to know that, with current use, CBFM would be able to receive credit for its existing carbon stock and if, we also consider the carbon stock and its value as a result of the stopped/no deforestation activities (lost functions by communities), then the carbon stock and its equivalent value at CBFM would be sufficient enough to compensate the local communities for their lost functions.

This is shown by the following research framework of the proposed study

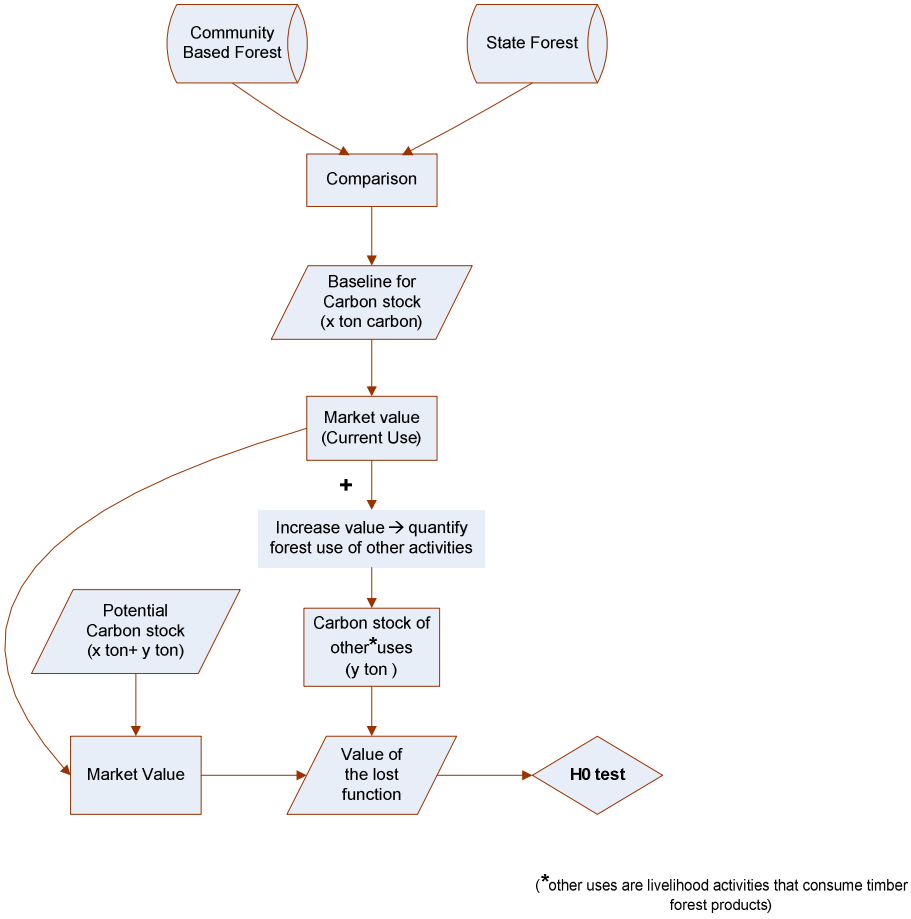


Figure 1: Research Framework

1.2.2. Specific Objectives

1) Quantification of land cover changes (using remote sensing) of the managed and unmanaged forests to make an estimate of carbon stock value at the managed forest (CBFM)

2) To estimate the value of the lost functions and uses for the CBMF community upon implementation of REDD context in near future.

3) To assess the applicability of PES at local level by making Comparison of the values of carbon stock (A) with value of lost functions or uses (B) such that

If

A>B There could be Potential for PES

A≤B There is most likely no potential for PES

1.3. Research Questions

1. (a) How much Carbon stock (in ha) has being Changed/accumulated in both managed and unmanaged forests?

1. (b) How much of the accumulated Carbon stock at CBFM could qualify for carbon credit?

1. (c) What is the Cash value of the accumulated Carbon Stocks under the perspective of REDD?

2. (a) What are the functions /uses of CBFM forests by local communities?

2. (b) What are the values of functions/uses that the local communities at managed forests have to forego in Comparison to the unmanaged forests

3. What would be the result if make comparison of the values of lost functions with value of Potential carbon Stock

1.4. Hypothesis

Ho: Values of lost functions or uses are higher than the amount of compensation in Community based forest.

H1: Values of lost functions or uses are not higher than the amount of compensation in Community based forest.

2. Basic Concepts in this study

2.1. Forest Management Practices in Tanzania

According to the forest policy of Tanzania, the country has an area of 34 million hectares of forests and woodlands. Almost two thirds of this area consists of woodlands in the public lands which have no clear management guidelines, and about 13 million hectares have been gazetted as forest reserve.

The total number of forest reserves in Tanzania is 827, out of which 621 are declared forest reserves and 206 are proposed forest reserves. Declared forest reserves are those which have been gazetted and their identity is recognized by the legislation, such forest reserve, therefore, include gazetted forests under the central government, local government, private forests and those under Participatory Forest Management (PFM), while proposed forest reserves are not therefore covered by any legislation and Few forests under central and local governments have a "proposed status".

Forest tenure in Tanzania falls into five major categories

(i) Central government forest reserves (81.5% of the total area of forest reserves and they are mostly declared. These include both productive and protective forests)

(ii) Local government forest reserves (these are managed at the level of District Councils under local governments, This is only 5% of the total forest area in the country)

(iii) Private forests (There are three private forests covering a total of 60,959 hectares in Tanzania)

(iv) Village forest reserves(these are forests under Participatory Forest Management (PFM) and they are categorized into two main entities CBFM and JFM forests

(v) General land forest - non reserved(Zahabu et al., 2005)

2.1.1. Community Forest Management

'Community Forest Management' (CFM) is a general term that describes a variety of programmes in which forest land, usually officially property of the state, is handed over to local communities for management purpose Examples of such are India's Joint Forest Management programme, Nepal's Community Forest User Groups and Tanzania's Community Based Forest Management programme, now re-named Participatory Forest Management (Skutch et al., 2010)

Involvement of local communities in natural forest management in Tanzania started in mid 1990's when it has been realized that continuing deforestation is the result of the failure of past conservation strategies that aimed to bring more forest under tenure state excluding the involvement of local communities. Participatory Forest Management (PFM) was introduced into law with the passing of the Forest Act of 2002 (Division, 2006).

CFM in Tanzania is undertaken in two different forms. These are either Joint Forest Management (JFM) or Community Based Forest Management (CBFM). These approaches are different in terms of forest ownership and the roles played by different actors and the detail of each approach is as follows.

- **Joint Forest Management (JFM)**

Under JFM the government or local authority who owns the forest, enters into a joint management agreement for the management of the forest with the local communities. Joint Forest Management takes place on “reserved land” – land that is owned and managed by either central or local government. Villagers typically enter into management agreements to share responsibilities for the management with the forest owner.(Division, 2006)According to the Forest Act (URT, 2002), a joint management agreement among other things includes: a statement of objectives of the agreement; rules regulating the use of and access to the forest reserve; and penalties for violation of rules. It also includes the roles of both the government and other actors to be involved in the forest management. In most cases the role of the government or local authority has been the provision of technical assistance through its professional foresters responsible for that area(Zahabu, 2008)

In general, forest reserves may be established for either protective or productive purposes. Protective forests are usually located in sites with steep slopes, those reserved or used principally for the purposes of protection of watersheds, soil conservation and the protection of wild plants. Alternatively they are used as nature reserves to protect nature and scenic areas of national or international significance and to maintain and enhance bio-diversity and genetic resources in an undisturbed, dynamic and evolutionary state. Productive forests in contrast are used principally for purposes of sustainable production of timber and other forest produce. In Tanzania, only about 3 million ha out of 14 million ha of reserved forests under central and local governments are protective forests. under JFM joint management agreements for the management of central and local government forest reserves are made in the light of the primary objective of the forest. With protective forests, more strict rules on access and use of the forest are made, while with productive forests, strategies for sustainable management and utilization are set, depending on the nature of the forest(Zahabu, 2008)

- **Community Based Forest Management (CBFM)**

CBFM projects are established by village councils on village land, therefore, they are sometimes referred to as Village Forest Reserves (VFRs).CBFM is managed by Village Forest Committee (VFC) of the village council. In order to execute its duties, the committee is guided by a VFR management plan made and agreed by a village council in consultation with other stakeholders, who in most cases are the professional (government) foresters responsible for that area. The committee is also responsible for instituting by-laws and other rules that are made by the village council with respect to the VFR management. Under Community Based Forest Management (CBFM), villagers take full ownership and management responsibility for an area of forest within their jurisdiction and it is "declared" by village and district government as a village land forest reserve. Following this legal transfer of rights and responsibilities to village government, villagers gain the right to harvest timber and forest products, collect and retain forest royalties, undertake patrols (including arresting and fining offenders) and are exempted from regulations regarding harvesting of "reserved tree" species, and are not obliged to share their royalties with either central or local government. The Community

Based Forest Management (CBFM) takes place in forests on "village land" (land which has been surveyed and registered under the provisions of the village land act (1999) and managed by the village council)

In terms of benefits to villages, experience reveals that many of the early VFRs were established on degraded forest land that had little merchandisable timber left (Blomley and Ramadhani, 2005). This means that utilization opportunities were limited and long times are required before the forests became commercially viable.

In 2001, there were 78 village forest reserves in Tanzania under CBFM covering an area of 186,292 hectares, whereas in 2006, it has been increased to 957 covering 1086506 ha of land, that indicates that CBFM activities have been increased by 879 forests in 1484villages. (Zahabu et al., 2005)As Community Managed Forest are under the control of village government , such forests provides promising results in controlling deforestation and forest degradation (Division, 2006; Blomley et al., 2008) and improved conservation of forest land , but their potential is less to contribute for poverty reduction of the concerned communities (Blomley et al., 2006)

2.1.2. General land forests

The general land forest, formerly known as public forestland is non gazetted or non reserved and it covered about 20.5 million hectares by 2001 (60% of all forest land). Proposed central and local government forests and village forests were in this category. These forests are “open access” characterized with insecure land tenure, shifting cultivation, harvesting for wood fuel, poles and timber, and heavy pressure for conversion to other competing land uses, such as agriculture, livestock grazing, settlements, industrial development in addition to wild fires. The rate of deforestation in Tanzania which is estimated at between 130,000 to 500,000 hectares per annum (MNRT, 1998) is mostly impacted in the general land forests(Zahabu et al., 2005)

2.2. Payment for Environmental Services (PES)

Forests Provide Environmental Services(Minang, 2007) that benefit the society as a whole. These services are often lost because of the over use and/or lack of financial incentives to preserve them. One of the more recent approaches that promotes such preservation is known as “Payments for Environmental Services (PES)”. The logic behind PES is that those who provide environmental services should be directly compensated, while those, who receive the services should pay for their provision. If people are being compensated for the environmental services that their land generates, they are more likely to choose an environmentally sustainable land use.(State, 2005)

Payment for the following four types of Environmental Services are available up to day (Wunder, 2005)

1. Biodiversity protection (e.g. conservation donors paying local people for setting aside or naturally restoring areas to create a biological corridor);
2. Watershed protection (e.g. downstream water users paying upstream farmers for adopting land uses that limit soil erosion, flooding risks, etc.);

3. Landscape beauty (e.g. a tourism operator paying a local community not to hunt in a forest being used for tourists' wildlife viewing).
4. Carbon sequestration and storage (e.g. as under the Clean Development Mechanism of the Kyoto Protocol);

Land, and Landowners, in areas providing carbon services could be entitled to receive Payment for such services(Torresa et al., 2009) as In Chiapas (Mexico) the Bioclimatic Fund was established to manage funds collected under the Scolel Té project, a carbon sequestration scheme based on agro forestry practices. More than 300 coffee and corn farmers participated in the project by planting trees on 20 percent of their land parcels on average to absorb carbon. In Bolivia, The Nature Conservancy, along with the Bolivian government, Amigos de la Naturaleza, and US-based energy companies, have developed the largest forest-based carbon project in the world (600,000 ha) to sequester 26 million tons of carbon over 15 years in the Noel Kempff Mercado National Park at a cost of US$9.6 million. In Argentina, the German Development Agency (GTZ) agreed to invest in a project to generate carbon offsets in La Plata/Fontana. Under this project, 120,000 ha of native forests will be protected to sequester 12.6 million tons of carbon.(Mayrand et al., 2004) It has been estimated that about 745,000 ha of land has been brought under carbon sequestration activities till 2006 , yielding carbon offset worth$84 million in the last ten years(Minang, 2007)

At present, Global Carbon Trading is only possible through Clean Development Mechanism (CDM) of the Kyoto Protocol. The KP is a legally binding international agreement that commits industrialized countries to reduce their emissions of six greenhouse gases (GHGs). Under the CDM of the Kyoto Protocol, a project to reduce carbon emissions can be set up in a non-industrialized developing country, and the carbon 'saved' can be 'credited' –on a per tone carbon base. Developed countries are legally bound to reduce their greenhouse emissions and on the other hand, they may also purchase carbon credits from CDM projects and offset these against their own obligations, thus creating a market for carbon credits(Banskota et al., 2007).

The terminology used for all the activities involving Bio-carbon under CDM is 'Land Use, Land Use Change and Forestry' (LULUCF)'. For the First commitment period of 2008-2012, eligible activities under LULUCF of the CDM are only limited to afforestation and reforestation projects.(Zahabu, 2008).

Payment for carbon services can provide new (especially private-sector) funding, that would help the poor communities involve in these services to improve their livelihoods.

Although there are still uncertainties in the full operation and ratification of the Kyoto Protocol, but the case studies conducted, indicates that the market for payment for carbon sequestration Services is rapidly evolving. So there is a hope that the projects under Payment for carbon services would expedite and increase in number after Kyoto Protocol entering into force.

(Under Kyoto Protocol **Forest is defined** in terms of canopy cover of 10-30%, tree height 2-5 m and area minimum patches 0.1 ha)

2.2.1. REDD

As it has been stated that at the present, forest carbon trading is only possible through Clean Development Mechanism (CDM) of the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), which is only limited to afforestation and reforestation projects for the first commitment period (2008-2012).(Angelsen, 2008). Although, afforestation and reforestation is a quick way to bind CO2 but it only promotes large scale monoculture plantations that ignore biodiversity aspect of the forest(Zahabu, 2008), and also, most of the community managed forests (e.g. as those found in Nepal and India) cannot qualify under CDM(Treves, 2004) due to strict condition(Minang, 2007)

As about two-thirds of the global terrestrial carbon is stored in forested areas in the form of standing biomass, leaf and forest debris, and soil(Banskota et al., 2007) and deforestation, particularly in the tropics, has been estimated to result in annual emissions of around 8 Gtons CO2, which represents almost 20% of anthropogenic greenhouse gas emissions(Angelsen, 2008) and only during the period of 1990 -2000, the deforestation rate in the tropical forest was recorded as of 12.3 million ha of forest per year(Banskota et al., 2007)

Although Community managed forests are based on the principal to control deforestation and degradation activities , and such forests have more CO2 stored than the unmanaged forests but avoiding deforestation to control CO2 emissions is not a recognized activity under the CDM of the Kyoto protocol.(Banskota et al., 2007).

The agenda item on “Reducing emissions from deforestation in developing countries and approaches to stimulate action” was first introduced into the COP agenda at its eleventh session in Montreal in December 2005(UNFCC). There is now a growing interest to include these emissions in the second commitment period after 2012(Banskota et al., 2007) as Reducing deforestation is a highly cost-effective way to quickly decrease the GHGs emissions and also, it make sense that CO2 removed from the atmosphere and stored in a tree is just as good as one not be emitted(Angelsen, 2008).

According to United Nations Framework Convention on Climate Change (UNFCCC), REDD refer to a broad set of approaches and actions that will reduce emissions from deforestation and forest degradation. REDD is based on a core idea: reward individuals, communities, projects and countries that reduce greenhouse gas (GHG) emissions from forests. REDD has the potential to deliver large cuts in emissions at a low cost within a short time frame and, at the same time, contribute to reducing poverty and sustainable development.(Angelsen, 2008)

A basic assessment of opportunity costs is necessary to set PES rates for the target resources and, a baseline is necessary for buyers of environmental services to set up PES programs and later assess them; otherwise it may possible that they may be paying for something that would have happened anyway(State, 2005)

2.2.2. Inventory approaches to estimate emission from deforestation and forest degradation

There are two approaches on the basis of which credit for carbon increase would be made under REDD. Theses are referred to as input-based and output-based approaches.

In input-based schemes, payments are conditional on the inputs which are assumed to produce a desired outcome, but where the outcome cannot be measured directly. Such schemes are also referred to as 'policies and measures' (PAM). Examples of PAMs for REDD include reforming land tenure and enforcing forest law. They also include the adoption of land use practices likely to secure a desired outcome, for example, reduced impact logging. In output-based schemes, payments are directly conditional on the outcome(Angelsen, 2008)

From effectiveness and efficiency perspectives, output-based schemes are preferable to input-based approaches as they directly connect payments with the service delivered.

Two types of output-based measures are relevant to the REDD debate to estimate Carbon stock changes.

(i) The stock-based or stock-difference approach; and

(ii) The process-based or gain-loss approach.

***Stock-difference approach*:**

This method estimates the difference in carbon stocks in a particular pool at two moments in time. It can be used when carbon stocks in relevant pools have been measured and estimated over time, such as in national forest inventories. This approach is suitable for estimating emissions caused by both deforestation and degradation, and it can be applied to all carbon pools.

***Gain-loss approach*:**

This approach estimates the net balance of additions to and removals from a carbon pool. In the REDD context, depending on how ecosystem rehabilitation is treated, gains result from growth and carbon transfer between pools (e.g. biomass pool to a dead organic matter pool due to disturbance). Hence, losses result from carbon transfer to another pool and emissions due to harvesting, decomposition or burning.

The stock difference approach is in line with the current focus of the UNFCCC, and is also the main proposal in the REDD negotiation., this approach has the advantages in terms of effectiveness(Angelsen, 2008).

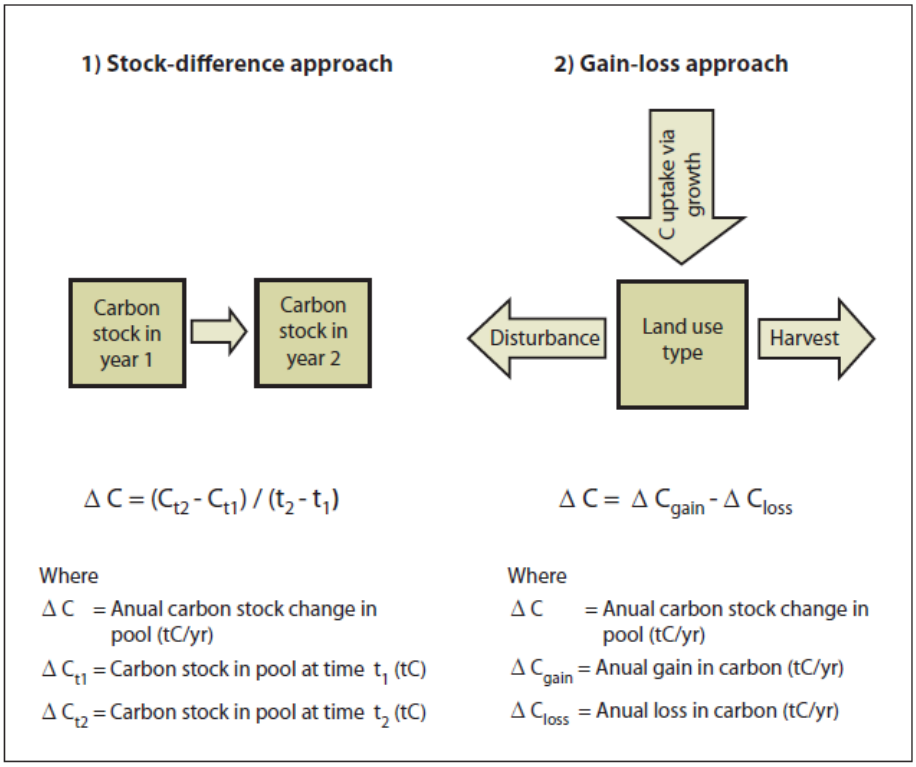


Figure 2: Estimating carbon stock changes

2.2.3. Baseline for deforestation

For crediting carbon emissions reductions, a baseline is required against which the savings can be compared. There is considerable uncertainty at the moment about how baselines may be determined under the operational policy of UNFCCC on Reduced Emissions from Deforestation and Degradation (Zahabu 2008).However, Almost all submissions by the Parties, as well as the Bali Action Plan (COP 13), suggest that baselines should include historical national deforestation under businesses as usual scenario (So far, the discussion in the context of the UNFCC is nominally restricted to deforestation(Vanlaake et al., 2008), so, the reference period might be typically set to the average deforestation rate of the last 10 years, and would be updated every 3 years. Each participating country may also set its own a reference scenario(Angelsen, 2008)based on past rates of forest loss, against which achievements in reducing deforestation would be measured(Zahabu, 2008). Carbon credits would be issued on the basis of the net reductions in rate of loss of forest biomass over the relevant accounting period, across the whole country, compared to the reference scenario. Participation would be voluntary, and funds would derive either from sale of carbon credits in a global market, or from a special fund managed by a multi-lateral organization(Zahabu, 2008), one of the problem with this approach would be that, as many countries don't exist reliable data for past deforestation rate(Angelsen, 2008)

Other options for selecting baseline are "National circumstances" and "Historical global deforestation" but, the practical implication of these are still to be worked out(Angelsen, 2008)

2.2.4. Opportunity Cost

Preserving forests means foregoing the benefits that would have been generated by the alternative land uses that would have replaced the forests. If forests are cleared for agriculture, for example, then preserving forests means foregoing the benefits of crop production. The difference between the benefits provided by the forest and those that would have been provided by the alternative use is the opportunity cost of avoiding deforestation and is usually the most important category of costs a country would incur if it reduced its rate of forest loss to secure REDD payments. Most estimates of REDD costs come from 'bottom-up' studies based on detailed information on particular activities in particular locations, at fixed prices(Angelsen, 2008)

One relatively simple method of determining opportunity costs is to estimate the benefits generated by forests in an area, and compare them to the benefits generated by non-forest lands in the same area , on a per hectare basis as described in fig.3 (Pagiola et al., 2009) that avoiding the loss of 1 ha of forest prevents 250tC from being emitted, but the alternative land use has a stock of 20tC, so the net emissions avoided are 230 tC. Maintaining forest foregoes $30/yr in income from pasture. Given the $10/yr that forests provide, the opportunity cost is $20/yr.

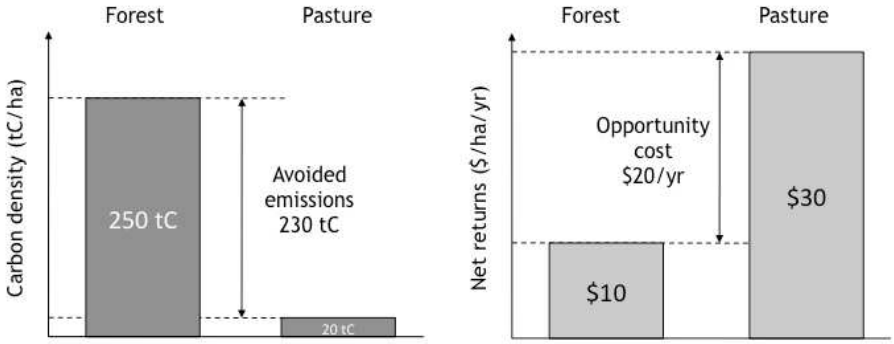


Figure 3: Opportunity cost (Pagiola et al., 2009)

2.3. Monitoring Forest Cover Changes via remote sensing

Quantifying GHG emissions from reduced deforestation requires measurements of changes in forest cover and associated changes in carbon stocks(DeFries et al., 2006). Remote sensing offer the possibility of spatially and temporally consistent estimates of forest cover(DeFries et al., 2002) and is the only practicable approach for monitoring deforestation at a national and International level (DeFries et al., 2006) that may be supported by ground measurement for verification(Angelsen, 2008)

Since the early 1990s, changes in forest area have been monitored from space with confidence (Angelsen, 2008) as multi temporal analysis of satellite imagery prove to be very effective for change detection because there is high correlation between spectral variation in the imagery and land cover changes(Kaya et al., 1998).

There are two approaches by which monitoring of forest cover changes can be made, these approaches are wall-to-wall mapping and sampling. Wall to wall mapping is a common approach in which the entire country or forest area is monitored, as in India and Brazil such approach is applied. Sampling approach is useful to reduce the costs of data analysis, and is especially suitable when deforestation is concentrated in discreet areas of a country or region. Recommended sampling approaches include

systematic sampling, whereby samples are taken at regular intervals (e.g. every 10 km), and stratified sampling, whereby samples are determined by known proxy variables (e.g. deforestation hotspots). Expert knowledge can also help determine sample priorities. A stratified sampling approach used, for example, in the Brazilian Project to Monitor the Brazilian Amazonian Rainforest (Projeto Monitoramento da Floresta Amazônica Brasileira por Satélite - PRODES), identifies 'critical areas' based on the previous year's monitoring to prioritize analysis for the following year(Angelsen, 2008)

There are a lot of examples available where the researchers used the remote sensing technique to monitor land cover/forest cover changes and to estimate the carbon stock value as studies conducted by (Lufafa et al., 2008),(Treves, 2004)and by so many other scientists and researchers

Reporting accuracy and verification of results are essential components of a monitoring system by remote sensing, accuracies of 80-95% are achievable for monitoring with medium-resolution imagery (e.g. Landsat) to discriminate between forests and non-forests, the best way to assess accuracy are through ground observations(Angelsen, 2008)

2.4. Livelihood need Assessment via Household interviews

Humans are the main force behind global conversions of land cover(Vitousek et al., 1997)where the rate of this land cover change (deforestation) is being accelerated with growing population pressure and enhanced access to forests. The assessment of theses forest uses need to be quantified to assess pressure on the forests. These assessments can be based on national or provisional statistics but it should also include detailed survey at the village level to assess domestic uses of forest products and illegal activities leading towards degradation and deforestation(Vanlaake et al., 2008)

Researchers rarely survey the entire population for two reasons (1) The cost is too high and (3)The population is dynamic, i.e., the component of population could change over time.(WIKIPEDIA, 2010), therefore, the sampling strategy is developed to conduct survey (e.g household survey)of the village population(Lindenberg, 2002) not only to reduce the resources(e.g. cost, time) but may also to improve the accuracy and quality of the data because of the smaller data set (WIKIPEDIA, 2010)

Concerns have been expressed in the debate on REDD as regards to the rights of indigenous people and communities dependent on forests and the impact of REDD programmes on such groups(Angelsen, 2008).The dependency of such communities can be better assessed by the household survey questionnaires as these include extensive detailed questions on family size, literacy, work dynamics, cultural practices, forest uses, income sources, assets, participation in community organizations and other issues. (Lindenberg, 2002).

2.5. Conceptual Framework for PES (Carbon services) at Tanzania

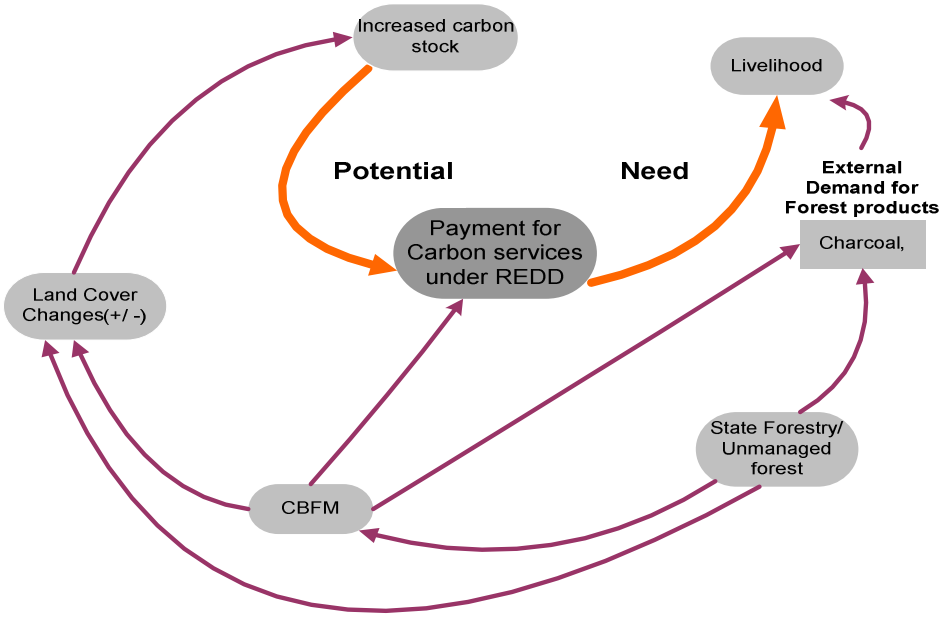


Figure 4: Conceptual Framework for PES (Carbon services) at Tanzania

There is interrelated relationship of PES with Land cover changes, livelihood, CBFM forest and state forestry.

Local communities at the study area fulfil their livelihood need major by state forestry and to some extent by CBFM forests. CBFM though brought positive impact on the land cover changes and increased the carbon stock in the area but with this, local communities have access only to some forest products and upon implementation of REDD Policy in the area, they may even have to forego for those Products .

Now the applicability and sustainability of PES (e.g. Carbon services) would depend upon the quantity of existing carbon stock and its equivalent amount in cash so that local communities could be compensated for their lost functions or services upon the implementation of REDD policy in the area.

3. Methods and Materials

This chapter describes how the research was conducted, the methods used for data collection and techniques used for data analysis.

Generally, it consists of the following steps to meet the research objective and to answer the research questions.

- Study area
- Data Sources and Methods of Data Collection
- Data Processing and Analysis
- Reliability and Validation
- Assumptions and Limitation of the study

We would describe these steps (except of study area) separately for each of the specific objectives of our research study.

3.1. Study Area

3.1.1. Gwata Ujembe Village

- **Socio-economic profile of the village**

Gwata Ujembe village is located about 50 km to the east of Morogoro town, along the Dar es Salaam-Morogoro highway. Administratively the village is located in Mikese ward, Morogoro Rural District .The total area of the village is 6209 hectares. It consists of five sub villages i.e. CCM, Schule, Likwambe, Karia and Gazaulole. There are 715 households in the village with a total population of 2,030 people (village 2008 statistics) having 60% poor, 35% middle while 5% the well-off (Zahabu, 2008).

The main economic activities of the people in this village are subsistence agriculture, and charcoal making and the main agricultural crops grown by villagers are maize, millet, sunflower, beans, cassava and sesame.

The climate of the area is Tropical, Semi arid and Humid. The mean annual temperature is 24 ^{o}C (Zahabu, 2008)

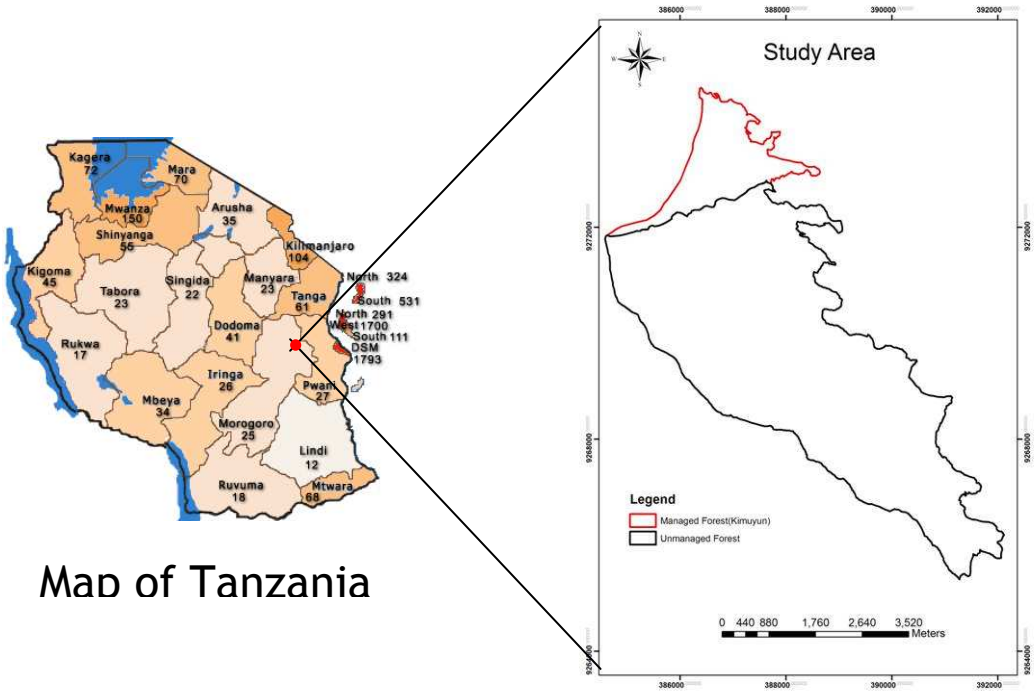


Figure 5: Location of study area (forest reserve)

- **Forest Reserve**

There are two forest reserves in the village i.e. Kitulangalo Sokoine University of Agriculture Training Forest Reserve (KSUATFR) and Kimunyu Village Forest Reserve having 600 and 307 hectares of land respectively. KSUATFR was a part of Government Forest Catchments Reserve that has been given to Sokoine University of Agriculture (SUA) in 1995 for training and research purpose (although protection was also one of the reason for changing its status).This forest is still owned by the government, but the management is mainly in the hands of the university and local community, following jointly prepared management guidelines.

Kimuyun village Forest Reserve was demarcated to the village community in 2000. This forest is the property of the village, which has full responsibility for its management. Both of theses forests are characterized by miombo woodlands vegetation where the predominant species are Brachystegia and Julbernadia.

There is Village Forest Committee in the village that supervises the management of the forests on behalf of the village government. This committee looks after both the KSUATFR and the KimuyunVFR. The committee members are elected by village general assembly. VFC mobilizes the local people and select the villagers to patrol the kimuyun while in case of KSUATFR, two villagers are employed as forest guards (paid by the university). There has been different by laws set by the village government for KSUATFR and Kimuyun Village Forest reserve. These by laws are in the form of different penalties charged against offenders who violate the rules set for these forests i.e. encroachment and harvesting of these forests for charcoal, timber and building poles etc.(Zahabu, 2008)

To carry out the research study and to meet our specific objective 1, we have selected "Kimuyun" as managed forest reserve because this forest is wholly solely owned and managed by Gwata village , for unmanaged forest we have selected an approximately 2161 ha of un-managed forest adjacent to the managed one.

For specific objective 2, we have selected "Gwata village" because kimuyun is located in and is the property of all the villagers of this village who were expected to be the "kimuyun forest reserve" beneficiaries

3.2. Land Cover Changes

For quantification of land cover changes over the period of 2000 and 2009 at both managed and un managed forests to make an estimate of Above Ground Carbon level, the following steps were carried out

- **Land cover mapping with satellite images**
- **Quantification of land cover changes (in hectare) of the existing carbon stock in managed and unmanaged forest**

Land cover mapping with satellite images

Monitoring of forest cover change using satellite remote sensing is practical and feasible for determining baseline deforestation rates against which future rates of change can be based, provided that adequate validation and accuracy assessments are conducted and documented. (Goetz et al., 2008)

The methodology of mapping land cover with satellite images consist of the following steps(NRM, 2008-2009)

- Image data selection
- Unsupervised Classification
- Field data collection
- Supervised Classification
- Accuracy Assessment

3.2.1. Image data selection

The best available images (clouds free/having less clouds) found at ITC RS lab were Landsat 2000(30m resolution) and ALOS 2008(10m resolution). The images were already geo-referenced. The study area i.e. managed and unmanaged forest were digitized as a one subset to use the same spectral signature for classification (unsupervised and supervised) and then these forests were digitized separately to make comparison for land cover change (of the managed and unmanaged forest) for the year 2000 and 2008.

3.2.2. Unsupervised Classification

Prior to collecting field data , unsupervised classification was done as it is a useful technique to stratify input images into spectrally homogeneous areas for optimized training and ground truth collection (Kuemmerle et al., 2006).Unsupervised classification of ALOS2008 image was done on the basis of seven classes, that gave a good estimates of the original image.

3.2.3. Field data collection

During the field visit, five distinguishable forest cover classes were found and we collected training units on the basis of those forest/land cover classes. i.e.

1) Very Dense Forest (>60 % forest cover) 2) Dense Forest (40-60%forest cover)

3) Medium Forest (20-40% forest cover) 4) Open forest (10-20%forest cover)

5) Farm /Bare land

Figure 6: Forest Classes

Training units at "Kimuyun" forest reserve were collected using line transects sampling method(Treves, 2004) whereas the area of the unmanaged forest was big enough to be covered in transects in a short period of time, so, "stratified random clustered sampling* was used as the same sampling scheme was used by (King et al., 2004) to collect more samples in a short span of time.

During the field survey the geographical coordinates of the land cover classes were recorded by using GPS (Prasad et al., 2009) and Ipaq instruments and a total of 70 training units were collected

[*"Stratified sampling" means that an equal number of sample points are allocated to each legend (irrespective of the size of the unit and number of polygon that belong to that unit)

"Clustered sampling" means that sampling points are concentrated in better accessible areas where several legends units occur at short distance and representative sampling means that the selected sample points have the image characteristics.(NRM, 2008-2009)]

3.2.4. Geometric Correction

The images were re-projected to geographic coordinate Arc 1960, UTM Zone 37 S in ERDAS IMAGINE processing software. As the image with high spectral resolution offers the potential of more accurate land-cover classification (Du, 2009) but we had the high spectral resolution image available only for the year 2000, for that, we had no detailed information available for the land cover classes , so we have to resample, using nearest neighbour method(Mertens et al., 2000) to change the spatial resolution of the landsat 2000 image to the ALOS 2008 (10m), the same spatial resolution of the images were necessary for calculating and for comparison of the areas .

3.2.5. Supervised Classification

Supervised classification of the image ALOS2008 was done in ERDAS software version 9.3 using Maximum Likelihood Classifier. Supervised Classification is one of the very effective technique in identifying complex land cover classes if prior knowledge of the study area exists in terms of good training data (Kuemmerle et al., 2006) to calibrate (train) and validate(test) the classification algorithm (Muchoney et al., 2002), and with maximum likelihood (ML) classifier, classes are built

on the basis of the training data's spectral values and all the unclassified pixels are assigned class based on the relative likelihood (probability) of that pixel (Hagner et al., 2007).

Supervised classification of landsat 2000 was done on the basis of the tone of ALOS 2008 (first four bands of landat were almost similar to that of ALOS as shown in table 1), sketch maps(land use) of the area for 2000 and knowledge of the forest guards(who accompanied with us during field data collection).

Table 1: Bands wavelength of Landsat and ALOS images

Band number	Landsat 5	ALOS
	Wavelength (micrometers)	
Band 1	0.45 - 0.52	0.42 - 0.50
Band 2	0.52 - 0.60	0.52 -0.60
Band 3	0.63 - 0.69	0.61 - 0.69
Band 4	0.76 - 0.90	0.76 - 0.89
Band 5	1.55 - 1.75	-
Band 6	10.40 - 12.50	-
Band 7	2.08 - 2.35	-

Both images i.e. Landsat 2000 and ALOS 2008 were classified into six major land cover classes i.e. Very Dense forest, dense forest, Medium forest, Open forest, Agriculture land and Bare land (For ALOS 2008 image, two extra classes' i.e. Clouds and shadow were also being added)

3.2.6. Accuracy Assessment

In thematic mapping from remotely sensed data, the term accuracy is used typically to express the degree to which the derived image classification agrees with reality (Foody, 2002)

One of the most common methods of accuracy assessment is the use of an error matrix or also called as confusion matrix. An error matrix provides not only a detailed assessment of the agreement between the sampled reference data and the classification results at specific locations, but also a complete description of misclassifications registered to each category. A variety of statistical indices can be calculated based on the matrix to obtain accuracy measurements to meet different needs, including overall accuracy, coefficient, user accuracy, and producer accuracy (Chen et al., 2009)

3.2.7. Quantification of land cover changes per hectare

Classified (supervised) image of 2008 was validated on the basis of the training units whereas the image 2000could not be validated as we had no such training units available for that.

The classified images were converted into polygon, clouds and shadow were assigned as a single class, the polygons were dissolved into the above mentioned six major forest cover classes and then kimuyun and unmanaged forest digitized boundaries (shape files) were clipped from the dissolved maps of 2000 and 2008 to get an estimate of forest cover change of these forests separately (All these functions were performed in ArcGIS software)

3.3. An estimate of Carbon stock value under REDD:

The secondary data was taken from Ph D thesis by (Zahabu, 2008). He has calculated the average annual sequestration rate (5.3 tCO2/ha/year) for "KSUATF" for the period 2004 to 2008 and also assumed this figure for kimuyun forest. So we used the same sequestration rate for kimuyun and unmanaged forest. The mass of dead trunks and belowground biomass may reach 14–34% of total biomass, but is not included here(Treves, 2004)

For both of the managed and unmanaged forest for the year 2000 and 2008, area under forest and net difference in theses areas were calculated using ArcGIS and Microsoft excel software. The percent decrease of unmanaged forest cover was taken as a reference for calculating potential carbon stock for managed forest that has been saved as a result of being getting the status of "managed forest reserve" and the opportunity cost of that saved hectare of forestland was calculated on the basis of minimum and maximum amount per hectare of that carbon stock under the REDD policy.

3.4. Forests uses by local Communities

To know about the current forest uses by local communities and to find the cash values of those uses, stake holders and household interviews were being conducted.

3.4.1. Stakeholder interviews

Stakeholders are the specific people or groups who have a stake, or an interest, in the outcome of the project(Visitask, 2009) and such people are the main key informant of the project activities.

To get general information of the specific issues i.e. status of Kimuyun forest growth and its uses by local communities, semi structured interviews were conducted of the stakeholders as in this method, majority of the questions are created during the interview, allowing both the interviewer and the person being interviewed the flexibility to probe for details or discuss the issues(FAO, 1990).The information got by these interviews were used for the further refinement of the household interviews.

For interview, the following stakeholders were being selected

1. SUA project staff members
2. District catchments officer
3. Regional NRM officer
4. Regional Statistician
5. Village guard/sub village (CCM) executive officer.

3.4.2. Household interviews

A Household is a group of people living together and sharing the same kitchen(Zahabu, 2008). Household's interview (face to face conversation) is one of the more effective forms of survey especially in the area where literacy level of the target population is low. In this method , the interviewer has the opportunity to probe or ask follow-up questions and to collect data on respondents opinion and perception(Trochim, 2006).

The household interviews were conducted using non proportional quota sampling. In quota sampling people are selected no randomly on the basis of some fixed quota where researcher has to specify the minimum number of sampled units that he/she want in each category rather than having numbers that match the proportions in the population.(Trochim, 2006) This method is typically used to assure that smaller groups are adequately represented in the sample(Raymond et al., 2009) on the basis of some specific characteristics(e.g. gender, socioeconomic status etc)(Morrow et al., 2007) where the researcher could perform specific analysis on the basis of these subgroup (Morrow et al., 2007). This method of sampling was adopted as we were interested to get a picture of forest uses on the basis of the wealth categories i.e. who is more dependent on forest and why? as those would be the people who have to lost their uses in the case of REDD policy implementation in the area .

There were three wealth categories found in the village i.e. Poor, Middle and relatively well off on the basis of the nature of the houses(Pagiola et al., 2007; Zahabu, 2008) as shown in fig.4

Well off: Brick houses with corrugated iron sheet

Middle: Corrugated iron sheet

Poor: Thatched grass roof

Figure 7: Households Categorization on the basis of wealth categories

For conducting household interviews, An equal number of sample was taken from each of the three wealth categories (with keeping in view to include female interviews to get gender balanced information), and a total of 30 household interviews were conducted such as

Table 2: No. of samples collected per sub village for Households Interviews

Sub village	Category of Households			Total
	Poor	Middle	Well-Off	
lukwambe	3	2	1	**6**
Schule	1	2	3	**6**
Gazaulole	1	2	3	**6**
CCM	1	3	2	**6**
Karia	4	1	1	**6**
Total	**10**	**10**	**10**	**30**

One of the limitation of the study was that we could not collect equal no. of samples (two samples) per wealth category per sub village due to the fact that middle and poor contribute only 35% and 5%(respectively) of the total household population and those were not equally distributed in the sub villages (villages far away from main road have been rarely found well off household).

The interviews contained both open and closed ended questions covering the following themes

- **Personal / Household information**

Number of Persons per Household and their education, occupation, land ownership, income and expenditure (Per month) etc.

- **Information regarding Livelihood activities(per household)**

Different Means of income, different products collected from managed and unmanaged forest and its equivalent amount in cash, no. of persons per household involved in such collection activities, trend of forest growth over time and reasons for that, role of village committees in forest conservation, and availability, accessibility and affordability of various energy sources in the area.

3.4.3. Analysis of the Household Interviews

The primary data collected from Households interviews were entered into excel to make the quantitative and qualitative analysis of the following

- Households Profile(Education, Occupation, Energy sources in use)and forest Management issues
- Size of land holding (in hectares) per household vs. production per hectares
- No. of trees harvested per Household per year for major uses i.e. For firewood, Charcoal making and the equivalent amount of money saved/earned by this.
- Different crops produced per hectare per household per year and its equivalent amount in cash

The basic aim of these calculations was to find the value of opportunity cost for avoiding deforestation for the study area and also to get general perspective about the people perception for the forest uses in the study area.

3.4.4. Reliability and Validity of Collected data

One way to conduct research is both valid and reliable is to be found in the use of multiple methods and multiple sources of data(Case, 2007). (Cohen et al., 2000)also described that the use of more than one source of data collection which is known as triangulation give more valid and reliable data.

In the research study, to ensure reliability and validity, various sources were used for data collection i.e. in addition to individual household interviews; information was collected not only from district and regional officers but also from village council members and project staff and researcher also tried to keeps on her own observation in the field.

3.5. Limitation of the study

One of the limitations of the study was the unavailability of the recent (2009) cloud free images that could be used for land cover classification and also for baseline (2000image); we couldn’t get any topographic map for forest cover from the district and regional offices.

4. Results

This chapter describes the main findings of research and are presented in 3 sections

- An Analysis of forest cover changes for the Period 2000 to 2009 and the value of existing carbon stock under REDD
- the values of forest uses by local communities
- Comparison of the values (Carbon stock vs. Forest uses)

4.1. Land/Forest Cover Changes

4.1.1. An analysis of forests covers Changes

The Classification of 2000 and 2008 images (of the managed and unmanaged forests) the basis of expert knowledge , land use map and ground observations gave the resultant maps as described below.

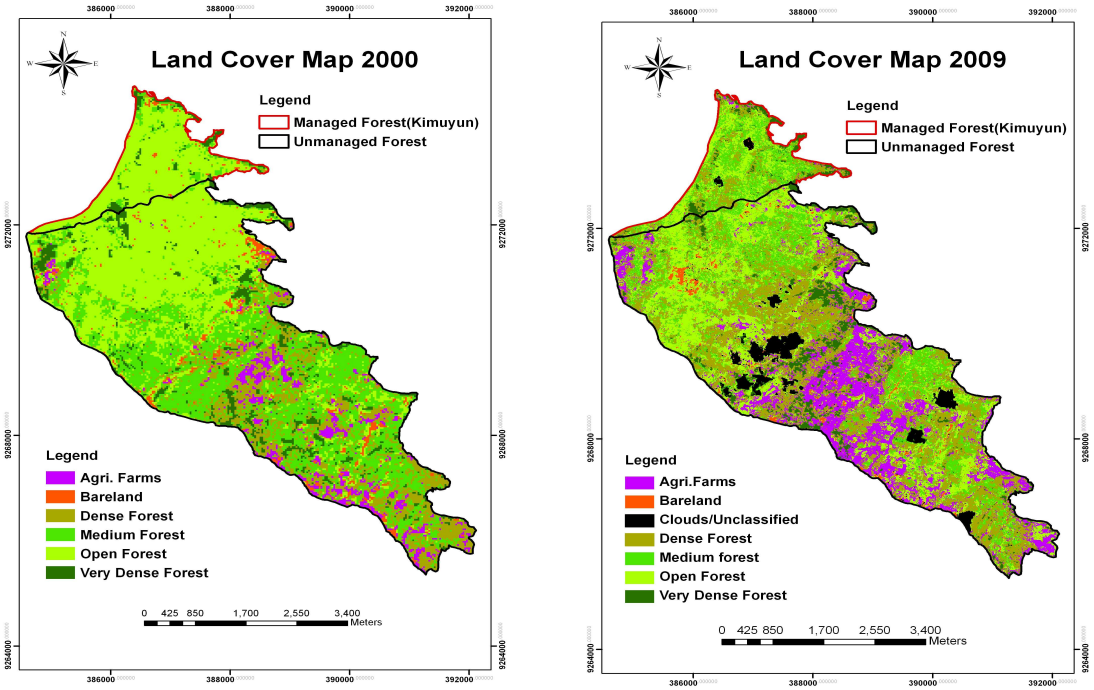


Figure 8: Classified images Landsat 2000 and ALOS 2009 (For more details see Appendix 1)

4.1.2. Kimuyun (Community Managed Forest)

The Forest cover changes at the managed forest "Kimuyun" is shown in classified map (Fig.8) and in table 3, that indicates that from the Period of 2000 to 2009, there has been increase in the area of

dense (2000%), medium (280%) and very dense forest (62%) whereas open forest and agriculture/bare land has been decreased and change to the said classes. The results of this land cover change give the impression that with a passage of time, CBFM has brought a positive impact on the forest cover change. During field visit, although there has been seen some sign of recent/fresh tree harvesting and animal grazing at the "Kimuyun", but still , these were on the smaller scale and controlled due to penalties and laws imposed by the village committee for this forest.

4.1.3. Unmanaged Forest (Village land)

As if the forest remains undisturbed, it grows substantially with the passage of time irrespective of its status of being the managed or unmanaged one, but if , peoples Preference for their land use become "Agricultural Productivity" then we can see the complete deforestation of the forest area . For unmanaged forest, the first case seems true in the case of very dense and dense forest covers that's area has being increased by 22 % and 55 % respectively where open forest has also been grown into dense forest (as shown in Fig. 8 and table 3), But with this we can also see the increase of Agriculture farms by more than 200% when the villagers demanded for the free allocation of land from the unmanaged forest and then they cleared the allotted land for Agriculture purpose

Conclusion:

Overall, the comparison of manages and unmanaged forest indicates that during the Period of 2000-2009, the rate of deforestation and forest degradation was under control at the managed forest whereas it has been accelerated/ increased in the case of unmanaged forest that conclude that management of CBFM was effective for retaining the forest growth.

Table 3: Comparison of Land Cover Changes for the year 2000 and 2009

kimuyun_2000 (Managed Forest)			kimuyun_2008 (Managed Forest)			
Forest_Cov	**Area_ha**	**(2009-2000) Area(%)**	**Frest_Cov**	**Area_ha**	**(2009-2000) Area(%)**	**(2009-2000) %change**
Very Dense Forest	26.8	8.7	Very Dense Forest	43.3	14.1	61.9
Dense Forest	3.0	1.0	Dense Forest	62.5	20.3	1973.3
Medium Forest	27.6	9.0	Medium forest	105.2	34.2	280.8
Open Forest	243.1	79.1	Open Forest	88.1	28.7	-63.7
Agri. Farms/Bareland	6.7	2.2	Agri. Farms/Bareland	4.6	1.5	-31.3
Clouds/Unclassified	0.0	0	Clouds/Unclassified	3.5	1.1	
Area_Total	**307.2**	**100.0**	**Area_Total**	**307.2**	**100.0**	

Unmanaged_2000			Unmanaged_2009			
Forest_Cov	**Area_ha**	**(2009-2000) Area(%)**	**Frest_Cov**	**Area_ha**	**(2009-2000) Area(%)**	**(2009-2000) %change**
Very Dense Forest	141.4	6.5	Very Dense Forest	172.2	8.0	21.8
Dense Forest	391.9	18.1	Dense Forest	606.8	28.1	54.8
Medium Forest	702.2	32.5	Medium Forest	368.9	17.1	-47.5
Open Forest	749.3	34.7	Open Forest	530.8	24.6	-29.2
Agri. Farms	111.9	5.2	Agri. Farms	368.6	17.1	229.6
Bareland	64.4	3.0	Bare land	44.6	2.1	-30.7
Clouds/Unclassified	0.0	0	Clouds/Unclassified	69.1	3.2	
Area Total	**2161.0**	**100.0**	**Area Total**	**2161.0**	**100.0**	

Accuracy Assessment

As the overall accuracy obtained for Classified ALOS 2008 image was 80.56% for the total collected 72 training units.

Table 4: Accuracy Assessment for classified image 2009

ACCURACY TOTALS					
Class Name	**Reference Totals**	**Classified Totals**	**Number Correct**	**Producers Accuracy**	**Users Accuracy**
Very Dense	15	15	15	100.00%	100.00%
Dense forest	17	19	14	82.35%	73.68%
Medium forest	8	8	6	75.00%	75.00%
Open forest	15	17	10	66.67%	58.82%
Farm	9	5	5	55.56%	100.00%
Bare	8	8	8	100.00%	100.00%
Totals	72	72	58		
Overall Classification Accuracy = 80.56%					

4.2. Potential carbon stock at managed forest

Stock difference approach (described in Section 2.2.2) was applied to calculate potential carbon stock at managed forest. It is indicated in table 5 that from the Period 2000 to 2009 , unmanaged forest was decreased more (-15.4%) as compared to managed one(-0.4%), So 15% of the managed forest was calculated that has been saved as a result of being getting the status of “managed forest reserve”, thus 46 hectares of managed forest was the potential carbon stock that could qualify for payment under REDD

Table 5: Potential carbon stock at managed forest

Forest Type	**Area Under Forest(ha), 2000**	**Area Under Forest(ha),2008**	**Net Difference(ha)**	**Net difference (%)**
Kimuyun(Managed)	300.5	299.2	-1.3	-0.4
Unmanaged	1984.7	1678.6	-306.1	-15.4
15.4 percent of Managed forest(300.5ha) = 46.3 ha				

4.3. An Analysis of Households Interviews

4.3.1. General Characteristics of Households

- **Educational Level**

The study (table 6) indicates that, the average size of the Household at Gwata Village is 7. Overall literacy level in the area is very low but however the middle and well off households' categories are better in their educational level as compared to the poor one.

Table 6: Household Profile

Category of Household	Av .Size of Household	Education Level (%)		
		Illiterate to Primary	Secondary	University
Poor	7	99%	1%	0
Middle	6	85%	14	1
Well off	7	84	16	0

- **Livelihood means**

The Study reveals that Agriculture is the main source of income for all of the wealth categories at Gwata Village, but the income earned merely by crop production is not sufficient enough to meet all of their Households expenses, So, they have to be involved in some other jobs/ side businesses as well. The Percentage of households involvement in various livelihood activities is shown if Fig.9, that indicate that the diversity of jobs for middle and well off Households are more than those of the Poor who are only dependent on daily wages, charcoal and bear/brick making. The area (Gwata) reflect the poverty as on average cash income of the well off , Middle and Poor household is US$ 2, US$1 and US$0.15 per day respectively(Zahabu, 2008)

Generally speaking, it can be said that more income of the well off is attributed by their more diversified jobs as compared to the Middle and Poor wealth categories at the Gwata village.

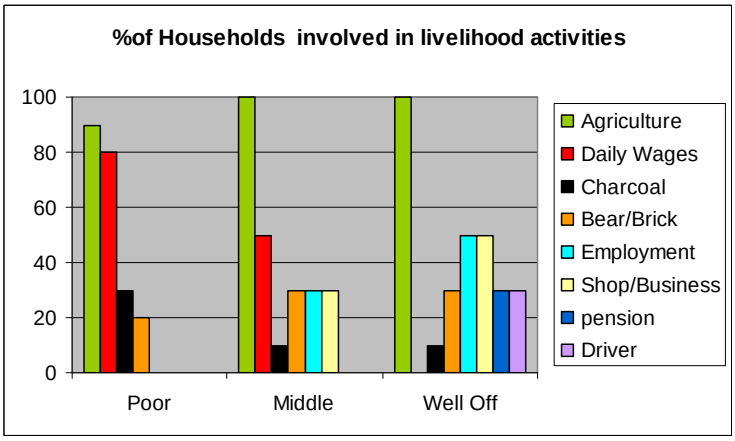


Figure 9: Livelihood means

- **Energy Sources**

The Fig. 10 and 11 indicates various energy sources used by Poor, Middle and Well off households for cooking and lighting purpose at the Gwata village.

The Fig. 10 shows that for cooking, Poor are totally dependent on fire wood, whereas 50% of the middle household use firewood(only) and the remaining 50 % use charcoal as well as firewood for cooking (i.e. sometime use charcoal sometime firewood). The dependency of well off on firewood is less as compared to poor and middle households as 30% of such households use only charcoal for cooking, 30% use charcoal and firewood and only 40% was found to use firewood as the only source for cooking.

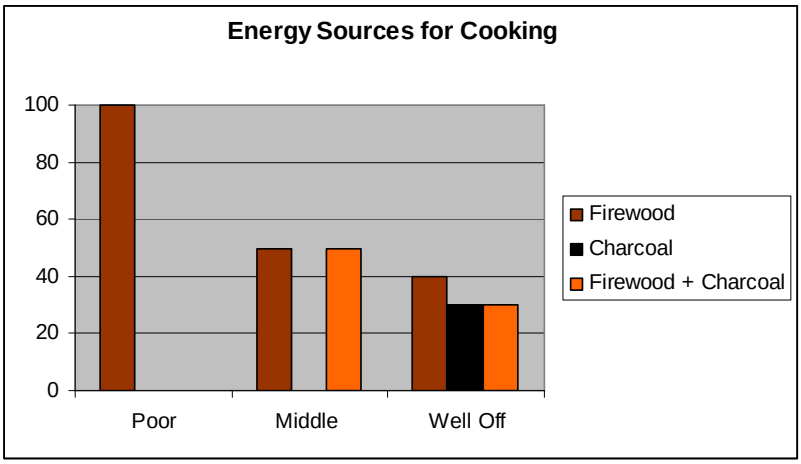


Figure 10: Energy sources

The Fig.11 Indicates that kerosene is the major source of lighting at village Gwata that is used by 100% of the Poor and Middle Households whereas 60 % of the well off use kerosene oil and 40 % use electricity. The facility of electricity was mostly found in the middle and well off Households, that were located near the main road (Dar es Salaam-Morogoro highway) whereas most of the population at Gwata village is deprived of this facility due to scattered nature of settlement.

Overall, kerosene oil was found available and affordable by all of the Household's Categories

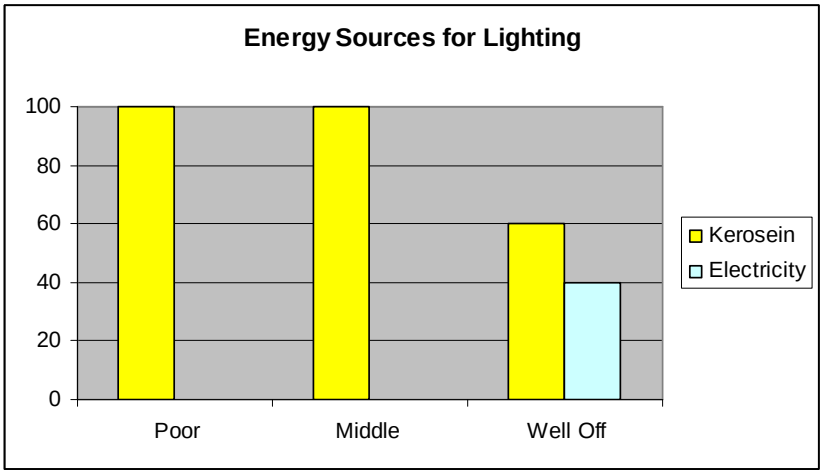


Figure 11: Energy sources

4.3.2. Forest uses by local Communities

Almost all the interviewees responded that they are not using managed forest "Kimuyun" for any purpose. Instead they are taking wood from their own farms or from the farms of other people upon their permission. More than 50 % of the respondents were of the view that the trend of managed forest in their village is increasing due to the village laws that have banned tree harvesting from the managed forest, and those laws are being implemented by the village Committee. For the question that whether village committee is fair in the implementation of those laws? 64 % of the respondents said yes while 23% were of the view that the village committee is not fair as it take money from some people and allow them for illegal tree harvesting at managed forest and also members of the committee don't share information about the funds they receive as a Credit for ban on tree harvesting from the managed forest.

Almost All the interviewed households responded that the trend of unmanaged forest forests in their area is decreasing and the poor are the most users of unmanaged forest. The main reasons for tree harvesting in the area were found as expansion of land for Agriculture purpose, firewood and charcoal making etc.

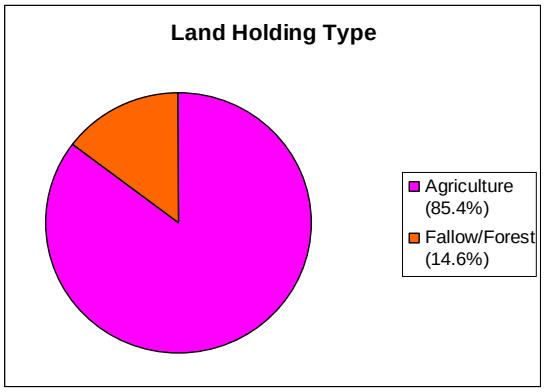
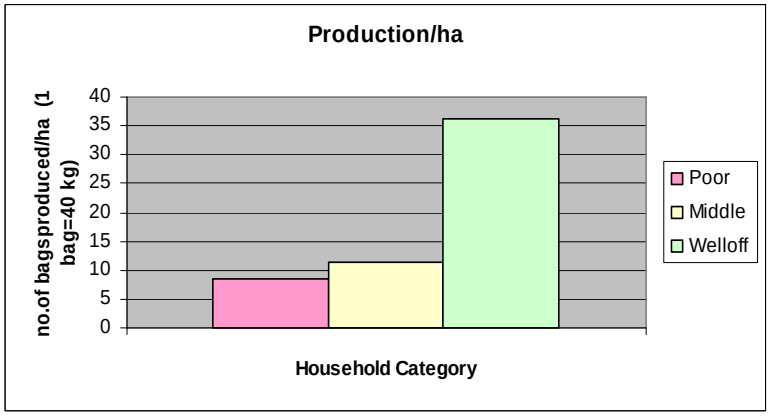


Figure 12: Land Holding Type

The type of existing land holding as shown in pie chart(Fig.12) indicate that communities have replaced 85 % of their land (forestland) by agriculture farms and only at the 15% of their land, there is forest or it is fallow.



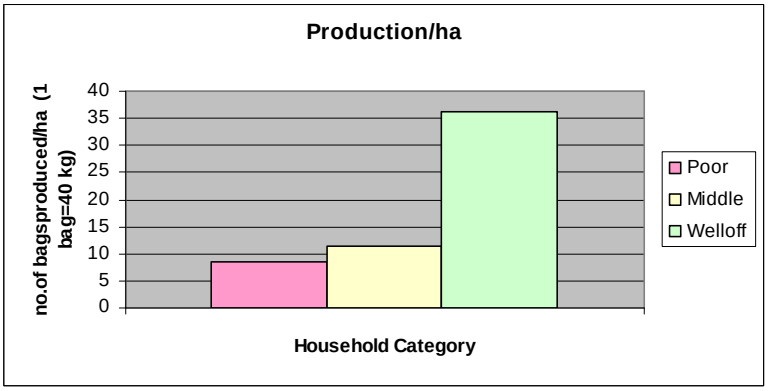


Figure 13: Agriculture Land Holding and Production per hectare

The average size of Agriculture land holding and Production per hectare of that land for all of the three wealth categories at village Gwata is shown in Figure 13. It has been found that although the average size of land holding of the well off and Poor household is 7.4 ha and 7.3 ha respectively, but the production per hectare of the well off household is far better (36.2 bags/ha, where I bag contain 40 kg of crop) than the poor one (8.6 bags/ha). The average size of land holding of the middle wealth category was found as 4.2ha with the production of 11.5 bags per hectare.

In Village Gwata, land from unmanaged forest was being allotted to the Households on the basis of their family size (household with larger family size got comparatively more land). The Productivity per hectare of the well off category was found higher due to the use of good varieties of seed and efficient methods of cultivation (e.g. tractor for ploughing).

4.3.3. Income earned by major forest uses

As it has been stated that the main reason for tree harvesting in the area was found to be expansion of agricultural land, firewood and charcoal making etc. We have calculated the amount of income that each of the household is earning per hectare harvesting of trees for such purposes as described below

- **Agriculture Crops**

The table 7 indicates the average amount of income (or saving) earned by each of the Household as a result of per hectare production of major crops grown in their farmland.

For calculating income per hectare, we found the total income produced by different crops per year and divide it by total area under Agriculture of the sample population. The income by different

agricultural crops per hectare gave the value of about US$72, which is the part of the value of the opportunity cost for local people for avoiding deforestation in the area.

Table 7: Income earned by Agricultural production per hectare

Total Value of Agriculture Crops
Maize =Tsh 12740000(US$ 9521.70) , Where IUS$ = 1338Tsh
Millet =Tsh 2875000 (US$ 2148.73)
Sunflower = 2120000(US$ 1584.46)
Minor Crops (Cassava, vegetables etc)=Tsh300000(US$242.30)
Total Value(US$) = 9521.70+ 2148.73+ 1584.86+ 242.30 = 13497.00
Area under Cultivation = 189 Hectares
Income Per Hectare (Tsh) = 13497/189 = US$71.50

- **Forest Products (firewood, charcoal)**

The Fig.14 indicates the no. of trees harvested per household per year for major uses.

It has been found that most of trees are harvested (123 trees) by Middle wealth category of the households, followed by poor (100 trees) and well off (46trees). The nature of major uses of the harvested trees are different for each of the three wealth categories i.e. Poor harvested trees mostly for firewood (61 tree) and also for charcoal making(38 trees) whereas the middle use the harvested trees mostly for charcoal making(49 trees), followed by bear/brick making(43trees) and for firewood(31 trees). The well off use the harvested tree for firewood (21 trees) as well as for charcoal making (19 trees) and to some extent for bear/brick making (6 trees).

If we compare this result with energy sources used by three wealth categories of Household (Fig.13), we would come to know that although Poor and middle wealth categories cut more trees for charcoal making than the Well off, but they don't use it by themselves, but they rather prefer to sell it in the market to earn money . The percent involvement of middle and well off households in bear/brick making is almost the same(as shown in Fig. 9), but the volume or size of the business of the of middle may be larger, that's why they need to cut more trees than the well off households for making charcoal and bear .

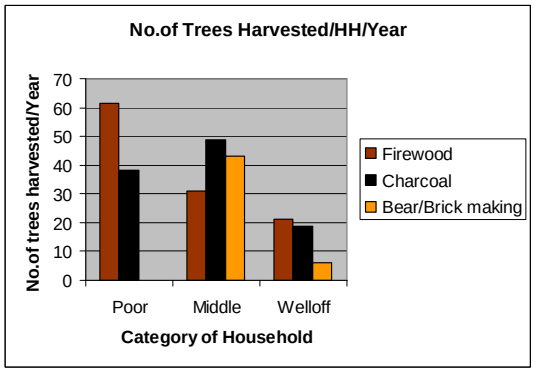


Figure 14 : No. of trees harvested per Household for major uses

The table 8 indicate the amount saved or earned by each of the household for harvesting of trees for major uses.

It has been found that on average, each of the household is cutting 38 trees/year for firewood that's saves their US$51 per year of income if they have to buy this quantity of fuel wood from the market. For charcoal making , an average of 35 trees are harvested per year, but as the market value of charcoal is higher than firewood, so income per hectare per year is found to be higher (US$ 366/=). An average of 22 trees are harvested per year for its use as fuel wood for bear/brick making that saves an equivalent amount of US$22/= Per Household(with the assumption that if they have to buy such quantity of fuel wood from the market for this purpose). Each of these values were obtained by dividing total number of trees harvested for specific use (e.g. for firewood) by sample size (i.e. 30 Households) for a year.

As most of trees for charcoal making is found to be harvested by Middle wealth group of(Fig.14) and the market value of charcoal is higher, So, we can say that Middle wealth category is earning more money by tree harvesting than the others wealth categories at the Gwata Village .

Table 8: Income or saving by cutting of trees for major fuel wood

Income or saving per Household from Fuel wood uses			
	Firewood	**Charcoal**	**Bear/brick making**
No. of trees harvested per Household/year	38	35	16
No. of bundles or no. of bags	38 x 3=114bundles	35 x 2 =70 bags	16 x 3 =48 bundles
Equivalent Amount in Tsh	114xTsh600=68400	70xTsh7000=490000	48xTsh600=28800
Equivalent Amount in US$	**51**	**366**	**22**

Assumptions made:

1 tree = 3 bundles of firewood	Where price of 1 bundle of firewood = Tsh 600/=
1 tree= 2 bags of Charcoal (1 bag=50kg)	Where price of 1 bag of charcoal = Tsh 7000/=
1US$=1338Tsh	

- **Income per Hectare by Charcoal making**

As it has been found in the Household's interviews that no one was using managed forest "Kimuyun" for Charcoal making and for this purpose, they were extracting wood from their farms i.e. unmanaged forest. So, we calculated average income of Household by Charcoal making on the basis of per hectare extraction of wood from the unmanaged forest such as

Total area of Unmanaged forest of Gwata Village = about 5100 hectares
Total Households in Gwata Village = 715
Income calculated per household by charcoal making (table 8) =US$ 366
Income for the whole village = 715 x 366 = US$ 261690
Income per hectare = US$ 261690 / 5100 hectares = US$ 51 per hectare

So, each of the Household at Gwata village is earning US$51 per hectare per year by making charcoal.

4.4. Comparing values of potential carbon stock with income earned by major forest uses

Income earned by Agricultural Crops by each of the Household = US$ 71.50 per hectare

Income earned by charcoal making by each of the Household = US$ 51 per hectare

Total income earned per household per hectare = US$71.50 + US$51= US$123

So, US$ 123 would be the opportunity cost by the local communities of avoiding deforestation.

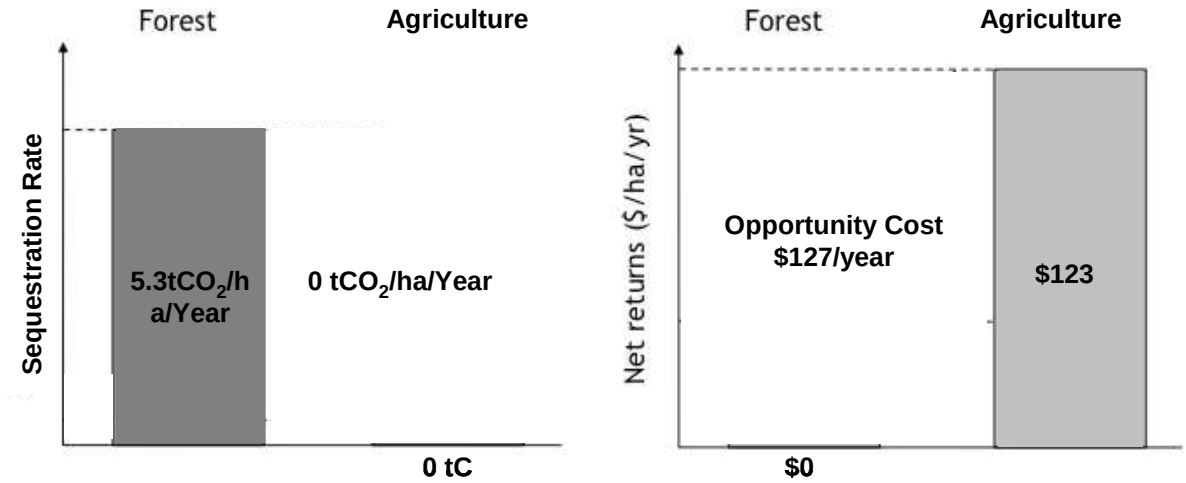


Figure 15: Opportunity cost (adopted from (Pagiola et al., 2009))

Payment under REDD per ton CO_2 is propose to be in the bandwidth of US$5- US$45 (Verplanke, 2009)

<u>The Opportunity cost i.e. US$ 123.00 for avoiding deforestation can be obtained at the market value US$24 per ton CO_2 such that</u>

Value under REDD = average annual sequestration rate * payment under REDD per ton CO_2(Zahabu, 2008)

= 5.3 tCO_2/ha/year* US$24per ton CO_2 = US$ 127 per hectare per year

(The sequestration rate "5.3 tCO_2/ha/year" for managed and unmanaged forest was adopted from (Zahabu, 2008)

Potential Carbon stock (forest area) at managed forest = 46.3 ha (derived in section 4.2)

Value of the Potential carbon stock at managed forest = US$127* 46.3= US$ 5880.00

No. of years for Kimuyun to get the status of "Managed forest reserve" = 9 years (2009 – 2000)

Amount to be Paid = 5880 / 9 = US$ 653 per year

On the basis ofUS$24 per ton CO_2 market value, communities at the Gwata Village would receive US$ 5880.00 for the first year of the REDD policy implementation (here assumed to be as 2009) and as this quantity of carbon stock (46.3ha) has being saved in the managed forest during the period of 9 years, so for the next subsequent years, this amount has been divided by "9" that give amount of US$ 653 per hectare would be received by the communities each year.

5. Discussions

5.1. Land Cover Changes

As to qualify for Payment under REDD, individual CFM Project has to prove that its forest management activities resulted in the control of deforestation and degradation activities as Compared to "business as usual" Scenario (Zahabu, 2008). To find the Potential for Community managed forest "Kimuyun" at Gwata Village, Tanzania, Satellite imagery for the Period 2000 and 2008 was used for land cover mapping (DeFries et al., 2002; Angelsen, 2008) of the "Kimuyun" and the adjacent unmanaged forest (Zahabu, 2008). The images were " Supervised Classified" (Muchoney et al., 2002; Kuemmerle et al., 2006) on the basis of the expert knowledge, ground observation (and also ton of 2009 image was used for 2000 image) and the resultant maps were Compared(Treves, 2004) to detect the land Cover Changes for the Period 2000 and 2009.

The Classified maps of the managed and unmanaged forest showed that with the Passage of time, the forest Cover of the managed forest has been improved as compared to unmanaged forest. Although managed forest "Kimuyun" is under the Supervision of Village Committee and there would be some bylaws available by the said committee for the avoidance of tree harvesting, but none of the interviewee responded that they were not using the "Kimuyun" just because of those laws, but rather, they replied that they have more than enough trees available at their/ nearby farms and it is not feasible for them to go far away to the managed forest just to bring trees for fuel wood and for charcoal making. So, this makes it questionable that whether it is the management of the village committee or it is People's own choice and availability of fuel wood at their farms that limit their movement for using "kimuyun". During field, we have also seen the signs of illegal tree harvesting (as kimuyun has potential tree available for timber use) and animal grazing at the kimuyun, as Security guard rarely do Patrolling due to its voluntarily nature of job . The reason of that illegal tree harvesting was told as via the Permission of the village leaders/ Village Committee for the sake of getting money. But in spite of this illegal tree harvesting, "Kimuyun" regenerated significantly during the Period of 2000-2009 as compared to the unmanaged forest where deforestation has been increased by more than 200% , that means that CBFM has a role in the forest reservation. Improvement in the forest cover of "Kimuyun" was also reported by(Zahabu, 2008).

Potential Carbon stock at "kimuyun" was found by using "Stock difference approach" with the assumption of having the same sequestration rate for both Periods i.e. 2000 and 2009 due to the non availability of the data for 2000. Potential carbon stock calculated by this method gave the value of 46 hectares, this method gave less potential carbon stock as compared with " the Gain –loss approach" that was used by (Zahabu, 2008) for the forest "Kimuyun" where the whole managed forest was assumed to be eligible for Payment under REDD. It means that the value of Potential carbon stock vary greatly on the basis of the approach used (Pagiola et al., 2009), although "stock-difference approach" is in line with the current focus of the UNFCCC (Angelsen, 2008) as it show the efficiency of a forest in terms of difference in carbon stock accumulation at two moments of time, but this approach has also some lacking as described below.

- As many Countries do not have reliable data available for past carbon stock and deforestation rate (Angelsen, 2008).The use of "Stock difference approach" for calculating Potential Carbon stock become less effective if the data for the past is missing. In our study, although the managed forest "Kimuyun" showed increase in forest carbon stock in 2009 as compared to 2000 but as we had no sequestration rate or carbon stock (data) available for the year 2000. So, we have to use the same sequestration rate for the both periods, which decrease the efficiency and purpose for using of this method.

- Under the "business as usual" Scenario, "Stock difference approach" gave only 46.3 hectares of Potential carbon stock that could qualify for Payment under REDD, this carbon stock would be considered for first year of Payment and for the next subsequent years, the communities would be able to receive money for only 5 hectares of carbon stock(as this amount of carbon stock has being accumulated during the period of nine years (2009-2000), So the potential carbon stock and its subsequent payment became very less if compared with "Gain-Loss approach" where the payment is supposed to be made for the whole area under managed forest. Payment for the whole area under managed forest using the "Stock difference approach" would be only possible if the referenced "business as usual scenario" i.e. unmanaged forest has become fully deforested in 2009 as compared to its forest cover in 2000. So under this method, either the communities would receive less credit for their managed forest or they have to choose that reference scenario that has become fully Cleared from forest trees as also mentioned by (Angelsen, 2008)

5.2. Opoortunity Cost

Opportunity cost at the study area was estimated on the basis of concept developed by (Pagiola et al., 2009) to compare the benefits generated by forests in an area with the non forest land in the same area. For this purpose, Household's interviews were conducted using non proportional quota sampling (Morrow et al., 2007; Raymond et al., 2009) to get the estimate of various forest uses by local Communities. The results of the Households interviews indicated that low level of education and less means for income make the People more dependent on forest uses. So they are clearing their allocated farmland (unmanaged forest) for agricultural purpose (Crop Production) and use the subsequent cut tress for charcoal making, and also, trees were being harvested mainly for charcoal making. Due to the non availability of cheaper energy sources for cooking, the trend of tree harvesting for firewood was also very common in the area (Cropper et al., 1994; Zahabu, 2008). On average, Each of the Household was earning US$123 in the form of agricultural crops and/or charcoal making from per hectare conversion or tree harvesting of the unmanaged forest for theses purposes, this amount could be obtained with a market value under REDD of US$24 per ton CO_2. Boucher's 2008 Calculated Opportunity Cost of US$2.22/t$CO_2$ for Africa, US$2.37/t$CO_2$ for America and US$2.90/tCO2 for Asia. Opportunity cost is often very different from the perspective of individual groups and that of the country or of the continent as a whole and it also vary greatly on the basis of the following factors (Pagiola et al., 2009).The opportunity Cost for "kimuyun" calculated by (Zahabu, 2008) gave the value of US$632/hectare where the value of charcoal is only estimated for this purpose. This value is much higher than the value found in the Present study i.e US$124per hectare where income from agricultural crops and charcoal was being estimated. The difference in value is due to the estimating no. of tree used per hectare for charcoal making. He assumed 136trees/hectare (assumed all trees per

hectare suitable for charcoal making and used conversion factor i.e $1m^3$ of wood yields 2.6 bags of about 53kg of charcoal plus including of labour cost as US$3 per bag) where as in this study, we have only considered the trees having 11-20 cm dbh as small (<11 cm dbh) trees are usually left for growth, and on the basis of information collected households interviews that an average size tree can produce 2 bags(50 kg per bag) of charcoal. We also did not consider labour charges per bag while computing the money.

- **Net vs. Gross value of Agricultural crops**

  The value of estimation of opportunity cost for agriculture depends on whether gross value (value of crop) is taken into account or the net income (out put value-input cost) is calculated. It is a common practice to consider the gross value but it overstates opportunity cost therefore the net value gives the real figure of the income earned by the agricultural productivity.

  For Calculating Opportunity Cost at Gwata Village, We consider gross values of agricultural Productivity and income from Charcoal making (Common Practice), which may have overstated this Value.

- **Spatial Detail**

Opportunity costs are likely to vary significantly from place to place, depending on both agro ecological conditions (for example, soil type, slope, and climate) and socioeconomic conditions (for example, distance to markets, availability of labour). So, it would be difficult to compare opportunity cost for two regions having different conditions and also, opportunity cost calculated at a small scale may mislead if it is being assumed for the whole region. The highest level of spatial detail could reduce this problem. So, the Opportunity Cost as obtained for the Gwata village with a market value of US$24per ton CO_2, Preferably should not be assumed for the whole region.

- **Variation Over time**

Opportunity Cost may vary over time. Land cleared for forest may initially be very productive but gradually became less Productive if the same crop is grown regularly and not left fallow to regenerate or switched to another use. In such cases, yield may change over time and even if yield is not changed, then value may change over time due to change in input and output Prices. It may also Possible that construction of road may also bring substantial impact on both input and out put prices. So, a single snap view of cost and benefits would be misleading.

In Gwata village, there has been drought from the last few years and the land is rained. We have only estimated the value of crops grown for the Period (2008-2009); it may possible that communities could get less or more income in the next subsequent years from their crops that may affect market value of US$24 per ton CO_2 as found in this study.

5.3. Potential for PES (e.g. REDD)

As it has been stated earlier that the Opportunity Cost of US$ 123 for avoiding deforestation can be obtained at a market value under REDD of US$ 24 per ton CO_2 that gave US$5880.00 for the first year of REDD implementation(here it was assumed as 2009) and about US$ 653.00 per year for the next subsequent years. As the value of US$24 per ton CO_2 is within the range of the market value under REDD (US$5 per ton CO_2 - 45 per ton CO_2). So, we can say at value equals or greater than US$24 per ton CO_2, there is Potential for PES (REDD) to be implemented or accepted at the Gawata Village.

Though at Present, Communities are not getting any benefit from the managed forest “Kimuyun”, the amount US$653 per year as credit for “Kimuyun” seems to be attractive for them as this would be the amount of money for which they have to lost nothing and the Perception of local communities for forest reservation in the form of “Kimuyun” was also Positive(found in Households interviews) due to the prevailing drought condition in their area (that affect their agricultural production badly) which they correlated with increased level of tree harvesting, So, there is more chances that REDD has being accepted and adopted by the local communities. After the REDD being implemented, it may possible that there has been demand by local communities to bring more area under managed forest to get more credit under REDD, but this would be only possible when the terms and conditions for payment under REDD would be found so convenient by the local communities that they may Prefer to get credit under REDD than growing crops and making charcoal from the same piece of land.

6. Conclusions and Recommendations

Conclusion

On the basis of the methods applied to conduct this study, it can be concluded that community based forest "Kimuyun" has Potential carbon stock available to qualify for PES (REDD) as its stock has Considerably been increased with the Passage of time when compared it with unmanaged forest (that is the pre requisite of any CBFM Project to qualify for REDD Program).On the other hand, the Opportunity Cost Calculated for avoiding deforestation in the Gwata Village gave an estimated value of US$123.00 per hectare, that could be achieved at a market value under REDD of US$24 per ton CO_2 . The bandwidth of market value of Carbon under REDD is US$5 per ton CO_2 - 45 per ton CO_2. As the estimated value for Carbon at "Kimuyun" (US$24 per ton CO_2) falls under the bandwidth value of REDD. So, we can say that there is Potential for CBFM "Kimuyun" to qualify for PES under the Perspective of REDD Policy and in the Case of "Kimuyun" where the Communities do not take any benefit from this forest, So, if the REDD has being implemented in the area, Communities would have to lost nothing in terms of forest uses, So, our null hypothesis is rejected which stated that the "values of lost functions or uses are higher than the amount of compensation in Community based forest".

Recommendations

The study would be improved if the following were to be applied / followed

- In addition to the above ground biomass , the estimate of belowground biomass, litter ,dead wood and soil organic carbon could gave a higher carbon stock that could be calculated for payment under REDD as the secondary data taken by (Zahabu, 2008)was only calculated on the basis of above ground carbon stock.

- We have no data available to compare sequestration rate (or carbon stock) with forest density classes. Further research is required that match density classes to different stock increases.

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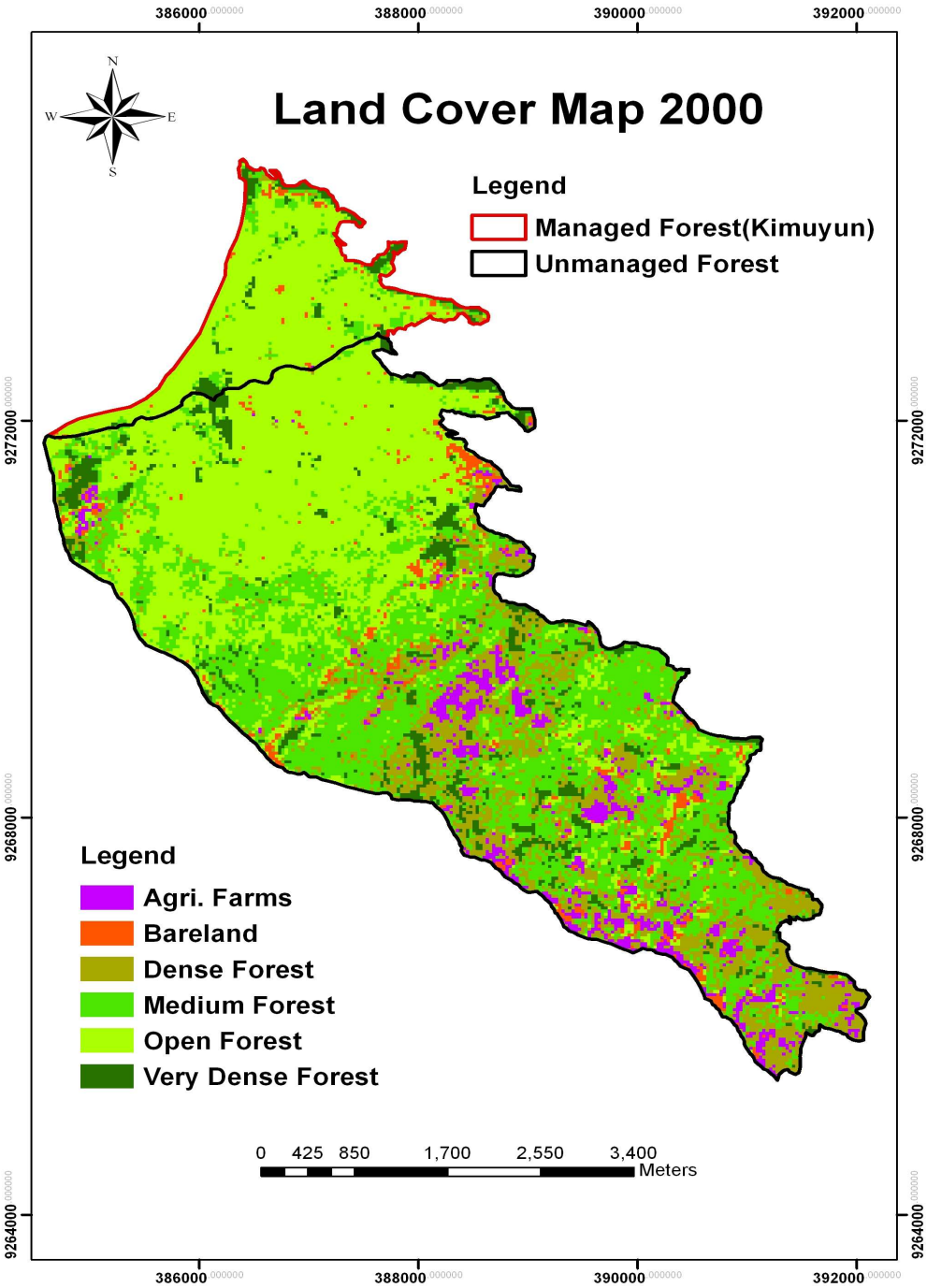
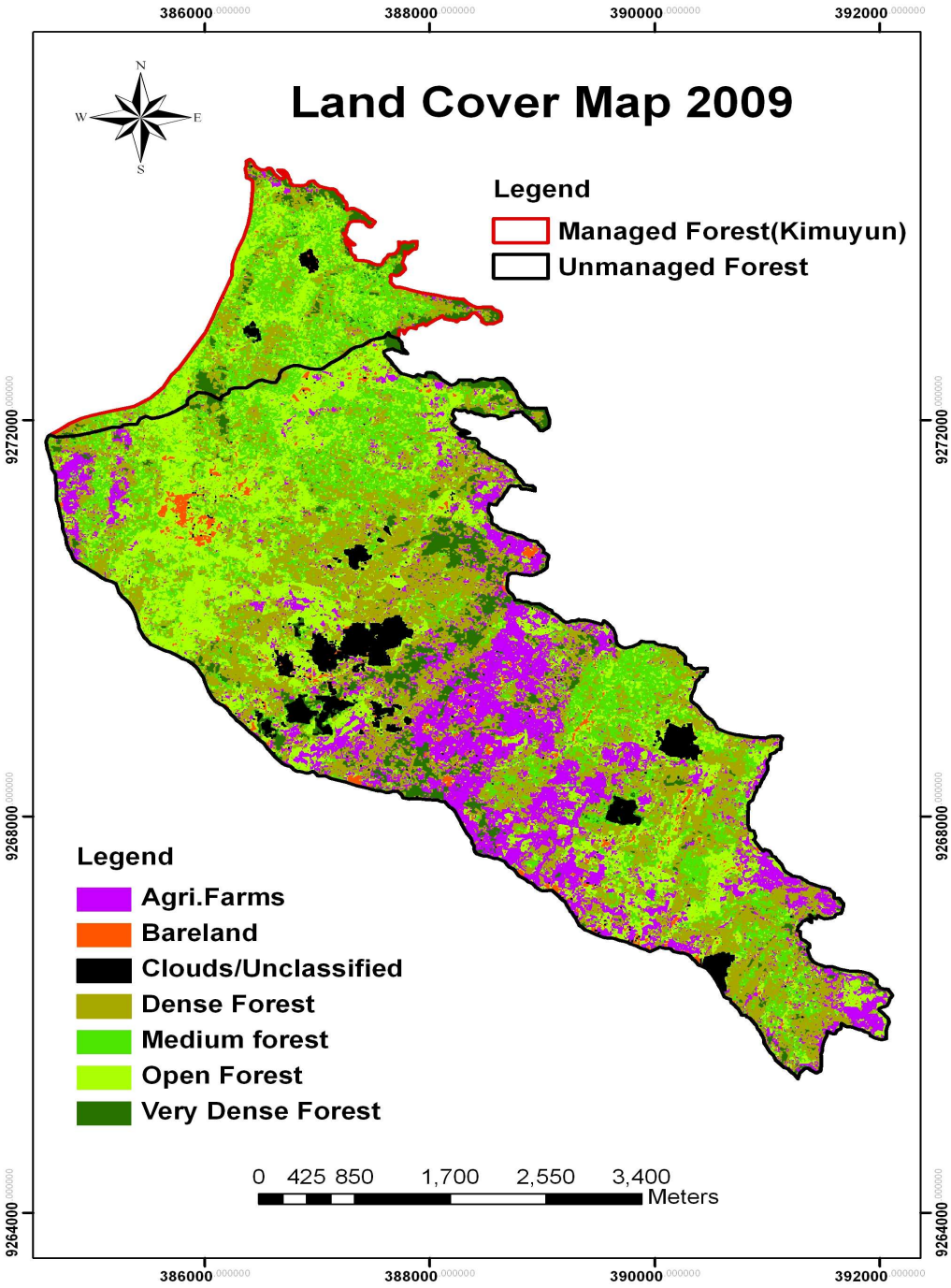
Appendix

1. Land Covers Maps




Land Cover Map 2009
N
W
E
S
Legend
Managed Forest(Kimuyun)
Unmanaged Forest
Legend
Agri.Farms
Bareland
Clouds/Unclassified
Dense Forest
Medium forest
Open Forest
Very Dense Forest
0 425 850 1,700 2,550 3,400
Meters
386000
388000
390000
392000
9272000
9268000
9264000

2. Household Questionnaire for the village ------, District Morogoro

Questionnaire no….
Category of HH: P, M, W

Part A: Personal/Household Information

1) Name of respondent……

2) **Household Profile**

	0-15		15-45		> 45	
	Male	Female	Male	Female	Male	Female
No. of Household members						
Education level						
Daily Activities /Occupation						

3)Do you have any land holding? Yes..... No.....

4)If Yes, could you please tell us the size of land holding (in ha) under each of the following category.
Agri……, Fallow……, Forestry……, Other ……

5) Income per Household by non forest activities (per month or per season)
i) Agri. Land a)Agri. Production(quantity of crops for own use)……..,
quantity of crops to sell……(amount in cash)……
b) by other use ----------
ii)Livestock/products (own use)----------,
to sell …….. (equivalent amount in cash)…….
ii) Daily Wages----------
iii) other----------
iv)other ----------

6)What is your household total expenditure per month ? ….....

7)Is the above mentioned income is sufficient enough to fulfill your expenses? Yes....., No.....

8)If Not, then by which sources then you meet your expenses?
Source Amount
1)

2)
3)
25) From Which forest do you get forest products?
a) CBFM b) un-managed forest c) both

10)if Yes, for what purpose

11) Do you know about the importance of forest Yes No
12)If yes, what are these?

13) What is the trend of the size of Forest in your area?(CBF, and Open forest)
a) Constant
b)Increasing
c)Decreasing

14) If the size of forest is decreasing, what are possible reasons for this?
a) Settlement
b)Livestock grazing
c)Wild fires
d)Cultivation
e)Charcoal making
f)Firewood collecting
g)other, specify: …….

14)Who are the most user of forest in your area

15)Why they need to use that?

18) Are there local by-laws used in your area to manage the forests?

19) How do the current by laws helped in managing forest in your village?

23)Do you know which forests you have open access and which forest is CBFM? Yes No

24)If Yes, how did you get this information?

26)Why you/ people need/prefer to use the managed forests.

27)If they are found to do so, then they are fined for this? Yes No

28)If No, why?

29)Do you know who are responsible to manage the forests in your areas?

30)What do you think they are fair in their duties? No Yes

31)If not , reason for this

32)Is all villagers are equally benefited from CBFM? Yes No

33)If No why

34) Dou you know about tax/permit for wood extraction from forest?
Yes No

35)If yes, then you pay it ? Yes No

36)Is it economical/affordable for you/people? Yes No

37)Reason for your answer

38) What benefits do you get from CBFM

	Food items	Non Food items(wood extraction for)				
Benefits	Fruits, Vegetables, Mushroom, Honey etc	For fire wood	For Timber	For Charcoal	For Building Poles	Other

no. of HH members involved						
Quantity drawn/month or year						
Species most preferred						
Availability 1)Plenty 2)Fair 3)Very low						
Quantity for own use						
Equivalent amount in Tsh						
Quantity to sell						
Mode of marketing*() i,ii,iii,iv)						
Marketing cost in Tsh						
Net amount earn by selling/month						

*() Mode of Marketing/Where the products are sold

i) at nearby market ii) at far away area/market

iii) Dealer visit to collect the products iv) other…..

39)How many bags of charcoal is prepared by this amount of wood? .....

Is wood extraction for charcoal making is on season basis?

40)Type of benefits by un managed forest(if any)

	Food items	Non Food items(wood extraction for)				
Benefits	Fruits, Vegetables, Mushroom, Honey etc	fire wood	Timber	Charcoal	Building poles	Other
no. of HH members involved						
Quantity drawn/month						
Species most preferred						

Availability 1)Plenty 2)Fair 3)Very low						
Quantity for own use						
Equivalent amount in Tsh						
Quantity to sell						
Mode of marketing(*Q9 I,ii,iii,iv)						
Marketing cost in Tsh						
Net amount earn by selling/month						

43)What suggestion would you like to give for better forest conservation in your village?

44)What are the following energy sources do you use?

Purpose to use	**Energy sources**						
Cooking	Fire wood	Charcoal	Crop residue	Animal dung	Parrafin/Kerosein	Electricity	Other
Preparing local bear							
Warming							
Lighting							
Other							
Easily Availability(Yes,No)							
Affordability(Yes/No)							
Amount spent per month							

3. Households Responses , District Morogoro

Do You Use Forest (Managed)?		If no, why?	
Yes	No	Has own farms/or collect wood from surroundings	Buy Charcoal
10% (For Medicinal Plants only)	90%	93%	7%

Trend of Forest of	Increasing	Decreasing	Constant	Don't know
Kimuyun?	67%	7%	3%	23%
Unmanaged forest?	0	97%	0	3%

Response given by	Who is the most user of forest ?						
	Poor	Middle	Well off	Immigrants	All Categories	Don't know	Rich &Poor
Poor	8				1	1	
Middle	8			1			1
Well off	7	1			1		1

Are there by laws in your area to manage forest?

Yes & followed	No	Don't know	Yes, but not followed
87(%)	0	3%	10%

How you to get Information about these laws?

Village Committee	other
97%	3%

Is Village Committee fair in their duties?

Yes	No	Don't know
64%	23%	13%

Importance of forest?

Source of rain/water(wood)	biodiversity	don't know
90%	3%	7 %