INFLUENCE OF FORESTLAND TENURE REGIMES ON FOREST CONDITION AND COMMUNITY LIVELIHOODS IN THE ULUGURU MOUNTAINS, TANZANIA

BY

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ABSTRACT

Uluguru Mountains are dominated by different forestland tenure regimes, but is not known which one has more positive influence on forest condition and community livelihoods. This study was conducted with the objective of assessing their influence on forest condition and community livelihoods. Data were collected through forest inventory, participatory rural appraisal and questionnaire survey. Microsoft excel was used to analyse inventory data. Livelihoods data were analyzed using Statistical Package for Social Sciences. The study showed that for the montane vegetation, state regime (Uluguru Nature Reserve) had higher stocking (volume 1233m^3/ha; basal area 78m^2/ha; density 777 stems/ha) compared to communal regime (Chief Kingalu Sacred Forest) with volume 798m^3/ha; basal area 49m^2/ha; density 1020 stems/ha. For the miombo vegetation, corporate/private (Tangeni Roman Catholic Church Forest Reserve) had higher stocking (volume 122m^3/ha; basal area 27m^2/ha and density 2573 stems/ha) compared to communal regime (Misumba Village Forest Reserve) with volume 23m^3/ha; basal area 10.8m^2/ha and density 4200 stems/ha. The most prominent tenure regime with regard to contribution to livelihoods capitals was the state. Financial capital as the surrogate livelihoods indicator was enabled or constrained by a number of socio-economic and institutional factors. Enabling socio-economic factors included market demand, hunger duration and household size whereas constraining socio-economic factors included education level, distance from homestead to the forest, land size and sex of head of household. Enabling institutional factor was rule violation. Constraining institutional factors included prohibition from entering the forest and forestland tenure insecurity. The study concludes that, state regime has successfully improved forest condition and livelihoods compared to other tenure regimes. It recommends that forest inventory should be conducted at predetermined intervals together with insuring tenure security and initiation of alternative source of income to the local people.

DECLARATION

I, Mariam Mohamed Kitula, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and that it has not been submitted for any degree award at any other university.

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DEDICATION

This work is dedicated to the family of the late Mr. Mohamed Kitula for their tireless encouragement throughout my study.

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LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
CARE	Career Assistance and Resources for Development
CBFM	Community Based Forest Management
CFR	Catchment Forest Reserve
CEDAW	Convention on the Elimination of All Forms of Discrimination Against Women
CKSFR	Chief Kingalu Sacred Forest
DANIDA	Danish international Development Agency
DAWASA	Dar es Salaam Water and Sewage Authority
DBH	Diameter at Breast Height
DFID	Department for International Development
FAO	Food and Agriculture Organization of the United Nations
FBD	Forestry and Beekeeping Division
FGD	Focus Group Discussion
GPS	Global Positioning System
H’	Shannon Winner Index of Species Diversity
Ha	Hectare
HIV	Human Immunity Virus
ID	Index of Dominance
JFM	Joint Forest Management
MNRT	Ministry of Natural Resources and Tourism
MOROWASA	Morogoro -Water and Sewage Authority
MVFR	Misumba Village Forest Reserve
NEAP	National Environmental Action Plan
NGOs	Non-Governmental Organizations

NORAD	Norwegian Agency for International Development
NS/ha	Number of Stem per Hectare
NTFP	Non Timber Forest Products
NWFP	Non-Wood Forest Products
P	Probability Level
PFM	Participatory Forest Management
PRA	Participatory Rural Appraisal
R^2	Coefficient of Determination
S.E	Standard Error
SLF	Sustainable Livelihood Framework
SPSS	Statistical Package for Social Sciences
TAFORI	Tanzania Forestry Research Institute
TRCCFR	Tangeni Roman Catholic Church Forest Reserve
UMADEP	Uluguru Mountains Agriculture Development Programme
UNR	Uluguru Nature Reserve
URT	United Republic of Tanzania
VNRC	Village Natural Resource Committee
WCST	Wildlife Conservation Society of Tanzania
WRI	World Resource Institute
β	Beta
χ^2	Chi Square

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Communities living adjacent to forests need ownership and guaranteed access to land as a basic asset to ensure food security as well as reduce unemployment and poverty (Shackleton, 2004). The forests offer numerous benefits to adjacent communities and society at large (Kaiza-Boshe *et al*., 1998). Such benefits include consumptive resources, spiritual and aesthetic needs, employment, and ecological services such as carbon sequestration and water provision. In spite of the importance of the forests to the country, they continue undergoing modification through anthropogenic activities including clearance of trees for cultivation, commercial charcoal production, fuel wood collection, rampant bush fires and harvesting of building poles (Monela, 1995; Luoga *et al*., 2000, 2006; Malimbwi *et al*., 2005). The high rate of anthropogenic activities gives a great concern with respect to maintenance of forest biodiversity. Deforestation is increasing in Tanzania resulting in decline of species diversity and erosion of the genetic base (Zahabu, 2001). It is estimated that deforestation has reduced the forest cover down to 38% (1999) from 44% (1971) due to the combined impact of widespread poverty, dependency on subsistence agriculture and wood-based energy (URT, 1998; FAO, 2001).

Much of the Tanzania's forest resource consists of dry miombo woodlands which cover 67% of the total forest area, mountain and coastal forests account for around 5% of the total forest area and contain most of the biodiversity values (URT, 2009). About 29% of the forest resource is protected, much of which being located on steep slopes, retained for water catchment purposes and control soil erosion. The remaining productive forests are managed mainly for fuel and timber production (URT, 2006). There are 80 000 ha of

plantations, primarily of *Pinus patula* and *Cupressus lusitanica*. National Parks comprise around 6% of the total forest area. In total Tanzania has about 34.3 million hectares covered by forest (FAO, 2010)

In Tanzania, management of forest resources was a monopoly of government through Forestry and Beekeeping Division. Experiences in the country have shown that centralized "top down" management is only effective with large expenditure on enforcement. This has led to formulation of new Forest Policy (URT, 1998) and forest 14 of 2002 with fundamental shift in favour of involvement of local communities in the management, a concept referred to as Participatory Forest Management (PFM). With these changes the management of forest resources is increasingly becoming the right and duty of local people. PFM operates as Joint Forest Management (JFM) and Community Based Forest Management (CBFM). Participatory forest management is principally a common property regime (Kajembe and Kessy, 2000). Currently PFM cover a total area of 4.1 million ha and it is operating in over 2475 villages. About 1457 villages are under CBFM and 1018 villages are under JFM (URT, 2008).

1.2 Problem Statement and Study Justification

In 1998, the Tanzania government reviewed its 1963 forest policy and adopted new forest policy whose objectives were rehabilitation and maintenance of forest resources and improving livelihoods of forests dependant communities (URT, 1998). One among the strategies adopted was devolution of management and ownership of forestland where by community and private sectors were empowered. However, it is widely recognized that insecure tenure rights, such as overlapping or conflicting claims, unfairness in the allocation of rights, or lack of recognition and acknowledgement of customary ownership, are major obstacles facing sustainable management of forest resources (Brokaw, 2006;

Paundel, 2007, Katani, 2010). Many studies have been done to assess different tenure regimes and resource base in the Uluguru Mountains (Burgess *et al*., 1998; URT, 2009). However, it is not known which forestland tenure regime has more positive influence on forest condition and community livelihoods in Uluguru Mountains. This study assessed the influence of forestland tenure regimes on forest condition and Community livelihoods. The results formed a basis for suggesting the best tenure regimes which leads to sustainable forest condition and livelihoods in Uluguru Mountains.

1.3 Objectives

1.3.1 Overall objective

The overall objective of this study was to assess the influence of forestland tenure regimes on forest condition and community livelihoods in Uluguru Mountains.

1.3.2 Specific objectives

The specific objectives of the study were:

i) To assess and compare the influence of different forestland tenure regimes on forest stock, tree species diversity and regeneration

ii) To assess and compare the influence of different forestland tenure regimes on community livelihoods

iii) To identify and assess socio-economic and institutional factors which enable or constrain the ability of the local communities to generate income from forest resources under different tenure regimes.

1.4 Research Questions

i. How do different forestland tenure regimes influence forest stock, tree species diversity and regeneration?

ii. Which forestland tenure regime has the highest significance influence on the forest stock, tree species diversity and regeneration?

iii. What livelihood capital has the highest significance influence to the local people?

iv. What are the socio-economic and institutional factors that facilitate the ability of local communities to generate income from forest resources?

v. What are the socio-economic and institutional factors that constrain ability of local communities to generate income from forest resources?

1.5 Limitations of the Study

The study faced the limitations of inaccessibility, traditional barrier and unwillingness to give information by some respondents.

1.5.1 Inaccessibility

The topographic nature of the study site was mountainous, that was an obstacle during forest inventory and livelihood data collection. Some forests and hamlets were not accessible by car. Nevertheless, walking long distances on the steep slopes solved this problem.

1.5.2 Traditional barrier

Traditions in the Chief Kingalu sacred forest do not allow outsiders to enter the forest in the absence of the Chief and traditional healers. This situation attributed to delays in data collection. In this study traditional healers were temporarily hired to assist in carrying out forest inventory in the sacred forest.

1.5.3 Unwillingness to give information

The researcher observed that most of respondents found it difficult to disclose estimates of their household annual income obtained from sale of forest products. The plausible reason could be rooted in the perception that the researcher was carrying out a study to identify the vulnerable households so that they may be supported. To overcome this problem, household annual incomes were estimated based on market values and making the respondents understand clearly the objective of the research.

1.6 Conceptual Framework

Uluguru Mountains is dominated by different forestland tenure regimes including Communal regime (Misumba Village Forest Reserve and Chief Kingalu Sacred Forest Reserve), State regime (Uluguru Nature Reserves) and Corporate/private regime (Tangeni Roman Catholic Church Forest Reserve). These tenure regimes consist of different institutional arrangements which are expected to have different influence on forest condition in terms of tree stock, diversity and regeneration as well as community livelihoods. Moreover, ability of the local communities to deliver income from forest resources as the surrogate livelihood indicator was expected to be facilitated or constrained by some socio economic and institutional factors. Figure 1 summarizes the conceptual framework underlying this study.

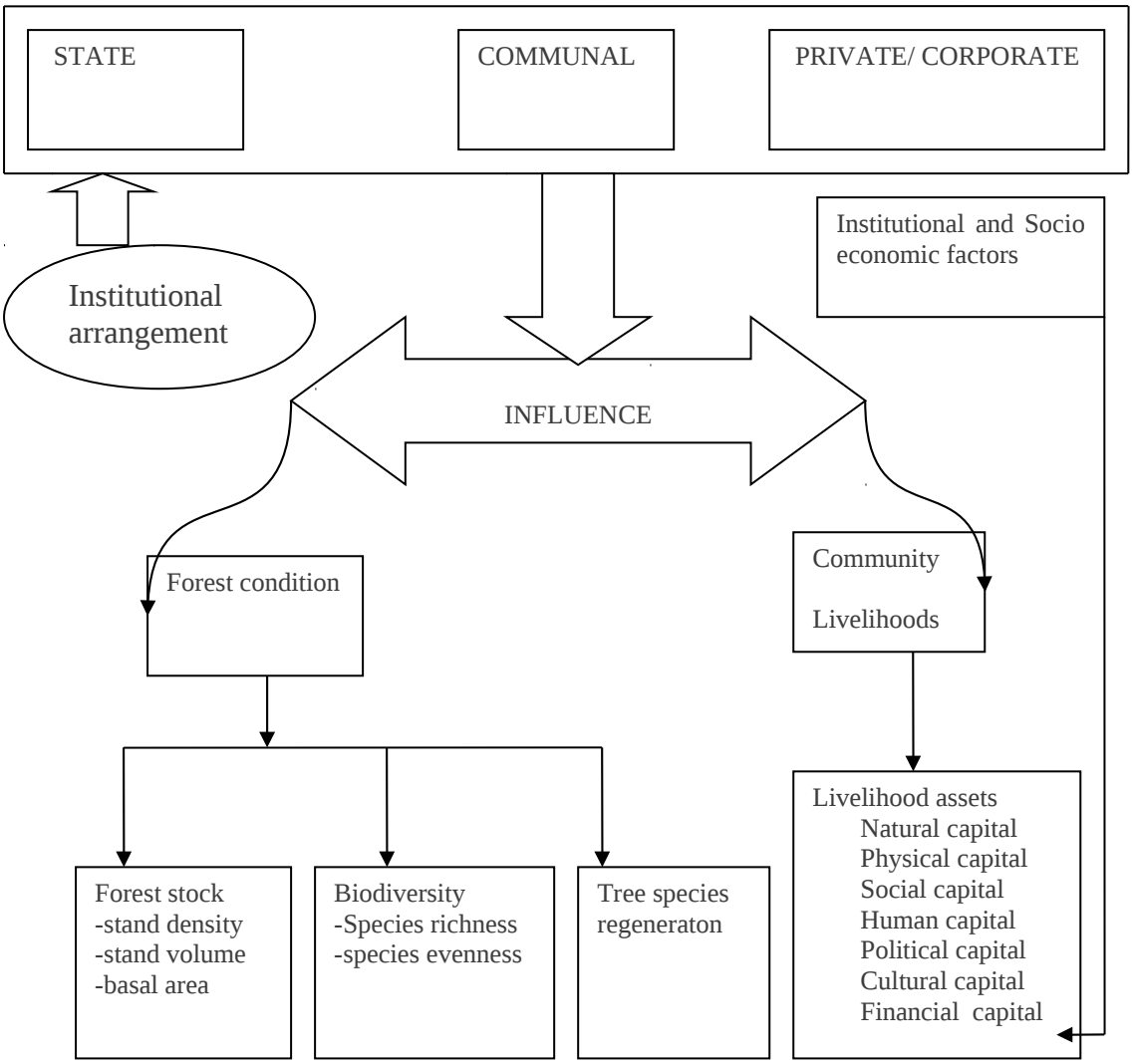

Figure 1: Conceptual framework underlying the study.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Land Tenure Systems in Tanzania

Land tenure is one of the principal factors affecting the ways in which forest resources are managed and the manner in which benefits are shared. Mwase *et al*. (2007) argued that land tenure insecurity results in a number of environmental problems including forest degradation and deforestation. The legal basis for land tenure in Tanzania is derived from two basic laws that were passed in 1999 namely the Land Act No. 4 of 1999 and the Village Land Act No. 5 of 1999 which state that all land in Tanzania is public land, which the President holds in trust for all citizens. The President delegates the power to designate, adjudicate and modify land tenure status to the Commissioner for Lands. District and Village Councils play an important role in managing land at the local level. These two laws have the overall objective of formalizing and legalizing traditional and customary land tenure arrangements. Tanzania recognizes three categories of land namely reserved, village and general land.

2.1.1 Reserved land

The reserved land refers to land set aside by central government for purposes of nature conservation including wildlife and forest reserves, national parks, Ngorongoro conservation area, marine parks and reserves, town and country planning, high way, and public recreation grounds (URT, 1999). The management of these specific areas is governed by specific laws, for example forest by Forest Act No 14 of 2002.

2.1.2 Village land

Village land includes all land within the boundaries of villages, of which there are more than 10 500 villages in Tanzania (Akida and Blomley, 2007). Village Councils and Assemblies are given powers to manage this land. The Village Land Act No 5 of 1999 (URT, 1999) allows village governments to enter into agreements with enterprises that provide wellbeing for the villagers. Village Councils are required to divide village lands into three categories: communal land, which is shared by a large number of individuals within the village and may include grazing, pastures, forests or other areas with natural resources; occupied land, which is used for housing, cultivation and businesses, and managed by individuals or families; and future land, which is set aside for future use by individuals of the community.

2.1.3 General land

General land refers to all public land, which is not reserved land or gazetted (URT, 1999). This type of land category is managed by the Commissioner of Lands, on behalf of the central government. The term public land is used interchangeably with general land, while in Tanzania all land is public and general land is part and parcel of it, which is a non demarcated public land. Lack of administration of the general land by the government has made it to be considered as open access land (Katani, 2010).

2.2 The Concept of Forestland Tenure

Forest tenure is a broad concept that includes ownership, tenancy, access, acquisition, partition and other arrangements for the use of forests by individuals, groups or state (Bruce, 1986; Reeb and Romano, 2006). Forest tenure is the combination of legally or customarily defined forest ownership rights and arrangements for the management and use of forest resources (Reeb and Romano, 2006). Statutory tenure systems are applied by

governments and are codified in state laws whereas customary tenure systems are determined at the local level and are often based on oral agreements (Hatcher and Bailey, 2009). According to FAO (2006) forest tenure determines who can use what resources, for how long, and under what conditions. It is increasingly being recognized that forest tenure plays a fundamental role in determining the fate of the world's forests (Hatcher and Bailey, 2009)

2.3 Types of Forest Tenure Systems in Tanzania

It is increasingly being recognized that forest tenure plays a fundamental role in determining the fate of the global forests (Hatcher and Bailey, 2009). Forest tenure is a basic building block of economic growth, social cohesion, personal well-being and environmental protection (Mwase *et al.,* 2007). Based on the type of legal ownership and the level of formal and informal control of and access to resources, four types of forestland tenure systems exist in Tanzania (URT, 1998). These include state forests (central and local forest reserves), general land forests, community/village forests and private forests.

2.3.1 State forests

In state forests the government retains most of the management responsibility either through exclusive control, or by granting limited user rights over the forests. The rights include noncommercial use rights, customary rights, and permits to hunt or gather dead wood and Non-Wood Forest Products (NWFPs). User rights are usually given to local people to satisfy their needs for forest products without commercialization by the users. They may or may not be regulated to the civilian through licenses and permits (URT, 2002).

The state forests entail the central and local government gazetted forest reserves. The central government forests are also known as national forest reserves owned and managed by central government through the Forestry and Beekeeping Division (FBD). They are either protection forest reserves (managed for conservation purposes including biodiversity or water catchment) or production forests (including natural and plantation forests, which are harvested for timber, fuelwood and other purposes). On the other hand, local government forest reserves are gazetted forests managed by district council for production and protection purposes. They are regarded as major sources of district revenues from charcoal and timber extraction (URT, 2002). However state forests of the Uluguru Mountains have the history of poor management and heavy exploitation from both legal and illegal logging, rampart fire, increasing agriculture and population pressure (Mitinje *et al.*, 2007)

2.3.2 Forests in general land

Forests on general land (or general land forests) are neither reserved nor gazetted. These areas constitute 51% of all Tanzania's forest land, and cover a total of 17.7 million ha (URT, 1998). They are open-access and are characterized by insecure land tenure, shifting cultivation, and harvesting for fuelwood, poles and timber. They are under heavy pressure from conversion to other competing land uses, such as agriculture, livestock grazing, settlements and industrial development, as well as from wildfires. The rate of deforestation in Tanzania is estimated at 420 000 ha/year and most of affected areas are in general land (FAO, 2006).

2.3.3 Village land forest reserves

The village land forest reserves occur on village land (URT, 2002). According to Akida and Blomley (2007) village land forest reserves in Tanzania cover a total area of slightly

more than 2 million ha. They are managed by the village council for both production and protection purposes, depending on their location, size and composition (URT, 2002). About 1457 villages are managing their village forest reserves through CBFM and 1018 villages are under JFM arrangements (URT, 2008). On the other hand, the village council may delegate forest management to a group of people within the community such as a women's group or a group of charcoal producers, timber operators or beekeepers. In such cases, the owner/manager is not the whole village but a sub-group or a sub-village (Reeb and Romano, 2006).

There is a wide variety of traditional, customary, clan or sacred forests that are managed at the community level for various reasons. Sacred forests are protected for burial sites, worship or religious purposes, while traditional forests are used for local consumption, for example, to provide dry-season grazing areas for pastoralists or local supplies of forest produce (Akida and Blomley, 2007). Both these types of forests are usually well protected. Rather than using formal institutions such as village councils, sacred and traditional forests are often governed by clan or village elders, and protected by local beliefs or superstition. They are often vary in size and highly fragmented. A study in the North Pare Mountains in northern Tanzania identified 290 clan (sacred) forests, locally called "mshitu" or "mpungi", covering a total area of 370 hectares (Lutatenekwa, 2009). In the Uluguru Mountains sacred forest also exist including Chief Kingalu Sacred Forest and Ugulo under the Wanyani clan used intensively for worshiping and offering sacrifice during the natural hazards (Mitinje *et al.,* 2007).

2.3.4 Private forests

The private forests are of two main kinds. The first is small-scale production of trees on private land, usually as part of an agricultural system. These forests may be the result of

agroforestry or more commonly the establishment of small woodlots ranging between 0.25 and 3 ha in size (Akida and Blomley, 2007). Efforts to establish woodlots by individuals are significant, especially in Iringa region, where shortages of wood have encouraged farmers to plant woodlots and establish nurseries. These woodlots consist mainly of pines and eucalyptus, which are sold locally for timber and poles. In Tanga region, Muheza district, small plots of teak (*Tectona grandis*) are common features. Unfortunately, there is no information on the total forest area under individual ownership. The total contribution of individual woodlots, including agroforestry systems, to household income and poverty alleviation are not known. The second type of private forestry involves large-scale private forestry enterprises obtaining leases on either village or general land for the purpose of planting trees. In this category, forests cover a total of 60,931 ha. Plantation forest are established for a range of purposes but mainly for timber are produced for a range of purposes, but mainly for timber, poles or wattle bark.

2.4 Relationship between Forestland Tenure and Underlying Institutions

Forestland tenure systems are static; the institutions which operationalise the tenure systems make them dynamic. Institutions under different forestland tenure regimes are sets of rules and regulations that constrain and motivate stakeholders to interact with ecosystems to ensure equity and sustainability of forest resources use, production, exchange and consumption (Smajgl and Laison, 2006). These include laws, polices, social ethics, mores, and values that define use, ownership and control of forest resources (Brokaw, 2006). Institutions under different tenure systems determine the performance, efficiency of natural resources management. However, various forms of tenure institutions can create a complex pattern of rights and other interests which can lead to conflict, particularly where, for example, state ownership is statutorily declared and state grants or leases have been made without consultation with existing customary owners. This clash of

de jure and *de facto* rights often lead to great uncertainties as to who has, or should have, the control over which forest resources. Moreover, several factors including socio-economic and political environment may affect the performance a particular type of forest tenure (Balint *et al*., 2002).

2.5 Forestland Tenure Systems versus Multiple Interest in Forest Management

Forestland tenure is an important part of social, political and economic structures. It is multi-dimensional, bringing into play social, technical, economic, institutional, legal and political aspects that are often ignored but must be taken into account (Ellis and Freeman, 2007). Moreover, different tenure systems are characterized by different interest towards forest resources use which complicates management and cooperation at landscape and watershed scales. Forestland tenure relationships may be well-defined and enforceable in a formal court of law or through customary structures in a community. Alternatively, they may be relatively poorly defined with ambiguities open to exploitation because they constitute with a web of intersecting interest. These include:

- Overriding interests: when a sovereign power (e.g. a nation or community) has the powers to allocate or reallocate forestland through expropriation
- Overlapping interests: when several parties are allocated different rights to the same parcel of forestland (e.g. one party may have lease rights, another may have a right of way)
- Complementary interests: when different parties share the same interest in the same parcel of forestland (e.g. when members of a community share common rights to cut timber, etc.)
- Competing interests: when different parties contest the same interests in the same parcel of forestland (e.g. when two parties independently claim rights to exclusive use of a parcel of forest land to collect non timber forest products)

In practice, multiple interests in the management of forest resources can be held by several different persons or groups. Different interests to the same parcel of forestland can complicate the whole process of managing the resources consequently deterioration of forest stock (Bruce, 2006). Lyamuya, *et al*. (1994) argued that existence of a web of intersecting interest of the different tenure regimes in the management of forest resources in Uluguru Mountains is an obstacle towards sustainable forest management.

2.6 Influence of Forestland Tenure Systems on Livelihoods

The term livelihoods have been extensively defined among academicians. Livelihoods are defined as the activities, the assets, and the accesses that jointly determine the living gained of the community (Ellis and Freeman, 2007). Livelihoods are also defined as a matter of ownership and circulation of information, the management of social relationships, the affirmation of personal significance and more than just a matter of finding or making shelter, transacting money, and preparing food to put on the table or exchange in the market place (Wallman, 1984). The most widely accepted definition of livelihoods is the activities, assets, capabilities and strategies required and employed in satisfying fundamental needs (Montoya and Drews, 2006). Livelihoods are thus ways of living for poverty alleviation, and not only ways of making a living. One feature that these definitions and interpretation share in common is that they eloquently underline the generally accepted idea that livelihood deals with people, their resources and what they do with these. Livelihoods essentially revolve around resources including; forest, land, crops, seed, labour, knowledge, livestock, money, and social relationships (Chambers and Conway, 1992). Likewise in Uluguru Mountains forest and land are the main livelihood assets of the residing communities (URT, 2009)

The liquidation of forest assets has a profound impact on communities that rely on the forest for food and economic development (Monela *et al.*, 2000a). Tenure system resulting from land conversion can lead to change in community capitals including financial, social, cultural, human, political and natural capitals (Ellis and Freeman, 2007). For example, indigenous populations may have traditionally used specific natural forest lands, but forest frontier settlers may end up with tenure rights after these lands are converted. In other cases, reallocation of timber rights may enable industrial concessionaires to pre-empt local forest users. Unclear or conflicting tenure status may add even more confusion to already complex management authority and overlapping jurisdiction for the management or government oversight. Therefore, livelihood assets cannot be disconnected from the issues of vulnerability which includes problems of access and changing political, economic, socio-cultural and natural circumstances.

2.6.1 Vulnerability

Vulnerability refers to trends, shocks and seasonality that people generally have little or no control and has adverse effects on their livelihoods (DFID, 2001). On creating and embracing new opportunities for the purpose of gaining a livelihood, people may, at the same time, have to cope with risks and uncertainties, such as erratic rainfall, diminishing resources, pressure on the land, changing life cycles and kinship networks, epidemics such as HIV/AIDS, chaotic markets, increasing food prices, inflation, and national and international competition. These uncertainties, together with new emerging opportunities, influence how material and social resources are managed and used, and on the choices people make to alleviate poverty (Batterbury, 2001). In this context, any forest or tree resources that the poor can freely access will inevitably form a critical part of their lives. The primary role of forests in the lives of the poor is thus as a “safety net” – one of many strategies to avoid falling into destitution (Shimizu, 2006). Therefore it is vital to

understand the context of sustainable livelihoods frameworks, of which livelihoods dynamic operate.

2.6.2 Sustainable livelihoods framework

Sustainable Livelihoods Framework (SLF) as shown in Figure 2 provides a way of thinking about the linkages between the context, vulnerability, and access to natural resources (Baumann, 2006). The framework is useful for looking at the contribution of forests/trees to people's livelihoods as well as for enabling an understanding of rights, access and the influences in broader context (Shimizu, 2006). SLF view people as operating in a context of vulnerability. It examines how different people pursue a range and combination of livelihood strategies given particular context, combination of assets and set of opportunities and constraints presented by institutional structures and processes (Shimizu, 2006). The asset heptagon includes seven assets which through structures and processes may be transformed into livelihood outcomes as (Montoya and Drews, 2006).

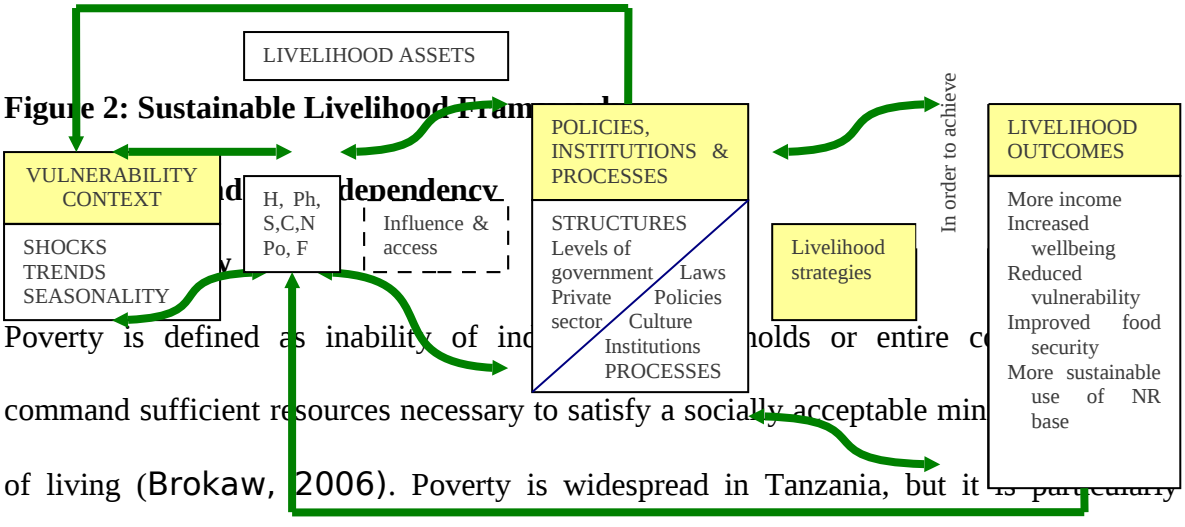

Figure 2: Sustainable Livelihood Fram

dependency

Poverty is defined as inability of ind holds or entire c command sufficient resources necessary to satisfy a socially acceptable min of living (Brokaw, 2006). Poverty is widespread in Tanzania, but it is particularly

Key:
H: Human capital N: Natural capital
Ph: Physical capital Po: Political capital
S: Social capital F: Financial capital
C: Cultural capital

About 88% of the estimated 17 million poor people in ess *et al.*, 2002). According to the World Bank, in 2002,

90% of the World's 1.1 billion people are those living on less than $1 per day depended on forests for at least some part of their income.

Forests provide a wide range of goods and services which are important to the livelihoods of adjacent communities (Monela *et al*., 2000a). Forests contribute to people's livelihoods in a variety of ways. In the context of sustainable livelihood frame work the role of forests to livelihoods of the rural poor is conceptualized in terms of (i) financial capital, (ii) physical capital, (iii) social capital, (iv) cultural capital, (v) human capital, (vi) political capital and, (vii) natural capital.

2.6.4 Livelihood capitals

2.6.4.1 Financial capital

Financial capital is the debt capital, investment capital, tax revenue, savings, grant funds, and all financial tools that can be used by communities as the value of exchange (Florian, 2009). The bulk of the household livelihood in Tanzania is met by forestry-related employment (Paavola, 2004). Rural people living adjacent to forests are engaged in collection of and/or trade in forest goods. Numerous forest resources such as fruits, honey, mushrooms, meat, poles, timber and charcoal are traded for generating household cash income, which may then be deployed towards other household needs. On the other hand, forests products are collected and used by local communities adjacent to forests to meet daily needs for energy, shelter, food and medicine which allow the scarce cash resources to be used to secure other household needs and to attempt to accumulate the necessary asset base for a more secure livelihood. This includes among others education of children, investment in agricultural tools and, capital for income generation activities. This shows that the engagement in forest activities has contributed to raising incomes of local communities adjacent to the forests, thus enhancing financial capital (Luoga *et al.*, 2000).

Mitinje *et al.*, (2007) emphasized that communities living close to Uluguru Mountains use forest products to meet their daily requirement and to supplement their income.

2.6.4.2 Physical capital

The development of infrastructure is one of the major roles that the forest has played in enhancing livelihoods of the people. Availability of forest resources which are important economically has contributed to the improvement of roads, school buildings and health facilities in communities living adjacent to the forests. In addition, communities have invested a lot in terms of labour in construction of village government offices by using poles from the forests. In most cases, the village government offices are also used by the village forest conservation groups, and this represents some of the instruments used to satisfy specific needs in the community. Similarly, the provision of cheap building materials is one of the contributions of the forest resources to the livelihoods of rural poor. Poles are collected freely by the communities living adjacent to the forests for the construction of houses and fences (animal and farm fences). Fencing is done around homestead for protection against theft, unwanted animals, safeguarding livestock, provision of privacy and demarcating boundaries. This suggests that forests are important in providing cheap and reliable source of building poles to the surrounding communities (Luoga *et al*., 2000).

2.6.4.3 Social capital

Social capital is mutual trust, norms of reciprocity, collective identity, and a sense of working together toward a shared future. In communities, social capital is divided into two types namely bonding social capital and bridging social capital. Bonding social capital refers to multiple linkages that encourage trust and enforce norms. Bridging social capital refers to single-purpose linkages (Kremer1 and Florian, 2004).

Since the current forest tenure reforms transferred management responsibilities to the local groups, it has promoted various community based institutions, thus enhancing social capital. The local people have formed various groups including forest management groups, and their networks have built alliances with other civil organizations and coordinated with local government for development activities. Many of these groups are linked with national networks. Moreover, they have established functional coordination with the local government for building synergy in various development activities. As a result, the local forest management groups have become windows for development activities, conflicts resolving mechanisms, including peace building and democratizing the society (Maxwell and Weiber, 1998).

2.6.4.4 Cultural capital

Cultural capital refers to the values and beliefs that have both economic and noneconomic implications. Cultural capital is the filter through which people interpret their lives and the world. It is transmitted to subsequent generations and is part of socialization of new residents in the community. The use of sacred forests in performing traditional rituals and medicinal plants for disease treatments is associated with the contribution of forest to the cultural capital. Communities and households identify and reserve certain sacred sites within forests for performing traditional rituals. These include spiritual sites identified by leaders and diviners centuries ago and are now either taboo, or used for specific ceremonies, as well as grave-sites of past relatives and leaders. Damage or destruction of these sacred sites means that (i) the ancestors would be homeless and, (ii) culture would be dead. No human activity is allowed to be conducted in these sacred areas. The areas are respected by all and this contributes to environmental conservation (Kajembe and Kessy, 2000).

Medicinal plants are used to overcome personal difficulties, to be safe from enemies, and to obtain personal favour for oneself and their families and in some situations as curses. Plants also provide important medicines for crop diseases and thus are important for maintaining agricultural crop production and hence improve food security. Other resources also have explicit cultural significance, including wood-piles, and use of certain fuel wood species only for specific rituals and ceremonies. Products from some animals (like elephant dung) are used to make traditional medicines. People can keep a bit of elephant dung at the household for emergency child diseases like malaria associated with shivering (Kitula, 2001).

2.6.4.5 Human capital

Human capital includes our formal education and education picked up through time; skills; health; values; and leadership (Florian, 2009). Promoting forest based income generating activities by using locally available materials is coupled with strengthening capacity of men and women in technical matters, thus enhancing human capital. The study conducted by Kanel (2006) revealed that through series of trainings, workshops, exposure visits and interactive dialogue with external actors including government officials the community gained confidence, skills to articulate their interests and concerns and skills for public leadership in Nepal. They also learnt several aspects of technical management such as record keeping, preparation of operational plans and various forest management activities. Ownership of small income generating activities by using forest based materials increases and contributes significantly to household income and, at the same time, improving technical skills and confidence. For example, palm leaves, serge and grasses are used for making mats, ropes, hats, food covers, fans, ornaments, brooms and grain silos. These products are usually marketed for household cash income (Tuxill and Nabhan, 1998).

2.6.4.6 Political capital

Political capital' is defined as the ability to use power in support of political or economic positions to enhance livelihoods; it refers to both the legitimate distribution of rights and power as well as the illicit operation of power which generally frustrate efforts by the poor to access and defend entitlements and use them to build up capital assets (Baumann and Sinha, 2001). Examples of the illicit use of political capital are relations among village elites, local officials and elected representatives.

Political capital is an essential link between local communities and forest management officers: It can be built up by drawing on other assets such as financial and human, can help in deploying assets to maximum effect. Lack of political capital for the villagers in Konkitunda India was an obstacle to make their livelihoods more secure and sustainable following decentralization policy in forest management. Political power is crucial for them to convert rights and assets into livelihoods objectives. Such relations, and the institutions on which they are based, form the locus of political strategies. Sustainable livelihood analysis must therefore consider options and choices not merely as institutional and technical matters, but also as political ones (Farrington *et al*., 1999).

2.6.4.7 Natural capital

Natural capital is the natural resource stocks from which goods and services useful for livelihoods are derived. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity to divisible assets used directly for production such as trees and land (Dfid, 1999). Activities to maintain, restore and improve the integrity of forest resources, the purity of water and scenic beauty, or the conservation of biodiversity are associated in enhancing natural

capital. Watershed protection, aesthetic value, nutrient storage and soil erosion control are, for example, an important natural asset for the communities (Tuxill and Nabhan, 1998). The study conducted in Kapkwai settlement on the impact of change of status of Mount Elgon forest reserve on livelihoods revealed good forest condition with diverse of natural resources including wood, food, lumber, poles, medicine and water sustain livelihoods of about 70% of the residing community (Gosalamang *et al.*, 2004).

Uluguru mountain forests are important for watershed protections. Water is essential compound for life. It is used for domestic and metabolic activities. Tree species found in or along water sources helps to protect water source from direct sunrays. Furthermore, Uluguru Mountains have gorgeous aesthetic value common to all the forests enjoyed by majority of the villagers and attract tourist internationally. Some use it as meditation sites during period of mental stress. Nutrient storage and soil erosion control are also important services from Uluguru Mountains. Soil fertility is brought by decomposition of organic matter, which helps to bind soil particles together. Also, trees acts as windbreak hence protect soil from wind erosion. Trees roots were also reported to protect soil from water erosion (URT, 2009). This in turn increases fertility in the forest and forest land becomes productive (Paavour, 2004).

2.6.4.8 Interdependency between livelihood capitals

These seven livelihood capitals are not ends in themselves, but rather, lead to a healthy ecosystem, vital economy, and social equity. Forms of livelihood capitals can also be converted, or invested, into other forms of capitals. For example, human capital can increase the social capital of a community, which in turn can increase financial or physical capital. Social capital and financial capital can increase the natural capital of a community. Therefore, livelihood capitals are interdependent to one another. Sustainability in

livelihood context means that investing in any form of capital does not mean depleting any other form (Kremer1 and Florian, 2004).

2.7 Socio-Economic and Institutional Factors Influencing Local Communities Income from Forest Resources

Forests are important natural assets for the livelihood of the rural people, the wood from the forest trees are intensively used by the rural people for heating and cooking purposes as well as for building and repairing houses while the forest land is used as pastures for livestock (Kajembe *et al.*, 2004a). However forest trees in rural areas are also used for income generation (Shahbaz, 2009). But ability of the forest to dispose income to the local community depends on a variety of factors ranging from socio-economic to institutional

2.7.1 Socio-economic factors

A successful and sustainable management system for forest resources relies on many factors. According to Pradhan (2006) socio-economic factors are very important in determining contribution to household income from forest resources under different forest tenure regimes. Socio-economic factors that may enable or constraint contribution of Forest resources to livelihoods of the local communities include: Market demand, household size, gender, education status, and distance from homestead to the forest, cultivated land size and hunger periods.

2.7.1.1 Household size

In African context a household is unit made up of not necessarily husband, wife and children but there are polygamous and extended families (Mbeyale, 2009). According to Poate and Daplin (1998) a household is defined as a group of people who eat from a common pot, share a dwelling house and have a unit of command from the head of

household, who is the main decision maker. Therefore, household determines per capita collection and utilization of forest products for subsistence. According to Mayeta (2004), the number of members in the household has an important implication for demand of forest products as a source of income and food. A large number imply more mouths to feed and more people to share household budget (Njana, 2008). Similarly Over exploitation of forest resources and environmental degradation in Uluguru Mountains have been claimed to be rooted by high population growth (Mitinje *et al.*, 2007).

2.7.1.2 Market demand

Market demand is defined as the total amount of products purchased within a specified geographic location (Shackleton, 2004). Kessy and Kingazi (2009) defined market demand of forest resources as a function of the quantities buyers are willing and able to purchase, which depends on the amount of capital they have at their disposal and signal of scarcity in local, national and international market for particular forest product. Reliable market demand of forest products contributes to the wellbeing of rural household by enabling them to sell forest products. Population growth, accessibility and proximity to market are important factors which determine ability of local communities to sell forest resources (Shackleton, 2004). The study conducted by Malimbwi *et al.* (2004) on charcoal supply in Dar es salaam city revealed that high population, well developed infrastructure network which have linked the city to different parts of the county have increased market demand of charcoal from the Coast, Morogoro and Tanga regions. Similarly reliable market demand and good networking have hastened local communities extraction of forest resource from Uluguru Mountains (Ponte and Daplin, 1998). Njuguna and Ongugo (2004) elucidated that high demand of forest resources have been associated by population growth and good infrastructure in urban centres of Kenya. Therefore assessing market demand is one of the most important ways that explains local communities' dependence on forest resources.

2.7.1.3 Gender

Gender refers to the socially constructed roles and relations between men and women (DRIF, 2001). According to Wilde and Mattila (1995) gender is a cultural construct related to the behavior learned by men and women. It affects what they do and how they do within a specific social setting. The word gender is not similar to sex, however sometimes is used interchangeably with sex. Sex refers to biological characteristics which define humans as female or male (DRIF, 2001). 'Gender relations' are characterized by unequal power that assigns specific entitlements and responsibilities to men and women. Mitinje *et al* (2007) revealed that in Uluguru Mountains, the primary players in the collection, processing, and marketing of edible wild plants from forest are women. Men are mainly responsible for construction timber, poles and charcoal. It shows that men are involved more in high-value activities compared to women. Despite the fact that many governments have ratified international gender instruments such as Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), gender inequality persists. This has implications for women's capacity to benefit from extraction of forest resources. But gender roles vary, in Madagascar poor women earned 37% of their income from forest products, compared to 22% earned by men. In Andhra Pradesh, 77% of women's income is derived from forests (FAO, 2009).

2.7.1.4 Distance from homestead to the forest

Distance is the leading factor for local communities' ability to generate income from forest resources. Closer distance of the households to forest makes the forest more venerable to extraction of resources due to low transport cost. Lutatenekwa (2009) observed that, in North Pare longer distance from the sacred forest increased extraction cost of forest resources hence reduced the ability of local community dependency on forests. Profit from

the enterprise depends on the hauling cost of the commodities which is a function of distance at any particular place. Communities located much close to forests probably have large chance to collect more resources than those located at a distance. McGregor (1995) in his study conducted in Shirungwi, Zimbabwe cited by Njana (2008) noted that, rising scarcities of woodland resource caused by increase in distance to woodland forest resources. As a result, households tended to shift their consumption of once depended woodland forest resource to alternatives which could offer similar use. However proximity to Uluguru Mountain has been observed to have no significant influence on extraction of forest resources since 92% of the residing population depend on forest resources for subsistence (Burgess, *et al.*, 2002).)

2.7.1.5 Hunger periods

Forests are characterized by fluctuating weather following global climate change, thus communities living in and adjacent become vulnerable through occasional hunger periods as a result of rain shortage or dynamics (Paavola, 2004). Longer hunger periods facilitate more dependency on forest resources as a source of income and food. Most preferred business that contribute to higher income to the local communities living adjacent to Uluguru Mountains include timber, fuel wood and building poles (Mitinje *et al.*, 2007). Moreover, farmer's intensification by clearing forests and transforming them to agricultural land become the most alternative way to overcome the situation. Hunting is also carried out around the forests (URT, 2009).

Paavola (2004) identified several plants which are used as famine foods for communities residing Uluguru Mountains. *Dioscorea sansibariensis* was found as the good energy source during famine. Others were mushroom, vegetables including *Justicia* sp. and *Saba Florida*. The study conducted by Msuya *et al.* (2004) on consumption of indigenous fruits

in Uluguru North and Ruvu North forest reserve identified several fruits used during food scarcity including *Vitex doniana*, *Annona senegalens*, *Schlerocarya birrea*, and *Englerophytum natalense*. This shows that, edible wild food plants are able to fill a variety of food gaps.

2.7.1.6 Occupation

Mitinje *et al.* (2007) studying socio economic factors influencing deforestation in the Uluguru Mountains Morogoro Tanzania revealed that, crop production is one of the major economic activity engaged by (98.3%) of the population. Farming plays a critical role in household's food security and cash crop production. Horticultural crops like tomatoes and cabbages are the most preferred income generating crops. Large proportions of communities (98%) are peasant farmers with low daily income below the monthly minimum wage of a Tanzanian civil servant $50 which an employed household head receive (Mitinje *et al.*, 2007).

2.7.2 Institutional factors

Institutions are rules and regulations which control what happens to a given resource through the allocation and enforcement of rights of use, access and transfer (Lanlands, 2005). Institutions can be defined as norms, rules of behaviour and accepted ways of doing things, they can be formal or informal (Kajembe and Kessy, 2000).

2.7.2.1 Tenure

Tenure encompasses the right to secure long-term access to land and resources, their benefits and the responsibilities related to these rights. Security of tenure is a critical yet often not acknowledged component in determining how rural people can improve their livelihoods and reduce poverty. Tenure, if clearly defined enables local communities to

protect forests and woodlands from encroachment so as to increase their benefits (FAO, 2001). In Tanzania, land belongs to the state and is divided into three tenurial categories: reserved, village, and general land. Since all the land belongs to the state, it is the responsibility of the government to direct land development efforts. Likewise, it is the responsibility of the government to protect land resources on behalf of land users by formulating policies to guide both resource utilization and conservation (Kajembe *et al*., 2004a).

2.7.2.2 Institutional arrangements

Institutional arrangements are the ways in which powers and function of the government are structured between and within government agencies in order to deliver administration services to members of the public (Boateng, 2006). Institutional arrangement is the main criteria for decision making. Currently government reforms emphasize decentralization of the authority to the local level and promotion of community involvement in the provision and management of forest resources in different areas under jurisdiction known as Participatory Forest Management (PFM) (URT, 1998). PFM is an institutional arrangement that can affect livelihoods outcomes since it aims at enhancing natural resources, building local institutional capacity and sustaining livelihoods through equitable and productive natural resources management (Njana, 2008).

Tanzania forest policy (URT, 1998) and legislation (URT, 2002) recognize two forms of PFM: Community based forest management (CBFM) and joint forest management (JFM). Each differs greatly in terms of forest ownership and cost/benefits flows. CBFM takes place on village land or private land and the trees are owned by the village government through Village Natural Resource Committee (VNRC), a group or individual. In this case the owner carries most of the costs and accrues most of the benefits relating to the

management and utilization. The role of the central government is minimal while the district authority only has a role in monitoring. JFM takes place on reserved land that is owned and managed by either central or local government, where a legally binding Joint Management Agreement (JMA) spells out how the forest management rights and responsibilities and associated costs and benefits are shared between the forest owner (central or local governments or even private owner) and the partner communities (Blomley and Ramadhani, 2005). Nevertheless local communities residing Uluguru Mountains.

2.7.2.3 Policies

National forest Policy (1998), Forest Act No. 14 (2002) and National Forest Programme (2001) are the paramount tools for the management of forest reserves in Tanzania. The policy emphasizes among other things the involvement of other stakeholders in the management of forest resources and it takes into account socio-economic, environmental, cultural and political changes. The Policy is backed up by the National Forest Act No. 14 (2002), and National Forest Programme (NFP) as the tools for implementing the policy. They are important tools in the management of forest resources which was envisioned to improve forest condition and people's livelihoods in a manner congruent with the general national poverty reduction (Blomley and Ramadhani, 2005). Uluguru Mountains in particular are under these legal instruments, so it is better to assess their performance in relation to poverty eradication and forest resources condition.

2.7.2.4 Traditional institutions

Traditional forest management in Africa was the main tenure system, which relied upon traditional institutions passed through the generations (Banana *et al.*, 2004). The management practices originated from the clan or community experience and often linked

to spirituality. Spirituality within African cultures emphasize kinship, unity, mutual respect, brotherhood and living in harmony with environment under informal rules. Having effective and credible traditional institution is one of such requirements. This ensured that, natural resources are well managed through observation of norms and taboos. The decline of power of the of the informal tradition institutions in resent times have weekend their authority over the forest, precipitating the current wide spread of open access (Ostrom, 1999; Kajembe *et al*., 2004a; Luoga *et al.,* 2005).

Despite the loss of legal power of traditional leaders on natural resources management, in some areas they still exist. For example in Uganda, a local chief authority still effectively enforces the full spectrum on forest management and accounts of 70% of all forest and woodland (Banana *et al.,* 2004). Continued effectiveness of traditional authorities in protecting forest resources is reported in Tanzania (Lutatenekwa, 2009). However legal mandate of chief dome in forest management have been abandoned since 1963 after independence. This provides evidence of almost total breakdown of local authority in areas of Tanzania (Luoga *et al.,* 2005). Proponent of the traditional institution argue that rules and regulations made by the community over long time are effective in natural resource because they are considered to be more relevant to local situations and are considered as legitimate by the local communities consequently reduced the cost of monitoring and law enforcement (Katani 2010; Ostrom, 2000). Traditional forest management in Uluguru Mountains was the main tenure system before colonization. Therefore it is worth to compare its influence with other newly tenure regimes on forest condition and local communities livelihoods.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Overview

This chapter presents the methodology used in this study. It covers the description of the study area, research design, sampling procedure, data collection, and data analysis**.**

3.2 Description of the Study Area

3.2.1 Location

The study was conducted in Uluguru Mountains, Morogoro Tanzania (Figure 3). The Uluguru Mountains are part of the Eastern Arc Mountains that stretch from Taita Hills in southern Kenya to the Udzungwa Mountains in south central Tanzania (Lovett *et al.*, 1995). The Mountains are located between $6^0$51’ and $7^0$12’S and $37^0$36’ and $37^0$45’E. Uluguru Mountains rise abruptly out of the coastal plain at approximately 300m above sea level (m.a.s.l) to a peak of 2600 m and covers the total of 404 km^2 (Masawe, 1992; Lyamuya *et al*., 1994).

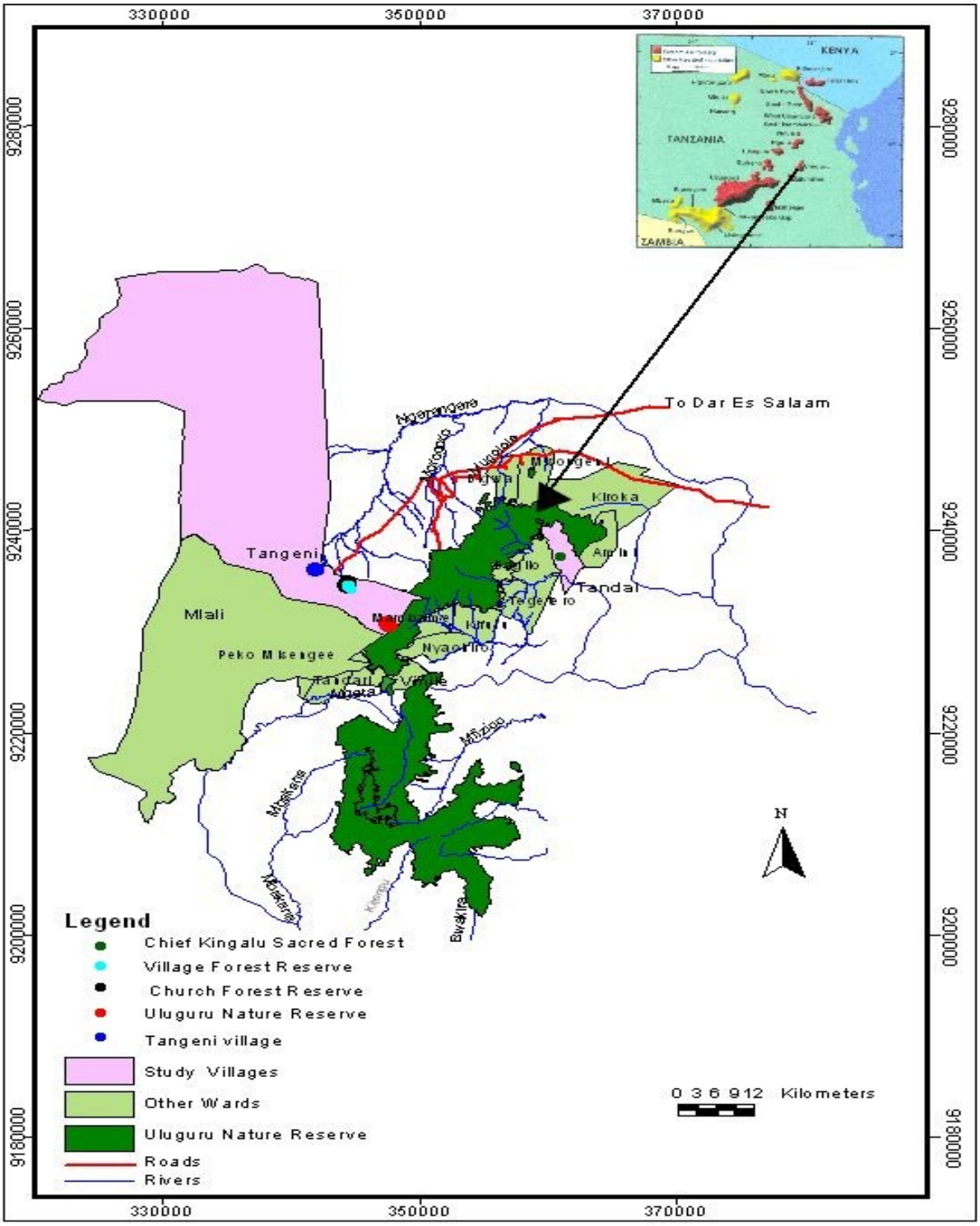

Figure 3: Map of Uluguru Mountains showing the study areas.

3.2.2 Climate

Amount of rainfall in Uluguru Mountains varies with altitude (Lovett *et al.*, 1995). The estimated rainfall is 2900 – 4000 mm per year on the eastern slope of the mountains and 1200 mm on the western slope. In Uluguru Mountains, rainfall is bimodal with dry season between May to late October, a short rain season between October to the end of December and a long rainy season between March and May (Masawe, 1992; Hymas, 2000). Temperature changes, with altitude ranging from below 0°C at higher altitude to above 26°C at lower altitude. In Morogoro town, average air temperature is 24°C with the coolest month being July with a temperature of 21ºC and the warmest being December with 26°C (Masawe, 1992).

3.2.3 Topography and hydrology

Uluguru Mountains have undulating physical features, dominated by hilly mountains which represent good sceneries. Also there are interesting features including upland grassland with swampy areas called Lukwangule plateau and Kimhandu and Lupanga peaks. These features attract local and foreign tourists. However, some areas of the Uluguru Mountains are inaccessible due to steep rocky outcrops. Sub montane forest (canopy 30 – 50 m tall) occurs below 1500 m.a.s.l., montane forest (canopy 15 – 30 m tall) above 1500 m – 2400 m and upper montane forest (canopy 15 – 20 m tall) above 2400 m altitude (URT, 2009).

The Uluguru Mountains are endowed with many rivers namely, Ruvu, Mgeta, Morogoro, Tangeni, Mfizigo, Mmanga, Mzinga, Ngerengere, Mvuha, Mbezi, Mngazi, Bigwa, Kilakala, Bamba and Kikundi. These rivers provide water to the local communities whereas Ruvu River supplies water to Dar es Salaam, Coastal and the rest of Morogoro Region for domestic, agriculture irrigation and industrial purposes.

3.2.4 Population

There have been increasing rates of Human population. Uluguru Mountains was at increasing rate of 6.5 per annum with a population density of more than 150 persons per km^2. According to 2002 population census, Uluguru Mountains contains 57 villages which consist of 90 232 inhabitants. This is an increase of about 30% compared to 70 567 inhabitants observed in the 1988 population census (URT, 1998, 2002). The high rate of population increase may result to over utilization of the forest and other resources available.

3.2.5 Fauna

Uluguru Mountains have high biodiversity value, particularly with regard to small fauna. More than 185 faunal species belonging to more than 60 families have been recorded in the Uluguru Mountains. More than 15% of these species are endemic to the Uluguru Mountains and Eastern Arc Mountains, while more than 10% are near endemic. About 10% of the species are threatened and/or trade restricted according to either IUCN and/or CITES (Lulandala, 1998).

3.2.6 Vegetation

The Uluguru Mountains have unique grassland ecology in the Lukwangule plateau, which is found at 2600 m a.s.l. The plateau is characterized by grassland and patches of upper montane forest. The area is a home of *Pittosporum goetzei*, which is only found at this locality. Other endemic species of importance found on the plateau include *Panicum lukwangulense, Streptocarpus glandulosissimus, Lobelia lukwangulensis, Syzigium parvalum, Schefflera lukwangulensis, Impatiens lukwangulensis, Impatiens pseudohamata, Impatiens Serpens, Impatiens uluguruensis* and *Lasianthus* species. However, overall

species richness and diversity decreases with an increase in altitude while the diversity of endemism increases with increase in altitude (UTR, 2009).

Moreover, a study done by Burgess *et al*. (2002) shows that the mountains continue to loose forest over time. Historical data shows that in early 1900s the Uluguru forests covered 500 ha in 1955 the forest cover dropped to 300 ha, again in 1977 went further down to 250 ha. Data of 2000 shows that the forests cover was estimated to be 230 ha. This is 65% loss of the total original forest cover.

3.2.7 Economic activities

3.2.7.1 Agriculture

Agriculture is the main economic activity and source of livelihood in the study villages. Crops grown include maize, cassava and fruits. Other crops grown include beans, bananas, vegetables, spices and coconuts. Crops for cash economy include vegetables, Irish potatoes, green beans, peas, bananas, carrots and onions. These crops are marketed in Morogoro town and Dar es Salaam city (Lyamuya *et al.,* 1994; Bhatia and Ringia, 1996). In most areas subsistence agriculture is carried out right up to lower forest edges of the Mountains (Hymas, 2000).

3.2.7.2 Livestock keeping

Animal husbandry is not a major economic activity by communities around Uluguru Mountains. The Waluguru are said to have no culture of keeping cattle together with use of related technologies such as oxen ploughs. Domesticated animals include goats, pigs, chickens and rabbits. The keeping of diary goats in the Uluguru (especially Nyandira area) had been promoted mainly by Uluguru Mountain Agriculture Development Project (UMADEP) (URT, 2009).

3.2.7.3 Forestry products

The main forest products include: timber, poles, withies, ropes, fuel wood, charcoal and medicinal plants. Others include honey, wild fruits, thatch grass, wild birds, bush meat, wild vegetables, insects, mushrooms and roots/tubers. These products are utilized at different level of intensity and are drawn from both natural and planted forest (Mitinje *et al*., 2007). Through various project interventions, residents of Uluguru Mountains have planted different tree species for purposes of meeting different needs.

Moreover, local people residing in the Uluguru Mountains do benefit from the forest through eco-tourism, collection of medicinal plants, firewood and wild vegetables. This is done under the supervision of staff from the Uluguru Nature Reserve. Worshiping in sacred sites, visiting commentary places; visiting tour attraction sites as well as collection of water for domestic use are some of the prominent benefits that the Uluguru Mountains offers to the local communities. This shows that the Uluguru Mountains adjacent communities to some extent depend on the Uluguru Mountains for their livelihoods. For that matter therefore, there is a need of establishing modalities that would assist the Uluguru Mountains adjacent communities to live in harmony with the forests (Kiel land-Lund, 1982).

3.2.7.4 Land use

In general, there is land scarcity and the available land has remarkable low soil fertility due to intensive land use leading to poor crop yields. Therefore, the Uluguru Mountains are confronted with considerable food insecurity due to inadequate land for cultivation. Land in the surrounding communities is customarily owned. Substantial portion of these customarily owned lands is covered by *Eucalyptus* sp. and *Cedrella* sp. which reduce wood demand from the reserve although they are invasive species.

3.3 Methods

3.3.1 Data collection

Data for this study consisted of both ecological and livelihoods data. Ecological data were collected through forest inventory, while livelihood data were collected through PRA approaches, Focus Group Discussions (FGD), key informants interviews, participant observations, market and questionnaire surveys. Secondary data were collected from literatures (archival documents), published and unpublished documents relevant to this study.

3.3.2 Forest inventory

3.3.2.1 Sampling design

For studying forest condition, a systematic sampling design was adopted. Within each forest under three forestland tenure regimes namely: State regime (Uluguru Nature Reserve), Communal regime (Misumba Village Forest Reserve and Chief Kingalu Sacred Forest) and Corporate/private regime (Tangeni Roman Catholic Church Forest Reserve) sample plots were laid down systematically. The design ensured an even spread of the sample plots throughout the forests and thus increased the chances of including all vegetation types in the forests (De Vries, 1986; Philip, 1994).

3.3.2.2 Number of sample plots, sampling intensity, size and shape of plots

According to Malimbwi and Mugasha (2002) and Malimbwi *et al*. (2005), financial and time constraints and purpose of the forest inventory may dictate the number of sample plots. Thus, in this study sampling intensities of 7 to 14% were adopted for studied forests as shown in Table 1.

Table 1: Sampling intensity and number of sample plot adopted in forest inventory

Tenure regime	Forest name	Forest area (ha)	Sampling intensity (%)	No. of sample
State	Uluguru Nature Reserve	10	7	10
Communal	Chief Kingalu Sacred Forest	2	14	4
Communal	Misumba Village Forest Reserve	3.7	12	6
Corporate/ private	Tangeni Roman Catholic CFR	3.8	13	7
Total		19.5		27

Sample plots were circular in shape, a design which has been used successfully in previous forest inventory (Nduwamungu, 1996). Its major advantage is that it reduces edge effects (Krebs, 1989). To ease the counting, each sample plot was sub-divides into four sub-plots (concentric plots) of 2 m (0.0013 ha), 5 m (0.0079 ha), 10 m (0.031 ha) and 15 m (0.0707 ha). Data recollected within each specified circle included:

(i) Within 2 m radius, all regenerants were recorded;

(ii) Within 5 m radius, all trees and shrubs with dbh ≤ 10 cm were recorded;

(iii) Within 10 m radius, all trees and shrubs with dbh ≤ 20 cm were recorded;

(iv) Within 15 m radius, all trees with dbh ≥ 20.1 cm were recorded.

Data recorded in field forms (Appendix 1) include: tree and shrub species names, number of trees, regenerants, diameter at breast height (dbh) (all trees and shrubs) and height for twenty trees used for fitting the equations.

3.3.2.3 Forest maps and plots layout

For each forest namely Uluguru Nature Reserve, Chief Kingalu Sacred Forest, Tangeni Roman Catholic Church Forest Reserve and Misumba Village Forest Reserve boundary

coordinates were taken using GPS traverse readings as adopted by Alemayehu, (2007). Forest maps were then drawn using GPS coordinates, and the areas occupied by each forest were calculated. In the Uluguru Nature Reserve, only 10 ha instead of the whole forest were involved in the inventory. This part of the forest area was purposively selected because it was close to the study villages and local communities obtained goods and services from this area for their livelihood.

Transect lines were laid down first on the map and then on the ground with the help of GPS to maintain distances and direction. For better layout of both transect lines and sample plots, the first plots were laid out at half interval from the boundary. In the Uluguru Nature Reserve two transect lines were laid down at an interval of 50 m followed by the allocation of sample plots at an interval of 70 m. In the Chief Kingalu Sacred Forest two transect lines were laid from eastern to western side followed by allocation of sample plots at an interval of 30 m. In the Misumba Village Forest Reserve transect lines were laid out perpendicular to the River Ngerengere at an interval of approximately 100 m, then followed by allocation of sample plots at an interval of 50 m. Sample plots were laid from the lower altitude of the forest to the peak. In the Tangeni Roman Catholic Church Forest Reserve one transect line was laid from the south east boundary to north east. Seven sample plots were laid at an interval of 50 m from each other (Figures 4-7). The intervals were varied inorder to lie as many sample plots as possible depending on the size of the forest.

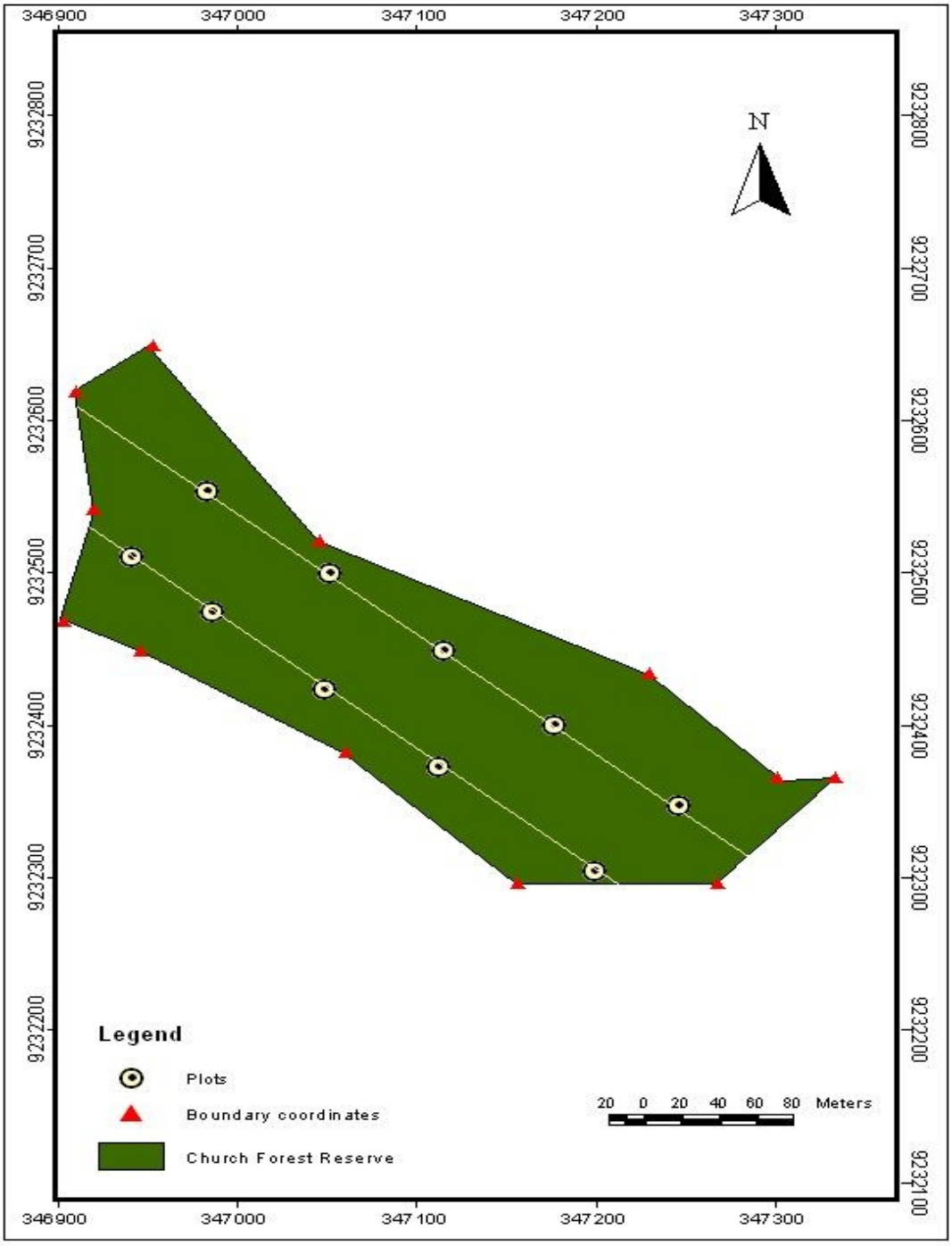

Figure 4: Map of Uluguru Nature Reserve showing the location of sample plots.

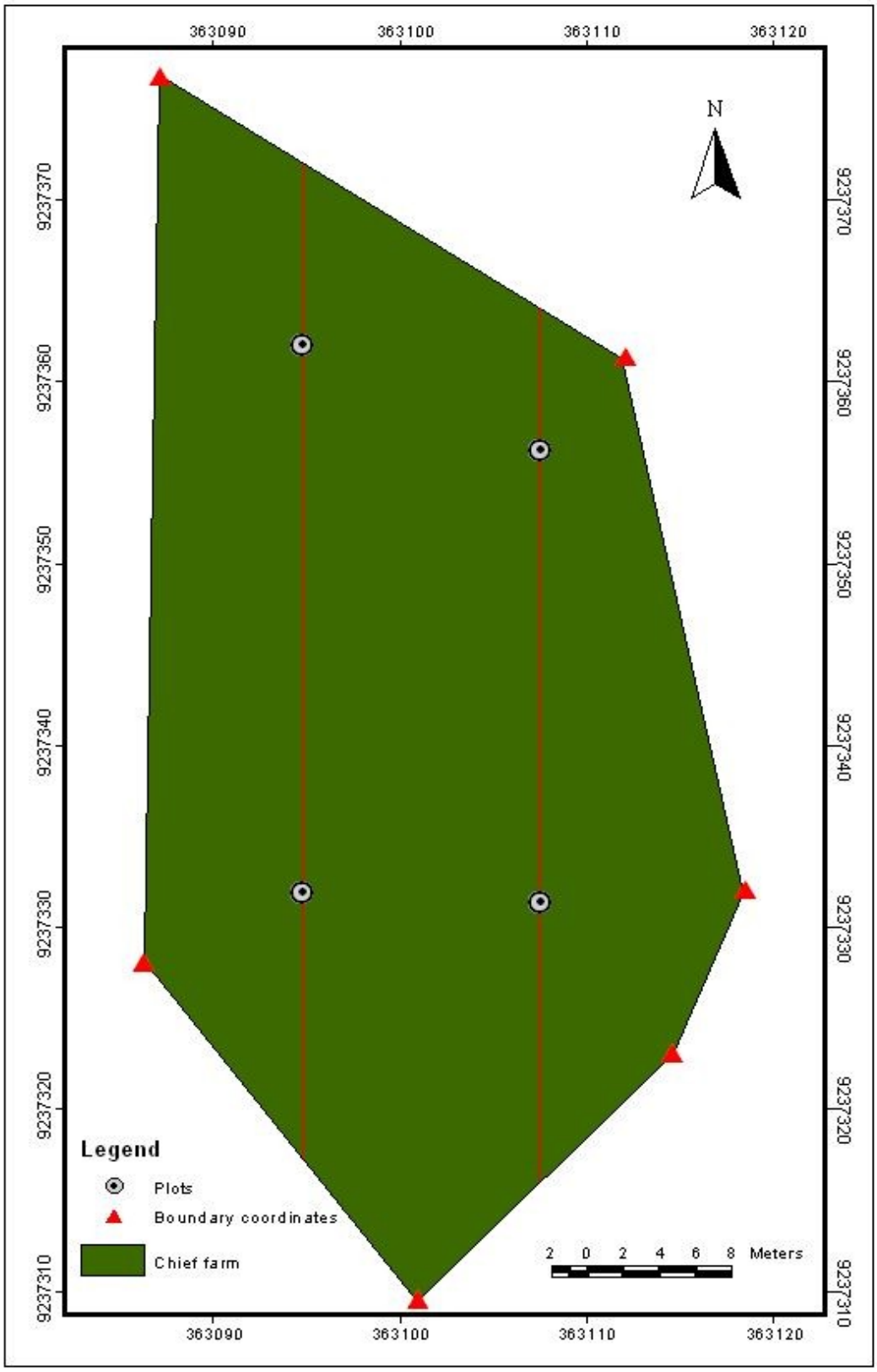

Figure 5: Map of Chief Kingalu Sacred Forest showing the location of sample plots.

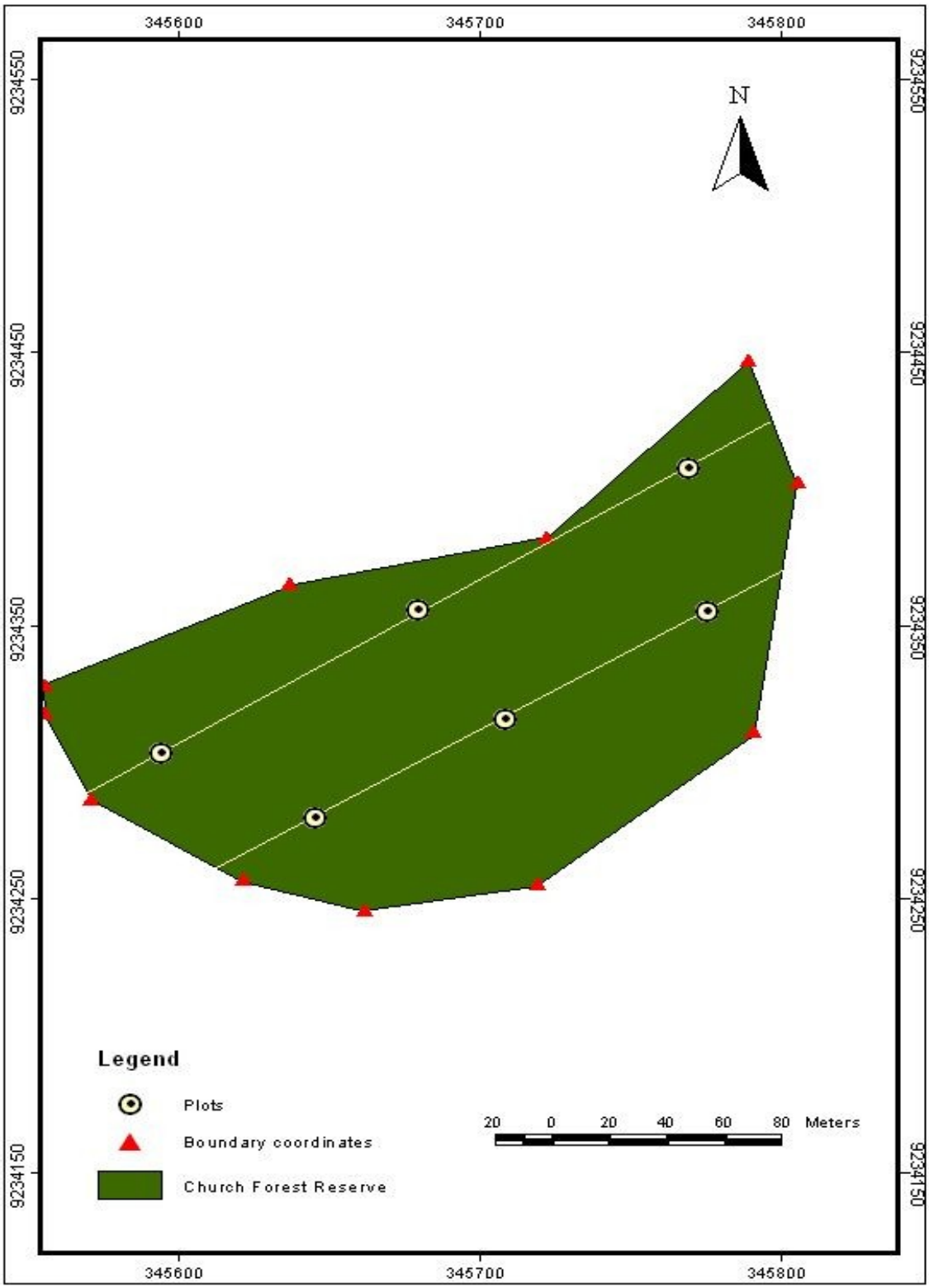

Figure 6: Map of Misumba Village Forest Reserve showing the location of sample plots.

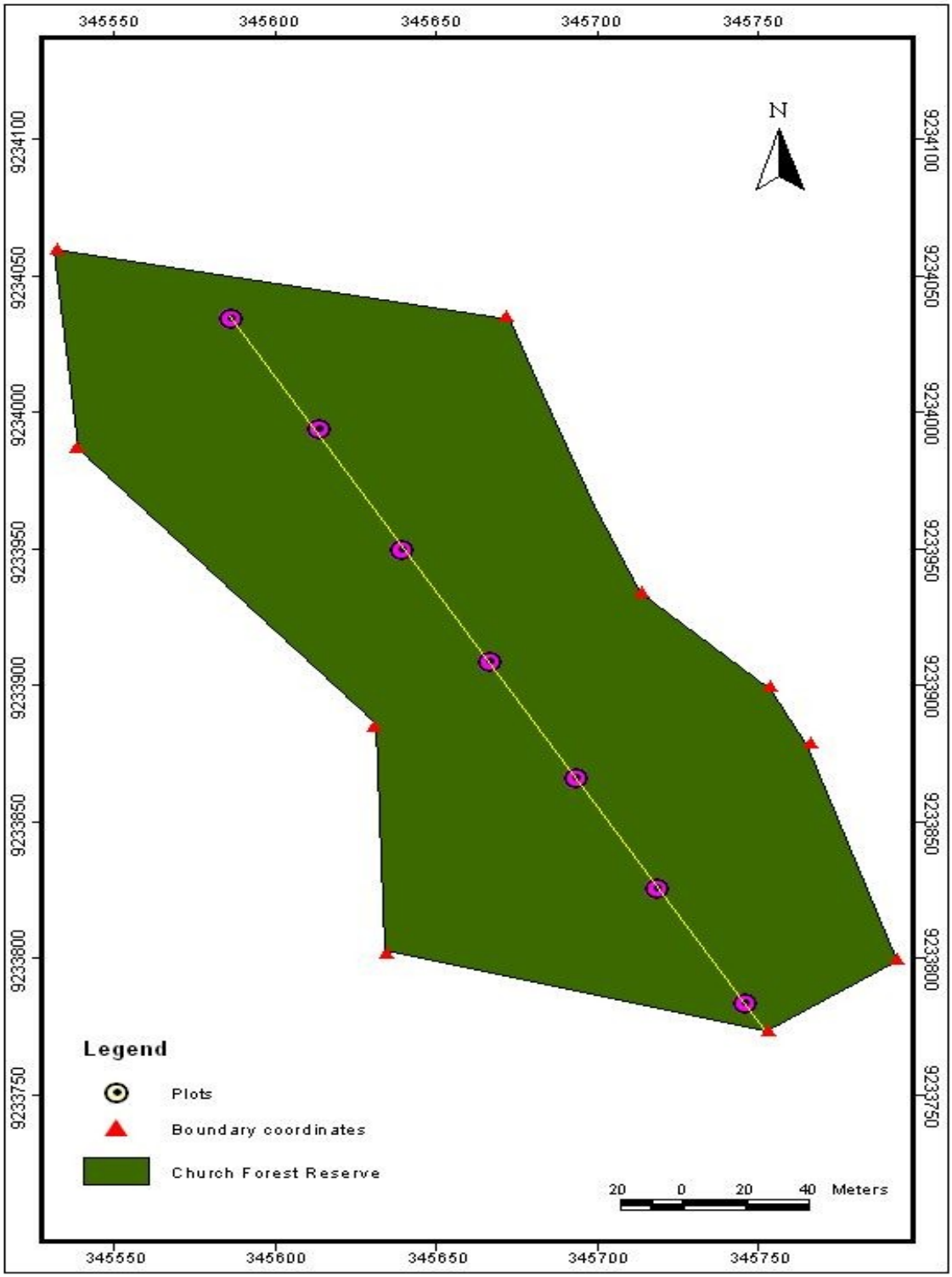

Figure 7: Map of Tangeni Roman Catholic Church Forest reserve showing the location of sample plots.

3.3.3 Livelihood data

3.3.3.1 Study design

A cross-sectional research design was adopted during data collection. Data were collected at a single point in time from selected sample of respondents to represent some large population as suggested by Kajembe (1994). This design was adopted for the study because it is cost-effective.

3.3.3.2 Units of analysis

Unit of analysis is one from which information is obtained or characteristics are described by Kajembe, (1994). Unit for analysis in this study was a household. A household is a smallest unit in a village. In African context a household is the complex unit made up of not necessarily husband, wife and children. There are polygamous people in the village and extended families are common. In this study, a household was defined as a group of people who eat from the common pot, share a dwelling house and have a unit of command from the heads of the households. According to Mbeyale (2009) a head of household is the main decision maker and can be a male or female.

3.3.3.3 Data collection methods

Various methods were used to collect both primary and secondary data in this study. Primary data were collected using Participatory Rural Appraisal (PRA) approaches such as: Observations, Focus Group Discussions (FGD), market survey, and questionnaire survey. These combinations of techniques were employed for data triangulation purposes (Mikkelsen, 1995; Luoga *et al.*, 2006). Secondary data were collected through review of published and unpublished materials from Sokoine University Library and internet.

a) Participatory Rural Appraisal

This is an explanatory method that aim at creating dialogue with stakeholders and getting necessary information concerning community priorities and problems as well as evaluating the options for solving the problems and come up with a community action plan to address the concern that has been raised from them though participatory communication and analytical method (FAO, 1997; FAO, 1999). Mbwambo (2000) argued that the approach allows local people to apply their indigenous knowledge, experience and capacity to share information. PRA achieve its objectives by using simple tools. In this research, PRA tools used included resource mapping, ranking and scoring, and time line. According to Chambers and Conway (1992) and Mikkelsen (1995) with PRA, villagers with minimum level of education can comfortably participate during the exercise with assurance of getting useful information in relaxed conversation. A group of 20 people from each village made up the PRA group with assistance of the village leaders. The composition of a group in terms of gender and age was taken into account. A group had 6 old men, 5 young men, 5 young women and 4 village councillors.

b) Observations

This method gave the researcher experience on a number of issues about the community by assuming a position as a member of the community**.** Much of the information was obtained by observing what is going on and by discussing with the villagers what, why and how things were done the way they were done. The method of participant observation was used to tie together the more discrete elements of the data collected by other methods and permitted to be examined within the context of social system (Kajembe, 1994). At times this resulted into a more complete understanding of both the individual elements and whole. In other times more questions about issues under the study emerged.

c) Focus group discussions

Focus group discussion is an instrumental in generating large body of knowledge about group under the study or community (Mikkelsen, 1995). Focus group discussions were conducted to groups of people in villages with respect to their economic activities. These included farmers, traders, teachers and nurses, women and young people. It was also used to supplement the structured questionnaire and other instruments to fill the perceived gaps. The type of information collected during focus group discussions included rating of forest use under four forest land tenure regimes, resource degradation, rating the effectiveness of tenure regimes in managing forest resources and livelihoods. A list of questions to guide focus group discussion is given in Appendix 2.

d) Checklist

A checklist was used to guide discussion with key informants (Appendix 3). According to Mettrick (1993) a key informant is an individual who is knowledgeable, accessible and willing to talk about issues under study. Key informants can be interviewed in person, or by phone. In this study personal interviews were done. Key informants in this study included village elders, traditional leader (Chief Kingalu), village environmental committee members and Regional Catchment Forest Officers.

e) Structured questionnaire

This was administered to a sample of households for the purpose of collecting both quantitative and qualitative data. Structured questionnaire was developed based on specific objectives. Sixty household from two villages (Tangeni and Tandai) were randomly selected to represent the population. Data collection included socio-economic, forest resources utilization, management issues and local people perception on the past and current resource utilization, evaluation of the contribution of forests under different tenure

categories on household's income. Questionnaire used in this study is attached as Appendix 4.

(ii) Secondary data collection

The researcher spent some time in searching for relevant information in libraries, the internet and government offices. Among the government offices visited include Morogoro Regional Catchments Forest Office, Tanzania Forestry Research Institute and Sokoine University of Agriculture National Library.

3.3.4 Data Analysis

3.3.4.1 Ecological data

Data from the four case study forests were separately analyzed to examine tree and shrub stocking and species diversity. The Microsoft excel spread sheet was used to analyze the data for various parameters. The parameters computed included; stem density (N), basal area (G) standing volume (V) and species diversity indices. Quantification of forest stocks and diversity indices was aimed at understanding the influences of different tenure regimes on forest condition. Before the computation of various parameters, a checklist of tree and shrub species was developed. Local names were matched with botanical names from the existing checklists (Appendices 5-8). Each tree was then given a code number for subsequent analysis.

Since only twenty sample trees in each forest were measured for total height, height diameter equation was fitted and used to estimate height of trees that were measured for DBH only. Simple linear regression analysis using Microsoft excel spread sheet was used to fit the equations. The selection of equation to use was based on higher coefficient of

determination (R^2) and lower standard error of estimate. The selected equations are shown in Table 2.

Table 2: Height diameter equations for the studied forest

Forest name	Tenure regime	Vegetation type	Regression equation	% R^2	SE
UNR	State	Montane	Y=5.41+0.633(D)	84	4.28
CKSFR	Communal	Montane	Y=1.847 + 0.538(D)	90	5.17
TRCCFR	Cooperate/private	Miombo	Y=0.095 + 0.495(D)	84	1.73
MVFR	Communal	Miombo	Y=0.849 +0.662(D)	80	1.829

Source: Own survey data 2009/10

Key: UNR = Uluguru Nature Reserve, CKSFR = Chief Kingalu Sacred Forest Reserve, TRCCFR = Tangeni Roman Catholic Church Forest Reserve, MVFR = Misumba Village Forest Reserve, SE = Standard Error of estimate

Stand density (stems/ha), basal area (m^2/ha) and volume (m^3/ha) were computed for each forest**.** Single tree volume for the montane forest was calculated using the general volume equation**.**

V = gh,*0.5

Where

V = volume of the i^{th} tree (m^3)

g = basal area of a tree

h_i = total height of a tree (m)

0.5 = tree Form factor which is recommended to be used for natural forest in Tanzania (Malimbwi and Mugasha, 2002).

Volume of standing trees in the miombo vegetation was calculated using the volume equation:

$V_i = 0.000011972 di^{3.1917}$ (Malimbwi *et al.*, 2005)

Where:

V = volume of the i^{th} tree (m^3)

di = the diameter at the breast height (1.3m) for the i^{th}

Computed parameters were separated into 7 diameter classes as shown in Table 3.

Table 3: Diameter class distribution in relation to tree dbh in cm

Diameter Classes	Dbh in cm
1	0-10.0
2	10.1-20.0
3	20.1-30.0
4	30.1-40.0
5	40.1-50.0
6	50.1-60.0
7	60.1-70.0
8	>70.0

Tables, pie charts and graphs were used to summarize inventory data. T-test at 5% level of significance was used to test if there was significance difference on forest stocking (density, basal area, volume) of the four studied forests under three tenure categories namely state (Uluguru Nature Reserve), Communal (Misumba Village Forest Reserve and Chief Kingalu Sacred Forest) and Corporate private (Tangeni Roman Catholic Church Forest Reserve). A comparison was made between the studied forests to ascertain the best tenure category.

Diversity indices

The indices of diversity computed for the studied forest were Index of dominance (ID) and Shannon Wiener Index (H).

Index of dominance (ID)

The index of dominance is the measure of individual's distribution among the species in the community. This index is also called Sumpson's index of diversity and is equal to the probability of picking two organisms at random that are of different species (Krebs, 1989; Misra, 1989). Since this study compares tree species diversity of different tenure regimes with the same vegetation type, the index of dominance was expatiated to provide reliable results on which tenure regime has more positive influence on individual tree species distribution. The greater the value of dominance index the lower is the specie diversity and vice versa. This index is computed as follows.

$$ID = \sum\left(\frac{ni}{N}\right)^2$$

Where:

ID is the index of dominance

ni= is the number of individual of species i^{th} in the sample

N= is the number of individuals (all species) in the sample and

∑ =is the summation sign

Shannon Wiener Index (H')

Shannon-wiener index of diversity was used to determine tree species diversity. This is the most widely used index of diversity, which combines species richness and evenness and also is not affected by sample size. Krebs, (1989) explained Shannon wiener index of diversity as the measure of information contents of a sample and since information content is the measure of uncertainty, the large the Shannon wiener index (the value H'), the greater the uncertainty. Therefore this index was adopted in this study due to the difference in sample size from different tenure regimes and certainty in measuring tree species diversity. It was expected to provide reliable result despite the difference in number of tree

species from the forests under different tenure regimes. The index increases as the number of species in the community increase but in practise for biological communities does not exceed 5.0. The Shannon-wiener value was calculated by Microsoft excel using the following formula as used by Malimbwi *et al*. (2005).

$$H = -\sum_{i=1}^{s} \left(Pi \log_a pi \right)$$

Where

H’ = the Shannon wiener index of diversity

Pi = the proportion of individual or the abundance of species in the sample

Log_a = the logarithm to a base a (any base of logarithm may be taken)

\- = the negative sign multiplied by the rest of the variables in older to make H positive

3.3.4.2 Analysis of livelihood data

In this study, both qualitative and quantitative data analysis were done. PRA data were analyzed with the help of communities and results were communicated back to them for verification. Data collected through questionnaire, participant observation and check list were analyzed using both qualitative and quantitative methods.

i. Matrix ranking and scoring on forestland tenure types

Ranking and scoring were employed to ascertain best tenure category. Respondents were asked to rank four tenure regimes in terms of their contribution to livelihoods.

ii. Qualitative data analysis

In each village, indices were made for the assessment of the influence of Uluguru Nature Reserve on livelihood capitals. Seven dimensions of livelihoods including human, social,

political, physical, natural financial and cultural capitals were considered during the study. Each dimension was explained by four statements or sub-dimension (Table 4). Each statement had to score 1-7 measured on four point Likert scale (1 = very poor, 3 = satisfactory, 5 = good, 7 = very good) as adopted by Shahbaz (2009). These statements were used to calculate indices of variables where, the results were grouped into 3 categories (0-0.49 = Poor, 0.5-0.74 = Satisfactory and 0.75-1 = Good) as adopted by Hortland (1993) cited by Mrutu (2010) (Appendices 15-21).

Table 4: Livelihoods dimensions and sub dimensions used in assessing influence of Uluguru Nature Reserve on livelihoods

Dimension Livelihood capitals	Sub dimension Livelihood indicators
Social capital	Trust between UNR management and local communities
	Collaboration with local institution in the management of UNR
	Collective action between UNR and local community
	ability conduct meeting and networking
Physical capital	influence on road construction
	Influence on construction of houses
	Influence on construction of schools
	Influence on construction of health centres
Natural capital	provision of water services
	provision of firewood
	Land distribution
	Climate amelioration

Human capital	Ability to enhance capability and skills
	Ability to enhance formal education
	Ability to enhance health status of community
	Ability to enhance enterprises
Cultural capital	Ability on respecting norms and taboos on forest management
	Ability to respect features with cultural values including trees, stones and lakes
	Ability to use traditional knowledge on forest management
	Ability to respect traditional leaders on decision making
Political capital	Ability to influence decision making to the local community
	Ability to Influence on voice and power to local communities
	Ability to influence the local community to gained confidence on public leadership
	Popularity of leaders, community with NGOS, State and other political partners
Financial capital	Sale of product from the forest
	Employments opportunities to local peoples
	Ecotourism opportunities to local people
	Fines from offenders

The indices were computed as presented below.

i) Dimension indices

$$DI=\sum\left(Yij/Y\max\right) \qquad i = 1, 2,\ldots\ldots x,\ j=1, 2,\ldots\ldots n)$$

Where:

DI = Dimension index for natural, physical, human, social, cultural, financial and political capitals

Yij = Frequency of scores to an individual sub-dimension of the main dimension

Ymax = Maximum frequencies of sub dimensions, which is 28

x = Number of sub dimension determining factors, which is 4

n = sample size which was 30 respondent of each village

Livelihood index

$$GI=\frac{\sum\left(\sum\left(Yij/Y\max\right)\right)}{n}$$

GI= Livelihood index

n= Total number of dimensions which is 4

iii. Quantitative data analysis

Data analysis were preceded by sorting, open ended responses were categorized and transformed followed by coding of the data to facilitate further analysis. The Statistical Package for Social Sciences (SPSS) version 16 was the main tool for quantitative data analysis. Descriptive statistical analysis included frequencies, cross – tabulations and measures of central tendencies (means) and variability (standard deviations and standard errors). Inferential statistical analysis was used to provide an idea about whether the patterns described in the sample were likely to apply in the population from which the sample was taken (Kajembe, 1994). As one of inferential statistical analysis technique multiple regression model was developed to show the relationship between households income as the surrogate of livelihood dependent variable obtained from sales of forest products from Uluguru Nature Reserve. Independent variables were forest tenure, education, household's size, distance from forest to the village, market demand, hunger periods, rule violation, gender, land size (in acre) and forest access rules. The multiple regression equation developed is given by;

$$Y_1 = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \ldots\beta_nX_n + e$$

Where:

Y_1 = household income obtained from the sell of Uluguru Nature Reserve forest resources

X_1 to X_n = independent variables, i.e. Institutional and socio economic factors that influences ability of households to generate income from Uluguru Nature Reserve.

β_0 = a constant showing intercept for regression equation

β_1 to β_n = independent variables coefficients which indicate how much a 1 unit increase or decrease in X_n changed household income.

e = error term

i = 1, 2, 3…n

n = Sample size (total number of respondents i.e. 60 for the purpose of this study

The explanatory power of the regression was assessed by its coefficient of determination (R^2). The coefficient of determination showed the strength of relationship between dependent and independent variables.

Independent variables (X_i values) that influences livelihoods in Uluguru Nature Reserve

X_1 = forestland tenure insecurity: forestland tenure insecurity encompasses inability to have right to secure long-term access to land and resources, their benefits and the responsibilities related to these rights. It was assumed that lack of tenure security will alienate local people from use of forest resources and reduce contribution to their household income. Forestland tenure insecurity was assumed to have negative sign of the estimated (-β).

X_2 = Household size. Household is defined as a group of people who eat from the common pot, share a dwelling house and have a unit of command from the head of the household can be men or women. Family size determines per capita collection and utilization of Uluguru Nature Reserve forest products. The number of members in the household has an

important implication in household ability to access enough food. A large number imply more mouths to feed and more people to share household budget Therefore, large household size in relation to the contribution to household income from the forest was assumed to have positive sign of (+β).

X_3 = Average distance (in km) from homesteads to the forest reserve. Longer distance from the forest to homestead is assumed to constrain the likelihood of the respondent's use of the forest as a source of income due to higher transportation cost. Therefore, increase on distance to the forest reserve, has negative effect on the contribution to households income. The expected sign for Beta value was negative (-β).

X_4 = Education level of the respondents (years of schooling). It is assumed that increased in educational level of local people around the forest tend to enhance capability and skills in performing other livelihood activities for income generation. Educated people also have ability to secure good job in companies, industries and government agencies. Therefore, high level of education was expected to have negative sign of (-β).

X_5 = Market demand. The hypothesis in this case was that, reliable marketing demand of forest products from Uluguru Nature Reserve would influence respondents to be engaged in extraction of forest resources for sale to supplement their daily income. There fore reliable market demand was assumed to have positive sign of (+β).

X_6 = Rule violation: Rule violation is a tense to defy control over use of forest resources infavour of private benefit. The hypothesis was that increasing rule violation by the residing communities will increase the likelihood in extraction of forest resources for sell

to supplement their daily earnings. Therefore the expected sign for beta value was positive (+β)

X_7 = Sex. Sex of the respondents has a profound influence on how men and women differ in the extraction and use of different types of forest resources as a source of income. It was assumed that inability of women being engaged in extraction of commercial forest products including timber; poles and charcoal have negative effect on supplementing household income. Therefore, the expected sign for Beta value was negative (-β).

X_8 = Land size hectares; the hypothesis in this case was that households with big farm size would have adequate space for tree planting, hence will reduce wood demand from extraction of forest resources for income generation and domestic consumption. The expected sign of the regression coefficient was negative (-β).

X_9 = Prohibition of forest resources; Prohibition is a manner in which extraction of forest resources are legally banned for conservation purposes. Since, livelihood promotions including extraction of forest products for sell are regarded as source of forest degradation and deforestation. Therefore increasing Prohibition of forest resources to the residing communities will decrease the likelihood in extraction of forest resources for sell. Therefore, the expected sign for Beta value was negative (-β).

X_{10} = Hunger periods: Average hunger periods in months determine level of dependence to the forest resources as alternative source of income to fulfill food deficit. The hypothesis was that increasing hunger periods will facilitate more extraction of forest resources for sell to secure food security. Hence, the expected sign of Beta value was positive (+β).

Linearity was assumed in this case. According to Tofallis (2008) linear model is reliable statistical tool in evaluating how an outcome or response variable is related to a set of predictors. Linear model was the first type of regression analysis to be studied rigorously, and to be used extensively in practical applications. This is because models which are linear on their unknown parameters are easier to fit than models which are non-linearly related to their parameters. As Kajembe (1994) argued, in postulating relationship among dependent and independent variables, linearity is normally assumed. Linear model was predicted in this study because first, numerous relationships have been found empirically to be linear, second, the linear specification is generally the most parsimonious; third the theory is often so weak we are not at all sure how the non-linear specification will be (Kajembe (1994) cited by Mohamed, 2009).

iv. Contents and structural functional analysis

Contents and structural–functional Analysis were used to handle qualitative information. The components of verbal discussion held with key informants were analyzed with the help of content analysis whereby recorded dialogue was broken into smallest meaningful units of information and theme. This type of analysis helped the researcher to ascertain values and attitudes of the respondents (Mayeta, 2004). Structural-functional analysis sought to explain social facts by the way in which they are related to each other within the social system and by the manner in which they relate to the physical surroundings (Kajembe, 1994). This type of analysis assisted the researcher to distinguish between obvious and latent functions. Obvious functions those are consequences which are intended and recognized by the actors in a system (Mbeyale, 2009). Latent functions are those consequences which are neither intended nor recognized.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Influence of Forestland Tenure Regimes on Forest Stock

Stocking generally include: number of stems, basal area and volume of standing trees and shrubs in a given area. Regeneration is as well included in the scope of stocking since today's regenerants are tomorrow's trees and shrubs (Njana, 2008). Table 5 shows results on stocking parameters namely stand density, basal area and standing volume for the four studied forest under different tenure regimes in the Uluguru Mountains. The study findings revealed that state regime represented by Uluguru Nature Reserve and communal regimes represented by Chief Kingalu Sacred Forest Reserve are characterized by montane vegetation type while communal regime (Misumba Village Forest Reserve) and

corporate/private (Tangeni Roman Catholic Church Forest Reserve) are miombo woodlands. Forests with similar vegetation type were compared so as to understand which tenure regime has more significant influence on stocking parameters. In this case state (Uluguru Nature Reserve) was compared with communal (Chief Kingalu Sacred Forest Reserve) and communal (Misumba Village Forest Reserve) was compared with corporate/private (Tangeni Roman Catholic Forest Reserve). Generally speaking the results showed that tenure regimes in Uluguru Mountains are differently influencing stocking parameters. These results concur with that of Balint *et al*. (2002) who reported that various forms of forestland tenure regimes consist of institutions regulating differently community livelihoods and resource condition.

Table 5: Tree stocking parameters by tenure regimes in Uluguru Mountains

Parameters	Forest tenure types		t-statistics	p-value
	State (Uluguru Nature Reserve)	Communal (Chief Kingalu Sacred Forest)		
N N/ha	777 ± 26	1020 ± 43	2.570	0.287 NS
G M^2/ha	78 ± 11	49 ± 7	2.201	0.132 NS
V M^3/ha	1234± 55	798 ± 25	2.200	0.236 NS
	Corporate/ private (Tangeni Roman Catholic Church Forest Reserve)	Communal (Misumba Village Forest Reserve)		
N N/ha	2573 ± 42	4200 ± 73	2.364	0.087 NS
G M^2/ha	27 ± 4	11 ± 3	2.228	0.000**
V M^3/ha	122 ±10	23 ± 9	2.200	0.000**

NS=Not significance

**= Significance ($p<0.05$)

4.1.1 Forest stand density

4.1.1.1 State regime (Uluguru Nature Reserve) versus communal regime (Chief Kingalu Sacred Forest)

Stem density indicates the degree of rowdiness of trees species in a given area (Njana 2008). Table 5 shows that there was no significant difference (p=0.287) in number of stem per hectare when state (Uluguru Nature Reserve) (777 ± 26) was compared with Communal regime (Chief Kingalu Sacred Forest) (1020 ±43). Despite the fact that there was statistical significant difference but communal regime (Chief Kingalu Sacred Forest reserve) had higher number of stems per ha compared to the state regime (Uluguru Nature Reserve). This probably is attributed by the dominance of small size trees (0-10 cm dbh) (Figure 8) which indicate increased recent disturbance as was observed during the field visit in the Chief Kingalu Sacred Forest Reserve.

Further more it was revealed that despite the fact that the Chief Kingalu Sacred Forest Reserve is dominated by small size trees, stems were distributed in all of the eight diameter classes as compared to state regime where there were no trees of above 70cm dbh (Figure 8 and 9). Lack of larger trees in the Uluguru Nature Reserve might be attributed to the nature of the forest itself since there was no signs of harvesting observed. Although disturbances were observed in the Chief Kingalu Sacred Forest, some tree species including; *Ficus stuhlmanii, Alabankya ulugurensis and Afzelia quanzensis* are strictly protected by norms and taboos and used only during natural hazards for performing traditional ritual hence contributing to their presence. This implies that communal tenure regime governed by informal institutions represented by chief Kingalu sacred forest reserve was more influential in conservation of valuable tree species which have spiritual significance values. Katani, (2010) reported that traditional management by norms and taboos in Ukerewe main Island has contributed to the presence of big diameter trees in micro spring forest.

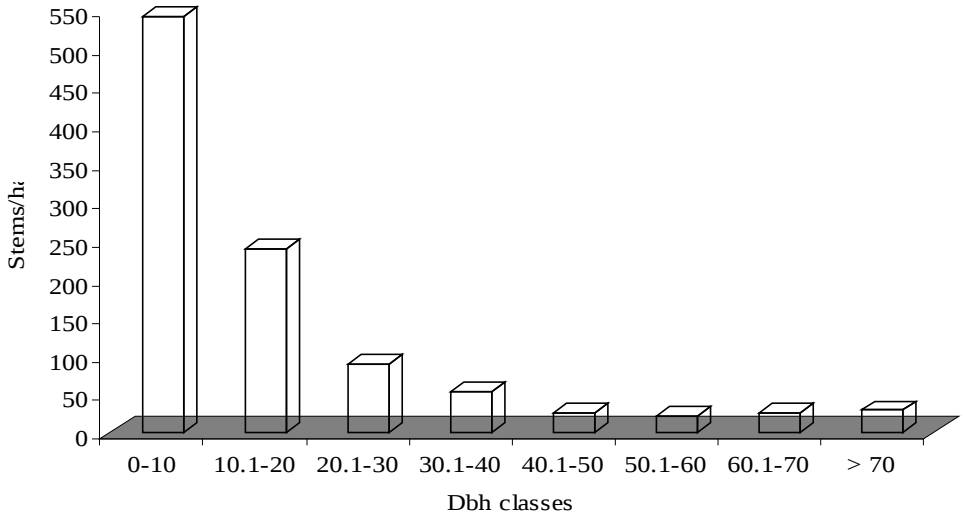

Figure 8: Stem distributions by diameter classes in the Chief Kingalu Sacred Forest.

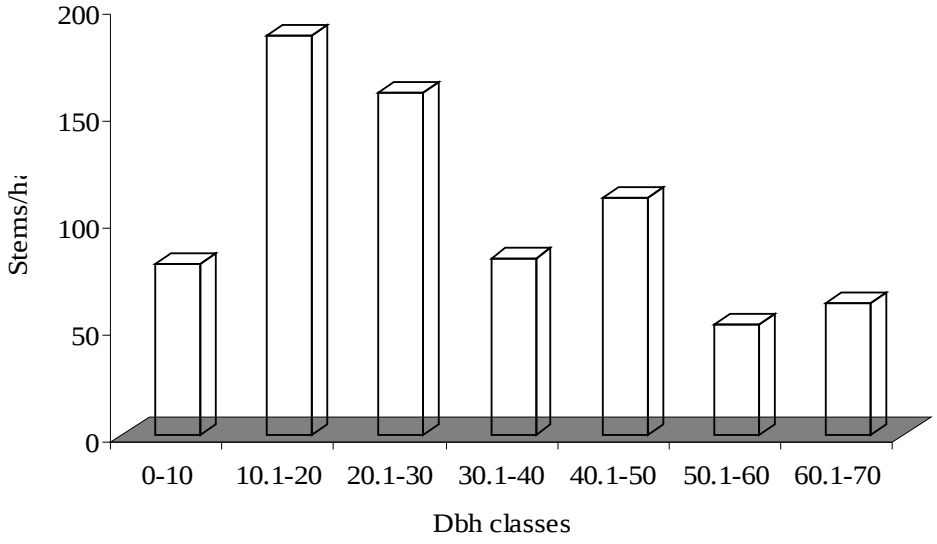

Figure: 9 Stem distributions by diameter classes in the Uluguru Nature Reserve.

Figure 9 indicate that in UNR dbh class two (trees with dbh from 10.1 – 20 cm) constituted large number of stems per ha and the figure did not show reversed 'J' shape trend as

expected. The distribution of number of stem per ha for the communal regime (Chief Kingalu Sacred Forest Reserve) show a normal reversed 'J' shape trend (Figure 8) which is common for natural forest with active regeneration and recruitment (Phillip, 1983). The results on stem density in (Table 5) can be compared with the results from other studies reported in the montane vegetation. The study by Malimbwi *et al.*, (2005) in Uluguru Nature Reserve reported 375±111 stems per hectare which was a bit lower than what has been observed in this study. The study by Mohamed (2006) on the impact of joint forest management in Handeni hill forest reserve reported stem density of 1083 ± 25 stems per hectare which was a higher compared to this study, probably due jurisdiction of JFM since 2005 . Lutatenekwa (2009) reported stem density of 757 ± 43 stems per hectare in the north pare sacred forest.

4.1.1.2 Communal regime (Misumba Village Forest Reserve) versus Corporate/private regime (Tangeni Roman Catholic Church Forest Reserve)

Stem density is portrayal parameter for describing stand characteristic. However it varies widely in the miombo woodlands where, it ranges from 380 to 1400 stems per hectare (Nduwamungu and Malimwi, 1997).

Table 5 shows that there was no significant difference (p=0.087) on number of stem per ha between Misumba Village Forest Reserve (communal) (4200 ± 73) and Tangeni Roman Catholic Church Forest Reserve (corporate/private) (2573 ± 42). Zahabu and Katani (2007) reported stem density of 3037± 641 stems per hectare in the Miombo woodland of Misumba Village forest Reserve which was a bit lower than observed in this study, certainly more trees have regenerated within the period of three years from 2007-2010. Nduwamungu (1996) and Mafupa (2006) reported 691 and 722 stems per hectare in miombo woodlands of Kitulangalo and Igombe, Tanzania respectively. However these

results were lower compared to this study definitely N depends very much on the minimum dbh measured from this study.

Although there was no significance difference on number of stems per ha between them but communal tenure regime represented by Misumba Village Forest Reserve had higher number of stems compared to corporate/private (Tangeni Roman Catholic Church Forest Reserve). Higher number of stems per ha for the Misumba Village Forest Reserve could be attributed by some sort of disturbances such as harvesting and wild fires that were said to have taken place inside the forest area. During the fieldwork such disturbances were witnessed to have taken place, which could be attributed by the weakness in institutional performance under communal tenure compared to corporate/private regime. The greater number of stems per hectare is attributed to the fact that germination and recruitment of young trees are enhanced through increase of gaps, light, raised soil temperature and reduced nutrient competition (Augsburg, 1984; Chardon and Robert, 1991). The relatively lower number of stems in the corporate/private tenure regime represented by Tangeni Roman Catholic Church Forest Reserve could be associated with the reduced disturbances due to strong rules and regulation implemented since colonial era when the forest was demarcated and leased as the church property in 1953. The strong rules and regulations excluded the surrounding community from free access.

Figures 10 and 11 show that stems distribution in both communal tenure regime represented by Misumba Village Forest Reserve and corporate/private (Tangeni Roman Catholic Church Forest Reserve) followed reversed 'J' shape trend which is common for natural forest with high regeneration and recruitment. According to Njana (2008) active regeneration and recruitment in natural forest is a good sign of sustainability which has chances of ensuring sustainable supply of products and services to the surrounding

communities. The distribution of number of stems per hectare also shows that trees in Misumba Village Forest Reserve are of < 30 cm dbh. This indicates that the forest is recovering following institutional rearrangement from free access to controlled use under CBFM since 2005.

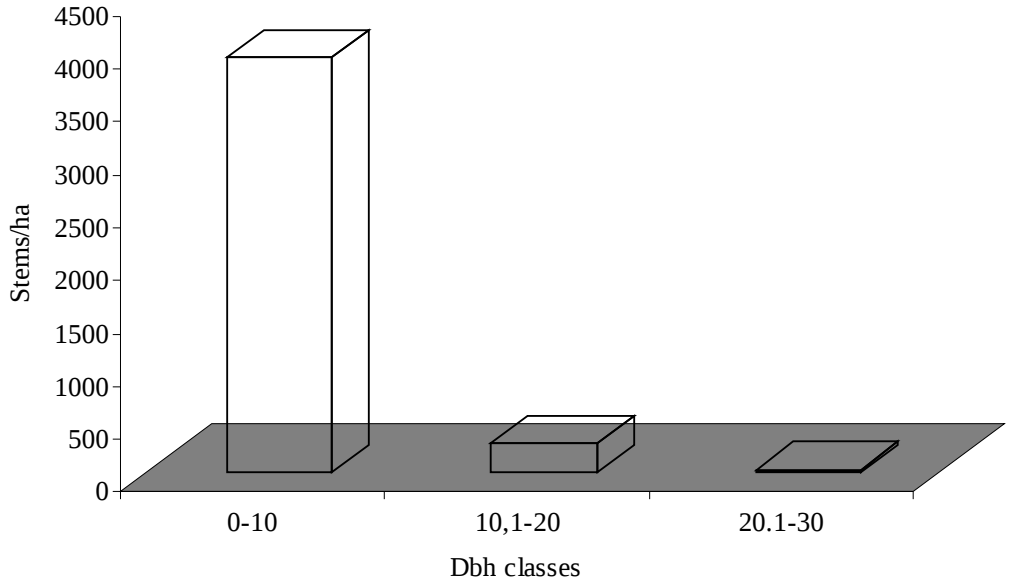

Figure 10: Stem distribution in diameter classes in Misumba Village Forest Reserve.

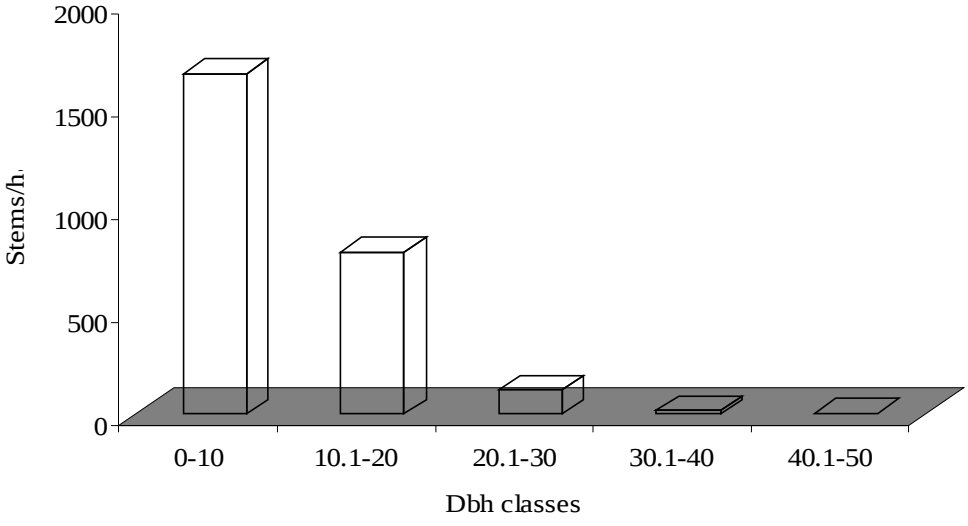

Figure 11: Stem distribution in diameter classes in Tangeni Roman Catholic Church Forest Reserve.

4.1.2 Basal area

4.1.2.1 State regime (Uluguru Nature Reserve) versus Communal regime (Chief Kingalu Sacred Forest Reserve)

Tree basal area (g) is the cross-sectional area of a tree or shrub at breast height whereas stand basal area (G) is the total basal area of all trees or of specified classes of trees per hectare (Philip and Gentry, 1993). Table 5 shows that there was no significant difference (p=0.132) on basal area per hectare between state regime Uluguru Nature Reserve (78 ± 11 m^2 per hectare) and communal regime Chief Kingalu Sacred Forest (49 ± 7 m^2 per hectare), the statistical insignificance difference could be due to difference in sample size of 4 for the Chief Kingalu Sacred Forest compared to 10 sample plots of the Uluguru Nature Reserve. Nevertheless state regime was found to have higher basal area than Communal regime. The observed difference on basal area between state and communal tenure regimes was contributed mainly by the high level of disturbance for the communal tenure regime compared to state. Disturbances were attributed with tenure change from communal to open access which was associated by the institutional weakness associated with the erosion of norms and taboos governing access to Chief Kingalu Sacred Forest Reserve. The discussions held with Chief Kingalu revealed that colonialists divided the forest into two parts namely government and chief forest. This implies that autonomy of the indigenous people in the management of forest resources was recognized and respected by the colonial government. The Chief Kingalu Sacred Forest was demarcated and covered about four wards namely Bigwa, Kiroka, Mkuyuni and Kinole. The boundary between government and chief forest was laid in Kinole at Bohomela village. After the abolition of chiefdom governances in Tanzania in 1963, the government issued permits for timber harvesting and most part of the Chief Kingalu Sacred Forest was disturbed through agriculture and settlements establishment (Plate 1).

Plate 1: A portion of the Chief Kingalu Sacred Forest encroached for agriculture

Figures 12 and 13 show that basal area distribution for the Uluguru Nature Reserve and Chief Kingalu Sacred Forest followed a J shaped trend indicating that larger diameter trees contributed more to basal area and volume. Higher basal areas were found in dbh classes (40.1-50, 50, 1-60, and 60.1-70) for Uluguru Nature Reserve and for Chief Kingalu Sacred Forest were found in dbh classes (50.1- 60, 60.1-70, and > 70). Lutatenekwa (2009) reported basal are of 1I0.53 m^2/ha which was higher compared to the findings of this study.

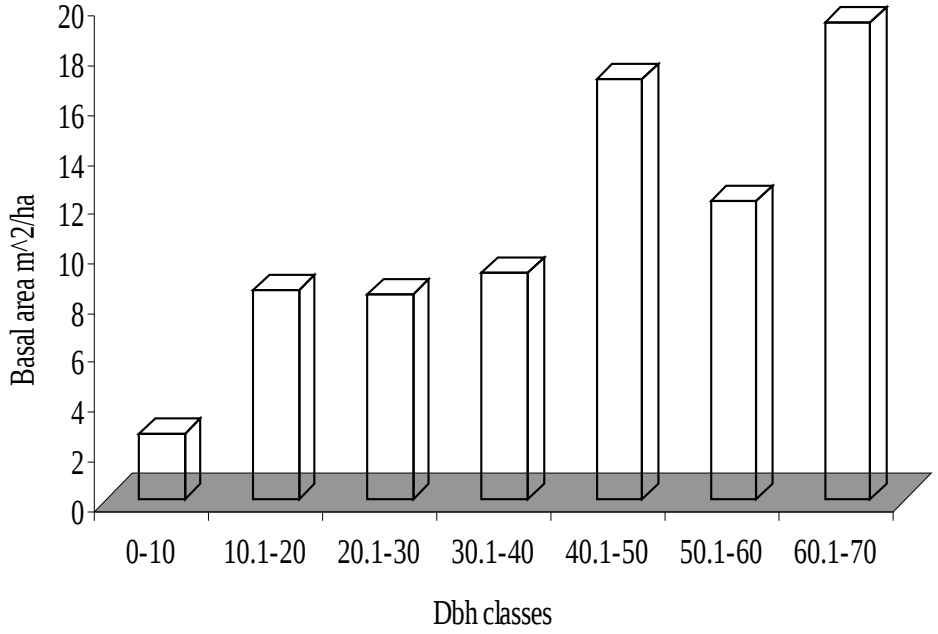

Figure 12: Basal area distribution by diameter classes in the Uluguru Nature Reserve.

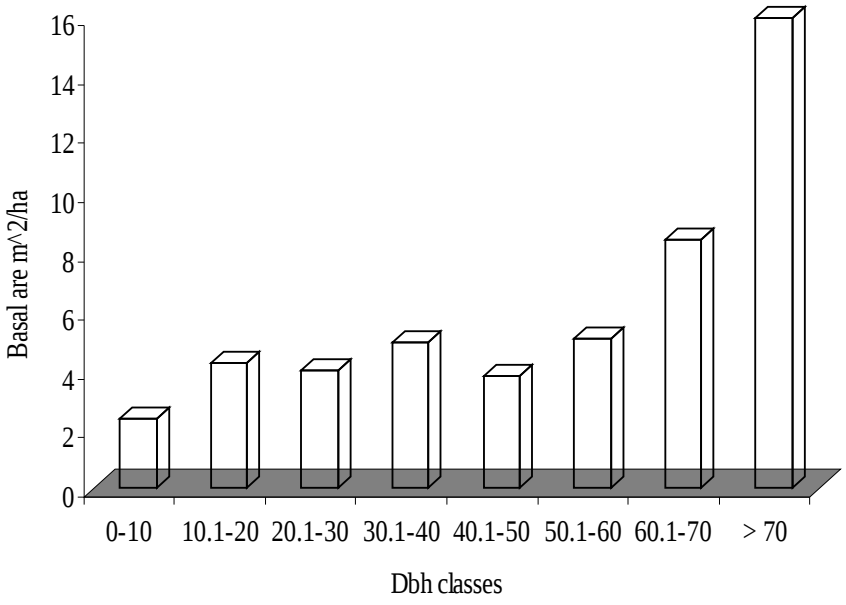

Figure 13: Basal area distribution by diameter classes in the Chief Kingalu Sacred Forest.

4.1.2.2 Corporate/private regime (Tangeni Roman Catholic Church Forest Reserve) versus communal regime (Misumba Village Forest Reserve)

In natural forests, basal area is a good measure of the potential of a site (Philip, 1994). In most miombo woodlands, the basal area range between 7 and 25 m^2 per hectare (Zahabu, 2001). Table 5 shows that basal area per hectare for the corporate/private tenure regime represented by Tangeni Roman Catholic Church Forest Reserve (27 ± 4 m^2 ha^{-1}) was significantly ($p=0.000$) different from communal tenure regime represented by Misumba Village Forest Reserve ($11 \pm 3m^2$ ha^{-1}). The difference in basal area can be attributed by presences of some huge trees in the corporate/private (Tangeni Roman Catholic Church Forest Reserve) depicted in dbh classes 30.1-40 and 40.1-50 as compared to communal (Misumba Village Forest Reserve) where there were no trees under such higher dbh classes. This can be attributed by the effectiveness of corporate/private forest land tenure regime on enforcing rules and regulations that have alienated the surrounding community from forest use compared to communal tenure regime which was open access since colonial era. Moreover the difference can be attributed by time difference since the gazettement of the corporate/private regime in 1953 as compared to communal forest in 2005. Zahabu and Katani (2007) reported basal area of 6.8 ± 1.18 in the communal tenure regime in the Misumba Village Forest Reserve.

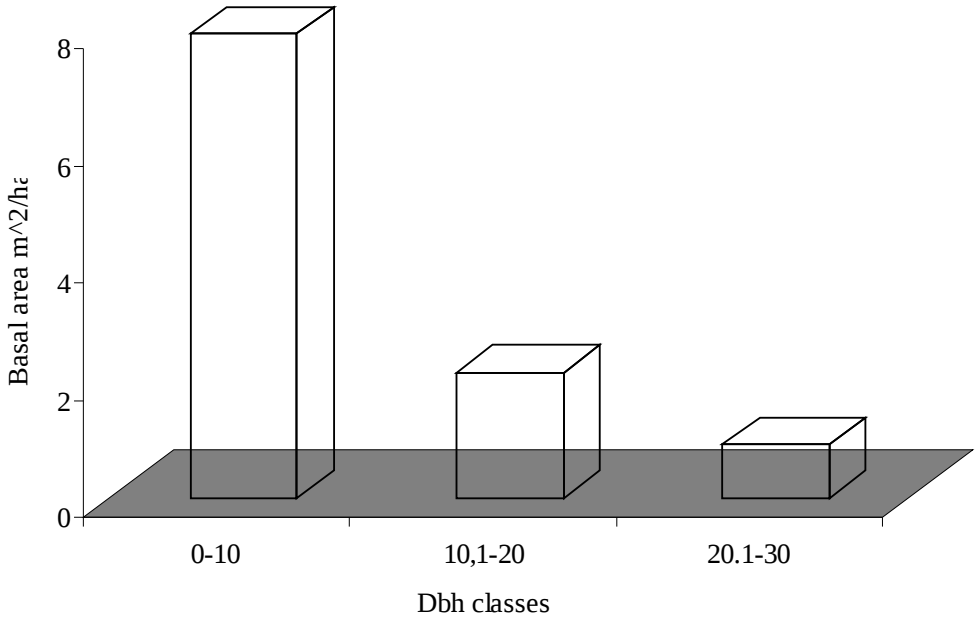

Figure 14: Basal area distribution by diameter class in Misumba Village Forest Reserve.

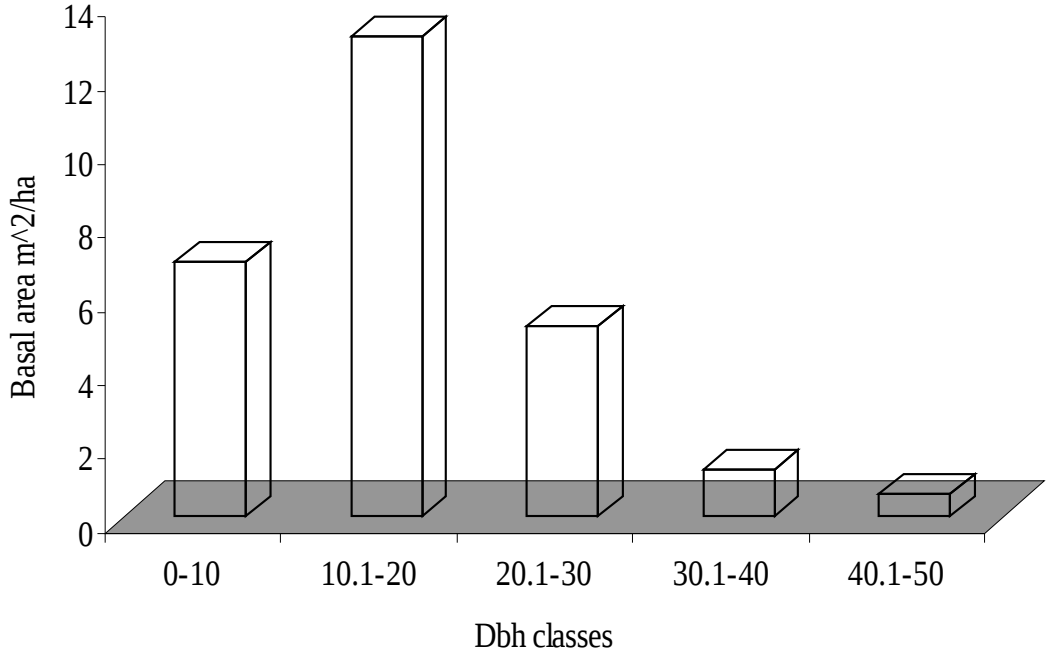

Figure 15: Basal area distribution by diameter classes for Tangeni Roman Catholic Church Forest Reserve.

4.1.3 Tree volume

4.1.3.1 State regime (Uluguru Nature Reserve) versus Communal regime (Chief Kingalu Sacred Forest Reserve)

Tree volume is usually determined by dividing the stem into sections, and then volume is computed for each section finally added to obtain tree volume (Malimbwi, 1997). However tree volume is estimated based on the measurement of diameter and height of the trees then fitted in the model to be adopted in estimating volume of the other trees based on vegetation type and stand characteristics (Malimbwi, 1997). In this study specific models were used for volume estimation due to lower cost of carrying inventory. Since only few individuals were measured.

Table 5 shows that there was no statistical significant difference (p=0.236) when volume per hectare for the state tenure regime (1234 ± 55 m^3/ha) was compared with the communal regime (798 ± 25 m^3/ha). However state forest had higher volume compared to communal Forest. The difference can be associated with the erosion of traditional institutions and introduction of formal institutions. In practice different forestland tenure regimes governed by different institutions in the management of forest resources have different influence on resource condition despite being of the same vegetation type (Bruce, 2006).

Other studies conducted in the montane vegetation type, under state and communal tenure regimes reported volume of 675.42±196 $m^{3/}$/ha in the Uluguru Nature Reserve (Malimbwi *et al*., 2005). Kijazi (2006) reported 1338 m^3/ha in closed stratum of Amani Nature Reserve which was more or less similar to state regime (Uluguru Nature Reserve). Lutatenekwa, (2009) reported a volume of 910 m^3/ha in north Pare Sacred Forest which was also more or less same with communal (Chief Kingalu Sacred Forest Reserve). Distribution of volume in diameter classes followed the normal ‘J’ shape trend expected for an even aged forest

indicating that large diameter trees contribute more to the volume of the forest (Figures 16 and 17).

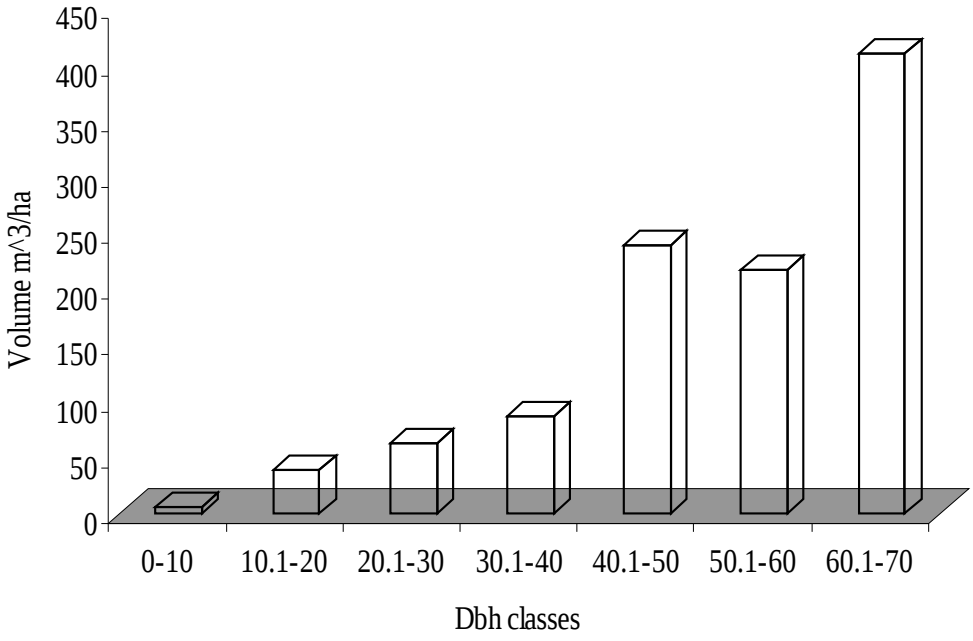

Figure 16: Distribution of tree volume by diameter classes in Uluguru Nature Reserve.

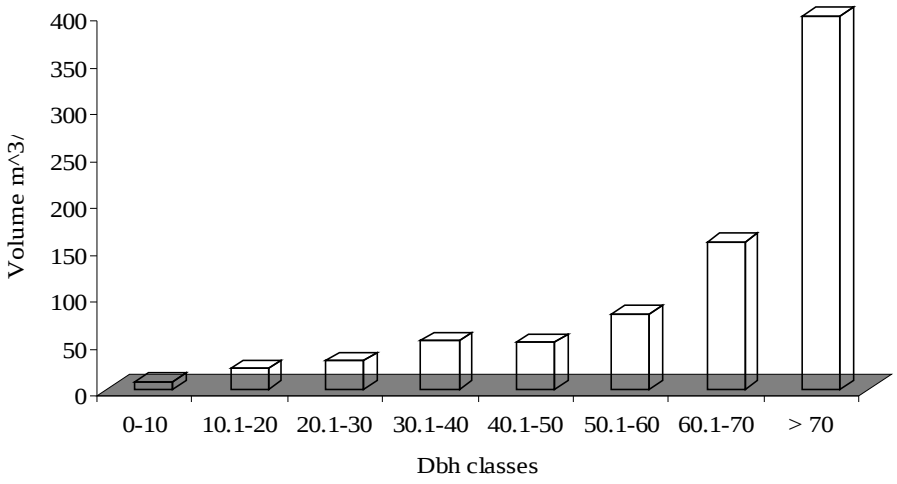

Figure 17: Distribution of tree volume by diameter classes for Chief Kingalu Sacred Forest Reserve.

4.1.3.2 Corporate/private regime (Tangeni Roman Catholic Church Forest Reserve) versus Communal regime (Misumba Village Forest Reserve)

Tree volume is the most reliable parameter on describing the quantity of merchantable Lumber of a stand (Zahabu, 2001). Table 5 shows that volume for the corporate/private (Tangeni Roman Catholic Church Forest Reserve) (122 ± 10 m^3/ha) was significantly (p=0.000) higher than communal regime (Misumba Village Forest Reserve) (23 ± 9 m^3/ha). Zahabu and Katani (2007) reported 18.22 ± 5.70 in Misumba Village Forest Reserve. These results were a bit lower compared to what has been observed in this study, perhaps this was attributed by growth within a period of three years resulted into increase in height and diameter hence high volume.

Higher volume in the private tenure than communal regime could be associated with better management. It was found that, although Tangeni Roman Catholic Church Forest Reserve is under corporate/private regime there was very strong collaboration with local people in the management of the forest. During key informants interview with Tangeni Roman Catholic Church leaders they elucidate the strong corporation existing between the Church and Village Natural Resource Committee (VNRC). This probably has contributed to the reduced forest disturbance and illegal harvesting which have resulted into larger volume for the church forest. According to Kajembe *et al.* (2004b) involvement of local people in the management of forest resources facilitates improvement of forest condition. Distribution of volume in diameter classes for both forest did not follow the normal 'J' shape trend indicating that small diameter trees contribute more to the volume of the forest (Figures 18 and 19).

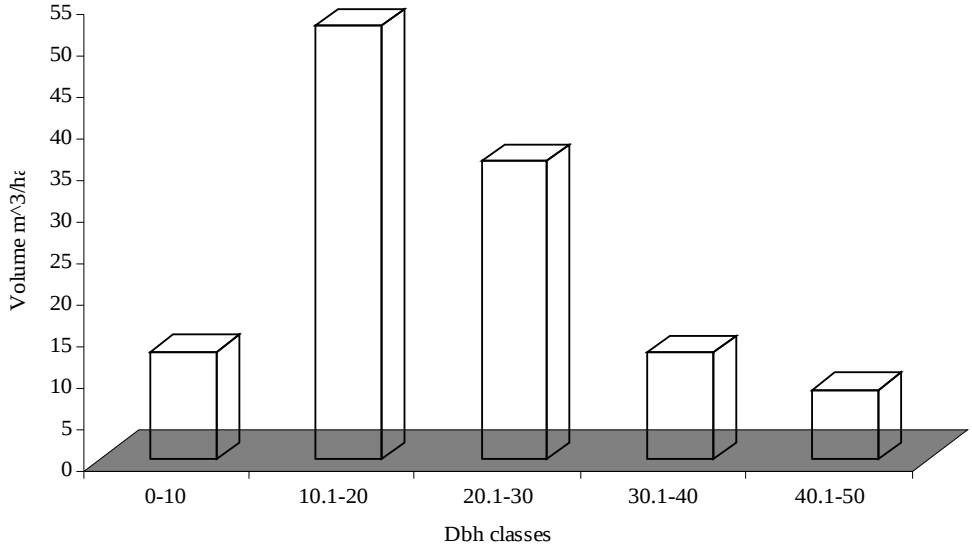

Figure 18: Distribution of tree volume by diameter classes in Tangeni Roman Catholic Church Forest Reserve.

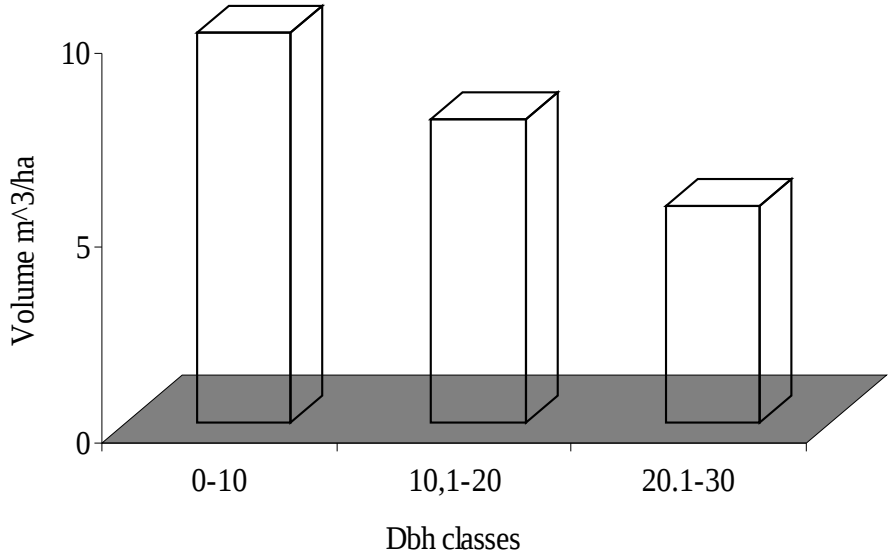

Figure 19: Distribution of tree volume by diameter classes in Misumba Village Forest Reserve.

4.2 Influence of Forestland Tenure Regimes on Tree Species Diversity

4.2.1 Overview

Tree species diversity refers to the variety of tree species on particular habitat (Sharma, 1992). Uluguru Mountains have the highest genetic endemism with seven genera than other mountains in East Africa including *Impatiens, Dionychastrum, Rhipidiantha, Pseudonesohedyoti, Lasianthus, Linnaeopsis* and *Stolzia* (URT, 2009). In this study Shannon winner and Simpson's indices were used to assess tree species diversity and evenness in different tenure regimes in Uluguru Mountain as shown in Table 6.

Table 6: Shannon winner and Symptoms diversity indices for the Uluguru Mountains

Tenure regime	Forest name	Vegetation type	Shannon winner Index (H')	Index of dominance (ID)
State	Uluguru Nature Reserve	Montane	3.48	0.04
Communal	Chief Kingalu sacred forest	Montane	3.21	0.05
Corporate/private	Tangeni Roman CCFR	Miombo	2.60	0.09
Communal	Misumba VFR	Miombo	2.53	0.14

4.2.2 Tree species diversity

4.2.2.1 Tree species diversity for the state regime (Uluguru Nature Reserve) versus communal regime (Chief Kingalu Sacred Forest Reserve)

Shannon-Wiener Index of diversity (H') was used to determine tree species diversity. The H' was calculated using natural logarithms for the state (Uluguru Nature Reserve) and communal forests (Chief Kingalu Sacred Forest). Results show that there was high species diversity in Uluguru Nature Reserve (3.48) than Chief Kingalu Sacred Forest (3.21). This probably is due to the government strategies of conserving catchment forest, by upgrading the forest into a Nature Reserve. According to classification of International Union of Conservation of Nature (IUCN) Nature Reserve is of high caliber in terms of conservation.

4.2.2.2 Tree species diversity for corporate/private regime (Tangeni Roman Catholic Church Forest Reserve) versus communal regime (Misumba Village Forest Reserve)

Results indicated that there was higher species diversity (2.60) in the corporate/private (Tangeni Roman Catholic Church Forest Reserve) compared to communal forests (Misumba Village Forest Reserve) (2.53). The conceivable reason could be illegal harvesting that was taking place in the communal forest. Discussion with village leaders revealed that there was illegal harvesting of valuable tree species including *Pterocarpus angolensis* and *Combretum mole* at night. This was evidenced during the forest inventory where a number of stumps were observed. Furthermore, illegal harvesting of valuable tree species in the communal forest may be attributed by limited funds and human labour to enforce the rules. This is evidenced by the fact that all the management initiatives introduced by the Wildlife Conservation Society Tanzania (WCST) including tree planting, provision of free seedlings to the villagers so that they can establish their own nurseries and woodlots, extension services on sustainable management have stopped after the project phased out.

The H’ value in this study is comparable to what has been found in other studies in miombo woodlands. Nduwamungu, (1996) and Zahabu (2001) reported H’ value of 3.79 and 3.13 respectively in the miombo woodlands of Kitulangalo forest reserve Morogoro, Tanzania. Recent studies in miombo woodlands of Igombe river forest reserve, Tabora, Tanzania by Mafupa (2006) and Handeni Hill forest reserve, Tanga, Tanzania by Mohamed (2006) reported H’ values of 2.90 and 3.10 respectively. However, an ecosystem with H’ value > 2 has been regarded as high diverse in terms of species in the scale of 0-5 (Barbour *et al*., 1999). Therefore Uluguru Mountain forests have reasonably high tree species diversity.

4.2.3 The index of dominance

The index of dominance is used to measure the distribution of individuals among the species in the community (Lulandala, 1998). The interpretation is that the greater the value of the ID the lower the species diversity in the community and vice versa

4.2.3.1 State regime (Uluguru Nature Reserve) versus communal regime (Chief Kingalu Sacred Forest Reserve)

Table 6 shows that there was high species richness for the state regime (Uluguru Nature Reserve) (0.04) compared to Communal regime (Chief Kingalu Sacred Forest) (0.05). This probably is due to the efforts put in place by the Government of Tanzania and NGOs on the conservation of biodiversity in Tanzania and Uluguru Mountains in particular. The country has been acknowledged as one of the most important nations in Africa for biodiversity conservation and this is one of the Tanzania's greatest assets (NEAP, 1994). The Eastern Arc Mountains in particular are designated as one of the 20 Global Biodiversity Hot Spot Areas (NEAP, 1994; Lulandala, 1998). Currently the forest has been promoted as the nature reserve and become world heritage site (URT, 2009). Furthermore, interviews with Village Leaders and Forest Officers revealed that there were very few fire incidences in Uluguru Nature Reserve as compared to other places in the Uluguru Mountains.

4.2.3.2 Corporate/private regime (Tangeni Roman Catholic Church Forest Reserve) versus communal regime (Misumba Village Forest Reserve)

Table 6 shows that there was high specie richness in Corporate/private regime (Tangeni Roman Church Forest Reserve) (0.09) compared to Communal regime (Misumba Village Forest Reserve) (0.14). The most likely reason could be associated the tendency of tree felling in the communal compared to cooperate/private regime. Discussion with villagers

revealed that some people use money as strategic power to create cordial relation ship with village leaders to have free access to cut poles, firewood and timber. This exhibit poor enforcement of rules in the communal regime compared to corporate/private regime. According to Alemayehu (2007) strong rules governing church forests in Northern Ethiopia did massive improvement to tree species diversity, despite the low budget directed to them.

The results on tree species richness for this study can be compared to some studies in miombo woodlands. Mafupa, (2006) reported the ID value of 0.135 in disturbed stratum of Igombe river forest reserve Tabora. This value is low compared to what has been observed in this study. Probably this is due to the disturbances that have been observed to exist in this forest. Malimbwi and Mugasha, (2001); Zahabu, (2001) observed the ID values of 0.085, 0.092 and 0.065 at Mkindo and Kitulangalo (general lands and forest reserve), in Morogoro. These results were more or less similar to what has been found in this study.

4.2.4 Tree species regeneration

Forest regeneration is the act of renewing tree cover by establishing young trees naturally or artificially after the previous stand or forest has been removed. Natural regeneration originate from root sprouts (suckers), stump sprouts (shoots) or seeds while artificial regeneration involves direct seeding or by planting trees (Huaton, 1994). Natural regeneration can be an effective means of regenerating the forest when conditions including light, heat, moisture and space are right. Although natural regeneration is reliable and ensures that only the trees suited to the site (i.e. the species already on the site) are established, the time delays in achieving regeneration can be long (Hamilton and Bensted-Smith, 1989). Moreover, the opportunities for genetic enhancement are limited (Lulandala, 1998).Despite these challenges, high regeneration potential is key factor for the perpetuity of the forest and the gauge of good tenure regime. There fore, in this study natural

regeneration potential in four forests under different tenure regimes in Uluguru Mountains was assessed and compared based on the vegetation types (Table 7).

Table 7: Tree species regeneration in four tenure regimes in Uluguru Mountains

Tenure regime	Forest name	Vegetation type	Mean Regenerates
State	Uluguru nature reserve	Montane	15287 ± 121
Communal	Chief Kingalu sacred forest	Montane	9615±76
Cooperate/Private	Tangeni Roman CCFR	Miombo	8022 ±129
Communal	Misumba VFR	Miombo	10128±54

4.2.4.1 Tree species regeneration for the State regime (Uluguru Nature Reserve) versus Communal regime (Chief Kingalu Sacred Forest Reserve)

The study revealed that state tenure regime (Uluguru Nature Reserve) had 15287± 121 stems per ha from 24 different tree species with Dbh less than < 5 cm. Tree species recorded with high regeneration in this forest are shown in Fig. 20 and Appendix 9. These include *Ocotea usambarensis* (20%), *Scolopia zeyheri* (14%), *Celtis zenkeri* (9%) *Dioscorea lonicuspis* (9%), *Scrodophleus fischer* (9%) and *Ficus kirkii* (8%).

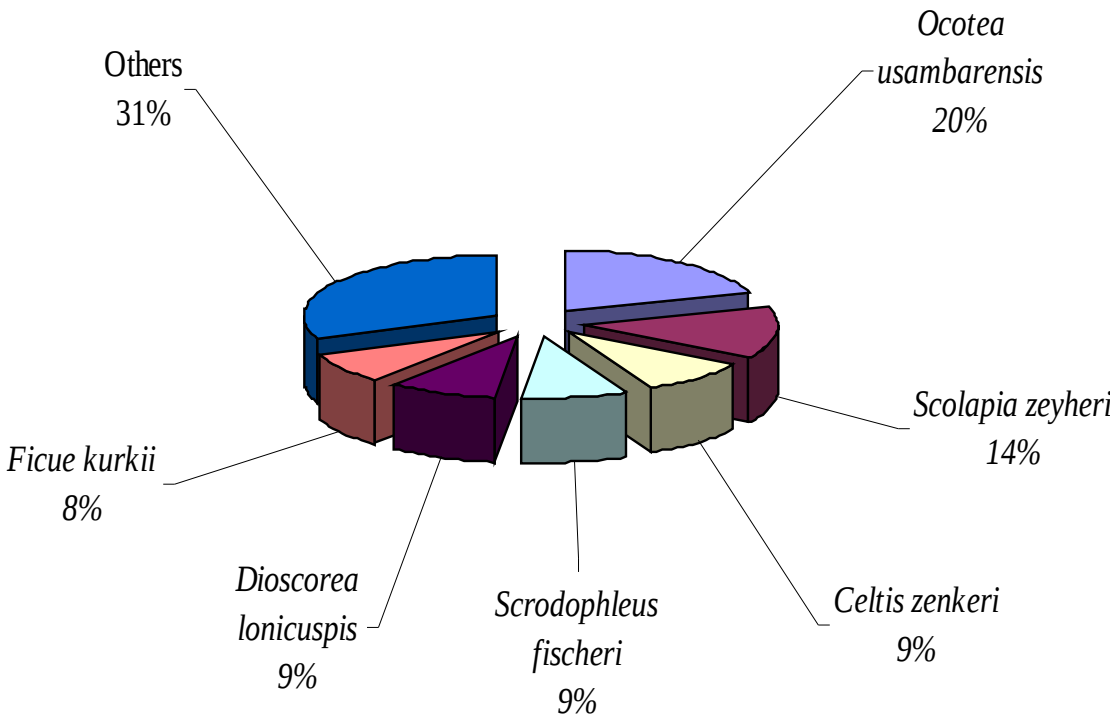

Figure 20: Percentage distribution of regenerants in the Uluguru Nature Reserve.

On the other hand the communal tenure regime (Chief Kingalu Sacred Forest Reserve) had an average of 10962 ± 116 stems per hectare from 12 different species with Dbh less < 5 cm. Trees recorded with high regeneration potential in this forest include *Afzelia quanzesis (31%), Lyptonychia usambarensis (12%), Ficus stuhlmanii* (*12%), Allanblackia ulugurensins (9%), Chrysophyllum spp (7%) and Ficus exsperata (7%)* as shown in Figure. 21 and Appendix 10.

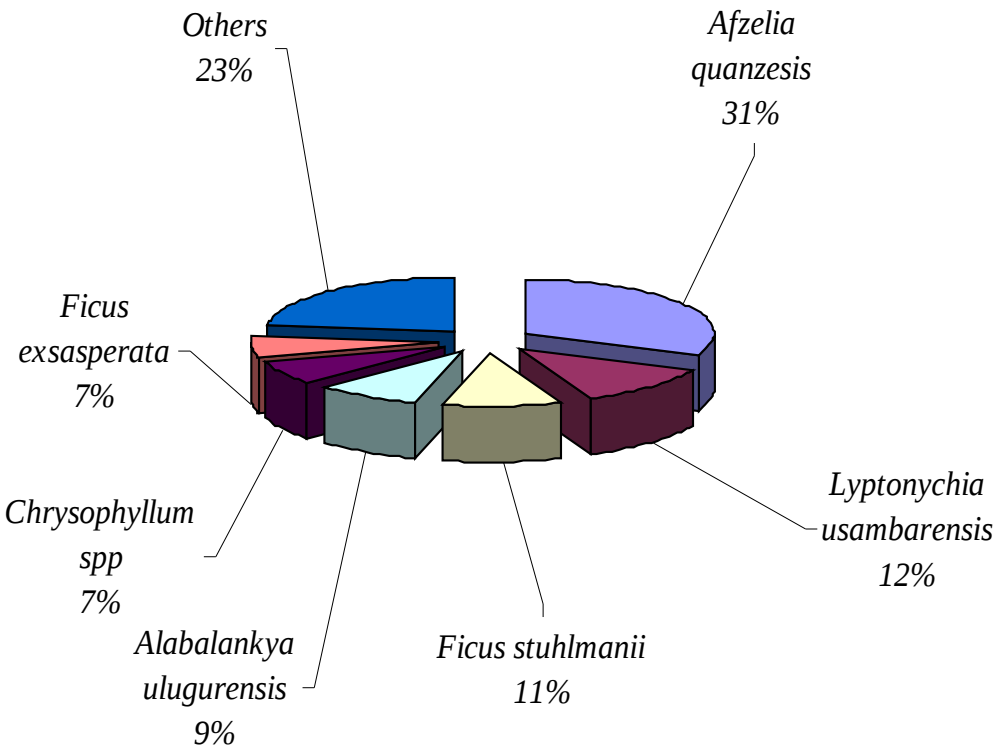

Figure 21: Percentage distribution of regenerates in the (Chief Kingalu Sacred Forest Reserve.

On comparing the regeneration potential of these two tenure regimes the study revealed high regeneration in the state (Uluguru Nature Reserve) than communal (Chief Kingalu Sacred Forest). The most plausible reason could be effective laws enforcement on conservation measures which has resulted into reduced disturbances. These disturbances include; fire incidence, timber logging, firewood and poles collection that were reported to have taken place in the state forest. According to Malimbwi and Mugasha (2002) reduced forest disturbances through harvesting tend to induce regeneration of plant species. On the other hand, low regeneration potential depicted in the communal tenure regime, probably due to the presence of big trees including *Ficus sycomonus*, *Ficus stuhmanii and Allabalackia ulugurensins* which formed closed canopy that suppressed other tree species

regeneration. Katani, (2010) reported that, presence of big trees in the Chemichemi micro spring forest in Ukerewe Island have suppressed the regeneration of other trees species.

4.2.4.2 Tree species regeneration for the corporate/private regime (Tangeni Roman Catholic Church Forest Reserve) versus Communal regime (Misumba Village Forest Reserve)

The study found an average of 8022 ± 129 stems per ha from 23 different species with Dbh < 5 cm in the Tangeni Roman Catholic Church Forest Reserve. Tree species found with high regeneration potential as indicated in Fig. 22 and Appendix 11 include *Diplorhnchus condylocaron* (19%), *Jurbernadia sp.* (14%), *Margarita discoidea (11%)*, *Albizia versicolor* (11%), *Pterocapus angolensis* (10%) and *Brachystegia boehmii* (5%).

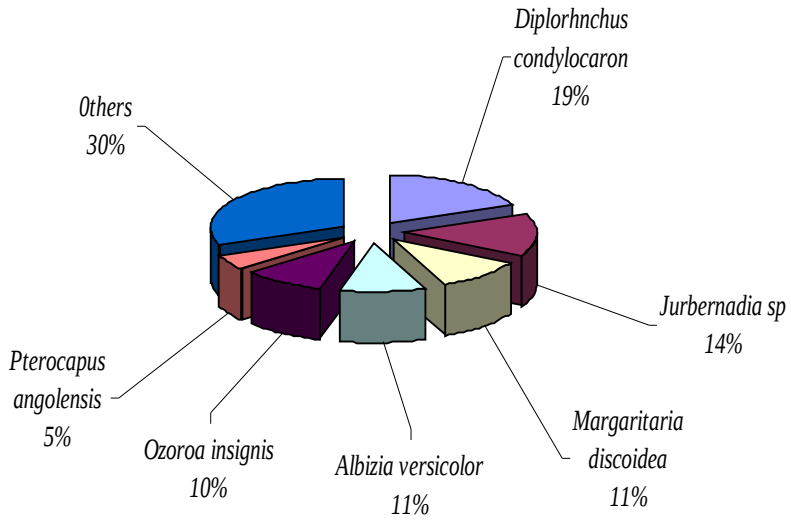

Figure 22: Percentage distribution of regenerants for the Corporate/private (Tangeni Roman Catholic Church Forest Reserve).

The study found an average of (10128±54) stems per ha from 23 different species with Dbh < 5 cm in the Communal regime (Misumba Village Forest Reserve). Tree species found

with high regeneration potential as indicated in Fig. 23 and Appendix 12 include *Julbernadia globiflora* (22%), *Mimbetembeta* (18%), *Annona senegalensis* (13%), *Brachystegia boehmii* (9%), *Brachystegia bussein (*11%) and *Diplorhnchus condylocaron* (5%).

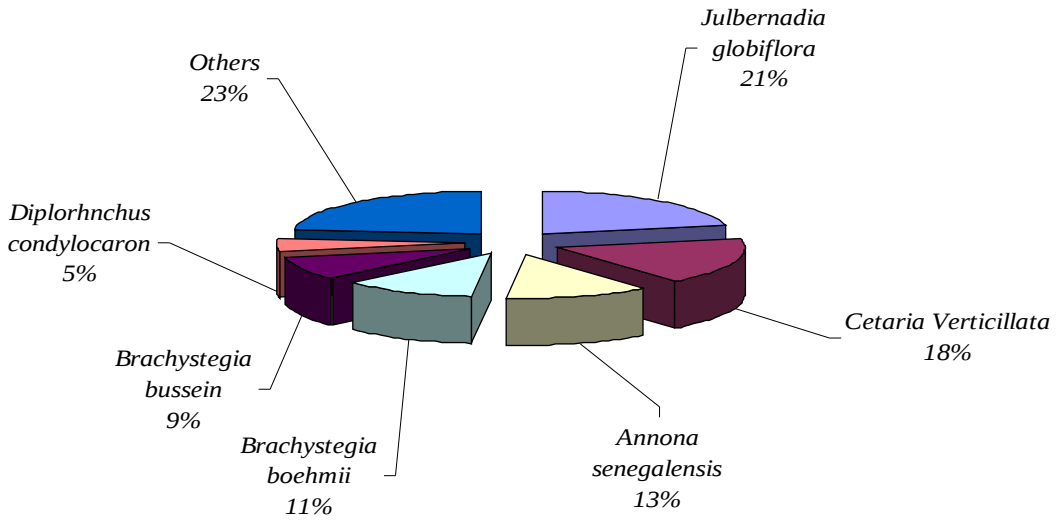

Figure 23: Percentage distribution of regenerants in Misumba Village Forest Reserve

The study revealed higher species regeneration for the communal tenure regime compared to Corporate/private regime. High regeneration in the Misumba Village Forest Reserve (Communal) is regarded to be contributed by high human disturbances experienced before tenure change from open access to CBFM following institutional rearrangement. Miombo species tend to regenerates faster through coppice regrowth and root suckers under favourable conditions of light, space and heat (Augspurger, 1984; Chazdon and Robert, 1991). Despite the high regeneration of *Jurbernadia globiflora* tree species in the Misumba Village Forest Reserve the study found valuable grasses (*Cetaria Verticillata*) for feeding livestocks and herbs (*Alovera spp*) used for making cosmetics and curing human disease including malaria and stomach ache (Plate 2).

Plate 2: Grass and herbs regenerants in the Misumba Village Forest Reserve

4.3 Influence of Forestland Tenure Regimes on Livelihoods

Ranking and scoring results presented in table 8 reveal that, state forestland tenure regime represented by Uluguru Nature Reserve was the most influential with regards to contribution to livelihood capitals as it ranked first. According to Kajembe and Kessy (2000) local people are the best assessors of the relative importance of various forest management regimes based on their roles. Livelihoods capitals discussed in this study include social, human, physical, political, natural, cultural and financial.

Table 8: Ranking order of tenure regimes in relation to the contribution to livelihood capitals

Tenure regime	Forest name	Vegetation type	Scores	Rank
State	Uluguru Nature Reserve	Montane	3	1
Communal	Misumba Village Forest Reserve	Miombo	2	2
Corporate/private	Tangeni Roman Catholic CFR	Miombo	1	3
Communal	Chief Kingalu Sacred Forest	Communal	0	4

Uluguru Nature Reserve is a state forest under the central government governed by formal institutions including forest policy (URT, 1998) and forest Act No 14 (URT, 2002).

Through such institutional arrangement extraction of forest recourses is illegal. However local communities residing around Uluguru Nature Reserve are entitled to extract Non Timber Forest Products (NTFP) and some do illegally extract timber for commercial purposes. This probably has facilitated high contribution to local communities' livelihoods hence ranked first. These results are in line with what Kajembe *et al*. (2004a) reported for state forests in Tanzania contributes more to the livelihood of people due to poor monitoring associated with few number of manpower. Consequently such type of forests behaves like open access resource regime due to poor enforcement of laws. On the other hand, Misumba village forest reserve (communal) is owned and managed by the village council, on behalf of the villagers. The forest is governed by village by-laws under Village Natural Resource Committee which does not allow extraction of forest resources. Currently its main objective is nature conservation for present and future generation. Furthermore, Tangeni Roman Catholic Church Forest Reserve is a Private/corporate church property leased since 1953 and does not allow extraction or accessibility to the forest. Chief Kingalu Sacred Forest is governed by traditional norm and taboos. The forest is meant for ritual purposes no one is allowed to enter the forest without the chief's permission. Therefore, the access rules for these three tenure regimes have alienated the communities from the use of forest resources hence poor contribution to livelihoods, while this is in contrary with the forest policy objectives of improving forest condition together with the local communities' livelihoods. It could be better if the livelihood promotion could be given prominent.

4.3.1 Influence of the state regime on social capital

The social capital describes the social resources people draw in the pursuit of their livelihoods (DFID, 2001). Indicators of social capital including trust between Uluguru Nature Reserve management and local communities; collaboration with local institutions in the management of Uluguru Nature Reserve; collective action between Uluguru Nature

Reserve and local community; and ability to conduct meetings and networking were rated using Likert scale. Table 9 summarises results on peoples' perceptions on influence of Uluguru Nature Reserve on social capital. The results revealed that the perceived level of social capital of the respondents in Tangeni and Tandai villages towards Uluguru Nature Reserve were 73% satisfactory while 15% were good and only 12% of the respondents claimed to be poor. Peoples' perceptions on social capital in these villages was not significantly different at Chi-square 2.957 and p=0.228.

Table 9: Perception level on the influence of Uluguru Nature Reserve on social

Social capital	Village names		Total	Chi-square	p
	Tangeni	Tandai			
0-3.4 (Poor)	4 (13)	3 (10)	7 (12)		
3.5-5 (Satisfactory)	20 (67)	24 (80)	44 (73)	2.957	0.228
5.1-7 (Good)	6 (20)	3 (10)	9 (15)		
Total	30 (100)	30 (100)	60 (100)		

Numbers in the brackets are percentages of respondents

This study depicted that trust was satisfactorily enhanced by the central government in the management of Uluguru Nature Reserve (state). A plausible explanation for this is that village governments in the study villages are given power to manage Uluguru Nature Reserve in partnership with central government. According to Shahbaz *et al.* (2008) Joint Forest Management seeks to develop partnership between stakeholders, particularly between local communities and the state to manage forests sustainably on the basis of friendly relationship and trust.

It was revealed that, strong collaboration was satisfactorily enhanced in the management of Uluguru Nature Reserve. It was found that formal rules (village by-laws) enforced by Village Natural Resource Committees (VNRC) and informal rules (controlled by clan leaders) together are used in the management of Uluguru Nature Reserve. Different clans were found to exist around Uluguru Nature Reserve. Traditionally, these groups are

responsible for controlling illegal activities and handling incidences of forest fires. The study revealed that setting fire in the forest and extraction of forest resources without permit is illegal. Violation to these rules were associated with fining Tsh. 50 000 or one being sent to jail for 5 years. Discussion held with Forest Officers declared these by-laws are operational and two cases in Tandai and one in Tangeni are currently at the court.

It was also found that people have engaged in collective actions in managing forest resources. In the study area, activities including tree planting, reporting to Forest Officers on illegal activities and fire fighting were done collectively. This suggests that people are willing to contribute free labour on forest conservation initiatives including combating fire incidences. Results on collective action are in line with what Minyuki and Boonttthavy (2004) argued on participation in forest management initiatives to increase awareness about the value of collective action on forest resource management.

Moreover, meetings were conducted regularly for the purpose of raising awareness to enhance collective action between local communities and Forest Officers on forest conservation issues. It was reported that meetings to deliberate issues concerning forest conservation are organized after every two months in Tangeni village while in Tandai village meetings are convened after every three months.

4.3.2 Influence of the state regime on human capital

At household level, human capital is the amount and quality of labour available. This varies according to household size, skill levels, leadership potentials and health status (Mayers and Vermeulen, 2002). Indicators of human capital including contribution of Uluguru Nature Reserve on enhancing capability, skills and education, contribution of the Uluguru Nature Reserve on improving health status of the individuals and capability of Uluguru

Nature Reserve on utilizing human resource were rated using Likert scale. Table 10 summarises results on peoples' perceptions on influence of the Uluguru Nature Reserve on human capital. The study revealed that 50% of respondents' perceptions on human capital were satisfactory, 35% good and 15% poor. The Chi-square statistics showed that there was statistical significant difference on people's perception on human capital between Tangeni and Tandai villages ($\chi^2 = 9.740; p = 0.008$).

Table 10: Perception level on the influence of Uluguru Nature Reserve on human capital

Human capital	Village names		Total	Chi-square	p
	Tandai	Tangeni			
0-0.49 (Poor)	2 (6.7)	7 (23.3)	9 (15)		
O.5-7.4 (Satisfactory)	12 (40)	18 (60)	30 (50)	9.740	0.008
0.75-1 (Good)	16 (53.3)	5 (16.7)	21 (35)		
Total	30 (100)	30 (100)	60 (100)		

Numbers in the brackets are percentages of respondents perception interviewed

The significant difference on people's perception on human capital is mainly certified by the efforts put by the government of Tanzania in collaboration with donor agents (DANIDA) in enhancing formal education in Tandai than Tangeni village. It was found that formal education in Tandai village was from primary to secondary level while in Tangeni village it just at primary level. In Tandai village secondary school was built by central government in collaboration with Uluguru Nature Reserve and donor agents including the government of France and Norway. The school was built as incentive for the local communities to facilitate conservation of Uluguru Nature Reserve in collaboration with the government. These results can be interpreted that Uluguru Nature Reserve has attracted donors to facilitate the promotion of formal education in the study area. Nearly 61% of respondents interviewed had formal education. Thirty nine percent of its

respondents had no formal education. Those who lack formal education could be due to early pregnancies. Siegmann and Sadaf (2006) reported that high level of illiteracy of the residing communities of the north western forest of Pakistan is one of the obstacles in getting quality human resource in forest management.

With regards to the ability of Uluguru Nature Reserve to improve health status of the surrounding communities, the results revealed that majority of respondents (90%) have reported to collect medicinal herbs from Uluguru Nature Reserve for primary health care. These findings are in line with other studies which reported that up to 80% of the rural Tanzanians relying on medicinal herbs from the forests (Kitula, 2001). Certainly this is due to the fact that traditional medicines are relatively cheaper as compared to conversional medicines which are rather expensive for the poor to afford (Kitula, 2001; Ongugo *et al.*, 2004).

The study revealed further that central government in collaboration with NGOs including WCST; CARE, UMADEP and development partners including France, Norway and Canada have contributed in capacity building to the local people. Promoting conservation of Uluguru Nature Reserve is associated with capacity building in technical matters. It was found that a series of trainings, reflexive workshops and exposure visits organized by Uluguru Nature Reserve in collaboration with NGO's and donor agents have enabled communities to learn several aspects of technical management namely record keeping, preparation of operational plans and use of bricks for house contraction instead of poles.

Results showed that, about 29% of respondents interviewed combine livestock keeping with farming. Proprietors of small agro enterprises like goat and pig keeping, fruits farming have significantly contributed to improving technical skills to the local community. These

results concur with what Paundel *et al.* (2007) argued that forest tenure reform in Nepal facilitated skills and capacity building among the local communities.

4.3.3 Influence of the state regime on physical capital

Physical assets include private owned assets that can be used to increase labour and land productivity (such as farm, animals, houses, tools and machinery), publicly owned economic infrastructure (roads, markets and electricity) and social infrastructure (schools and hospital) (DFID, 2001). Table 11 presents results on peoples' perceptions on influence of Uluguru Nature Reserve on physical capital. The results showed that 73.3% of respondents' perceptions on physical capital were satisfactory, 12% good and 15% poor. The chi-square statistics ($\chi^2 = 3.739; p = 0.154$) did not show significant difference on peoples perception on physical capital between Tandai and Tangeni villages at $p<0.05$

Table 11: Perception level on the influence of Uluguru Nature Reserve on physical capital

Physical capital	Village names		Total	Chi-square	p
	Tangeni	Tandai			
0-0.49 (Poor)	2 (6.7)	7 (23.3)	9 (15)		
0.5-0.74 (Satisfactory)	25 (83.3)	19 (63.3)	44 (73.3)	3.739	0.154
0.75-1 (Good)	3 (10)	4 (13.3)	7 (12)		
Total	30 (100)	30 (100)	60 (100)		

Numbers in the brackets are percentages of respondents

Regarding influence of Uluguru Nature Reserve on house construction, the study showed that majority of respondents (95%) live in their own houses while 5% people live in rented houses. Seventy percent of the houses were built with burnt bricks and roofed with iron sheets. Despite the fact that most houses were built with burnt or mud bricks, roof frames, doors and windows were made of wood obtained from the Uluguru Nature Reserve. These results are in line with what Kajembe *et al.* (2004a) argued that extraction of building materials by local communities around Kwizu catchment forest reserve in Same district has facilitated improvement of their houses.

It was further found that Uluguru Nature Reserve has contributed to the improvement of infrastructure in the study area. Road construction is important for the development of marginal and fragile areas. Access to motorized transport has potential of broadening economic options. It was observed that there was high accessibility by gravel roads paved in critical portions in both study villages. This situation has facilitated easy transportation of goods to the market year round. Other types of infrastructure including markets, schools and health centers have been built in both villages by the central government in collaboration with Uluguru Nature Reserve and Donor agents as incentives to the local people in facilitating forest conservation.

4.3.4 Influence of the state regime on natural capital

The contribution of Uluguru Nature Reserve on enhancing natural capital based on indicators including forest condition, energy source, water supply and land distribution were rated using Likert scale. Table 12 summarises results on peoples' perceptions on influence of Uluguru Nature Reserve on natural capital. The results showed that 80% of the respondents voted for good while 18% for satisfactory and only 2% voted for poor. There was no significant difference on people's perception on the influence of Uluguru Nature Reserve on natural capital between the two study villages ($\chi^2 = 1.174; p = 0.556$).

Table 12: Perception level on the influence of Uluguru Nature Reserve on cultural capital

Natural capital	Village names		Total	Chi-square	p
	Tangeni	Tandai			
0-49 (Poor)	0 (0)	1 (3.3)	1 (2)		
0.5-0.74 (Satisfactory)	5 (16.7)	6 (20)	11 (18)	1.174	0.556
0.75-1 (Good)	25 (83.3)	23 (76.7)	48 (80)		
Total	30 (100)	30 (100)	60 (100)		

Numbers in the brackets are percentages of respondents

Results from forest inventory revealed that Uluguru Nature Reserve has good forest condition (Table 5). This condition has contributed in supplying forest goods and services to the surrounding communities. Findings from this study indicate that 87% of the respondents used firewood for both domestic and commercial purposes. 42% use timber for commercial purposes. Apart from wood, Uluguru Nature Reserve is rich in biodiversity (Fig. 20) hence, ensured sustainable supply of NTFPs including medicinal plants, vegetables, fruits, climate amelioration, aesthetic value and cultural practices. According

Pokharel *et al.* (2007) good forest condition has significantly improved contribution of NTFPs to the forest residing communities in Nepal.

Water is an essential natural capital from the Uluguru Nature Reserve which is used not only for drinking but also for irrigation. It was revealed that the study sites are dissected by many rivers including Ngerengere in Tangeni and Mbezi in Tandai which is called Ruvu in down stream. Hundred percent of respondents reported to use free water from Uluguru Nature Reserve for domestic purposes (Plate 3).

Plate 3: River Ngerengere flowing from Uluguru Nature Reserve

Water from the Uluguru Nature Reserve is also used for irrigation. It was found that nearly 48% of the respondents interviewed had access to either river or stream water to irrigate vegetables during dry season. Nevertheless, stream water was not sufficient to meet their requirements. Results from PRA revealed that Morogoro Water and Sewage Authority (MOROWASA) and Dar es Salaam Water and Sewage Authority (DAWASA) have

conflictive relationship with farmers in the upstream. Farming along the river banks is associated with degradation of water sources which has resulted into water shortage in Morogoro urban, costal region and Dar es Salaam. Local people in the study area claimed that at down stream water is used for business by the government institutions but nothing is returned to the local communities for conservation purposes.

Land is an important natural capital for people living in Uluguru Mountains. The study revealed that agriculture is the main livelihood strategy around Uluguru Nature Reserve. Majority of respondents (90%) interviewed had their own land, 6% rented while only 4% have encroached Uluguru Nature Reserve. It was observed that Uluguru Nature Reserve has been encroached for growing bananas and marijuana (Plate 4). Shahbaz and Ali (2006) reported that, state forests in Pakistan are illegally encroached for agricultural purposes.

Plate 4: Portion of Uluguru Nature Reserve encroached for growing bananas

4.3.5 Influence of the state regime on cultural capital

Table 13 shows peoples' perception on the influence of Uluguru Nature Reserve on cultural capital. The study revealed that 73% of the respondents considered the influence being good while 22% of respondents voted for satisfactory while only 8% who voted as poor. The chi-square test did not show any significant difference on people's perception on

the influence of the Uluguru Nature Reserve on cultural capital between the study villages (Chi-square 0.372 and p=0.830).

Table 13: Perception level on the influence of Uluguru Nature Reserve on cultural capital

Cultural capital	Villages		Total	Chi-square	p
	Tangeni	Tandai			
0-0.49 (Poor)	3(10)	2(7)	5 (8)		
0.5-74 (Satisfactory)	7(23)	6(20)	13 (22)	0.372	0.830
0.75-1 (Good)	20(67)	22 (73)	42 (70)		
Total	30 (100)	30 (100)	60 (100)		

Numbers in the brackets are percentages of respondents

Source: Own field data 2009/10

Uluguru Nature Reserve contains sacred sites used as ritual sites. Discussion with village elders revealed that at times of natural hazards including drought, prolonged rains, and outbreaks of pest to crops including locust and armyworms traditional rituals are performed to overcome the situation. Ceremonies are conducted by clan heads. The ceremonies are associated with preparation of local brew some of which is given to ancestors as the sacrifice while the remaining is taken by the members. It was reported that in 1930 there was locust outbreak and tradition rituals were conducted to overcome the hazard and it is claimed that till recently there was no other outbreak that has taken place. The study conducted in Udzungwa National Park by Kajembe and Mbwambo (2000) reported about "Bokela" as a mountain God whereby local people offer scarifies in times of drought, diseases and famine.

High level of cultural capital is also associated with presence of features which have explicit cultural significance including stones, mountain lakes, grave yards, certain tree species including *Sterculia appendiculata* and *Ficus stuhlmanii.* Discussions with key

informants revealed that *Ficus stuhlmanii* is the most respected tree species by the Lugurus. The tree is used during serious illness to a person who believes that problem is associated with his or her ancestor's names. The tree bark is pilled and tied on the left arm of the patient, then the patient is given his or her ancestors name. *Sterculia appendiculata* is used during the girls' initiation ceremonies as the place to overcome misfortune. Shemdoe (2003) reported existence of sacred trees used for worshipping and offering sacrifices and other ritual purposes among the Maasai communities in Manjara Biosphere reserve.

Discussion with key informants revealed that despite the fact that Uluguru Nature Reserve is under central government, norms and taboos are still in use in the management of sacred sites within it. In Uluguru Nature Reserve there is Mountain Lake at Tangeni village where River Ngerengere is originating. At this place, no one is allowed to go without village elders and traditional healers. The place is governed by norms and taboos of the Lugurus and extraction of any resource is strictly prohibited. Damage or destruction of these sacred sites means that (i) the ancestors would be homeless and, (ii) the culture would be dead and water sources will disappear. These results concur with Banana *et al.* (2004) who reported that the disappearance of 'kintu' the king of Kabaka tribe in dense forest in Uganda attributed to inaccessibility by the residing community hence attributed to the resilience of the forest. Katani (2010) found that, Nzuitaka as one among the micro spring forest in Ukerewe Main Island is still managed by customary rules by the Bahila and Wasilanga clans and provides a great support of water sources to a number of the households.

4.3.6 Influence of the state regime on political capital

Table 14 shows peoples' perception on the influence of Uluguru Nature Reserve on political capital. The results revealed that the perceived level of political capital of the respondents were 80% good while 15% satisfactory and only 5% of the respondents

claimed to be poor. There was no significant difference (Chi- square 3.861 and p=0.145) on peoples perception on political capital between the study villages.

Table 14: Perception level on the influence of Uluguru Nature Reserve on political capital

Political capital	Villages		Total	Chi-square	p
	Tangeni	Tandai			
0-3.4 (Poor)	1 (3.3)	2 (6.7)	3 (5)		
3.5-5 (Satisfactory)	2 (6.7)	7 (23.3)	9 (15)	3.861	0.145
5.1-7 (Good)	27 (90)	21 (70)	48 (80)		
Total	30 (100)	30 (100)	60 (100)		

Numbers in the brackets are percentages of respondents

Focus group discussions revealed that due to series of training and exposure visits, the communities have gained confidence on public leadership. The study revealed that communities have voice and power to express their views concerning their fate on their livelihoods following the government agenda that needs them to be compensated and move from the Mountains to down stream. People did not hesitate to express their unwillingness to move to the down stream at Lubungo village. They compared that area with the desert. The village Chairman said “since majority of the villagers are subsistence farmers, it is impossible to grow crops yearly in the desert”. Interviews with Forest Officers showed that it is very difficult to induce new intervention in Uluguru Nature Reserve on conservation due to high political capital that community have. In Tandai, there is a portion of Uluguru Nature Reserve which is highly destructed due encroachment and deforestation. Uluguru Nature Reserve in collaboration with Vice President Office and development partners (France and Norway) secured funds for the rehabilitation for the purpose of including the area in JFM programme. Unfortunately, the local communities refused. This is because the matter was misunderstood by the villagers and it was sent to the national assembly for

resolution. Villagers had the feeling that village leaders are selling their land to whites and the whole process was stopped.

4.3.7 Influence of the state regime on financial capital

Financial capital denotes the financial resources that people use to achieve their livelihoods and it may include cash income, savings and ready convertible liquid capital (DFID, 2001). Indicators of the financial capital including sale of forest products, employment, ecotourism and fines were used to assess people's perception on financial capital. Table 15 shows peoples' perception on the influence of Uluguru Nature Reserve on financial capital. The results revealed that the perceived level of financial capital were 80% good while 13.3% satisfactory and only 6.7% of the respondents claimed to be poor. There was no significant difference at chi-square 2.217 and p=0.318 on people's perception on financial capital between the study villages.

Table 15: Perception level on the influence of Uluguru Nature Reserve on financial capital

Financial capital	Village names		Total	Chi-square	p
	Tangeni	Tandai			
0-3.4 (Poor)	2 (6.7)	2 (6.7)	4 (6.7)		
3.5-5 (Satisfactory)	5 (16.7)	3 (10)	8 (13.3)	0.747	0.583
5.1-7 (Good)	23 (76.7)	25 (83.3)	48 (80)		
Total	30 (100)	30 (100)	60 (100)		

Numbers in the brackets are percentages of respondents

The results showed that despite the fact that extractions of valuable forest resources in Uluguru Nature Reserve are strictly prohibited but the situation on the ground is different. Local communities living adjacent to the forest derive a number of valuable commercial products from the forest. Discussions with village leaders

disclosed that extraction of forest resources for commercial purposes such as timber and building poles occurs frequently. The study found that 65% of the households' income depends on the UNR to supplement daily earnings. This indicates that Central Government has not yet produced desirable results in conserving UNR since illegal activities are still rampant and apparently, forest exploitation has increased instead of decreasing. This probably has attributed to higher contribution to household income. These results concur with what Kajembe *et al.* (2004a) argued that despite the fact Kwizu Forest Reserve is managed by the state poor law enforcement has facilitated illegal extraction of forest resource hence improved local communities' income.

Moreover, it was revealed that there are a number of non-timber forest products extracted legally from the UNR for commercial and domestic purposes. For example, during fieldwork, beehives were observed in UNR. Kajembe and Kessy (2000) recommended beekeeping as an environmentally friendly income-generating activity that should be promoted by the local communities residing around forest reserves in Tanzania. Other non-timber forest products that are collected for sale in small quantities from the forest include local medicines, ropes, fruits (for example, *Vangueria infausta, Flacourtia indica*), and mushrooms. It was revealed that Uluguru Nature Reserve contributes 31.2% (Tshs 22 519) to the total household income per month. The results are in line with what other studies reported else where in Tanzania. Kajembe *et al* (2003) found that, non timber forest products are highly required by the local communities residing around Duru Haitemba Forest Reserve as a source of income and food to sustain livelihoods.

It was also revealed that there were some employment opportunities created by the Uluguru Nature Reserve for the purpose of supplementing household income. Discussion with village leaders showed that people were employed in planting trees along the forest boundaries and construction of infrastructure such as market, hospitals and schools funded by WCST, Care, UMADEP and NORAD in collaboration with Uluguru Nature Reserve. These results concur with what Kanel (2004) who observed that, participatory forest management has created job opportunities in Nepal that supplemented about 9% of the local communities' income.

The study revealed that commercial timber and poles harvesting have been banned in Uluguru Nature Reserve since 1979. Prior to the ban the formal right holders of Uluguru Nature Reserve (State) was entitled to receive the royalty on sales of forest wood. Since the ban some legal fees for non timber forest products and fines goes to the village government where the money is spent for building infrastructure including market, hospitals, schools buildings and road repair. These in turn can facilitate improvement of financial capital to the local communities. Moreover, the study revealed that UNR encourages eco-tourism to the surrounding communities. Discussion with village leaders revealed that there are groups of people responsible for guiding tourists to the different historical sites within the reserve and are paid 10 $ per trip. The tourists are also reported to buy different commodities including mats, pots, carvings and drums hence increase the local people's income.

4.4 Livelihood Capital with Highest Significance Influence to the Local People

Based on the local people preference and interest, respondents were asked to rank the seven livelihood capitals in terms of their importance to livelihoods. The PRA results in appendix

14 revealed that in all study villages financial capital was found to be prominent as it was ranked highest with a score of 6 which concur with questionnaire results where the financial capital scored the highest index of 0.85 (Table 16). Probably this is due to the fact that, of the seven livelihood assets, financial capital is the most versatile as it can be converted into other types of capitals or it can be used directly to attain livelihood outcomes. Certainly, this is because local communities residing around Uluguru Nature Reserve are entitled to extract Non Timber Forest Products (NTFP) and some do illegally extract timber for commercial purposes, perhaps this has contributed much to the local communities' income. Generally, the performance Uluguru Nature Reserve on livelihoods is at satisfactory level (0.73 which is equivalent to 73%).

Table 16: Livelihood Indices of dimension in Uluguru Mountain

SN	Livelihood index 0f Dimension	Village names		Average (N=60)
		Tangeni (N=30)	Tandai (N=30)	
1	Natural capital	0.81	0.77	0.79
2	Physical capital	0.63	0.60	0.61
3	Human capital	0.58	0.72	0.65
4	Social capital	0.64	0.62	0.63
5	Political capital	0.83	0.77	0.80
6	Cultural capital	0.76	0.81	0.78
7	Financial capital	0.82	0.88	0.85
	Average livelihood index	0.72	0.74	0.73

4.5 Socio-Economic and Institutional Factors Enabling or Constraining Ability of the Local Communities to Generate Income from Sale of Forest Products from Uluguru Nature Reserve

Table 17 shows the impact of socio-economic and institutional factors on income obtained from selling of forest products in the Uluguru Nature Reserve. Multiple linear regression models were employed in the assessment of socio-economic and institutional factors enabling or constraining the contribution of Uluguru Nature Reserve forest resources to local communities' income as the surrogate of livelihoods. The goodness of fit of the models was found to fit well with coefficient of determination (R^2) of 0.912 implies that independent variables explained about 91.2% variation of dependent variable. This study came up with the following socio-economic factors: market demand, household size, hunger duration, education level, and distance to the forest, land size (ha) and sex. Institutional factors include rule violation, prohibition and forestland tenure insecurity.

Positive correlation was depicted between income obtained by household from selling forest products from the Uluguru Nature Reserve and market demand, household size, rule violation, and hunger duration. On the other hand, negative correlation was depicted between income obtained by household from selling of forest products from the Uluguru Nature Reserve and prohibition, education level, forestland tenure insecurity, distance to the forest, land size (ha) and sex.

Table 17: Socio-economic and institutional factors that enabling or constraining household income from sell of forest products from Uluguru Nature Reserve

Socio-economic and institutional	Coefficients (a)		R^2 = 91.2	
factors X_i	B	S. E	t	Sig. (p value)
Market demand	0.239	0.130	4.161	0.000*

Household size	0.036	0.096	0.529	0.599 ns
Rule violation	0.005	0.182	0.054	0.957 ns
Hunger duration	0.148	0.123	1.813	0.076 ns
Prohibition from resource extraction	-0.128	0.090	-2.047	0.046*
Education level	-0.016	0.105	-0.264	0.793 ns
Tenure insecurity	-0.473	0.116	-7.425	0.000*
Distance to the forest	-0.009	0.114	-0.110	0.913 ns
Land size (ha)	-0.640	0.113	-7.746	0.000*
Sex	-0.010	0.076	-0.194	0.847 ns
Constant		0.382	9.254	0.000*

a Dependent Variable: Income level from sell of forest products from Uluguru Nature Reserve (Y_i). SE =Standard error of the estimate. *Statistically significant at 0.05 level of significance, ns = not statistically significant at 0.05 level of significance, β = Beta weight

4.5.1 Socio economic factors that enabling local communities to generate income from Uluguru Nature Reserve

4.5.1.1 Market demand

Market demand of forest resources is a function of the quantities buyers are willing and able to purchase, which depends on scarcity in local, national and international market (Kessy and Kingazi 2009). Reliable marketing demand of forest products from Uluguru Nature Reserve contributes 50% of the local communities' income (Mitinje et al., 2007).

Table 17 shows that increasing market demand significantly (p=0.000) contribute to increased household income from sell of forest resources from the Uluguru Nature Reserve. Table 18 gives summary results of household income from selling of some forest products from Uluguru Nature Reserve. It was reported by 84% of respondents interviewed during the survey reported that, there are market opportunities for products obtained from Uluguru Nature Reserve. It was observed that Uluguru Nature Reserve is closer to the big cities of Morogoro, Coastal region and Dar es Salaam where there are high market opportunities for forest products. Timber and poles from Uluguru Nature Reserve have high demand for building purposes while firewood is important resource for bricks making and cooking. Average annual income of about Tsh. 276 666 per household could be obtained from selling timber in study villages. Forest food including honey is in high

market demand. It was found that about Tsh. 30 000 per year were accrued by households from honey sales. In addition, honey is used as medicine to cure diseases associated with stomach upset, cough and skin burn. These findings are supported by FAO (1989) and McNeely *et al.* (1993), who reported that liable market demand of forest resources has been extensively used as an attractive measure world wide for encouraging communities to sustain their livelihoods.

Table 18: Household income from selling of some forest products from Uluguru Nature Reserve

Product	Estimated average annual income per households in (Tsh.)
Timber	276 666.00
Poles	113 000.00
Weaving	64 000.00
Honey	30 000.00
Firewood	23 000.00
Medicine	15 000.00

4.5.1.2 Household size

In African context a household is unit made up of not necessarily husband, wife and children but there are polygamous and extended families (Mbeyale, 2009). Family size determines per capita collection and utilization of Uluguru Nature Reserve forest products. Table 17 shows that household size has a positive correlation (Beta = 0.036) but is not statistically significant (p=0.599) with income obtained by household from selling of forest products from the Uluguru Nature Reserve. This implies that although the relationship was not significant but increasing household size is likely to increase income from selling of forest products. Table 19 summarizes results on distribution of household by family size. It was found that households with 1-3 people constitute 11.1% while households with family size 4-6 people were 46.7% and households with more than 6 people were 41.7%. Large family size stimulates high extraction of forest resources for selling. These findings concur

with Kessy (1998) who reported that development pressure over resources particularly forest resources is caused by increasing human population. This is because increased human population increases demand for different products from the forest (Mayeta, 2004). WRI *et al*., (1992) reported that increased demand for resources, which emanate from increased human population, has made resource use in rural areas unsustainable.

Table 19: Percentage distribution of respondents by household size

Household size	Village name		Total
	Tangeni (n=30)	Tandai (n=30)	
1-3 people	2 (6.7)	5 (16.7)	7 (11.1)
4-6 people	16 (53.3)	12 (40)	28 (46.7)
Above 6 people	12 (40)	13 (43.3)	25 (41.7)
Total	30 (100)	30 (100)	60 (100)

Numbers in bracket are in percentage

4.5.1.3 Hunger duration

Hunger duration experienced by households is determinant factors for dependence on Uluguru Nature Reserve as source of livelihoods. Table 17 shows that hunger duration has a positive regression coefficient (Beta = +0.148). This means an increase in hunger duration increases the likelihood of the Uluguru Nature Reserve contribution to local communities' income. This implies that, a unit increase in hunger duration forces households to derive their income from Uluguru Nature Reserve by (0.148). Hunger duration is not statistically significant (p=0.076). Hunger duration experienced by households in the study area is within the average of 5.3 months.

The study found that maize, bananas, beans and root crops were the main food crops in all study villages. Nevertheless, respondents claimed that, harvest is low compared to food demand. It was found that 90% of the respondents purchase food yearly to compliment the

deficit as opposed to 10% who maintain food security yearly. Food shortage in the study area is attributed to drought which contribute (81%); inadequate land for agriculture (65%); use of poor agricultural implements and technologies (52%); poor land fertility (30%) and poor seed quality (4%), (figure 24). These results concur with those of Shetto, (1998) who reported that poor agricultural technologies, inadequate land and drought are the main causes of low crop yield in Tanzania.

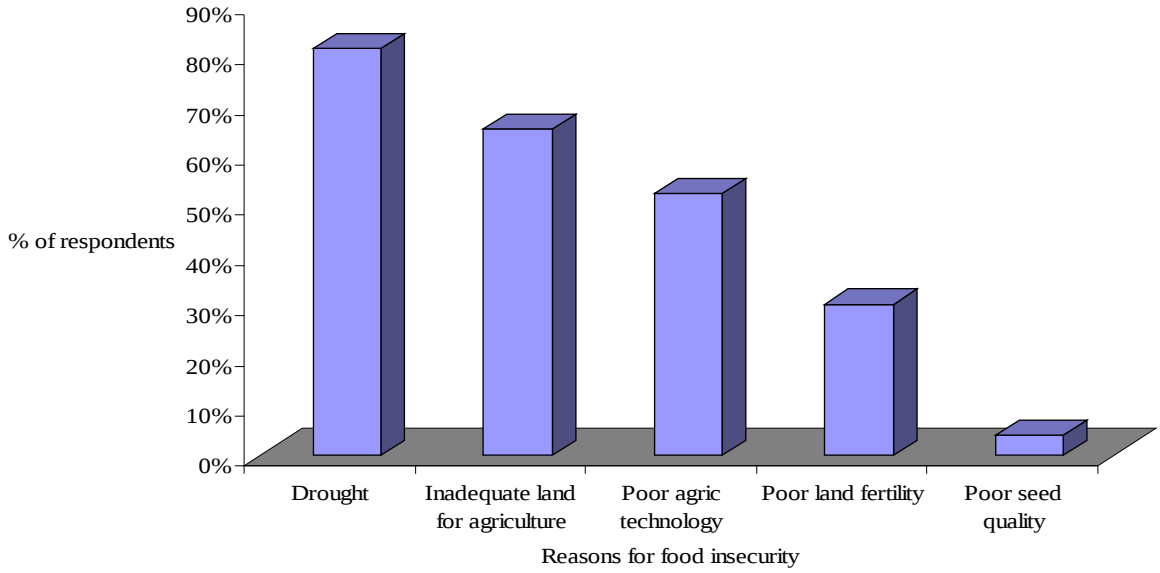

Figure 24: Reasons for food insecurity in the study villages.

During this period (November to Much) harvesting of forest resources from Uluguru Nature Reserve for sale was done by 65% of respondents to meet household requirements. This shows that hunger duration motivates people to extract forest resources as their livelihood strategy for income generation to cope with the situation. These results concur with those of Burgess *et al* (2002) who argue that, high extraction of forest resources and extension of farm land to secure food security has been the primary reason for forest loss in the Uluguru Nature Reserve which has resulted into reduced original forest cover from 500

km^2 to 230 km^2. Meshack (2003) reported that households obtain at least one third of their total income from forests in the West Usambara Mountais, Northern Tanzania. Other livelihood strategies adopted by households to cope during hunger periods include; food purchase (90%), engaged in petty business (71.7%), work as casual labour (55%), remittances (30%) and livestock (8%). Figure 25 shows livelihood strategies in the study area to cope with hunger situation.

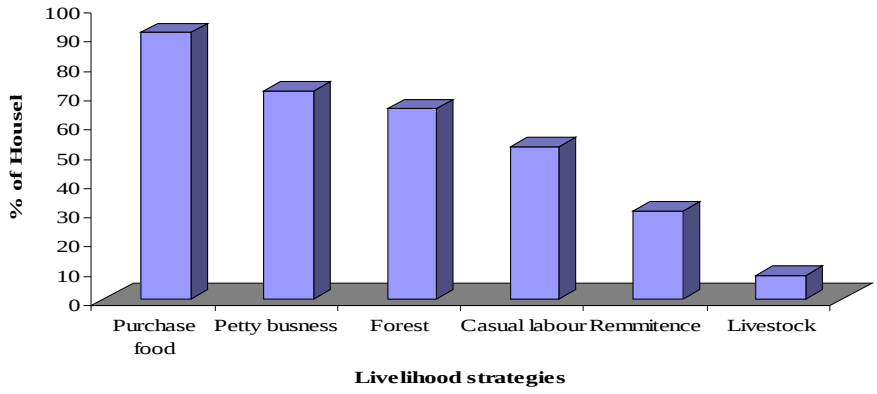

Figure 25: Livelihood strategies in the study villages during hunger duration.

4.5.2 Institutional factors enabling local communities' ability to generate income from Uluguru Nature Reserve

4.5.2.1 Rule violation

Rule violation is an anxious to defy control over use of forest resources infavour of private benefit (Kajembe *et al.*, 2004). Contravening rules governing access to forest resource by the residing communities increase the likelihood in extraction of forest resources for sell to supplement daily earnings. Table 17 shows that rule violation has a positive correlation (Beta = 0.005) and is not statistically significant (p=0.957) with income obtained by household from selling of forest products from the Uluguru Nature Reserve. This implies

that although the relationship was not significant but increasing rule violation is likely to increase income from sell of forest products. The study revealed that access to commercially important forest products such as timber, charcoal and poles is prohibited. About 25% of respondents interviewed mentioned to be involved in illegal timber harvesting from Uluguru Nature Reserve. These people have the tendency of using money as a strategic power so as to have more illegal access to timber harvesting from Uluguru Nature Reserve. They have established a cordial relationship with Forest Officers. Average monthly income accrued from sell of timber was about Tshs 276 000. This amount was observed to be higher compared to the minimum wage obtained by a person employed by the government (Tshs 135 000 per month). This indicates that access of the poor can easily be regulated while the more powerful actors can defy control which undermines rules compliance and legitimacy of the law. The results concur with what Kajembe *et al* (2004a) argued that despite the ban of extraction of valuable commercial products including timber and poles in Kwizu Catchment Forest illegal harvesting of such products persist.

The continued illegal extraction of forest resources was elucidated by village leaders and local communities show a clear institutional failure. Central government has shown a weakness in safeguarding the forest, a fact that is also manifested by the very few cases of criminal that have been tied while extraction of forest resources is still rampant. Moreover, it was observed that forest patrols are mostly practiced along the roads and not inside the reserve where the actual theft is done. Although each of the surrounding village has village environmental committee to deal with policing issues the *de facto* protection is not realized because the by-laws formulated are not yet to be enacted as legal instruments.

4.5.3 Institutional factors that constraining ability of household to generate income from sell of forest products from Uluguru Nature Reserve

4.5.3.1 Prohibition from resources extracting

Prohibition is a manner in which extraction of forest resources are legally banned for conservation purposes (Kajembe *et al.,* 2004). Table 17 shows that prohibition has a negative correlation (Beta = -0.128) and is statistically significant (p= 0.046) with income obtained by household from selling of forest products from the Uluguru Nature Reserve. This implies that increasing prohibition is likely to reduce income from selling of forest products. The study revealed that access to commercially valuable forest products such as timber, charcoal and poles are legally prohibited. This is because harvesting of these forest resources is blamed to be associated with degradation and deforestation of the Nature Reserve. It was reported that any person caught by Forest Officers harvesting these valuable forest resources from Uluguru Nature Reserve is fined about Tsh. 50 000 and the logs and all his working gears are confiscated. Therefore prohibition has discouraged some households from extraction of forest resources for income generation

4.5.3.2 Tenure insecurity

Forestland tenure insecurity encompasses inability to have right to secure long-term access to land and resources, their benefits and the responsibilities related to these rights (Bruce, 1986). Table 17 indicate that, tenure insecurity has a negative regression coefficient (Beta= -0.473) and statistically significant (p= 0.000). This shows that, the likelihood of the Uluguru Nature Reserve contribution to local communities' income is constrained by the state tenure regime. All respondents acknowledged that, UNR is owned by the government, even though they generally expressed their opinion that, the state tenure regime is a constraint to them in terms of the contribution their income. It was further observed that, communities in the study area are strictly prohibited from extraction of commercially

valuable forest products including timber, charcoal and poles. Therefore, challenge to the communities lie on ‘tenure’, they lack security with their user rights for valuable commercial products from the Uluguru Nature Reserve.

The uncertainty condition on securing local communities livelihoods shown in this study is contrary to forest policy objective of improving forest condition and well being of the local people. During the Discussion with Forest Officers, it was realized that, local community’s residing around the Uluguru Nature Reserve are involved in the management of forest resources through Village Natural Resource Committee, (VNRCs) under Joint Forest Management (JFM). Despite such collaboration local people residing Uluguru Nature Reserve have no *de jure* right over extraction of valuable forest resources. Discussion with village leaders disclosed that despite the fact that local communities are involved in the management of forest resource but there is no jurisdiction of formal joint management agreement, with appropriate user rights signed between them and central government.

Through such institutional arrangement, communities around UNR are not entitled to extract valuable forest products for selling to supplement their household income. Therefore having only *de facto* rights have constrained the local communities’ ability to generate income from Uluguru Nature Reserve. These results are in line with what Shemweta *et al* (2004) observed that having the *de facto* right over forest resources in Tanzania has constrained the ability of the local communities to secure their livelihoods. Monela, *et al.,* (2000b) reported that lack of property rights by the local communities residing around forest reserves in Tanzania is their major obstacle in extraction of forest resources for income generation hence discourages them to get involved in forest conservation in the long run. According to FAO (2001) security of tenure is a critical yet often under acknowledged component in determining how rural people can improve their

livelihoods and reduce poverty. Tenure, if clearly defined enables local communities to protect Forests Reserves from encroachment so as to increase their benefits.

4.5.4 Socio economic factors constraining ability of households to generate income from sale of forest resources from Uluguru Nature Reserve

4.5.4.1 Education level

Educational level is the determinant factor on enhancing capability and skills in performing different livelihood activities for income generation (Mohamedi 2009). Table 17 shows that education level has a negative correlation (Beta = -0.016) but not statistically significant (p=0.793). Although the relationship was not significant but increasing household level of education of respondents is likely to contribute to reduced household income from sell of forest products from Uluguru Nature Reserve. This implies that increasing level of education reduces level of dependence on forest resources.

Table 20 gives distribution of respondents by education levels. The findings showed that 28.3% of respondents interviewed had no formal education and 65% had attained primary level education. Few respondents (3.3%) had secondary education and 3.3% had acquired university education. People with high level of formal education are likely to secure good jobs in urban areas. Moreover people with high level of formal education have capacity and skills in engaging in other economic activities. This situation reduces dependence on forest products as a source of income. These findings concur with those argued by Ojating and Student (1997) cited by Lutatenekwa (2009) that modern education leads to capacity building to the local people hence reduce dependency to forest resources for income generation. Mitinje *et al.* (2007) argued that as people become more educated they shy away from most of tradition ways of life in favor of the modern ways of life including employment in companies and industries.

Table 20: Percentage distribution of respondents by education level

Education level	Village names		Total
	Tangeni	Tandai	
	(n=30)	(n=30)	
No formal	8 (26.7)	9 (30)	17 (28.3)
Primary	19 (63.3)	20 (66.7)	39 (65)
Secondary	1 (3.3)	1 (3.3)	2 (3.3)
University	2 (6.7)	Nr	2 (3.3)
Total	30 (100)	30 (100)	60 (100)

Numbers in bracket are percentages of respondents

4.5.4.2 Distance from homesteads to the Uluguru Nature Reserve

Distance is the leading factor for local communities' ability to generate income from forest resources. Closer distance of the households to forest makes the forest more venerable to extraction of resources due to low transport cost Lutatenekwa (2009).

Table 17 indicated that distance from homesteads to the Uluguru Nature Reserve is negatively correlated (Beta=-0.009) with income from selling of forest products. Table 21 gives percentage distribution of respondents by distance (km) from homesteads to Uluguru Nature Reserve. In this study distance from home to the Uluguru Nature Reserve was categorized into close, far and very far. It was found that majority of respondents interviewed during the survey are staying far (31.7%) and very far (56.7%) from the Uluguru Nature Reserve.

It was found that people whose households were located far from the Uluguru Nature Reserve have little influence regarding extraction of forest resources. The plausible explanation is that people who stay far away from the forest reserve usually are not depending very much on forest. As a result most of them tend to find alternative ways of income generation rather than extraction of forest resources and hence reduce household

income contribution from the forest. These findings corresponds to what Mohamed (2009) observed, longer distance from the residents to the forest discourage extraction of forest resources due to high transaction costs hence, reduces contribution of forest to house hold income.

Table 21: Percentage distribution of respondents by distance (km) from homesteads to Uluguru Nature Reserve

Distance	Village names		Total
	Tangeni	Tandai	
	(n=30)	(n=30)	
1-3 km (close)	5 (13.3)	2 (6.7)	7 (11.7)
4-6 km (far)	11 (36.7)	8 (26.7)	19 (31.7)
Above 6 km (very far)	14 (46.7)	20 (66.7)	34 (56.7)
Total	30 (100)	30 (100)	60 (100)

Numbers in bracket are percentages of respondents

4.5.4.3 Land size in (hectares)

Land is an important natural asset for the local people living in Uluguru Mountains, who are subsistence farmers (Mitinje *et al.,* 2007). Table 17 shows that land size is significantly (p=0.000) contribute to reduced household income from sell of forest products from the Uluguru Nature Reserve. The study revealed that 98% of household interviewed own land. Distribution of households by land size is given in Table 22. Results showed that majority (58%) of respondents owned farm size from 0.5-1.5 ha while others (28%) had farm size 1.6-2.5 ha and few (12%) had farm size above 2.5 ha and very few respondents had no land (2%). Regardless of land shortage respondents were able to practice agroforestry and establish woodlots. Several woodlots of *Eucalyptus, Grevilea*, and *Pines* were found to be established in the study area to substitute wood products from Uluguru Nature Reserve and contribute to household income. These findings concur with those of Rurai (2007) who reported that farmers with larger farm sizes tend to retain trees in their farms that enable

them to obtain essential products including firewood and construction material as a result they don't go to the catchments forest to collect those products and therefore contributes to resilience of the forest.

Table 22: Percentage distribution of respondents by land (ha) size residing around the Uluguru Nature Reserve

Farm size (ha)	Village names		Total
	Tangeni	Tandai	
	(n=30)	(n=30)	
0 (none)	0 (0)	1 (3)	1 (2)
0.5-1.5 (small)	14 (46.7)	21 (70)	35 (58)
1.6-2.5 (medium)	11 (33)	6 (23)	17 (28)
Above 2.5 (large)	5 (17)	2 (7)	7 (12)
Total	30 (100)	30 (100)	60 (100)

Numbers in bracket are percentages of respondents

4.5.4.4 Sex of the head of the household

Sex of the respondents has a profound influence on how men and women differ in the extraction and use of different types of forest resources as a source of income. Table 17 shows that sex was negatively correlated (Beta=-0.010) with income from sell of forest products from the Uluguru Nature Reserve. Distribution by sex between male and female heads of households by involvement in different forest activities is given in Table 23. The study revealed that in the study area there were inequalities between male and female regarding extraction of forest products from Uluguru Nature Reserve for sells. Women were not involved in timber harvesting from Uluguru Nature Reserve, because they are not able to camp for more than a week to harvest timber illegally. Few women were involved in harvesting of poles (26.7%), weaving materials (33.3%), honey (5%), firewood (25%) and medicinal plants (13.3%) compared to men. This shows that involvement of women on forest activities that are highly demanded at the market is low. This in turn reduces income

of women from sell of forest products from Uluguru Nature Reserve. These results concur with what Agarwal (2000) observed that despite the fact Nepal is wealth in forests resources products but women are marginalized on tangible benefits distribution and it was found that they are mere spectators than the beneficiaries.

Table 23: Distribution of men and woman headed households by forest activities

Forest activities	Sex	
	Men	Women
Timber	50 (83.3)	None
Poles	50 (83.3)	8 (26.7)
Weaving	40 (66.7)	20 (33.3)
Honey	12 (20)	3 (5)
Firewood	50 (83.3)	15 (25)
Medicine	6 (20)	8 (13.3)

Numbers in bracket are percentages of respondents

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Forestland tenure regimes prevailing in the Uluguru Mountains influenced differently tree stocking, tree species diversity and livelihoods. Comparisons made based on vegetation types including Montane for Uluguru Nature Reserve (state) and Chief Kingalu Sacred Forest (communal) and Miombo woodland for Misumba Village Forest Reserve (communal) and Tangeni Roman Catholic Church Forest Reserve (corporate/private) found that Uluguru Nature Reserve had higher stocking and tree species diversity compared to Chief Kingalu Sacred Forest. This implies that Political dynamics which has resulted into the abolishment of chiefdom in Tanzania in 1963 has undermined Chiefs power in managing forest.

In comparing corporate/private (Tangeni Roman Catholic Church Forest Reserve) and communal (Misumba Village Forest Reserve) characterized by Miombo woodland vegetation type, corporate/private tenure regime (Tangeni Roman Catholic Church Forest Reserve) had higher stocking and tree species diversity compared to communal (Misumba Village Forest Reserve). This shows that private forest with rights of occupancy (lease) has alienated the surrounding communities from forest use hence high stocking and trees species diversity compared to Misumba Village Forest Reserve which was open access before the implementation of CBFM.

The study found that forests are important natural assets for rural people with respect to contribution to their livelihoods through provision of different forest products. Among the four tenure regimes, Uluguru Nature Reserve under state was observed to be the most prominent in contribution to livelihoods in all study villages as compared to other three tenure regimes where their access rules have alienated the residing communities from the use of forest resources hence poor contribution to livelihoods. Certainly this was attributed by the fact that state forests in Tanzania behave like open access hence contribute more to the livelihoods of people.

Nevertheless, Uluguru Nature Reserve has long denied communities legitimate opportunities to use forest reserve resources as the source of income. Local communities have been deprived of autonomy and sovereignty over their forest resources. The study revealed that contributions of state tenure regime represented by Uluguru Nature Reserve to local communities' income is enabled or constrained by number of socio-economic and institutional factors. Multiple linear regression models were employed in the assessment of these factors. The study found that, enabling socio-economic factors were market demand, household size and hunger duration

whereas constraining socio-economic factors include education level, distance from homestead to the forest, land size and sex. Enabling institutional factor was rule violation. Constraining institutional factors include prohibition and tenure insecurity.

The goodness of fit of the model was found to fit well with findings of this study (91.2%) which is shown by a constant of 0.000. Generally, the classification power of the model was able to accurately explain by 91.2% of the household income derived from the forest by respondents which is enabled or constrained by a number of socio economic and institutional factors. Generally speaking, the study found that Uluguru Nature Reserve under state was a better tenure regime in improving forest condition and livelihoods than the other forestland tenure regimes which have successfully improved forest condition but livelihood promotion is still contested.

5.2 Recommendations

Based on the findings of the study, the following recommendations are pertinent

5.2.1 The need to conduct indepth forest inventory

For the purpose of sustainable management of the forests under different tenure regimes in Uluguru Mountains it is essential that an in-depth forest inventory is conducted so as to quantify stocking of tree and shrub species. This will serve as baseline data that will be used to compare forests dynamism under different tenure regimes and act as guide in the preparation of management plans which are important in forest management.

5.2.2 The Need of ensuring tenure security to the local people

There is a need of well arranged institutions under different tenure regimes which take into consideration the importance of tenure security and management autonomy as institutional

component which secure long term livelihood promotions of the local communities. This will shift from rhetoric to action oriented decentralized policies.

5.2.3 Need for initiation of alternative sources of income

More sources of income under different tenure regimes need to be initiated through provision of income generating activities including commercial tree nurseries, fish farming projects and intensifying beekeeping activities, so as to improve the livelihood of the adjacent communities. Without direct tangible benefits, poor communities are unlikely to carry on with forest protection over long run.

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APPENDICES

Appendix 1: Flora inventory field plot form

Date …….. Recorder …… Tenure type …….

Village …… Ward …… Division …….

Plot No. …….. Strata ……. Vegetation type …….

Trees

Code	Local name	Number of stems	Dbh (cm)

Regenerants count

Code	Local name	Number of stems

Appendix 2: A list of questions to guide focus group discussion

1. Ownership of different tenure regimes?
2. How are these tenure regimes managed?

3. How do you rate the contribution of the four tenure regimes to livelihoods?
3. Which institutions are involved regarding access to forest resources?
4. What are the objectives and roles of institutions?
5. How do local communities meet their livelihood needs?
6. Do forest resources under different tenure regimes contribute to livelihoods of local communities in any way?
7. Who have/are use/user right ? What resources?
8. How institutions facilitate the contribution of forest resources to local communities' livelihoods?
9. Are there market forces which prompt communities' collection of Uluguru Nature Reserve forest resources to meet their livelihood needs? What are they? How far are they located?
10. What are your responsibilities in the management of UNR?
11. What is the number and distribution of staff in the management of UNR? Is the number of staff adequate? If no why?
12. What are challenges in management of UNR? Way forward and strategies in improving management of UNR?

Appendix 3: A checklist used to guide discussions with key informants

a) Checklist to village leaders

1 What is the village population?
2 What is the population of farmer? Type of crops grown their population village wise
3 Social services and infrastructure? How many hospitals in each village?
4 Is there any contribution from UNR in contraction of these infrastructures?
5 What is the main income generating in the village?
6 What is the average household income per year?
7 What is the contribution of forest resources to house hold income?
8 What is the availability of resources from UNR?
9 Are they (Plenty/fair/scarce) Which resources? Why?
10 Are there market opportunities for forest resources? What are they? How far are they located
11 What services does UNR provide?
11 Are there any cultural and ritual activities done in the UNR? Mention them? When?
12 When are they done? For what purpose?
13 Do people have access to loans?
14 How is UNR managed?
15 What are the institutions regarding access to forest resource?
16 How do the institutions involved in the management of UNR facilitate the contribution to livelihoods?
17 Does the institutions enable or constraint contribution to livelihoods?
18 What is the role of local communities in the management of UNR?
19

b) Check list to forest officers

1 Please can you give us short description of management of Uluguru Nature Reserve?
   - What is the size of the UNR
   - Are the management plans?
   - Activities done
2 Description about UNR forest reserve?
   - What are the objectives of Uluguru Nature Reserve

- When was it declared as a Nature Reserve
- Management strategy
- Collaborative forest management
- Capacity of staff and their categories and enumeration
- Facilities, equipments and vehicles
- -Infrastructure, office, fire tower/or lookout tower

3 What are the types of threats, threatening UNR?
4 What are the solutions to these threats? Encroachment, Drought, Fire, disease
5 What are the socio- economics benefits the communities obtain from the forest?
6 How do you implement the new forest policy in the forest reserves?
7 Are the any interventions commenced to improve the residing Communities livelihoods?
8 What are the forest resources legal allowed to be extracted by the local communities?

c) Checklist to Chief Kingalu

1. History about Chief Kingalu sacred forest
2. What are the objectives of the sacred forest
3. How are the rules and regulation enforced? Does the surrounding community respect
4. What are the management problems and their causes
5. Management strategies to improve sacred forest
6. Number of times people allowed to enter in sacred forest
7. What are the activities done in sacred forest
8. Factors for sacred forest change in forest condition or compared to other tenure regimes
9. Comment on how sacred forest should be managed?

Appendix 4: Household Questionnaire

Date …….. Interviewer …… Village …… Ward …… Division …….

A: Household identification variables

No.	Item	Name/Number
1.0	Name of interviewee	
2.0	Questionnaire number	
3.0	Village name	
4.0	Ward name	
5.0	Division name	
6.0	Region name	

B: Household baseline data

1.0 Tribe of household head _____
2.0 Gender of respondent
- (i) Male _____
- (ii) Female _____

3.0 Age of head of household[years] _____
4.0 Marital status
- (i) Single _____
- (ii) Married _____
- (iii) Divorced _____
- (iv) Widowed _____

5.0 Education status
- (i) None _____
- (ii) Primary school _____
- (iii) Secondary school ____
- (iv) College/ University ____
- (v) Others[Specify] _____

6.0 Household size _____

Household composition

Age category	Male	Female
< 20 years		
20 – 40 years		
41 – 60 years		
> 60 years		

7.0 Residence period of respondent in the area[years] _____

8.0 Main household income generating activities

No.	Type of economic activity	Estimated annual income[TShs]
1.0	Agriculture	
2.0	Livestock keeping/Livestock	
3.0	Petty business	
4.0	Employment	
4.0	Collection of forest resources products	
5.0	Beekeeping	
7.0	Brick making[burning]	
8.0	Timber	

9.0 (a) Do you own land for agriculture?

(i) Yes _____

(ii) No _____

(b) If Yes in 9 (a), what is the land size cultivated _____ [ha].

(c) If Yes in 9 (a), how did you acquire the land?

1. buy
2. inheritance
3. hire
4. encroachment

(d) Type of crops cultivated

No.	Type of crop	Amount harvested	Amount sold	Income generated out of crop sale (TShs)
1.0	Maize			
2.0	Millet			
3.0	Sweet potatoes			
4.0	Cassava			
5.0	bananas			
6.0	pineapples			
7.0	Rice			
8.0	Citrus fruits			

10.0 Does the harvest satisfy your annual household food requirements?

(i) Yes

(i) No

11.0 Reasons for inadequate agricultural crop production if any?

(i) Use of poor agricultural tools and technology _____

(ii) Draught _____

(iii) Poor seed quality _____

(iv) No fertilization/ infertile soil _____

(v) Inadequate land for agriculture _____

12.0 If No in 11 what do you do to fill the deficit?

(a)

(i) Purchase food
(ii) Collect products and services from UFR
(iii) Provided by the government
(iv) Causal Lab our
(v) Reduce number of meals
(vi) remittances

(b) What is the distance from UFR to your residence (km) _____

(c) What is the hunger period (months) _____

13 Are there market opportunities for products and services from Uluguru Mountains forest?

(i) Yes
(ii) No

(e)How do you rate the demand of Uluguru forest products and/services?

(i) High
(ii) Average
(iii) Low

14 (a) Is there any institution(s) managing UFR?

(i) Yes
(ii) No

(b) If Yes in 2.0 (a), name the institution(s)

(e) Does your village have a forest management committee?

(i) Yes
(ii) No
(iii) Don't know

15 (a) Do you have access to credits/loans?

(i) Yes
(ii) No

(b) If Yes in 3.0 (a), who/which institutions provide the credit/loans?

(c) What is the status of access to credits/loans?

(i) Easy
(ii) Difficult
(iii) Very difficult

(d) What are reasons for your answer in 15 (c)?

(a) Do you collect and use products and services from chief Kingalu sacred forest?

(i) Yes
(ii) No

(b) If No in 6.0 (a), why? ----------

(c) For how long have you been engaged in collection and use forest resources?

(e) Do you use forest resources for income generation form chief Kingalu sacred forest?

(i) yes
(ii) No

If yes in e above Sale of products and services from Chief Kingalu forest sacred forest

No.	Product &/service	Amount sold	Unit price (TShs)	Total income per year (TShs)	Species	Gender 1. Male 2. Female	Accessibility 1.Freely; 2.Permition; 3. Illegally
1.0							
2.0							
3.0							

If yes in e above Sale of products and services from Uluguru nature reserve

No.	Product &/service	Amount sold	Unit price (Tshs)	Total income per year (Tshs)	Species	Gender 1. Male 2. Female	Accessibility 1.Freely; 2.Permition; 3. Illegally
1.0							
2.0							
3.0							

If yes in e above Sale of products and services from village forest reserve sacred forest

No.	Product &/service	Amount sold	Unit price (Tshs)	Total income per year (Tshs)	Species	Gender 1. Male 2. Female	Accessibility 1.Freely; 2.Permition; 3. Illegally
1.0							
2.0							
3.0							

If yes in e above Sale of products and services from Church forest reserve

No.	Product &/service	Amount sold	Unit price (Tshs)	Total income per year (Tshs)	Species	Gender 1. Male 2. Female	Accessibility 1.Freely; 2.Permition; 3. Illegally
1.0							
2.0							
3.0							

Appendix 5: Checklist for Uluguru Nature Reserve species code

Spp code	Botanical name	Local name	Spp code	**Botanical name**	**Local name**
1	*Maesopsis eminii*	Mlulu	26	*Ficus kirkii*	Msumba
2	*Caloncoba welwitschii*	Chitomvu	27	*Scrodophleus fischeri*	Mkande
3	*Funtumia africana*	Mbondwa	28	*Tragia brevipes*	Chiange
4	*Afrosersalisia sp.*	Msambwa	29	*Cussonia spicata*	Mbwimbwi
5	*Entandrophragma excelsum*	Mbokoboko	30	*Trichilia emetica*	Mnyangedu
6	*Ficalhoa laurifolia*	Msomolo	31	*Rhus vulgaris*	Msulu
7	*Strombosia scheffleri*	Msunguti	32	Schefflera lukwangulensis	Mlumangadu
8	*Ficus stuhlmanii*	Mtamba	33	*Ficus stuhlmanii*	Msunguwili
9	*Dracaena usambarensis*	Mdigisi	34	*Trilepsium madagascariense*	Chititu
10	*Sysygium spp*	Mmusu	35	*Vangueria infausta*	Msada
11	*Rubus scheffleri*	Mfifi	36	*Tragia brevipes*	Chundi
12	*Combretum schumannii*	Mpela mwitu	37	*Cyathea manniana*	Msembesembe
13	*Euclea divinorum*	Mlengela	38	*Erlangea cordifolia*	Msunguru
14	*Bombeya rotundifolia*	Mtati	39	*Dracaena usambarensis*	Msingizi
15	*Ocotea usambarensis*	Mseli	41	*Desmodium adscendens*	Mbugi
16	*Unkown*	Chiambaza	40	*Trichilia emetica*	Msembelele
17	*Mangifera indica*	Mwembe	42	*Unkown*	kizangwa
18	*Podocarpus latifolius*	Mnyanzili	43	*Leptonychia usambarensis*	Mmanga
19	*Scolopia zeyheri*	Mzona	44	*Isolana heinsenii*	Mkole
20	*Ficus lutea*	Mkuyu	45	*Terminalia mollis*	Mvumba
21	*Synsepalum cirasiferum*	Mkumbulu	46	*Xeroderris stuhlmannii*	Mng'eng'ena
22	*Newtonia buchananii*	Mkuvi	47	*Basella alba*	Derega
23	*Celtis zenkeri*	Msese	48	*Trema orientalis*	moza
24	*Parinari excelsa*	Mngama	49	*Dioscorea lonicuspis*	Dendego
25	*Macaranga kilimandschrica*	Mkongolo	50	*Justicia heterocarpa*	Mwidu

Appendix 6: Checklist for Chief Kingalu Sacred Forest species code

Spp code	Scientific name	Local name
1	*Trema oreintalis*	Mbefu
2	*Antiaris usambarensis*	Mbila
3	*Cinnamomum verum*	Mdalasini
4	*Musa sp*	Mdizi
5	*Artocarpus heterophyllus*	Mfenesi
6	*Ficus stuhlmanii*	Mfonza
7	*Triumfetta cordifolia*	Mfunvu
8	*Macaranga kilomandscharica*	Mgida
9	*Grevillea robusta*	Mgrevilea
10	*Synsepalum cerasiferum*	Mikumburu
11	*Erlangea cordifolia*	Misugusugu
12	*Khaya anthotheca*	Mkangazi
13	*Allanblackia ulugurensis*	Mkanyi
14	*Lyptonychia usambarensis*	Mkole
15	*Afzelia quanzesis*	Mkola
16	*Newtonia buchananii*	Mkuvi
17	*ficus lutea*	Mkuyu
18	*Xylopia aethiopica*	Mlawilila
19	*Chrysophyllum sp.*	Mlongelonge
20	*Schefftera lukwangulensis*	Mlumangudu
21	*Mnanaa*	Mnanaa
22	*Cocos nucifera*	Mnazi
23	*Albizia harveyi*	Mnguangua
24	*Vanhueria infausta*	Msada
25	*Ficus exasperata*	Msasa
26	*Cedrella odorata*	Msedelela
27	*Ocotea usambarensis*	Mseli
28	*Celtis gomphophylla*	Msenze
29	*Dracaena usambarensis*	Msigisi
30	*Ficus kirkii*	Msumba
31	*Ficus exasperata*	Mtamba
32	*Ficus sycomonus*	Mvulanze
33	*Milicia excelsa*	Mvule
34	*Berssama abyssinica*	Mfumba
35	*Bridelia micrantha*	Mwiza
36	*Bauhinia petersiana*	Mzigila

Appendix 7: Checklist for Tangeni Roman Catholic Church Forest Reserve species code

Specie code	Botanical name	Local name
1	*Macaranga kilinmandschrica*	Mdondoro
2	*Cussonia zimmermania*	Mdindilingoma
3	*Brachystegia bussei*	Mmanga
4	*Xeroderris stuhlmannii*	Mng'eng'ena
5	*Diplorhnchus condylocaron*	Mtogo
6	*Annona senegalensis*	Mzanng'we
7	*Jurbernadia sp*	Muhangala
8	*Margaritaria discoidea*	Mkwalekwale
9	*Acacia polyacantha*	Muwindi
10	*Bauhemia sp*	Mbalawala
11	*Ozoroa insignis*	Mpondelo
12	*Pterocapus angolensis*	Mninga
13	*Albizia versicolor*	Mnyanza
14	*Sterculia appendiculata*	Mgude
15	*Ficus stuhlmanii*	Mtamba
16	*Sclerocarya birrea ssp.caffra*	Mng'ongo poli
17	*Albizia harveyi*	Mvulamvula
18	*Combretum molle*	Mlama
19	*Entandrophragma excelsum*	Mbokoboko
20	*Senna siamea*	Mbiriti
21	*Dracaena sp*	Msenene
22	*Mangifera indica*	Mwembe
23	*Leptonychia usambarensis*	Mkole
24	*Grevillea robusta*	Mglevilea
25	*Psidium guajava*	Mpera
26	*Tabernaemontana pachysiphon*	Mlongelonge
27	*Cedrella odorata*	Msedelela
28	*Synsepalum cirasiferum*	Mkumbulu
29	*Piper umbellatum*	Mnembonembo
30	*Erlangea cordifolia*	Misungusungu
31	*Senna siamea*	Mkenge
32	*Vitex domiana*	Mfulu
33	*Syzgium cumini*	Mzambarau
34	*Brachystegia boehmii*	Myombwe
35	*Unknown*	Mesule
36	*Alovera spp*	Nzigili
37	*Unknown*	*MIfumba*si

Appendix 8: Checklist for the Misumba Village Forest Reserve species code

Spp code	Scientific name	Local name	Spp code	Scientific name	Local name
1	*Stereospermmum kunthianum*	Mng'eng'ena	19	*Senna siamea*	Mbiriti
2	*Annona senegalensis*	Mzang'we	20	*Pterocapus angolensis*	Mninga
3	*Julbernadia globiflora*	Mhangala	21	*Mangifera indica*	Mwembe
4	*Diplorhnchus condylocaron*	Mtogo	22	*Bauhenia sp*	Mkambala
5	*Margaritaria discoidea*	Mkwalekwale	23	*Ozoroa insignis*	Mpondelo
6	*Brachystegia bussein*	Mmanga	24	*Bauhenia sp*	Mbalawala
7	*Brachystegia boehmii*	Myombwe	25	*Dracaena sp*	Msenene
8	*Combretum molle*	Mlama	26	*Acacia polyacantha*	Muwindi
9	*Albizia versicolor*	Mnyanza	27	*Acacia hockii*	Mgunga
10	*Podocarpus latifolius*	Mnyanzili	28	*Piper umbrellatum*	Mnembonembo
11	*Parinaria excelsa*	Mngama	29	*Lecamodiscus flaxinifolius*	Mbewambewa
12	*Vitex ferruginea*	Mfulu	30	*Alovera spp*	Nzigili
13	*Cussonia arborea*	Mdindilingoma	31	*Dioscorea lonicuspis*	Derega
14	*Teminalia mollis*	Mmongwe	32	*unknown*	Mfumbasi
15	*Cussonia zimmerimannii*	Mkwangule	33	*unknown*	Mmiwamiwa
16	*Tectona grandis*	Mtiki	34	*Unknown*	Mdimilo
17	*Albizia petersiana*	Mkenge	35	*Elangea cordifolia*	Msaganumbu
18	*Khaya anthotheca*	Mkangazi	36	*Cetaria Verticillata*	Mimbetambeta

Appendix 9: List of tree species regenerants in Uluguru Nature Reverse

Spp code	Scientific name	Venarcular name	N/hectare
1	*Maesopsis eminii*	Mlulu	159
3	*Funtumia africana*	Mbondwa	159
4	*Afrosersalisia sp.*	Msambwa	159
7	*Strombosia scheffleri*	Msunguti	318
8	*Ficus stuhlmanii*	Mtamba	159
9	*Dracaena usambarensis*	Mdigisi	80
10	*Sysygium spp*	Mmusu	80
11	*Rubus scheffleri*	Mfifi	557
12	*Combretum schumannii*	Mpela mwitu	80
14	*Bombeya rotundifolia*	Mtati	239
15	*Ocotea usambarensis*	Mseli	3025
17	Mangifera indica	Mwembe	80
18	*Podocarpus latifolius*	Mnyanzili	239
19	*Scolopia zeyheri*	Mzona	2070
22	*Newtonia buchananii*	Mkuvi	239
23	*Celtis zenkeri*	Msese	1433
26	*Macaranga kilimandschrica*	Mkongolo	239
27	*Ficus kirkii*	Msumba	1274
28	*Scrodophleus fischeri*	Mkande	1354
32	*Schefflera lukwangulensi*s	Mlumangadu	159
39	*Dracaena usambarensis*	Msingizi	159
47	*Basella alba*	Derega	717
48	*Trema orientalis*	moza	398
49	*Dioscorea lonicuspis*	Dendego	1354
50	*Justicia heterocarpa*	Mwidu	557
	TOTAL		**15287**

Appendix 10: List of regenerating tree species with DBH < 5cm for the Chief sacred forest

Spp code	Botanical name	Local name	N
2	*Antiaris usambarensis*	Mbila	385
7	*Celtis gompghophylla*	Mfumvu	385
11	*Erlangea cordifolia*	Misungusungu	385
13	*Allanblackia ulugurensins*	Mkanyi	769
14	*Isolana heinsenii*	Mkole	1154
15	*Afzelia quanzensis*	Mkola	2308
19	*Tabernaemontana pachysiophon*	Mlongelomge	385
25	*Ficus exersperata*	Msasa	385
29	*Dracaena usambarensis*	Msenze	385
30	*Bridelia micrantha*	Msumba	385
31	*Ficus stuhlmanii*	Mtamba	1538
32	*Ficus sycomonus*	Mvulanze	1154
	TOTAL		**9615**

Appendix 11: List of Tree species regenerants in Church forest reserve

SPP CODE	Botanical name	Local name	N
1	Mdondoro	*Macaranga kilinmandschrica*	110
2	Mdindilingoma	*Cussonia zimmermania*	330
3	Mmanga	*Brachystegia bussei*	110
4	Mng'eng'ena	*Xeroderris stuhlmannii*	220
5	Mtogo	*Diplorhnchus condylocaron*	1429
6	Mzanng'we	*Annona senegalensis*	110
7	Muhangala	*Jurbernadia sp*	1099
8	Mkwalekwale	*Margaritaria discoidea*	879
9	Muwindi	*Acacia polyacantha*	110
10	Mbalawala	*Bauhemia sp*	110
11	Mpondelo	*Ozoroa insignis*	549
12	Mninga	*Pterocapus angolensis*	769
13	Mnyanza	*Albizia versicolor*	989
17	Mvulamvula	*Albizia harveyi*	110
18	Mlama	*Combretum molle*	110
19	Mbokoboko	*Entandrophragma excelsum*	110
26	Mlongelonge	*Tabernaemontana pachysiphon*	110
29	Mnembonembo	*Piper umbellatum*	110
30	Misungusungu	*Erlangea cordifolia*	110
34	Myombwe	*Brachystegia boehmii*	110
35	Mesule	*unknown*	220
36	Nzigili	*Aloveral spp*	110
37	MIfumbasi	*unknown*	110
	TOTAL		**8024**

Appendix 12: List of Tree species regenerants in Village forest reserve

Spp code	Scientific name	Vernarcular name	N/hectare
2	*Annona senegalensis*	Mzang'we	1154
3	*Julbernadia globiflora*	Mhangala	2179
4	*Diplorhnchus condylocaron*	Mtogo	513
5	*Margaritaria discoidea*	Mkwalekwale	256
6	*Brachystegia bussein*	Mmanga	897
7	*Brachystegia boehmii*	Myombwe	1282
8	*Combretum molle*	Mlama	128
9	*Albizia versicolor*	Mnyanza	128
10	*Podocarpus latifolius*	Mnyanzili	256
16	*Tectona grandis*	Mtiki	128
17	*Albizia petersiana*	Mkenge	128
27	*Acacia hockii*	Mgunga	128
29	*Lecamodiscus flaxinifolius*	Mbewambewa	128
30	*Alovera spp*	Nzigili	256
31	*Dioscorea lonicuspis*	Derega	128
32	*Unknown*	Mfumbasi	128
33	*Unknown*	Mmiwamiwa	128
34	*Unknown*	Mdimilo	128
35	*Elangea cordifolia*	Msaganumbu	128
36	*Cetaria Verticillata*	Mimbetambeta	1795
37	*Unknown*	Msovila	128
	TOTAL		**IO124**

Appendix 13: Matrix scores for Tenure regimes

Tenure regimes	URN	VFR	CFR	CSFR	Scores	Rank
URN	XX	URN	URN	URN	3	1
VFR	XX	XX	VFR	VFR	2	2

CFR	XX	XX	XX	CFR	1	3
CSFR	XX	XX	XX	XX	0	4

Appendix 14: Matrix scores for livelihood capital assets

Livelihood Capitals	Financial	Natural	Human	Physical	Cultural	Social	Political	Scores	R
Financial	XX	FC	FC	FC	FC	FC	FC	6	1
Natural	XX	XX	NC	NC	NC	NC	NC	5	2
Human	XX	XX	XX	HC	HC	HC	HC	4	3

Physical	XX	XX	XX	XX	PC	PC	PC	3	4
Cultural	XX	XX	XX	XX	XX	CC	CC	2	5
Social	XX	XX	XX	XX	XX	XX	SC	1	6
Political	XX	XX	XX	XX	XX	XX	XX	0	7

Key

R=Rank

FC=Financial capital NC=Natural capital HC= Human capital PC=Physical capital

CC=Cultural capital SC=Social capital

Appendix 15: Multiple indices for social capital

Village name	Perception on Trust	Perception on relation with other organization	Perception on collective action	Perception on conducting Meetings	Social capital indices
Tandai	5	3	3	7	0.64
Tandai	3	5	1	7	0.57
Tandai	1	5	1	7	0.50
Tandai	5	5	1	5	0.57
Tandai	5	1	5	5	0.57
Tandai	5	1	5	5	0.57
Tandai	5	5	5	5	0.71
Tandai	5	5	3	1	0.50
Tandai	7	5	5	3	0.71
Tandai	7	3	5	3	0.64
Tandai	1	5	5	3	0.50
Tandai	5	5	5	5	0.71
Tandai	5	5	3	7	0.71
Tandai	7	5	3	3	0.64
Tandai	5	5	5	5	0.71
Tandai	5	5	5	5	0.71
Tandai	7	7	7	7	1.00
Tandai	5	5	5	5	0.71
Tandai	1	3	5	3	0.43
Tandai	5	3	5	3	0.57
Tandai	3	5	7	3	0.64
Tandai	5	7	7	7	0.93
Tandai	3	5	5	3	0.57
Tandai	5	5	5	5	0.71
Tandai	7	7	7	7	1.00
Tandai	5	5	5	5	0.71
Tandai	1	5	1	5	0.43
Tandai	5	7	1	5	0.64
Tandai	5	3	5	1	0.50
Tandai	5	1	1	1	0.29
Tangeni	5	1	1	5	0.43
Tangeni	5	5	5	5	0.71
Tangeni	5	5	5	5	0.71
Tangeni	5	3	3	5	0.57
Tangeni	3	5	3	1	0.43
Tangeni	5	3	3	7	0.64
Tangeni	1	3	5	3	0.43
Tangeni	5	5	3	5	0.64
Tangeni	5	5	5	5	0.71
Tangeni	3	5	5	5	0.64
Tangeni	7	5	5	5	0.79
Tangeni	7	5	3	7	0.79
Tangeni	1	1	3	7	0.43
Tangeni	7	3	5	7	0.79
Tangeni	7	5	5	7	0.86
Tangeni	7	5	5	7	0.86
Tangeni	7	5	3	5	0.71

Tangeni	7	1	7	5	0.71
Tangeni	3	1	7	5	0.57
Tangeni	1	5	3	3	0.43
Tangeni	1	5	5	3	0.50
Tangeni	5	5	5	5	0.71
Tangeni	7	1	5	5	0.64
Tangeni	7	7	5	5	0.86
Tangeni	3	5	5	5	0.64
Tangeni	1	7	5	3	0.57
Tangeni	5	3	1	5	0.50
Tangeni	5	7	1	5	0.64
Tangeni	5	7	3	1	0.57
Tangeni	5	3	5	5	0.64

KEY

7= Very good 5=Good 3= Satisfactory 1= Poor

Social capital indices

0-0.49= Poor 0.50-0.74= satisfactory 0.75-1=Good

Appendix 16: Multiple indices for human capital

Village name	Perception on capability and skills	Perception on formal education	Perception on enhancing Health status	Perception on enhancing enterprises	Human capita indices

Tandai	5	7	5	5	0.79
Tandai	5	5	7	7	0.86
Tandai	5	7	7	5	0.86
Tandai	7	5	5	5	0.79
Tandai	1	3	5	5	0.50
Tandai	5	5	5	7	0.79
Tandai	5	7	5	1	0.64
Tandai	5	5	7	5	0.79
Tandai	5	5	5	3	0.64
Tandai	3	5	5	3	0.57
Tandai	5	3	5	5	0.64
Tandai	3	3	1	1	0.29
Tandai	5	5	3	5	0.64
Tandai	5	5	7	5	0.79
Tandai	7	3	5	5	0.71
Tandai	5	7	5	7	0.86
Tandai	5	1	1	3	0.36
Tandai	5	5	7	7	0.86
Tandai	7	5	5	3	0.71
Tandai	7	5	7	7	0.93
Tandai	5	7	7	5	0.86
Tandai	3	3	5	7	0.64
Tandai	7	7	7	5	0.93
Tandai	1	3	5	5	0.50
Tandai	5	5	1	5	0.57
Tandai	7	7	5	7	0.93
Tandai	5	5	5	5	0.71
Tandai	5	5	7	5	0.79
Tandai	5	5	5	7	0.79
Tandai	7	5	5	5	0.79
Tangeni	3	5	3	5	0.57
Tangeni	3	7	3	1	0.50
Tangeni	5	7	3	5	0.71
Tangeni	5	7	5	5	0.79
Tangeni	7	5	5	1	0.64
Tangeni	5	1	3	1	0.36
Tangeni	3	7	1	5	0.57
Tangeni	3	5	1	5	0.50
Tangeni	7	5	1	5	0.64
Tangeni	5	3	5	3	0.57
Tangeni	3	3	1	3	0.36
Tangeni	5	5	3	5	0.64
Tangeni	7	5	5	5	0.79
Tangeni	5	5	7	7	0.86
Tangeni	5	3	3	1	0.43
Tangeni	5	5	3	5	0.64
Tangeni	3	5	3	5	0.57
Tangeni	3	3	1	3	0.36
Tangeni	5	5	1	5	0.57
Tangeni	1	1	5	3	0.36
Tangeni	3	5	3	1	0.43
Tangeni	5	3	3	3	0.50
Tangeni	3	5	5	3	0.57
Tangeni	7	5	5	5	0.79
Tangeni	7	5	5	5	0.79
Tangeni	1	5	3	1	0.36

Tangeni	7	5	3	5	0.71
Tangeni	7	5	1	5	0.64
Tangeni	7	3	1	5	0.57
Tangeni	3	7	1	3	0.50

KEY

7= Very good 5=Good 3= Satisfactory 1= Poor

Human capital indices

0-0.49= Poor 0.50-0.74= satisfactory 0.75-1=Good

Appendix 17: Multiple indices for physical capital

Village name	Perception on road construction	Perception on house construction	Perception on schools construction	Perception on Hospitals construction	Physical capital indices
Tandai	5	1	3	3	0.43
Tandai	5	1	5	7	0.64

Tandai	5	5	7	7	0.86
Tandai	3	5	7	5	0.71
Tandai	3	1	1	3	0.29
Tandai	3	5	7	7	0.79
Tandai	5	5	5	5	0.71
Tandai	5	5	3	5	0.64
Tandai	5	5	3	3	0.57
Tandai	5	1	1	1	0.29
Tandai	5	7	3	3	0.64
Tandai	3	7	3	3	0.57
Tandai	5	5	3	5	0.64
Tandai	7	7	5	5	0.86
Tandai	5	5	3	3	0.57
Tandai	5	3	7	3	0.64
Tandai	1	5	3	3	0.43
Tandai	5	1	3	1	0.36
Tandai	7	5	3	3	0.64
Tandai	3	3	3	3	0.43
Tandai	7	1	5	3	0.57
Tandai	7	5	7	7	0.93
Tandai	7	5	5	3	0.71
Tandai	3	3	1	1	0.29
Tandai	3	5	5	5	0.64
Tandai	5	3	5	7	0.71
Tandai	5	3	5	3	0.57
Tandai	5	5	3	3	0.57
Tandai	5	5	3	5	0.64
Tandai	1	1	5	7	0.50
Tangeni	5	5	7	7	0.86
Tangeni	3	5	5	5	0.64
Tangeni	1	5	7	7	0.71
Tangeni	5	5	5	5	0.71
Tangeni	5	5	7	1	0.64
Tangeni	1	5	7	5	0.64
Tangeni	5	3	3	5	0.57
Tangeni	1	3	5	5	0.50
Tangeni	5	3	5	3	0.57
Tangeni	5	5	3	5	0.64
Tangeni	5	5	3	3	0.57
Tangeni	3	7	3	5	0.64
Tangeni	5	3	5	5	0.64
Tangeni	3	3	3	7	0.57
Tangeni	7	5	7	7	0.93
Tangeni	1	5	5	5	0.57
Tangeni	5	5	3	5	0.64
Tangeni	5	3	5	5	0.64
Tangeni	5	5	5	5	0.71
Tangeni	3	5	5	3	0.57
Tangeni	1	3	1	3	0.29
Tangeni	1	3	3	3	0.36
Tangeni	1	5	7	5	0.64
Tangeni	5	3	5	3	0.57
Tangeni	5	3	7	5	0.71
Tangeni	5	5	5	3	0.64
Tangeni	5	3	7	5	0.71
Tangeni	5	7	5	5	0.79

Tangeni	3	5	5	5	0.64
Tangeni	3	5	5	5	0.64

Appendix 18: Multiple indices for natural capita

Village name	Perception on water services	Perception on Energy	Perception on land	Perception on goods	Natural capital index
Tandai	5	3	5	5	0.64
Tandai	7	5	3	7	0.79
Tandai	7	5	5	5	0.79
Tandai	7	5	7	7	0.93
Tandai	5	7	7	3	0.79
Tandai	7	5	7	7	0.93
Tandai	7	7	7	5	0.93
Tandai	5	5	5	7	0.79
Tandai	3	3	1	3	0.36
Tandai	7	7	5	5	0.86
Tandai	5	3	5	7	0.71
Tandai	5	3	5	7	0.71
Tandai	5	5	7	5	0.79
Tandai	5	5	5	7	0.79
Tandai	5	5	5	7	0.79
Tandai	5	7	3	7	0.79
Tandai	5	7	3	5	0.71
Tandai	5	5	7	5	0.79
Tandai	5	7	7	3	0.79
Tandai	7	7	5	3	0.79
Tandai	5	5	7	5	0.79
Tandai	7	5	3	7	0.79
Tandai	5	5	5	7	0.79
Tandai	7	7	5	5	0.86
Tandai	7	5	5	7	0.86
Tandai	5	5	5	7	0.79
Tandai	5	5	3	7	0.71
Tandai	5	5	3	5	0.64
Tandai	5	7	5	7	0.86
Tandai	5	5	5	7	0.79
Tangeni	5	3	5	5	0.64
Tangeni	7	1	7	5	0.71
Tangeni	3	7	5	7	0.79
Tangeni	5	5	7	5	0.79
Tangeni	7	5	5	7	0.86
Tangeni	5	5	5	5	0.71
Tangeni	5	5	7	7	0.86
Tangeni	7	5	7	5	0.86
Tangeni	7	5	5	7	0.86
Tangeni	7	5	5	7	0.86
Tangeni	7	5	5	5	0.79
Tangeni	5	7	5	5	0.79
Tangeni	5	5	5	7	0.79
Tangeni	7	5	5	5	0.79
Tangeni	5	5	5	7	0.79
Tangeni	7	5	5	5	0.79
Tangeni	5	5	5	7	0.79
Tangeni	7	7	5	7	0.93
Tangeni	7	5	7	5	0.86
Tangeni	7	5	5	5	0.79

Tangeni	5	5	5	7	0.79
Tangeni	7	7	5	7	0.93
Tangeni	5	7	7	7	0.93
Tangeni	7	5	7	5	0.86
Tangeni	7	5	5	7	0.86
Tangeni	7	5	5	7	0.86
Tangeni	7	5	5	7	0.86
Tangeni	7	5	5	5	0.79
Tangeni	5	5	5	5	0.71
Tangeni	3	5	5	5	0.64

Appendix 19: Multiple indices for political capital

Village name	Perception on representation	Perception on Voice/power	Perception on Relation with NGO	Perception on popularity of leaders	Political capital indices
Tandai	3	1	5	3	0.43
Tandai	7	5	7	5	0.86
Tandai	5	5	5	5	0.71
Tandai	5	1	5	7	0.64
Tandai	7	5	5	5	0.79
Tandai	5	7	7	5	0.86
Tandai	5	1	3	3	0.43
Tandai	7	5	5	5	0.79
Tandai	7	5	5	5	0.79
Tandai	7	5	7	5	0.86
Tandai	3	7	1	5	0.57
Tandai	5	7	5	5	0.79
Tandai	7	5	5	7	0.86
Tandai	5	7	5	5	0.79
Tandai	7	7	7	5	0.93
Tandai	7	7	5	5	0.86
Tandai	5	7	7	5	0.86
Tandai	5	5	7	7	0.86
Tandai	7	5	5	5	0.79
Tandai	7	5	5	3	0.71
Tandai	5	7	5	5	0.79
Tandai	5	3	5	3	0.57
Tandai	5	7	7	7	0.93
Tandai	1	5	7	5	0.64
Tandai	7	7	7	7	1.00
Tandai	5	7	7	1	0.71
Tandai	7	7	5	5	0.86
Tandai	5	7	5	5	0.79
Tandai	5	7	5	5	0.79
Tandai	7	5	5	7	0.86
Tangeni	5	5	7	7	0.86
Tangeni	7	5	5	3	0.71
Tangeni	7	5	5	5	0.79
Tangeni	5	7	5	5	0.79
Tangeni	5	5	7	7	0.86
Tangeni	7	5	5	7	0.86
Tangeni	7	5	7	5	0.86
Tangeni	5	7	7	7	0.93
Tangeni	7	5	5	5	0.79
Tangeni	5	7	5	7	0.86
Tangeni	1	3	1	5	0.36
Tangeni	7	5	7	7	0.93
Tangeni	7	7	7	3	0.86
Tangeni	7	7	5	7	0.93
Tangeni	7	5	5	7	0.86
Tangeni	5	5	7	5	0.79
Tangeni	5	5	7	5	0.79
Tangeni	7	7	5	7	0.93
Tangeni	7	7	5	7	0.93
Tangeni	7	3	7	5	0.79

Tangeni	7	5	5	7	0.86
Tangeni	7	7	5	7	0.93
Tangeni	7	5	7	7	0.93
Tangeni	7	7	3	5	0.79
Tangeni	5	5	7	5	0.79
Tangeni	7	7	5	7	0.93
Tangeni	7	5	7	7	0.93
Tangeni	5	3	5	5	0.64
Tangeni	5	5	5	7	0.79
Tangeni	3	7	7	7	0.86

Appendix 20: Multiple indices for cultural capital

Village name	Perception on Ethnic identity	Perception Norms/taboos	Perception on Iconography	Traditional knowledge	Cultural Indices
Tandai	7	5	7	7	0.93
Tandai	7	5	5	5	0.79
Tandai	5	5	7	7	0.86
Tandai	5	5	7	3	0.71
Tandai	7	7	5	5	0.86
Tandai	5	7	7	5	0.86
Tandai	7	5	5	7	0.86
Tandai	5	7	3	1	0.57
Tandai	7	7	7	7	1.00
Tandai	5	5	3	5	0.64
Tandai	7	7	7	5	0.93
Tandai	3	1	5	1	0.36
Tandai	5	3	3	3	0.50
Tandai	1	1	3	5	0.36
Tandai	7	7	7	5	0.93
Tandai	5	5	7	5	0.79
Tandai	7	5	7	7	0.93
Tandai	7	7	7	5	0.93
Tandai	7	5	7	7	0.93
Tandai	7	7	5	7	0.93
Tandai	5	5	7	7	0.86
Tandai	7	7	5	7	0.93
Tandai	3	5	5	5	0.64
Tandai	7	3	3	7	0.71
Tandai	7	7	7	3	0.86
Tandai	5	7	5	7	0.86
Tandai	7	7	5	7	0.93
Tandai	7	7	3	7	0.86
Tandai	5	7	5	7	0.86
Tandai	7	7	7	7	1.00
Tangeni	5	3	1	1	0.36
Tangeni	7	5	7	5	0.86
Tangeni	7	5	5	5	0.79
Tangeni	7	3	5	5	0.71
Tangeni	7	5	3	5	0.71
Tangeni	7	5	5	3	0.71
Tangeni	5	5	5	7	0.79
Tangeni	5	5	7	5	0.79
Tangeni	7	3	1	1	0.43
Tangeni	7	5	7	7	0.93
Tangeni	5	5	7	5	0.79
Tangeni	5	5	7	5	0.79
Tangeni	3	3	5	7	0.64
Tangeni	5	5	5	7	0.79
Tangeni	7	5	7	7	0.93
Tangeni	7	5	5	5	0.79
Tangeni	5	5	7	3	0.71
Tangeni	5	5	7	7	0.86
Tangeni	5	3	1	3	0.43
Tangeni	7	7	5	5	0.86
Tangeni	5	7	5	5	0.79
Tangeni	3	7	5	7	0.79

Tangeni	5	7	5	3	0.71
Tangeni	7	7	5	5	0.86
Tangeni	7	5	7	5	0.86
Tangeni	7	5	7	7	0.93
Tangeni	5	7	5	7	0.86
Tangeni	7	5	5	3	0.71
Tangeni	5	5	7	5	0.79
Tangeni	7	7	7	5	0.93

Appendix 21: Multiple indices for financial capital

Village name	Perception on sell forest products	Perception on provision of employment	Perception on revenue distribution	Perception on wealth distribution from donor	Financial Indices
Tandai	3	1	5	3	0.43
Tandai	7	5	7	5	0.86
Tandai	5	7	5	5	0.79
Tandai	5	1	5	7	0.64
Tandai	7	5	5	5	0.79
Tandai	5	7	7	5	0.86
Tandai	5	1	3	3	0.43
Tandai	7	5	5	5	0.79
Tandai	7	5	5	5	0.79
Tandai	7	5	7	5	0.86
Tandai	3	7	1	5	0.57
Tandai	5	7	5	5	0.79
Tandai	7	5	5	7	0.86
Tandai	5	7	5	5	0.79
Tandai	7	7	7	5	0.93
Tandai	7	7	5	5	0.86
Tandai	5	7	7	5	0.86
Tandai	5	5	7	7	0.86
Tandai	7	5	5	5	0.79
Tandai	7	5	5	7	0.86
Tandai	5	7	5	5	0.79
Tandai	5	3	5	3	0.57
Tandai	5	7	7	7	0.93
Tandai	1	5	7	5	0.64
Tandai	7	7	7	7	1.00
Tandai	5	7	7	7	0.93
Tandai	7	7	5	5	0.86
Tandai	5	7	5	5	0.79
Tandai	5	7	5	5	0.79
Tandai	7	5	5	7	0.86
Tangeni	5	5	7	7	0.86
Tangeni	7	5	5	3	0.71
Tangeni	7	5	5	5	0.79
Tangeni	5	7	5	5	0.79
Tangeni	5	5	7	7	0.86
Tangeni	7	5	5	7	0.86
Tangeni	7	5	7	5	0.86
Tangeni	5	7	7	7	0.93
Tangeni	7	5	5	5	0.79
Tangeni	5	7	5	7	0.86
Tangeni	1	3	1	5	0.36
Tangeni	7	5	7	7	0.93
Tangeni	7	7	7	3	0.86
Tangeni	7	7	5	7	0.93
Tangeni	7	5	5	7	0.86
Tangeni	5	5	7	5	0.79
Tangeni	5	5	5	5	0.71
Tangeni	7	7	5	7	0.93
Tangeni	7	7	5	7	0.93

Tangeni	7	3	5	5	0.71
Tangeni	7	5	5	7	0.86
Tangeni	7	7	5	7	0.93
Tangeni	7	5	7	7	0.93
Tangeni	7	7	3	5	0.79
Tangeni	5	5	7	5	0.79
Tangeni	7	7	5	7	0.93
Tangeni	3	5	5	5	0.64
Tangeni	5	3	5	5	0.64
Tangeni	3	3	5	1	0.43
Tangeni	3	7	7	7	0.86