" ECOLOGICAL AND SOCIO-ECONOMIC IMPACT OF CHANGING LAND USE IN KILOMBERO VALLEY, TANZANIA "

BY

DEMETRIUS MATHIAS MALOPOLA

B.Sc. Hons (FORESTRY)

SOKOINE UNIVERSITY OF AGRICULTURE, TANZANIA

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN RANGE MANAGEMENT (ECOLOGY OPTION)

DEPARTMENT OF LAND RESOURCE MANAGEMENT & AGRICULTURAL TECHNOLOGY, FACULTY OF AGRICULTURE, UNIVERSITY OF NAIROBI, KENYA

APRIL, 2006

DECLARATION

I, hereby, declare that this thesis is my original work and has not been submitted for a degree in any other University.

Demetrius Mathias Malopola, B.Sc. — Date: 10/APRIL/2006

This thesis has been submitted with our approval as university supervisors

Kassim. O. Farah, PhD — Date: 30/6/06
Department of Land Resource Management & Agricultural Technology
University of Nairobi, Kenya

Wellington. N. Ekaya, PhD — Date: 30/6/06
Department of Land Resource Management & Agricultural Technology
University of Nairobi, Kenya

DEDICATION

This work is dedicated to my parents, Mr. Mathias Malopola and Mrs. Sesilia Valimba.

ACKNOWLEDGEMENTS

I would like to express my gratitude to the REDPA/PINEP Programme for awarding me the scholarship, which enabled me to pursue the course work and undertaking this study. I deeply express my appreciation to my supervisors, Dr. Kassim O. Farah and Dr. Wellington N. Ekaya for their guidance, advice, and unhesitating support in completing this study. They have been a great source of inspiration, and strength while pursuing the study.

I am very grateful to Dr. Mtengeti and Dr. Mbaga of Sokoine University of Agriculture, Department of Animal Science, for their advice and guidance during my fieldwork in Tanzania A lot of thanks go to Mr. Msalilwa and Mr. Kiwela, technicians of the Faculty of Forestry and Nature Conservation, Sokoine University of Agriculture, for their assistance in soil analysis and fieldwork. My appreciation extends to the Principal, Mr. Kapinga and all staff of Livestock Training Institute Morogoro, Tanzania, for allowing me to use the Institute's facility during my fieldwork. I wish to extend my gratitude to Malinyi Division and Ward administrative bodies for granting me a research permit. Many thanks go to my enumerators (Mr Y. Likongo, Mr. S. Kaswahili, Mr. K. Bomani, Mr. Y. Mbwasi, Mr. M. Lihonga and Mr. F. Mnyeli) for their assistance during data collection.

Special thanks and deep gratitude are extended to my father, Mr. Mathias Malopola, my mother, Mrs. Sesilia Valimba, and my wife, Mrs. Noella Govela for their encouragement, emotional and moral support throughout the period of this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ANOVA	Analysis of Variance
DBH	Diameter at Breast Height
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
IUCN	International Union for Conservation of Nature and Natural Resources
LSD	Least Significant Difference
NGOs	Non Governmental Organisations
NOPA	Nomadic Pastoralists in Africa
PINEP	Pastoral Information Network Programme
REDPA	Regional Dryland Programme in Eastern Africa
Tsh	Tanzanian shillings
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNSO	United Nations Sudano – Sahelian Office
WWF	World Wide Fund For Nature

ABSTRACT

The study was conducted in Malinyi ward, Ulanga district in Tanzania. The aim of the study was to determine the ecological and socio-economic effects of changing land use patterns due to pastoral migration in the area. The emphasis was on vegetation changes, soil characteristics, and local people's perception about changes in natural resource utilization patterns and interaction between livestock keepers and cultivators in area that may attribute to such migration and subsequent alteration in land use types. The study area was mainly an alluvial floodplain, receiving long term average rainfall of 1000mm per annum. The predominant land uses were cultivation, grazing, and the combination of the two (agro-pastoralist). The study methods employed were fieldwork analysis for vegetation such as density, cover, production, species composition and plant recruitment and soil characteristics include pH, moisture content, organic carbon, organic matter, total nitrogen, bulk density, and texture. Interviews were conducted using structured questionnaires; both formal and informal discussions were also held with key informants including household heads, elders, government, and development agencies to get socio-economic information in the study area.

The results of the field vegetation analysis showed greater number of woody species recruitment, density, and crown cover in agro-pastoral area than the pastoral, cultivators and reserve areas. The comparison of density for three selected woody species showed significant differences ($P < 0.05$) for *Bauhinia thonningii* and *Combretum tertifolium* and no significant difference for *Afrormonsia angolensis* among four land use types. For woody vegetation crown cover of selected species showed significant difference ($P < 0.05$) for *Combretum tertifolium* and no significant difference

for *Afrormonsia angolensis* and *Bauhinia thonningii* between land use types. Herbaceous vegetation biomass production and basal cover were higher in reserve area than pastoral, agro-pastoral, and cultivators areas. When compared between land use types the basal cover of selected grass species showed significant differences ($P < 0.01$) for *Hyperrehnia dissoluta* and *Panicum maximum*, while there was no significant difference for *Themeda triandra*. All three-forb species (*Bidens pilosa*, *Watheria indica* and *Flaveria bidentis*) basal cover showed no significance differences between land use types. The soil characteristic of the study area had higher moisture, organic matter, organic carbon, nitrogen content, and low bulk density in reserve area than agro-pastoral, pastoral, and cultivator area. The socio-economic information showed that there was increasing demand on land resources due to population increase and changing land use patterns. The cultivators have been forced to hire farmland, the fallowing period had been shortened and existence of conflicts between the cultivators and livestock keepers. This resulted in reduction of vegetation cover, wildlife numbers, low water level of Kilombero River and its tributaries. There are also mutual benefits between the three communities, the Ndamba cultivators used get livestock products and crop market, the Sukuma agro-pastoralists labour and market for crop and livestock products and the Maasai pastoralists market for livestock products and food, the major problem between them is livestock damage to farmer's crops.

The study recommended demarcation of grazing land from farming land, technological support to improve soil and water conservation, crop and livestock production and development of proper marketing systems for crop and livestock products. Future research should focus on integration of crop and livestock production, protection and management of preferred plant species in the study area.

CHAPTER ONE

1.0 INTRODUCTION

The United Republic of Tanzania has a total land area of approximately 942,575 km^2. Of this, the islands of Zanzibar and Pemba comprise 2,642 km2 (Hamerslay, 1972). The cultivated area of Tanzania occupies only 7.8% of the total landmass. Tropical savannah and tropical rainforests occupy 92.2%, fifty percent of which is natural pastureland (rangeland) and supplies over 90% of the livestock feed requirement while 42% is not utilised due to tsetse fly infestation (UNEP, 1986; UNEP, 1998; Bureau of statistics of Tanzania, 2001). The Central part, which is occupied by pastoralists communities is Semi – arid, with some parts receiving an average annual rainfall of less than 400mm (Skoupy, 1993; Bureau of statistics of Tanzania, 2001).

According to Ndagala (1993) pastoralists in Tanzania make 26% of human population, one percent being pastoralists and 25% agro-pastoralists. The problems facing pastoral communities in Tanzania are livestock rustling, poor means of communication, harsh environmental conditions, poor agricultural, and livestock production. Due to the above problems, the pastoral communities have been forced to move to less populated and high agricultural potential areas of the country. The regions most affected by pastoral migration are Mtwara, Rukwa, Coast, Morogoro, and Tabora (Magimbi, 1991; Mtengeti, 2000). One of the high agricultural potential areas where there has been a major migration of pastoralists and agro-pastoralists is Kilombero valley. The Kilombero valley occupies about 1.2% of Tanzania's total area and has 39% (330,000 hectare) of the total irrigation potential area of the Country. Also Since 1956 the valley was classified as a game control area (World Bank, 1994 as cited in Haule, 1997).

This migration has created pressure on the land resources in the valley, which caused changes in the traditional agricultural practices, such as shifting cultivation, which is not or practised to less extent as more land is used for settlement, cultivation and livestock keeping. This has created conflicts in resource use and environmental disturbance, which result in ecological and socio-economic changes in the Kilombero valley. To date, there exists paucity in information and data on the effects of this migration of pastoralists and agro-pastoralists and changing land use in Kilombero valley. Yet such information and data is crucial not only to policy makers but also to development workers and stakeholders, if key production areas such as the Kilombero valley are to be sustainably and wisely managed.

The general objective of the study was, to determine the ecological and socio-economic effects of changing land use patterns due to pastoral migration into the Kilombero valley, Tanzania.

The specific objectives of the study were:

1. To determine the effect of land use changes on vegetation and soil characteristics.
2. To determine local people's perception about changes in natural resource utilization patterns and interaction between livestock keepers and cultivators.

The working hypothesis of the study was land use changes have no effect on vegetation and soil characteristics and on natural resources utilization in Kilombero valley.

CHAPTER TWO

2.0 LITERATURE REVIEW

2. 1 Importance of agriculture and livestock for rural development in Tanzania

The land area of Tanzania is 88100km^2 with arable land of 4 millions hectares. The cultivated area occupies only 7.8% of the total landmass (UNEP, 1986; Bureau of statistics of Tanzania, 2001). Agriculture is the mainstay of Tanzanian's economy. According to UNEP (1998) Tanzania is divided into six agro-climatic regions, namely the Coast, Arid lands (Maasai steppe and northern part, receive under 500mm of rainfall), Semi-arid lands (central and south-eastern part, receive 500 – 800mm rainfall), Plateaux, Highlands and Alluvial plains (Kilombero, Rufiji, Usangu, and Wami). In 1994 and 1998 agriculture contributed more than 75% of export earnings, accounts 50% of gross domestic product (GDP), and the livelihood of some 80% of the population depends upon agriculture or its related industries (UNEP, 1998). Major export crops are coffee, cotton, cashew nuts, sisal, tobacco, tea and cloves, while the major food crops are grains (maize, rice and sorghum), bananas and tubers such as cassava, potatoes, and yams (IFAR, 1993; UNEP, 1998). Subsistence farmers produce most of the food crops, and it's estimated that about 25% of the maize and 50% of rice production is marketed locally. It is through farming and land tenure systems that agriculture has in some areas become unsustainable and destructive. Agriculture sector suffers the effects and adverse impacts of environmental problems through land degradation due to poor agricultural practices, such as use of agro-chemicals, mechanisation, shifting cultivation, and indiscriminate use of fire. These manifests themselves as the form of soil erosion, loss of vegetation cover and ground water pollution, salinization, loss of soil fertility and ultimately desertification.

According to Swift (1980) as cited in NOPA (1992) Pastoralism is defined as production systems in which 50% or more of household gross revenue comes from livestock or livestock related activities. Or where more than 15% of household food energy consumption consists of milk or milk products produced by the household. An agro-pastoral production system is one in which more than 50% of household gross revenue comes from farming, and 10–15% from pastoralism. A number of authors have described pastoralism in Africa in recent years in terms of a "crisis" (NOPA, 1992; Vedeld, 1992; Niamir-Fuller, 1994). Central features of this crisis include prolonged droughts; population increases encroachment of agricultural lands and conservation areas. Leading to alienation of grazing lands and displacement of pastoralist populations. Degradation of fallow land and land around inadequate numbers of water points, the marginalisation of pastoralists within national policies and hence development programmes. Inadequate access to markets and unfavourable exchange rates between livestock and grains, supply of social services too mobile groups of herders, increasing levels of insecurity, warfare and conflicts between nation states. Also Sedentarisation, emigration and urbanisation; breakdown of traditional social and institutional structures; increasing marginalisation of women and the growing general levels of poverty and vulnerability to famine. Clearly there is a great deal of regional variation in the incidence of particular processes and problems, and thus in the dimensions, as well as depth, of the "crisis". Generally, however, these trends are resulting in greater competition for scarce resources, heightened levels of tension within and between pastoralist and agro-pastoralist social formations, rising numbers of disputes, and increased instances of overt conflict. A pattern of acute and often destructive conflict has been superimposed on the endemic or chronic conflict as integral to situations of multiple resource use (Ndagala, 1991).

Pastoralists in Tanzania make up 26% of the population, 1% being pure pastoralists and 25% agro-pastoralists (Ndagala, 1993). The pastoral community is composed of the Maasai, the Iparakuyo and the Barbaig, whereas agro-pastoralists include the Sukuma, the Gogo, and the Mbulu (Ndagala, 1990). Tanzania ranks third in sub-Saharan Africa in terms of cattle numbers after Ethiopia and Sudan, in that order. By 1995, Tanzania had 15.6 million cattle, 10.7 millions goats and 3.5 millions sheep (UNEP, 1998). Ninety nine percent were produced in the traditional sector by pastoralists and agro-pastoralists, which contributed 25% and 14% of meat and milk, respectively to the agricultural gross domestic products (GDP). The total agricultural GDP for the 1994 and 1998 financial years was 50%, indicating that over 90% of the agricultural GDP came from traditional herds (Ole-lengisugi, 1994; Mwilawa, 1996; UNEP, 1998). Also Ndagala (1991) reported that 60% of the national herd is owned by agro-pastoralists while pure pastoralists owned 39%. However, as in most African countries, in Tanzania the relations between pastoralists and the state have always been problematic. UNSO and UNDP (1994) reported policy-makers and planners have regarded pastoralists in Tanzania as backward, economically irrational and resistant to change, a view based on their relative lack of enthusiasm for such things as school and western dress. Consequently, many attempts have been made to bring pastoralists into mainstream society; most failed to achieve the desired results. Each subsequent failure strengthened the view that pastoralists were resistant to changes, and conflict resulted in Tanzania's pastoral area.

Cousins (1996) pointed out that conflicts in Tanzania's pastoral areas are occurring at 3 levels: (i) between pastoralists and the state, over land rights (ii) between competing land

users, over access to diminishing resources (iii) between pastoral organisations, over different approaches to halting the loss of land. Internal divisions within some pastoralist communities are also a source of tension. Also he stated there are two driving forces underlying the alienation of pastoral land: government policies that favour settled agriculture and privatisation, and widely held views on the inefficiency and destructiveness of pastoralism. Past policies of villagilization and current directives for issuing title deeds to village land, together with land use planning, are leading to the break up of the pastoral commons. Villagilization imposed an alien system of government, statutory law, and decision making on indigenous systems, with administrative and political functions being transferred from traditional leaders to village and district councils. Villagilization also disrupted customary land tenure; land being nationalised in 1962 and recently privatisation policies have been pursued. In 1992 legislation was introduced to extinguish all customary rights to land.

Liberalisation of the economy has increased possibilities for marketed crops and encouraged individuals and companies to acquire land for commercial farming. In Simanjiro district, for example, some 45 000 acres had been acquired for 72 farms by 1993, almost all alienated from former livestock pastures (Cousins, 1996). In northern Tanzania the interests of conservationists and the tourism industry have also come into conflict with pastoralists and hunters and gatherers, with many of the latter groups being forcibly removed from protected areas. More and more pastoralists have been pushed into marginal areas, herds have declined, and people have been forced into crop farming. These areas is characterised by having poor means of communication, famine which accelerates dependence in food aid, poor crop production and animal husbandry, harsh

environmental conditions i.e. high temperature and low rainfall and environmental degradation such as bush encroachment, soil erosion and climatic changes. Due to the above problems, the pastoral communities have been forced to move to high agricultural potential areas of the country such as Mtwara, Rukwa, Coast, Morogoro, and Tabora regions (Maghimbi, 1991; Mpiri, 1995; Mtengeti, 2000). Also pastoralists are organising themselves into NGOs to defend their interests and taking government to court to fight land alienation. External NGOs are assisting pastoralists and their NGOs, and have convened workshops to consider approaches to conflict resolution. These have examined traditional mechanisms for handling conflict, and the problems attendant on attempting to integrate these into contemporary local government structures (Cousins, 1996).

According to Gueye (1994) in Senegal co-existence between farmers and herders in the same area is often thought to be a source of potential conflict as far as access to and use of available resources are concerned, and this does not mean, however, that the two groups are naturally antagonistic. Further more, NOPA (1993) stressed that inspite of the different dimensions of conflicts in relations among pastoral groups themselves, and between pastoral and agricultural societies in Africa, there is no "prior" opposition between pastoralists and agriculturists. It is rather the effect of particular policies (for example, decisions promoting the extension of cash crops to the detrimental of pastoral spaces) and other external factors, which have rendered conflict in their relations. Legislative texts, which are generally favourable to agriculturists, serve to widen still further the gap-between these two communities and are at the roots of many of the new types of conflicts emerging. Also from a geographical and spatial point of view, the two systems of production do not utilise space in the same manner, and this difference leads to situations

of rising antagonism (in the context of increasing scarcity of land). From the economic point of view, animal herds constitute an important source of capital and savings for both herders and agriculturists in Africa, where as agriculture is practised for both auto-consumption and manufacturing (NOPA, 1993). Majok and Schwabe (1996) and Arntzen (1997) reported that the general wisdom has been that in semi-arid areas, livestock production is more productive than crop production. In addition, drier areas are more suitable for small stock and/or wildlife. In dry lands or areas of frequent drought crop-livestock system is a very important agricultural system for rural development. Small ruminants, i.e. sheep and goats are particularly important for livelihood in these regions. Gilles and Valdinia (1992) cited that this was particularly true in Bolivian highlands areas characterised by "agro-pastoralism", the combination of livestock and rainfed crops production. Crop production in these areas is an important source of livelihood, but it is also a risky endeavour. Crops and animal alike are threatened by frequent droughts. Livestock often play a crucial role in these systems because they are the only "perennial crop" that farmers have. They can utilise natural rangelands and the residues of failed crops and provide the capital reserves needed to meet financial emergencies.

Waters-Bayer and Bayer (1992) pointed out that livestock production has many function for rural development, such as provision of food, raw material, labour (energy to work), manure, means of saving and investment, source of cash, security and identity. For rural economy livestock production can make productive use of areas, which could not otherwise be used. In ecological terms, animal-based systems are particularly suitable for making use of dryland resources. But livestock can also give value to otherwise wasted resources in more humid areas. Forage is derived from land that is not suitable for

cropping (wayside edges, waterlogged areas, rocky land, and scrub areas) and from land that is temporarily not being cropped. They further stressed that livestock can also play a role in rural areas in manipulating vegetation to the benefit of human life. In sub humid areas, grasses grow tall and dry off quickly after the end of the wet season. Grazing reduces the combustible standing biomass and lowers the risk of uncontrollable fires during the dry season. Browsing animals can be used to control the growth of bushes and thorny shrubs. Bourn *et al.* (1986) as cited by Waters-Bayer and Bayer (1992) stated that livestock keeping permits intensification of land use with low level of external inputs. In deed, it has been observed that in many parts of the tropics that, as the percentage of land cultivated increases, so does the number of livestock. Integration is also possible when different groups operating close to each other raise crops and animals. A spatial integration of crops and livestock is achieved; for example, herdsmen graze in fallow fields. This complementary land uses alone results in higher food production per unit area than if cropping and livestock were spatially segregated. And the beneficial links via manure for fertilising crops and crop residues for feeding animals per unit area. Also Nyariki (1998) stated that in agro-pastoral system in Sub-Saharan is the interlinkage between livestock and crop production is not something new. Livestock production is an integral part of agricultural production and is not separate and a part from crop production. The linkages between crop production and cattle possession are principally through increased area under crop and yield per area cropped. It is argued that the link between livestock biomass and land use intensity is associated with livestock access to marginal fodder (such as crop residues) as a result of cultivation and fallow land, proximity to markets and services, and particularly in more arid areas, the availability of water.

According to Grove and Edwards (1992), sustainable agricultural systems should maintain or increase biological and economic productivity. Biological productivity is required to feed individual farm families and the population of non-farm people. Economic productivity is required to provide income for farmers. Also they pointed out that the systems should be both stable and resilient. Stability reduces risk and leads to continuity in income and food supply by fulfilling the short-term needs of farmers without endangering natural resources. Resilience permits adaptation to changes in the biophysical and socio-economic environments. They should be environmentally compatible to avoid contamination and to minimise adverse environmental impact on adjacent and down stream environments. Finally, they should be socially compatible with local people and political economies.

2.2 Land use conflict among multiple resource users

According to Blench (1997) in semi–arid Africa conflicts over natural resources range from local disagreements over the use of forest products to international disputes over water supplies; they have often resulted in environmental degradation and at times, in loss of life. Expanding populations intensify pressure on limited land resources, and this is often coupled with rapid social change, including the introduction of new technologies, the commercialisation of natural resources, the privatisation of state services, and an increased interest in natural resource use from governments, companies and Non Governmental Organisations. Also UNSO (1992) reported that land resources in Sudano-Sahelian region, in general, are under increasing pressure due to the population growth has increased the use of the land in economies dependent on agriculture, drought and desiccation. These have forced pastoralists to move away from drought prone areas and

rely increasingly on crop cultivation and farmers to increase the cultivated area in order to compensate for low yields and the excessive development of cash crops. Many researchers believe that land ownership play importance role in agricultural reform and better land management. The conferring or recognition of property right to the land, individual or communal, provides what is often the essential element since it gives land users a vested interest in better land management.

Blench (1997) stated that conflict over extensive and patchy common pool resources such as wetlands and grazing has made them more difficult to conserve and manage. Frequently conflict is viewed in its most negative form, as threats or actual violence. However it may also be non-aggressive and lead to positive social change and improvements to natural resources. Progressive approaches within development projects will examine the specific interests of those involved and consider the role of conflict within the process.

Cousins (1996) stated that multiple resource use is a central feature of many production systems, especially in pastoralism and agro-pastoralism. It typically involves complex combinations of the following variables: different categories of users, users of different status, different uses, resources of differential productivity, economic value and ease of control, different sets of rights and obligations for users of resources. Niamir-Fuller (1994) also describes in Africa overlapping territories, managed jointly by neighbouring groups, which allows some room for expansion and functions as fallback areas in difficult years. They are also buffer zones between groups, maintained for similar reasons, but more extensive and used by more than two groups. The latter requires ad hoc negotiations

over use between the different groups when the need to use them arises. Multiple and overlapping rights to resources are also a feature of agro-pastoral systems of production in Africa (Scoones and Wilson, 1989; Scoones, 1996) and of African tenure systems in general (Berry, 1993).

In Africa pastoral ecosystems multiple resource use has ecological and economic rationales, which are particularly compelling, where the productivity of resources is highly variable over space and time -i.e. where so-called "non-equilibrium" ecological dynamics are found (Behnke, 1994). The emerging paradigm suggests that the dynamics of many arid and semi-arid rangelands of Africa may be driven by episodic events such as droughts or fires. Thus causing the condition of grazing system at any particular time is determined more by the chance occurrence of non-biological events than by interaction between the biological components of the system itself" (Behnke and Scoones, 1993; Ellis and Swift, 1988; Westoby *et al.,* 1989).

Behnke and Scoones (1993) show how mobility can increase the overall carrying capacity within a region, which incorporates a wide range of seasonal carrying capacities in different zones. This assumes a pattern of predictable environmental fluctuation. Sandford (1983) makes a similar argument for situations where stock movement takes place in response to unpredictable rainfall fluctuations, disease outbreaks, borehole breakdowns, and range fires. In the former case pastoralists often follow regular transhumant route; in the latter movement is more contingent and depends on herd owners preserving access to fallback areas. For pastoralists, "opportunistic" herd movement over long distances is thus essential in order to track environmental variability

and thus to maintaining the large herds which constitute their main source of livelihoods (Behnke and Scoones, 1993). Variability occurs at both the macro-scale (e.g. contrasts between clay veld savannah and sand veld micro-scale (e.g. between riverine areas and top lands), and thus modified forms of opportunism are found in agro-pastoral systems as well (Scoones and Wilson, 1989).

Behnke (1994), Swift (1994) and Sylla (1994) trace the implications for tenure and administration of this emerging perspective in Africa: in non-equilibrium environments, non-exclusive forms of rights to use resources are complementary to opportunistic stocking and herding strategies. Indeterminate social and territorial boundaries provide "a degree of fluidity which suits everyone's requirements". Complexity and flexibility mean that close regulation by administrators is therefore inappropriate (and generally ineffective), and devolution of administration and management to individual pastoralists and communities is more feasible. It also suggests that local users should be given legal rights over resources, something which is still absent in many pastoralist and agro-pastoralist situations in Africa (Lane, 1991; NOPA, 1992; Lane and Moorehead, 1994). The "new thinking" also asserts that a situation of chronic or endemic conflict is a central feature of non-equilibrium settings (Behnke and Scoones, 1993; Scoones, 1994; Niamir-Fuller, 1994). This helps to explain the high degree of inter-group conflict often associated with pastoralism, and the patterns of co-operation and reciprocal access, which exists among them. Environmental variability thus results in a high degree of political (and sometimes military) competition, ameliorated by periods when competitors relate to each other as allies, neighbours or even kin (Behnke, 1994).

The policy implication of this perspective is a shift in administrative focus from regulation and control of resource use to mediation and arbitration between the conflicting interests of individuals and groups. This further suggests that legal frameworks should focus on procedural rather than substantive law (Vedeld, 1993), which cannot easily codify customary law without losing its internal complexity, flexibility and adaptability to change. Procedural law would specify the framework within which interested parties could legitimately put forward claims to resources, the administrative/rural institutions which should process claims, the criteria for choosing between opposing claims, and enforcement procedures (Behnke, 1994). Similarly, Scoones (1994) suggests that conflict be explicitly addressed and accepted as inevitable rather than being ignored or treated as an incidental or removable feature. Again, the recommendation is to establish formal institutional arrangements for negotiation, arbitration, and resolution. Sylla (1994) and Vedeld (1992) advocate a central role in conflict resolution for pastoral organisations, and Swift (1994) highlights conflict resolution as a central function of pastoral administration at different levels in Africa.

Traditional institutions with these functions were deeply embedded within the social and cultural norms and practices of different groups, and often integrated into other social, economic and political structures (Rugege, 1995; Bradbury *et al.*, 1995; Sylla, 1994; and Bollig, 1994). Less integrated and less effective, was mechanisms for negotiating agreements and ending conflicts between ethnic groups, pastoralists, sedentary agro-pastoralists and cultivators in East Africa (Ndagala, 1991; Bollig, 1994). Conflict was endemic, and often regulated by stock raiding and warfare rather than negotiation. This characterisation, however, is inadequate as a description of the situation in recent

decades. The literature on pastoralist and agro-pastoralist systems, and more generally on agrarian change, has a central theme in the undermining of pre-colonial social and institutional orders. Some of their features were incorporated into colonial systems of administration, resulting in the mixed or "hybrid" nature of current legal and administrative systems in Africa pastoral society (Vedeld, 1992; Swift, 1994; Sylla, 1994; Rugege, 1995). As the authors cited above in relation to the "new thinking" on pastoralism imply the institutional frameworks that currently exist often fail to deal adequately with disputes and conflicts (Bradbury *et al.*, 1995). This institutional malaise can only be partially understood by referring to the institutions themselves; the wider context of rapid rates of social and economic change combined with political instability has also to be taken into account.

A number of procedures or processes are used in dispute settlement and conflict resolution, ranging from those which stress collaboration and voluntary efforts to find a solution, to those in which a third party makes a binding decision. Pendzich (1994) and Anderson *et al.* (1996) provide useful definitions:

- Fact-finding in the investigation of key issues in a conflict by a neutral third party, which gathers information from all sides and prepares a summary; this can be a useful input to a negotiation process.
- Facilitation of a neutral third party in running a meeting and helping to make it productive; this can involve assisting in developing an agenda, keeping participants on track, and in ensuring that all parties have an equal voice. Often their role is limited to a single meeting. Collaborative planning is a process in which the parties agree to work together in anticipation of a conflict, and plan ways to avoid the conflict.

- Negotiation is a voluntary process in which parties meet face to face to agree on an acceptable solution to a dispute. Mediation is the assistance offered by a neutral third party to a negotiation process; the mediator has no power to direct therapies or render a decision. All parties as a trusted, impartial person must accept the mediator; sometimes the best mediators are local people who are familiar with cultural norms and local setting.
- Reconciliation is the attempt by a neutral third party to communicate separately with disputants, in order to reduce tensions and agree on a way forward.
- Arbitration involves the submission of a dispute to a third party acceptable to both disputants, who makes a binding or advisory decision after hearing arguments and reviewing the evidence.
- Adjudication is a judgement rendered according to objective standards, rules, or laws, by a judge or administrative officer with the authority to rule on the issue in dispute.
- Deciding which process to use is the key to success, no single approach is presumed to be effective in all situations (Pendzich, 1994).

According to Marc (1995), conflict management where power is unequal is a key issue. Inequality limits the usefulness of negotiation, mediation, and other joint problem-solving processes. In these situations, weaker parties may, for example, withdraw from negotiations but without ultimate benefit. Distrust based on inequality of power may pre-empt constructive discussions. South Africa's legacy of highly skewed distributions of wealth and power provides many such situations (Marc, 1995). Attempts to equalise power can take place both outside arenas or direct interaction between parties (e.g. during a pre-negotiations phase) or even within the processes themselves.

2.3 Importance of vegetation resources in food production systems

Herlocker (1999) defined vegetation as the sum total of plants covering the area. The vegetation resource comprises of woody and herbaceous plant species. Woody plant species are used for firewood, building, implements, bush fencing to protect livestock at night, and for other purposes like food for humans and livestock, and medicinal value for man and his animals. According to Dregne (1985) and Oladele (1999) wood is the sole or major source of fuel for cooking and heating in the poor, less developed countries where they cannot afford other sources of fuel (kerosene and electricity). Herbaceous vegetation in the tropical savannah grasslands is the coexistence of grasses, sedges and legumes (Medina, 1987).

Boonman (1993) reported that in East Africa herbaceous vegetation is used for livestock feed, soil and environment conservation. He emphasised that grasslands have aroused renewed interest following the United Nations Environment Programme (UNEP) reports, which showed that due to the destruction of tropical rainforests, tropical grasslands turn more carbon dioxide into carbohydrates than forests. Tree cutting can be detrimental to agricultural productivity, by causing soil erosion and environmental degradation. The removal of vegetation exposes the soil to erosion and increases runoffs The degree of grazing and browsing strongly affects the structure, composition, quality, and productivity of land resources. Pratt and Gwynne (1977) stated that as an indicator of environmental condition, vegetation in East Africa has several roles; vegetation is more than a resource and it also provides a protective mantle for the soil with the ability to improve soil texture and rainfall infiltration. In some situations, the nature of the vegetation cover is more important to rainfall infiltration than the nature of the soil itself.

2.4 Vegetation and soil change in relation to land use practices

The changes in vegetation overtime reflect the influence of (a) Short-term (up to several years) fluctuations in climate. (b) Disturbance by man through his use of the land. Land cover refers to any features, which cover the earth's surface. Thus land cover normally refers to vegetation, water bodies, artificial constructions, bare soil and rock surface (Shishira, 1994). Also land use has been defined by FAO (1976) as cited by Shishira (1994) as the function of the land determined by natural conditions and human intervention. Also it can be defined as man's activities on land, which are directly related to the land. In other words the term "land use "describes the human activities carried out to obtain good or benefits from the land. And (c) the natural tendency of vegetation to change through a succession of secondary (seral) vegetation communities, toward an ecologically steady (or climatic) state Archer and Smeins (1991), as cited in Herlocker (1999). Also Pratt and Gwynne (1977); Walker and Noy-Meir (1982) and Ellis and Swift (1988) stated that changes in vegetation cover in Savannah ecosystems may be of several kinds. The causes of change have been the subject to considerable debate, ranging from natural fluctuations in weather patterns to man caused perturbations

Harbouszky *et al.* 1986, as cited in Alemu (1999), reported that rangelands are under pressure everywhere as the demand for land use rights grow. He explained that the situation stems from the political, demographic, socio-economic and technical changes. Overgrazing of rangeland results into the negative trends such as desertification and the encroachment of bush land. The process of degradation of the range vegetation starts with a reduction in the density of most palatable perennial species followed by a reduction in the total cover of the herbaceous layer and increase in woody component of the

vegetation (Tietema *et al.*, 1994). The increase of woody vegetation is attributed to various factors such as overgrazing, soil erosion, changed fire regime, and climatic change acting alone or in combination (Walker *et al.*, 1981; Walker and Noy-Meir, 1982; Friedel, 1986; Medina, 1987). Skarpe (1991) also reported the relative importance of inter and intra specific competition for water and of disturbance by fire as regulatory mechanisms for the total amount and spatial distribution of woody plants in an arid savannah of Botswana.

In Zambia a study done by FAO (1979) found that the cause of bush encroachment in areas receiving less than 800-mm rainfall per year was the reduction of dry season ground herbage due to grazing, which was essential for the hot late, burns. As a result trees and shrubs density increased and led to the development of thickets, which are notorious for their low productivity. Also in high rainfall area over 1000mm per year the vegetation was mainly miombo woodland, which forms a highly closed canopy. If opened through tree clearing leads to dense natural regeneration of wood species through root sucker and coppice growth. In this way grass growth is suppressed and the woodland becomes impenetrable. Therefore, higher rainfall areas have the problem of controlling the natural regeneration of woody species in the closed woodland while lower rainfall areas have the problem of preventing encroachment of woody species into the open woodland.

A study of vegetation in the Simanjiro plains of Tanzania, for example, indicated that regeneration of woody species was pronounced due to overgrazing, mounting pressure for cultivation and lack of annual fires (Kahurananga, 1979). The influence of tree cutting on woody vegetation is significant when it is associated with burning and clearance for

agriculture (Kariuki, 1996; Herlocker, 1999). In contrast, Ellis and Swift (1988) reported that vegetation dynamics in Africa pastoral systems are most attributed to external factors independent of human activity. Behnke and Scoones (1993) also reported that in African pastoral systems different combinations of factors, of which grazing pressure is but one element might be required to cause alterations in rangeland vegetation. Several studies have been done in many parts of the world, and most of them have revealed that, the change and/or loss of vegetation resources for various reasons depend upon the local conditions. However, in disagreement with these views, Farah (1991) reported that the present grazing management in Machakos is neither irrational nor inherently causing degradation in its impact on the natural vegetation. He argued that increasing woodiness is not an unwanted by-product of heavy grazing but the result of protecting trees in recently settled areas of Southern Machakos, Kenya.

Many researchers emphasise that encroachment of woody plants into grassland or wooded grassland areas are closely correlated with the activities of man. It is a widely held belief that most rangelands suffer woody vegetation encroachment, and desertification process is believed to be more serious in the areas where there is interaction between crop cultivation and livestock production. From this scenario, it is evident that most of Eastern Africa rangelands have undergone serious vegetation changes due to land uses changes. These changes have automatically affected the livelihood of the local community/people living in that area.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the study area

The study was conducted in Lugala and Igawa villages in Malinyi ward, Ulanga district, in Morogoro region between March and August 2001. The study area is located at approximately 650 and 450 kilometres from Dar es Salaams and Morogoro town respectively. It lies between latitudes 8^0 47'- 8^0 70' south of the equator and longitudes 36^0 05'- 36^0 14' east. Malinyi forms part of the Kilombero game control area and the Selous ecosystem (Jatzold and Baum, 1968; DLM 2000). The area is between 280 to 300 metres above sea level and varies from flood plain to rough topography in miombo woodland.

The soils of the floodplain are heavy black cotton and sandy soil, which, due to yearly inundation are generally fertile (Jatzold and Baum, 1968). In the wet season experiences extensive flooding and many roads are completely cut off. The area lies in the alluvial plain agroecolgical zone, and crop-planting season in the ward is from November to April (Haule, 1997; UNEP, 1998). However, there is a great variation in weather from year to year. Temperature ranges from 21°C to 35°C with high humidity during the rainy season. Mean annual rainfall ranges from 1000 to 2000mm with hardly any precipitation from June to October.

The Kilombero river joined by the Great Ruaha to become Rufiji river which discharge water to Indian Ocean. Approximately 65% of the water in the Rufiji river originates from Kilombero river (WWF, 1992; Haule 1997). Ulanga District lies in ecological zone III and

typical semi-humid tropical climate (Jatzold and Baum, 1968; Pratt and Gwynne, 1977; WWF, 1992; Herlocker, 1999).

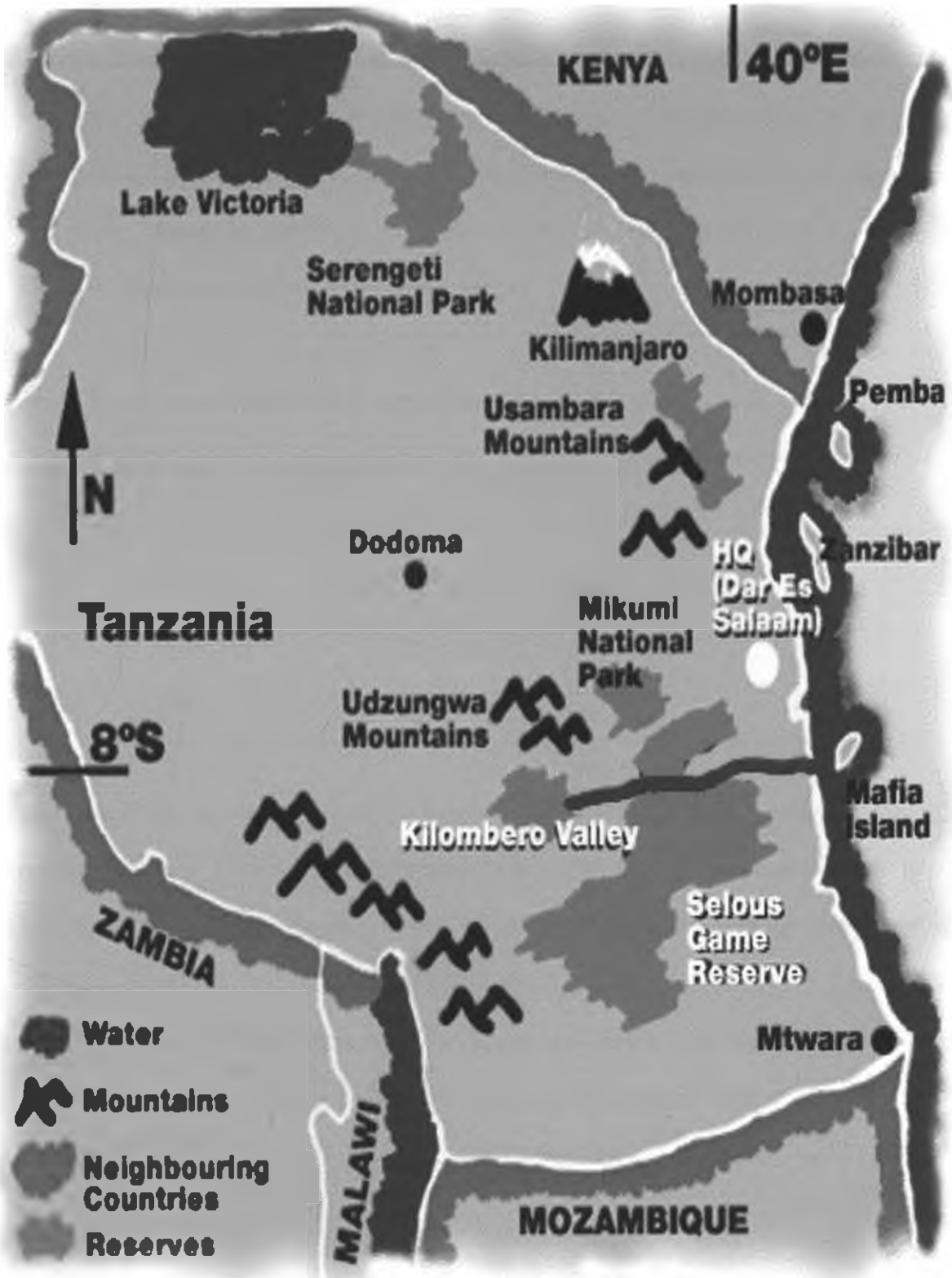
The vegetation of Malinyi area is dominated by forest, wooded grassland, and seasonal swamp grasses. Herbaceous species such as *Panicum maximum, Themeda triandra, Phragmites mauritianus, Hyparrhenia dissoluta, Cyperus distans* and *Pennisetum purpureum* with wood species restricted to the better-drained site around the edges and the elevated sites on floodplain. Woody species that are tolerant to occasional flooding are dominant in the area. These include *Borasus palm, Ficus sp., Kigelia africana, Bauhinia thonningii, Afrormosia angolensis, Dalbegia melanoxylon, Lonchocarpus capass, Combretum sp., Acacia sp., Vitex sp, Annona chrysophylla* (Jatzold and Baum, 1968; WWF, 1992; Haule, 1997; Herlocker, 1999).

Malinyi ward and Kilombero valley is rich in wildlife, with significant numbers such as lions, elephants, buffaloes, and pukus. The wetland area serves as a dry grazing reserve for animals like elephants and buffalo, migrating from Selous Game Reserve. The floodplain is also rich in bird species and the wetland supports one of the country's largest inland fisheries with high species diversity some endemic to this area (WWF, 1992; Haule, 1997).

According to Tanzania population census of 1988 Ulanga District has a population of about 137,887 (90.6% rural and 9.4% urban dwellers). With a population density of 4.4 persons per square kilometre, this is lower than the Morogoro region density of 17 persons per Kilometre Square, which is also considered as low density. The District has multi ethnic groups: the Ndamba, the Bena, the Pogoro, the Ndwewe, the Ngoni and the

Ngindo (The United Republic of Tanzania, 1990). Subsistence agriculture is the main economic activity of the local population. Wide ranges of crops are grown at subsistence level rice and maize being the major crops. However from late 1970's to date livestock immigration into Malinyi area is common and practiced by tribes such as the Maasai, the Sukuma, the Mbulu and the Barbaig (Mang'ati) from semi arid area of Tanzania. Therefore, currently the main human activities in Malinyi are cultivation of crops and livestock husbandry.

Figure 1: Tanzania map describing the location of Kilombero valley



3.2. Study methods

3.2.1 Selection of the study sites

Prior to the actual field study, visits to the study area were made in order to identify land use practices and location of each land use type. Four-land uses in four different locations in Lugala and Igawa villages were identified and selected for the vegetation and soil study based on observed similarity in ecology (vegetation and landform). The identified land uses are listed in Table 1 below.

Table 1: Land use types in Malinyi division, Ulanga district, Tanzania

Land use type	Description of Land use (tribe involved)
I	Agro-pastoralists area (the Sukuma)
II	Pastoralists area (the Maasai)
III	Cultivators area (the Ndamba)
IV	Reserve area

The difference between these land uses was based on agricultural practices used by each community/tribe. Land use I refer to hand hoe and animal traction cultivation plus grazing (livestock keeping), Land use II refers to grazing (livestock keeping) only, Land use III refers to hand hoe and tractor cultivation, and Land use IV refers to no cultivation and grazing. The land use type and the study area were identified based on personal observation and in consultation with informed sources such as local administrative officers (at ward and division level), local elders and Lugala Lutheran Hospital staff.

3.2.1.1 Woody vegetation

To collect woody vegetation data, three woody species were identified for study based on the importance of each species on soil conservation, species availability, crop and livestock production, and household use in the study area. These species were *Afrormosia angolensis*, *Bauhinia thonningii*, and *Combretum ternifolium*. A six kilometres transect was established a cross each land use type in order to assess the impact of the land use practices. Four sampling points were marked out along each transect at regular interval of 1 kilometre. Five plots of 20m by 20m were established at each sampling points, i.e., one at the centre of transect, two left and two right at regular interval of 100m to served as replications or sampling units. The study had a total of 80 sampling points, 20 per each land use.

A quadrat method procedure described by Muller-Dombois and Ellenberg (1974) and Brower *et al.* (1990) was used The number of individual species, diameter at breast height, recruitment, and height was counted, measured, and recorded for all species. Two perpendicular crown cover diameters of three selected species were measured and recorded. Woody species were identified and listed using botanical names. The records were then used to calculate the woody vegetation attributes under consideration (density and cover). Woody species were identified and listed on species basis.

Density: This is the number of individuals per hectare or count of species per unit area (Brower *et al.*, 1990)

$$\textbf{Density per hectare} = \frac{\textbf{No. of individuals of a species inside a plot}}{\textbf{Area of a plot}} \times 10000$$

Crown cover: This refers to the vertical projection of the aerial parts of individuals of the species under consideration on to the ground (Muller-Dombois and Ellenberg, 1974 and Brower *et al.*, 1990).

$$\text{Crown cover} = ((D_1 + D_2) \div 4)^2 \times \Pi$$

D_1 and D_2 are diameter measured of crown perpendicular to each other

$$\text{Crown cover per hectare} = \frac{\text{Area cover of a species inside a plot}}{\text{Area of a plot}} \times 10000$$

3.2.1.2 Herbaceous vegetation

Herbaceous vegetation data collection, three grass and three forbs species were identified for the study based on the importance of the each species on soil conservation, species availability, crop and livestock production, and household use in the study area. The three grass species were *Hyparrhenia dissoluta*, *Panicum maximum,* and *Themeda triandra*, and forbs species were *Bidens pilosa*, *Flaveria bidentis,* and *Watheria indica.* Herbaceous species were identified and listed on species basis.

Transects, sampling points used for woody vegetation were also used for herbaceous vegetation. The plot for herbaceous vegetation was 0.5m by 0.5m in (Cook and Stubbendieck, 1986). Two perpendicular clump diameters of three selected grass species were measured and recorded. The herbaceous vegetation within a plot was clipped, weighed, sun dried, reweighed and recorded Herbaceous species were identified and listed on species basis. The records were then used to calculate the herbaceous vegetation attributes under consideration (basal cover and biomass).

Basal cover: is the measuring the circumference or the diameter of a clump of grass above the ground and calculating the circular area for the foliage (Brower *et al.*, 1990).

$$\text{Basal cover} = ((D_1 + D_2) \div 4)^2 \times \Pi$$

D_1 and D_2 are clump diameter measured perpendicular to each other.

$$\text{Basal cover per hectare} = \frac{\text{Area cover of a species inside a plot}}{\text{Area of a plot}} \times 10000$$

Biomass: is the weight of the individuals of a population or group of population, and often is expressed per unit area or volume.

$$\text{Biomass in kilogram per hectare} = \frac{\text{The weight of individuals inside a plot}}{\text{Area of a plot}} \times 10000$$

3.2.1.3 Collection of soil samples

Soil samples were collected from four sampling points along the six kilometres transect at 0 – 15cm depth in each land use type (Okalebo *et al.*, 1993). Auger and core were used to collect the soil samples. A total of 16 samples were collected from the four land use types. The samples were weighed, dried, reweighed and passed through a 2mm sieve to separate debris and gravel. Anderson and Ingram (1993) a procedure was used to determine Moisture content of the soil samples. Total Nitrogen was analysed by the Micro-Kjeldahl method. Available organic carbon and organic matter were analysed by calorimetric method. The pH was determined by using pH meter and electro conductivity meter under ratio of 1: 2.5 of soil and water (Landon, 1991; Anderson and Ingram, 1993). Soil texture was analysed by hydrometer method (Okalebo *et al.*, 1993). Bulk density and Cation exchange capacity were determined based on Anderson and Ingram (1993) procedures.

3.2.1.4 Socio-economic survey

The data on crop and livestock production, natural resource uses and relationships between the Ndamba cultivators, the Sukuma agro-pastoralists, and the Maasai pastoralists were collected using a semi-structured questionnaire, formal discussion and observations. A sample of 90 households was drawn from Lugala and Igawa villages in Malinyi division. The 90 households were selected through cluster or area sampling by considering land use types. The cluster sampling was found suitable since crop and livestock production and natural resources uses vary between land use types. In each land use 30 household heads were randomly selected from sampling frame for interview. Each household head was interviewed to solicit socio-economic data. Both closed and open-ended questions were used. Formal discussions with local elders, development agents, and government officers were also conducted.

3.3 Experimental design and statistical analysis for the study

The Complete Randomised Design (Scifres, 1974; Steel and Torrie, 1980) was used to compare change of each selected species attributes and sun dried herbaceous biomass among the four land use types. Descriptive statistics such as percentage, and range were also used to describe vegetation data The Least significant difference (LSD) was employed to separate the means (Scifres, 1974; Steel and Torrie, 1980) after the analysis of variance (ANOVA). Soil physical and chemical analysis results were expressed using simple descriptive statistics. The data collected using questionnaires were summarised, ranked, and expressed using descriptive statistics such as percentages and frequency. The data collected were analysed using General statistic (Genstat) and Micro soft excel computer statistical programs.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Vegetation study

The vegetation inventory for three selected, woody species (density and crown cover), grasses and forbs species for basal cover and herbaceous biomass production varied between land use types in the study area.

4.1.1 Species composition and recruitment of woody vegetation

The wood vegetation of the area was composed of mixed species dominated by *Combretum sp*, *Bauhinia thonningii* and *Croton sp*. The number of wood species encountered in all land use types during sampling was 28. Twenty five in agro-pastoral area, nine in pastoral area, eleven in cultivator area and ten in reserve area. Among the 28 species five were recorded in all four land use type. A shown in Table 2 and Figure 2 below agro-pastoral area had high woody species number, density, and recruitment than pastoral, cultivator (original inhabitant), and reserve area. The diameter at breast height and height was bigger in reserve area when compared to agro-pastoral, pastoral and cultivator (original inhabitant) areas. Since the vegetation analysis covered a short period, one should expect additional species to be listed if the inventory were to be done over a longer period of time and in different seasons.

Table 2: Density, mean diameter, and height of woody vegetation

Land use type	Density/ha	Average Diameter (cm)	Average Height (m)
Agro-pastoral area (I)	338 (260)	6	5
Pastoral area (II)	25 (4)	16	9
Cultivator area (III)	34 (19)	15	10
Reserve area	35 (1)	27	15

Note: in bracket is density of regenerating shrubs and tree

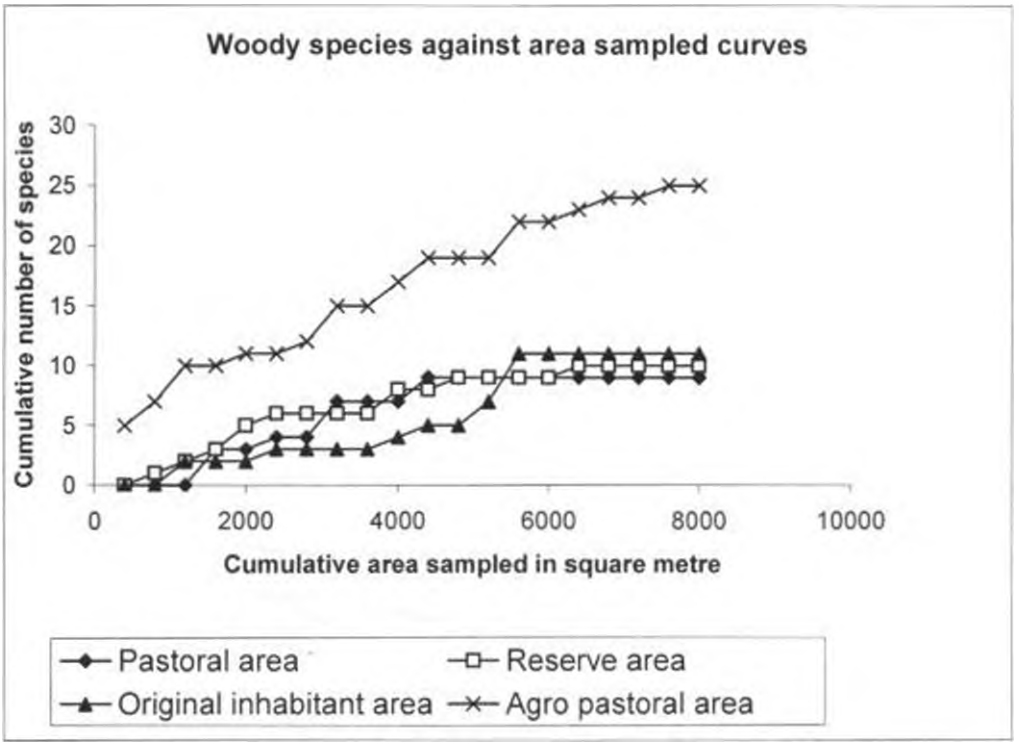


Figure 2: The number woody vegetation species in four land use types

The results above are associated with land use practices in each area. Agro-pastoral area was using oxen ploughing and handhoe, wood vegetation was cleared mainly for farming, but stumps were not uprooted. Also wood species were cut for domestic use and livestock sheds "*boma*. As a result, regeneration was high during fallowing period from seeds, root suckers and stumps. In pastoral area, wood vegetation was cut for domestic use and livestock sheds "*boma*", seeds, root suckers and stumps regeneration was difficult due to grass cover, which hindered seed germination during early stage of development due to competition. In the cultivator (original inhabitant) area wood vegetation was cleared and stumps were uprooted for crop production, as hired tractors and handhoes were used during ploughing. This limited regeneration from stumps and root suckers. Seed germination was common in fallow area. In Reserve area wood vegetation recruitment was low due high grass cover as in section 4.1.4 below that limits seed germination during early stage of development due to competition.

It can be concluded from the results of this study that land use practices due to human activities had an effect on species woody vegetation composition and recruitment. The results are therefore, in agreement with other study done in other areas. (Coppock 1994) as cited by (Alemu 1999) reported that ecological stability in Borana, Ethiopia is threatened by increased cereal cultivation on upland soil and wood encroachment as well as soil erosion which can be attributed to heavy grazing by cattle. Also Kahurananga, (1979) reported that regeneration of woody species was pronounced due to overgrazing, mounting pressure from cultivation and lack of annual fires.

The study area, therefore, is phasing the problem of controlling high recruitment and species composition in agro-pastoral area and low recruitment and species composition of wood vegetation in pastoral area as shown in appendix 3.

4.1.2 Density and cover of woody vegetation

The density of three selected tree species in the four land use types area shown in Table 3.

Table 3: Density of selected woody species (trees/ha)

Land use type	Tree species		
	Afrormosia angolensis	***Bauhinia thonningii***	***Combretum ternifolium***
Agro-pastoral area (I)	3a	24b	23b
Pastoral area (II)	1^a	1^a	3^a
Cultivator area (III)	4^a	1^a	9^a
Reserve area (IV)	3^a	8^a	5^a

In a column, numbers followed by a common superscript letter for tree density was not significantly different (P<0.05)

The total density of selected woody species, agro-pastoral area had a higher density (250 tree ha^{-1}) followed by reserve area (16 tree ha^{-1}), cultivator area (14 tree ha^{-1}) and lastly pastoral area (4 tree ha^{-1}). As far as individual woody species were concerned, *Combretum ternifolium* had higher density than *Bauhinia thonningii* and *Afrormosia angolensis* in agro-pastoral, pastoral and cultivator areas, while *Bauhinia thonningii* had higher density than *Afrormosia angolensis* and *Combretum ternifolium* in reserve area.

There was no significant difference (P < 0.05) in density of *Afrormosia angolensis* when comparison was made among four land use types, while there were significant differences (P < 0.05) for *Bauhinia thonningii* and *Combretum ternifolium*. Mean separation indicated that *Bauhinia thonningii* and *Combretum ternifolium* had a higher density in agro-pastoral area than pastoral, cultivator, and reserve areas.

A shown in Table 4 the woody crown cover per hectare for selected species was high in agro-pastoral area than pastoral, cultivator and reserve areas.

Table 4: Crown cover of selected woody species (m^2/ha).

Land use type	**Tree species**		
	Afrormosia angolensis	***Bauhinia thonningii***	***Combretum ternifolium***
Agro-pastoral area (I)	174[a]	997[a]	662[b]
Pastoral area (II)	4[a]	10[a]	9[a]
Cultivator area (III)	56[a]	15[a]	202[a]
Reserve area (IV)	6[a]	414[a]	14[a]

In a column, numbers followed by a common superscript letter for tree crown cover was not significantly different (P < 0.05)

From the Table 4 results *Bauhinia thonningii* had higher crown cover in agro-pastoral, pastoral and reserve areas, while *Combretum ternifolium* had higher crown cover in cultivator (original inhabitant) area when compared with other two species. The percentage crown coverage per hectare of each species was found to be 36%, 2.2%

and 0.6% for *Bauhinia thonningii*, *Combretum ternifolium* and *Afrormosia angolensis*, respectively. This shows that *Bauhinia thonningii* had higher crown cover in the study area.

There was highly significant difference ($P < 0.05$) for crown cover of *Combretum ternifolium* when comparison was made among land use types. As in Table 4 comparison among land use types for *Afrormosia angolensis* and *Bauhinia thonningii* crown cover were not significantly difference. Means separation for *Combretum ternifolium* showed that agro-pastoral area had higher crown cover per hectare than pastoral, cultivator and reserve areas.

As shown in Tables 3 and 4 woody density and crown cover showed similar trends. The agro-pastoral area had higher woody density and crown cover than pastoral, cultivator and reserve areas. The reasons for such results for the present study can be attributed to land use practices as in section 4.1.1 above. Therefore, immigration of pastoralists and agro-pastoralists and changing land use patterns has effect on woody density and crown cover in the study area. The results are, therefore in agreement with those reported by FAO (1979), in Zambia that the encroachment of woody plants into grassland or wooded grassland areas was attributed to human activities. Tietema *et al.* (1994) reported that the degradation of vegetation resources starts with a reduction in the density of the most palatable perennial species followed by a reduction in the total cover of the herbaceous layer and an increase in the woody component of the vegetation. Also Alemu (1999) stated that the rangelands experience more woody vegetation encroachment and desertification process in the areas where there is

interaction between crop cultivation, livestock production and sedentary agro-pastoral area, as is the case in this agro-pastoral area in this study.

The settlement of pastoralists and agro-pastoralists has increased the demand of *Afrormosia angolensis* as the species is more used for construction, firewood, charcoal and timber than other woody species. *Bauhinia thonningii* and *Combretum ternifolium* had higher density and cover due to regeneration from root sucker and coppices. From this study it was not possible to determine the effect of other factors such fire and climate due to the short-term nature of the research. In general the agro-pastoral area had moderate woody vegetation cover while pastoral, cultivator and reserve areas had low woody vegetation cover.

4.1.3 Species composition and biomass production of herbaceous vegetation

The herbaceous vegetation of the study area was composed of mixed species dominated by grasses. The number of herbaceous species encountered in all land use types during sampling was 32 (13 and 19 for grass and forbs species respectively). The herbaceous vegetation biomass in kilograms per hectare were 1219, 478, 1688, and 10470 for agro-pastoral, pastoral, cultivator and reserve areas, respectively.

There was a significant difference ($P < 0.05$) for biomass production when comparison was done among four land use types. Further analysis showed that the reserve area had higher herbaceous biomass production per hectare than agro-pastoral, pastoral and cultivator areas. The results indicate that land use practices have an effect on herbaceous vegetation production. Therefore, pastoralists, agro-pastoralists, and

cultivators (original inhabitant) modes of production have decreased herbaceous biomass production in the area.

4.1.4 Cover of herbaceous vegetation

The basal cover area of individual selected grass species are as shown in the Table 5. The total basal coverage per hectare for all three species were 5%, 9.2%, 0.7% and 22% for agro-pastoral, pastoral, cultivator and reserve areas, respectively. This shows that cultivator area had less percentage of grass basal cover. The basal coverage per individual species in all four land use types was 524, 258, and 140m^2/ha for *Hyparrhenia dissoluta*, *Themeda triandra* and *Panicum maximum*, respectively. This indicating that *Hyparrhenia dissoluta* was more common in the study area than the other two species. In terms of species coverage in each land use type, *Themeda triandra* had a higher basal coverage in agro-pastoral and cultivator areas, *Hyparrhenia dissoluta* in reserve area and *Panicum maximum* in pastoral area.

Table 5: Basal cover of selected grass species (m^2/ha)

Land use type	**Grass species**		
	Hyparrhenia dissoluta	***Themeda triandra***	***Panicum maximum***
Agro-pastoral area (I)	162[a]	278[a]	55[a]
Pastoral area (II)	265[a]	188[a]	468[b]
Cultivator area (III)	26[a]	41[a]	0 [a]
Reserve area (IV)	1641[b]	526[a]	38[a]

In a column, numbers followed by a common superscript letter for grass basal cover was not significantly different (P < 0.05)

There were highly significant differences ($P < 0.05$) among four land use types for grass basal cover for *Hyparrhenia dissoluta* and *Panicum maximum* species, while *Themeda triandra* showed no significant difference among four land use types. Further analysis showed that *Hyparrhenia dissoluta* had a higher basal cover in reserve area than agro-pastoral, pastoral and cultivator (original inhabitant) areas, and *Panicum maximum* had a higher basal cover in pastoral area than agro-pastoral, cultivator and reserve areas.

As shown in Table 6 forb species in the study area were found in cultivated area as weeds or on degraded land as encroachers. The selected forb species were not found in all sampling plots in pastoral and reserve areas. However, they were found in sampling plots of cultivated fields of cultivators (original inhabitant) and agro-pastoralists. This didn't mean that there were no forbs in pastoral and reserve areas. All three forb species basal cover was higher in agro-pastoral than cultivator (original inhabitant) area. In terms of species coverage in each land use type, *Flaveria bidentis* had higher basal cover than *Bidens* pilosa and *Watheria indica*.

Table 6: Basal cover of selected forb species (m^2/ha)

Land use type	Forbs species		
	Bidens pilosa	***Watheria indica***	***Flaveria bidentis***
Agro-pastoral area (I)	2 67[a]	2[a]	4[a]
Pastoral area (II)	0[a]	0[a]	0[a]
Cultivator area (III)	1[a]	1[a]	2[a]
Reserve area (IV)	0[a]	0[a]	0[a]

In a column, numbers followed by a common superscript letter for forbs basal cover was not significantly different ($P < 0.05$)

There were no significant differences among four land use types for all three forb species. As shown in Tables 5 and 6 the higher the grass species coverage the lower the forbs species coverage. Reserve and pastoral areas had higher grass species coverage, while agro-pastoral and cultivator areas had higher forb species coverage. The reasons for such results from this study can be attributed to human activities. The result is, therefore is in agreement with those reported by Boonman (1993) that the degree of cultivation, grazing and browsing strongly affects the structure, composition, quality and productivity of land resources.

The cultivator (original inhabitant) and agro-pastoralists preferred areas covered by *Hyparrhenia dissoluta* and *Panicum maximum* for crop production. These species were associated with soil fertility and floods, suitable for rice cultivation. *Themeda triandra*, however, had wider ecological amplitude and spread over both flooded and non-flooded areas, which meant that spatial distribution played a significant role in resource

utilisation. Also *Hyparrhenia dissoluta* was used for house roofing in the area. Therefore, settlement, cultivation, and grazing have reduced herbaceous coverage in the area.

4.2 Physical and chemical characteristics of soils

The physical and chemical characteristics of soils in the study area are shown in Table 7 below.

Table 7: Mean values of soil characteristics (pH, moisture content, organic carbon, organic matter, total nitrogen, bulk density, and texture) for the four land uses types

Land use type	pH	%MC	%OM	%OC	%N	CEC	BD	ST
Agro pastoral area (I)	6.32	4.55	3.59	0.89	0.15	10.29	1.29	scl, c, cl
Pastoral area (II)	5.68	10.17	5.88	0.87	0.27	17	1.53	scl, c
Cultivator (III)	6.24	15.61	3.77	0.99	0.19	16	1.31	scl, l
Reserve area (IV)	5.78	17.73	6.14	1.38	0.23	10.14	1.23	scl

Note: %MC = percentage moisture content, %OM= percentage organic matter, %OC= percentage organic carbon, %N= percentage nitrogen, CEC= cation exchange capacity me/100g, BD= bulk density gm/cm^3, ST= soil texture (s= sandy, cl=clay, and l=loam).

As shown in Table 7, the soil pH value ranged from 5.68 – 6.32, hence it was of low acidic value to neutral. The soil moisture content exhibited a wide range from 4.55% – 17.73%, with organic matter ranging from 3.59% – 6.14%. The organic carbon

percentage was low ranging from 0.87% - 1.38%. The total nitrogen percentage ranged from 0.15% - 0.27%, while Cation exchange capacity was from 10.14 – 17 me/100g. The soil bulk density ranged between 1.23 – 1.53gm/cm^3 with a texture of sandy clay loam as dominant, but there were also sand clay, clay loam, loam and clay. Generally the reserve area was more fertile than the agro-pastoral, pastoral, and cultivator areas. As reserve area had higher organic matter, higher organic carbon, higher moisture content and low bulk density when compared with other land uses. However the soil characteristics of the study area are almost the same as they had low ranges (Table 7).

4.3 Socio-economic survey

The socio-economic survey was conducted during farming period between March and August 2001 between Ndamba cultivators, Sukuma agro pastoralists and Maasai pastoralists.

4.3.1 Characterisation of the study population

The socio-economic survey revealed that the population of Malinyi ward in 2000 was 22,274 people (3365 household), which showed an increase of 35.23% from 14,427people in 1988 population census (Bureau of statistics of Tanzania, 2001). This increase was high compared to Tanzania population, which was estimated to be 32,844,000 people in 2000 an increase of 29.29% from 1988 (Bureau of statistics of Tanzania, 2001). A total of 415 and 1,516 pastoralists and agro-pastoralists in 34 and 114 households respectively were living in the area. That was 8.7% of the population in the study area.

Table 8: Household size, age, and education level of household head

Characteristics	Cultivator	Agro-pastoralist	Pastoralists
Age of household head (Hhh)			
<45	12	21	24
≥46	28	9	6
Education of Hhh			
None	2	17	26
Primary	20	12	4
Secondary	8	0	0
Adult	0	1	0
House hold size			
< 10	25	12	17
10 – 20	5	12	8
> 20	0	6	5
Mean household size	8	13	12

As shown in table 8 the respondent household heads 17,24, and 12 that is 70%, 80% and 7% were below 45 years old for the Sukuma agro-pastoralists, the Maasai pastoralists and the Ndamba cultivator respectively. The household heads of agro-pastoralist and pastoralist were young, while those of cultivator were old. This can be due to the immigration of the young and strong agro-pastoral and pastoralists people,

while cultivator population was affected by urban migration of the young generation. Most of these household heads were males by 96.7% and females 3.3% of the respondents. Based on the information given by respondents the household size in the study area ranged from 1 – 49 people, with the average of 11 people per family. The average household size in the area was greater than 4.9 the mean household size in Tanzania for 1996, with 5.1 and 4.3 for rural and urban respectively (Bureau of statistics of Tanzania 1997). In terms of tribe the Sukuma agro-pastoralists had large household size than other two tribes (Table 8). The reasons behind this can be polygamy and extended families. The education status of the household heads showed that 50% of the respondent had not attended school; most of them were the Maasai pastoralists 86.7% and the Sukuma agro-pastoralists 56.7%. In general household heads that went to school percentage wise are 40% primary school, 8.9% secondary and 1.1% adult education.

According to the responses obtained the Maasai pastoralists started settling in the study area from late 1970's and probably in 1978 from Arusha region in Monduli districts. They passed through Kilosa district in Morogoro region before settling in the study area. The Sukuma agro-pastoralists started settling in Malinyi area from 1980's and probably 1983 from Mwanza, Tabora and Shinyanga regions. They passed one to two regions before settling in Malinyi area. This movement of the Maasai pastoralists and the Sukuma agro-pastoralists could be the indicator of how livestock movement is a major problem in Tanzania. These movements had created natural resource management problems and land use conflicts in the study area. The major reasons for the Maasai pastoralists and the Sukuma agro-pastoralists settling in the study area

were grazing land, outbreak of disease in their former land and crop cultivation. These are the major reasons for all pastoral and agro-pastoral movement in Tanzania and Africa in general as stated by Sandford (1983). But the uniqueness of Tanzania pastoralists and agro-pastoralists' movement was that they moved into highly agricultural potential area (wetlands). Government policy of favouring agricultural sector in pastoral area and the presence of tsetse fly infection in large parts of Tanzania could be the reasons for the pastoralists and agro-pastoralists movements as cited in (UNEP 1986; UNSO and UNDP 1994; Cousins 1999).

4.3.2 Crop and livestock production

The socio-economic analysis revealed that the livelihoods of people in the study area are based on crop and livestock production. A hundred percent of the Ndamba cultivator and the Sukuma agro-pastoralists interviewed were involved in crop production. The crop production is based on rice *(Oryza sativa)* and maize *(Zea may)* in the form of intercropping or monocropping. Other crops include cassava *(Manihot esculenta)*, *Cajanus cajan*, sweat potatoes *(Ipomea batatas)*, ground nuts *(Arachis hypogaea)*, sesame *(Sesamum indicum)*, millet (*Pennisetum sp)*, Sourghum (*Sorghum bicolour)*, soya bean (*Glycine max)*, barmbara nut *(Voandzeia suterranea)*, and sugarcane *(Saccharum officinarum).*

Both group of people own an average farm size of 2.4 to 6.6 hectares. Also fruit tree such as *Musa sapientum*, Cocos nucifera, *Mangifera indica*, *Pusidium guajava*, *Carica papaya*, *Terminalia catapa*, *Citrus sinensis*, *Annona squamosa*, *Persea americana* and other *Citrus sp* were grown for subsistence use close to the home compound. Most of

the crops grown were used for both food and income. Also the Sukuma agro-pastoralists and the Maasai pastoralists used crop residue as animal feed during dry season. This had created conflict between livestock keepers and the cultivators, as livestock fed on crop, which were in farms. The problems facing crop production are wildlife, livestock and agricultural inputs such as seeds, chemicals, and tractors. Also poor marketing had hampered the growing of cotton as cash crop in the study area.

Based on the information given by respondents strategies employed by the Ndamba cultivator to improve soil fertility were crop rotation, and fallowing 66.7% and 6.7% of respondent respectively, while the Sukuma agro-pastoralists used crop rotation 30%, fallowing 13.3%, livestock manure 30% and mixed cropping 26.7%. Also both cultivator and agro-pastoralists were practising early cultivation, planting, weeding and harvest, bird controls, mixed cropping and planting in correct spacing to in order to improve crop production.

The Maasai pastoralists and the Sukuma agro-pastoralists practiced livestock production in the study as in Table 9 below. The communal grazing system was practised in all societies for cattle, local sheep, and goat. The Ndamba were involved in poultry, especially local chickens and ducks breed. They also had about 4, 12 and 19 dairy cattle, dairy goat, and pig respectively.

Table 9: Mean, median and range of livestock distribution

Class of stock	Tribe	Mean	Median	Range	Sum
Cattle	I	28.23	20	0 – 150	847
	II	119.26	74	25 –535	3578
Sheep	I	5.47	1.5	0 – 30	164
	II	59.47	52.5	20 – 222	1784
Goats	I	3.4	0	0 – 50	102
	II	9.13	0	0 – 98	274

Note: Tribe I – Agro-pastoralists II - Pastoralists

As shown in Table 10 above the estimate of livestock number in the study area indicates that the Maasai pastoralists have large number of livestock per family than the Sukuma agro-pastoralists. Also according to the respondents interviewed, the study area had an estimate of 7273, 2646 and 698 cattle, sheep and goats respectively. While 6000 cattle, 600 sheep and 600 goats where registered during 2001 tax collection. The actual number of livestock in the area was not known, as livestock census was not conducted since the arrival of pastoralists and agro-pastoralists in the area. This showed the importance of carrying out livestock census in the area. This will assist in the determination of carrying capacity and improves livestock tax collection. About 55% of respondents said their livestock were decreasing and 45% said the livestock were increasing in the area. However, the studies found out that the numbers of livestock are actually increasing in the area. In 1997, 5600 cattle where registered for tax collection, while 2001, 6000 cattle where registered, showing an increase of 400 cattle.

The study revealed that the sources of livestock feed in the study area were grass during wet and dry seasons, while crop residues were used in dry season. The use of tree leaves was not common in the area, and the most used species was *Tarmarindus indica*. There was no dry season grazing reserve, as the suitable dry season grazing area was under Kilombero game control area, where livestock were not allowed to graze.

Asked to lists the problems in livestock production, the respondents mentioned diseases such as East Coast fever, trypanosomiasis, anaplomosiasis, foot root and a variety of intestinal worms. The second problem was the limitation of grazing land, as good grazing area was under Kilombero game control area. There was large grazing area in the miombo woodland that extends to Songea region but pastoralists and agro-pastoralist avoided the area because of tsetsefly. That is why most of them were concentrated along the flood plain. Marketing of livestock was another problem in the area, as most of livestock keepers depend on Mtimbira action market, which was conducted once monthly. Livestock taxation was another problem, as the Government collected 500Tsh per head of cattle and 300Tsh per head of goat and sheep. This resulted in the conflict between the local government officers and livestock keepers. As found during study in 1998 four tax collectors were bitten and injured by the Sukuma agro-pastoralists youth group called "Sungusungu" when they were counting livestock during tax collection campaign. Wildlife predation was also common problem in the area, as the area had predatory animals such as Lions, hyenas, and leopards.

4.3.3 Utilization of natural resources

According to the responses of people interviewed vegetation resources in the study area are used for house construction material, households material, fuel wood, livestock feed, medicine and traditional value. The woody vegetation was used mainly for fuel wood (fire and charcoal) and building material (pole and timber). Other uses included handle, canoes, pounding motor, shade, medicine, and fruits. The tree species that were mostly used include *Bauhinia thonningii*, *Afrormosia angolensis*, *Croton sp*, *Acacia campylacantha* and *Combretum ternifolium*. According to the respondents the endangered or fast declining wood species were *Afrormosia angolensis* and *Acacia campylacantha*. These woody species were decreasing because of increasing pressure on land for crop cultivation, settlement (population increase) and grazing. Natural tree species conservation / protection was done by the Ndamba cultivator and the Sukuma agro-pastoralists, for tree species that provide shade, fruit, and medicine such as *Vitex doniana*, *Annona chrysophylla* and *Tamandarindus indica*.

Agroforestry or tree planting practices in the study area was common near houses of the Ndamba cultivator for exotic species, which provided edible fruits, pole for house construction and timber. These tree species include Cocos nucifera, *Mangifera indica*, *Delonix regia*, *Eucalyptus sp*, *Annona squamosa*, *Carica papaya*, *Musa sp*, *Anacardium occidentale*, *Tectona grandis*, *Senna siamea*, *Calliandra calothyrsus*, *Azidiratica indica*, *Terminalia catapa*, *Citrus sinensis*, *Pusidium guajava and* other *Citrus sp*. According to the respondent and field observation there was no tree planting in crop fields and in pastoral and agro-pastoral area inspite of the Governments campaign in tree planting.

Based on information from respondents, herbaceous vegetation in the study was mainly used for house / hut construction and livestock feed. The grass species, which were mostly used, include *Hyparrhenia dissoluta, Themeda triandra, Phragmites mauritanius* and *Panicum maximum*. According to the 95.5% of respondents these grass species were declining in area coverage due to settlement, crop cultivation and livestock grazing. In general there was no grass protection or management measures taking place in the study area.

The study area had a variety of wildlife species that were used by local people as source of protein and income generation. Tourists hunting were also common in the area during the dry season. According to the 62.2% of respondents illegal hunting was common in the area, and it is at its peak during wet season. This is associated with floods, at that time game scout patrol was limited that made local people intensify illegal hunting. The wild meat from the study area was sold within and outside Kilombero valley. The respondents interviewed reported that the diversity of wildlife species in the area had not been affected. However the individual animal numbers had been drastically reduced due to loss of vegetation cover, illegal hunting, livestock keeping, extension of crop cultivation, and increase of human population as in Table 10. These reasons when ranked the score were as follows, extension of crop cultivation, illegal hunting, livestock keeping, loss of vegetation and increase of human population by 63%, 53.3%, 26.7%, 18.9% and 5.6% respectively.

Table 10: Percentage frequency of reasons given for wildlife decline

Reasons	Cultivator	Agro-pastoralists	Pastoralists
Loss of vegetation cover	26.7	23.3	6.7
Illegal hunting	60	26.7	73.3
Livestock keeping	36.7	16.7	26.7
Extension of crop cultivation	50	53.3	86.7
Increase of human population	16.7	0	0

4.3.4 Environmental profile and trend

Based on the interviews on what major changes in land use have taken place. The respondent reported that the change in land use practices is associated with the introduction of livestock production by immigrant Maasai pastoralists and the Sukuma agro-pastoralists, and population increase of original inhabitant which have resulted into the reduction of vegetation cover and subsequent environmental degradation. Clearing land for cultivation, settlements, fuel wood collection, and livestock grazing had increased, which contributed to the decrease of important woody and herbaceous species such as *Afrormosia angolensis, Acacia campylacantha, Hyparrhenia dissoluta* and *Themeda triandra* in the area. Also uncontrolled tree cutting and burning for hunting, farm preparation and production of fresh grass (which is commonly now) contributed to loss of vegetation cover in the area. Although no evidence was found of the extinction of any plant species, but respondent said there was a decline of some important species such as *Afrormosia angolensis, Acacia campylacantha, Hyparrhenia dissoluta* and *Themeda triadra*. The decline of vegetation cover was also associated with low level of water in Kilombero river and its tributaries during dry season, reduced

numbers of wildlife species, appearance of soil dust in the air due to wind erosion in dry season (August – October) and small gully erosion in grazing area.

Based on information from respondents, the effort to stop or reduce loss of vegetation cover and environment degradation in the study area was not done as they reported no tree planting program and grass protection or management measures taking place in the study area. However all respondent (100%) agreed that large-scale environmental problems such as deforestation and desertification was caused by the society rather than by natural causes. Ninety four percent of respondents agreed that, if they would continue putting pressure on environment as they were doing now, they would not be able to sustain their present and future state of natural resource use. Therefore, in order to stop or reduce loss of vegetation cover and environmental degradation respondent suggested that people should practice controlled tree cutting, legal hunting and fishing methods should be used and tree planting programme should be introduced.

4.3.5 Interaction between livestock keepers and cultivators

The interaction between the Ndamba cultivators, the Sukuma agro-pastoralists, and the Maasai pastoralists in the study was good by 86.7% and bad by 13.3% of the respondents. Good interaction was shown through shared natural resources such as river water, vegetation (grass and forest) and land, and the exchange of household resources as shown in table 11.

Table 11: Number of respondents who received household resources from other communities

Resources	Cultivator	Agro-pastoralists	Pastoralists
Food (crop&livestock products)	30 (30)	3 (30)	30(28)
Labour force	0(8)	11(0)	7 (0)
Utensils &other non consumable good	0 (12)	29 (0)	13 (0)
Oxen	12 (0)	0 (3)	0 (0)

Note: Number of respondent supplied to other communities in brackets

The three communities participated together in development activities such as construction of schools, hospitals, and markets. They also participated together in national and traditional ceremony and in problem solving. The Ndamba elders are happy with the pastoralists and agro-pastoralists, because of the decrease of predator and crop destructive wild animals, which were serious problems before their arrival. During the time of the study respondent said, crop destructive animals such as buffaloes, elephants, monkeys, baboons, bush pigs had been reduced hence saving the time, which was used in patrolling the crops field for other activities. Also the incidence of predatory animals such as lions and leopard attacking people and livestock had decreased due to hunting and the traditional values of pastoralists and agro-pastoralists, i.e. being regarded as a hero in the society when you kill a lion among the Sukuma agro-pastoralists and the Maasai pastoralists. Also cultivators regarded agro-pastoralists as a source of power by hiring oxen that are used to cultivate large areas, which enhance production of large amounts and varieties of food crop. That reduced famine, which was previously common. The cultivators bought milk and milk products

from livestock keepers, which increased protein consumption that was previously obtained from wildlife, fish, and chicken only. However, they complained about land shortage due to the immigration of the pastoralists and agro-pastoralists that have settled in the floodplain area used by Ndamba cultivators as reserve land for the growing population and shifting cultivation. Therefore cultivators have been forced to hire farmland at price ranging from 5,000Tsh to 10,000Tsh per acre per year. Also the fallowing period had been shortened from five to one years or no fallowing that led to low soil fertility hence low crop production. Also respondent reported that conflicts exist between the cultivators and livestock keepers due to the damage of crops by livestock. In 1996 in Igawa village the Ndamba cultivators fought with the Maasai, because one Maasai herder grazed animals in a rice farm. Also during the study period (April 2001) conflict arose in Itete village (near by division), between the Pogolo cultivators and the Sukuma agro-pastoralists. The reason behind the conflict was the damage of crops by livestock. The relationship between pastoralists and agro pastoralists is good as they use the same area for grazing, but there is a problem of cattle rustling which the Maasai pastoralists commonly practise. Fifty six percent of respondents interviewed suggested that clear boundary should be put between grazing land and farmland. Agro-pastoralists also suggested that the Ndamba cultivators should keep livestock and the Maasai should practice crop cultivation so that to counterbalance the effects.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATION

The study was carried out to assess the effects of pastoral and agro-pastoral mode of production on ecological and socio-economic due to changing land use in Kilombero valley, Ulanga district. The reasons for carrying this study was that since the arrival of pastoralists in the 1970's and agro pastoralists in the 1980's, no study had been conducted to assess ecological and socio-economic effects of changing land use patterns due to pastoral migration, although there were some conflicts in the use of natural resources in the area. The study involved field inventory for species composition, woody plant density and crown cover, herbaceous plant basal cover and biomass production, soil characteristics (PH, moisture content, organic matter, organic carbon, total nitrogen, cation exchange capacity, bulk density and texture) and questionnaire survey for socio-economic evaluation shed light on local people's perception about changes in natural resource utilization patterns and interaction between livestock keepers and cultivators.

For vegetation characteristics, three selected woody species; crown cover and density showed encroachment of woody plants into grassland and wooded grassland areas as a result of the human activities such as cultivation, grazing and combination of the two. Agro-pastoral areas had higher density and crown cover of *Combretum ternifolium* ($P < 0.05$) than other land use types because wood vegetation was cleared for farming, but stumps were not uprooted. As a result regeneration was high during fallowing period from seeds, root suckers and stumps. The density and crown cover of *Afrormosia angolensis* were the same in all land use because of the economic importance of the

species in the study area. *Bauhinia thonningii* density was higher in agro-pastoral areas ($P < 0.05$) than other areas due to high recruitment as for *Combretum ternifolium* explained above but crown cover showed no significant difference between land uses because of the crown shape, (big shape in area of low density such as pastoral, cultivator and reserve areas, and small shape in agro-pastoral area with high density). The vegetation composition and regeneration of woody species was higher in the agro-pastoral area than pastoral, cultivator and reserve areas due to mode of production (interaction of cultivation and grazing), wood vegetation was cleared for farming, but stumps were not uprooted. As a result regeneration was high during fallowing period from seeds, root suckers and stumps. The basal cover of herbaceous vegetation of for three selected grass and forb species and their respective biomass production was also affected in the study area by cultivation, grazing and the combination of the two. The reduction of grass cover by cultivation and grazing increased the coverage of forb species in the area. The reserve area had higher biomass production ($P < 0.05$) than agro-pastoral, pastoral and cultivator area.

The soil characteristics of the study area showed that reserve area was more fertile than the agro-pastoral, pastoral, and cultivator areas. As reserve area had higher organic matter, higher organic carbon, higher moisture content and low bulk density when compared with other land uses. However the soil characteristics of the study area are almost the same as they had low ranges.

Vegetation resources trend in the study area showed reduction in the total cover of the herbaceous layer and an increase in the woody component of the vegetation. The

woody vegetation encroachment was more in the agro-pastoral area than in pastoral and cultivator areas. This attributed to the interaction between crop production (cultivation) and livestock production. These have created a problem of controlling encroachment of natural regeneration of woody species into open woodland in pastoral areas area while in cultivator's area have a problem of turning the land to a bare ground, due to lack of natural regeneration and tree planting efforts. These problems had affected the livelihood of the local inhabitant in the area as they walk 2 to 10 kilometres to collect fuel wood and building materials, while agro- pastoralists and pastoralists travelled long distances for pasture. Human factor via land use types was one of the major factors in modifying the vegetation cover and species diversity in the study area. Therefore both original inhabitants and immigrants are held responsible for the destructive removal of vegetation through cultivation, grazing, and domestic uses in the study area. Changing the government policy on land use and natural resources management to address land alienation problem in pastoral area, and intensify tsetsefly control measures in the country could control the pastoral and agro-pastoral movement in Tanzania.

The socio-economic structure of the study is base on crop and livestock production, the Ndamba does crop cultivation, the Sukuma does crop cultivation and livestock keeping, and the Maasai does livestock keeping. Crop and livestock production was used for both food and income. Both spatial (separate area) and intergrated productions exist between crop and livestock production in the study area. Introduction of livestock keeping in the study area have increased the percent of cultivated land due to availability of animal power (oxen ploughs) and reduction of destructive wild animals.

Crop residues for feeding animals were common but not legalised by local government authority in cultivation areas. In order to increase crop production, agricultural extension service should be intensified, and the indigenous knowledge and resources of the Ndamba cultivator and the Sukuma agro-pastoralists should be shared between the two communities. Proper crop marketing should be established especially for cash crops such as cotton, which once was the major source of income in the area. The provision of veterinary services and construction of livestock dips may improve livestock production in the area.

The interaction or relationship between the three communities the cultivator, agro-pastoralists and pastoralists is good as they depend from each other for social and economic benefits. The benefit of pastoralists and agro-pastoralists immigrant to local inhabitants were livestock products such as milk and milk products, meat, oxen power and livestock tax which was used for development activities in the area. Pastoralists had created market for crops as they bought food crops from cultivators and agro pastoralists. Moreover, agro-pastoralists sold food crops to cultivators and pastoralists hence reducing the food shortage in the study area. The conflicts among the three mode of production exist at individual level, which are cause by livestock feeding on crops and cattle rustling which is done by pastoralists.

The study recommends the following based on the results, discussion and conclusion;

- Demarcation of grazing land from farming land should be done to minimize conflict between livestock keepers and cultivators

- Technological support in farming systems, and soil, vegetation, and water conservation are needed in the area.
- Development of proper marketing systems for crop and livestock products in the study area
- Future research should focus on integration of crop and livestock production, protection and management of preferred plant species, and determination of livestock carrying capacity in the study area.

LITERATURE CITED

Alemu, D. T. 1999. Impact of land use on vegetation resources with emphasis on woody vegetation in the semi-arid areas of Abala District, North Afar, Ethiopia. M.Sc. thesis, Department of range management, University of Nairobi, Kenya.

Anderson, J. M. and J. S. I. Ingram. 1993. Tropical soil biology and fertility. A hand book of Methods, 2nd Edition, C.B.A International

Anderson, J. M., Gauthier, G. Thomas, and J. Wondelleck. 1996. "Addressing Natural Resource Conflicts through Community Forestry: Setting the Stage". Paper for E-Conference on "Addressing Natural Resource Conflicts through Community Forestry", FAO, Rome.

Arntzen, J. 1997. Sustainability and rangeland management. **In:** Economy and ecosystems in change: Analytical and historical approaches. *International Society for Ecological Economics.* Edward Elgar. Cheltenham, U K.

Behnke, R.H 1994. Natural Resource Management in Pastoral Africa. London: Commonwealth Secretariat.

Behnke, R. H., and I. Scoones. 1993. Rethinking range ecology: Implications for range management in Africa, p. 1-30. **In** Behnke, R. H., I. Scoones and C. Kerven (eds.) Range ecology at disequilibrium: New models of natural variability and pastoral adaptations in African savannas. ODI, London. U.K.

Berry, S. 1993. No Condition is Permanent. The Social Dynamics of Agrarian changes in Sub-Saharan Africa Madison: University of Wisconsin Press.

Blench. L 1997. Aspects of Resource Conflict in Semi-Arid Africa. ODI Natural Resource Perspectives No.16, London.

Boonman, J. G. 1993. East Africa's grasses and fodder's: The ecology. Mc Graw-Hill Book Co U.S.A.

Bollig, M. 1994. The application of PRA methods to the study of conflict management in a pastoral society" RRA Notes 20. London: IIED.

Bradbury, M., S. Fisher and C. Lane. 1995. Working with Pastoralist NGOs and Land Conflict in Tanzania. London IIED.

Bureau of statistics of Tanzania, 1990. The United Republic of Tanzania, 1988 Population census. Morogoro Region

Bureau of statistics of Tanzania, 1997. Tanzania demographic and health survey 1996. Bureau of statistics and Macro International. Dar es salaam

Bureau of statistics of Tanzania, 2001. The United Republic of Tanzania, Tanzania in figures. National bureau of Statistics planning and privatisation. Dar es Salaam, Tanzania.

Brower, J. E., J. H. Zar, and C. N. von Ende. 1990. Field and laboratory methods for general ecology. WCB, Wm.C. Brown publishers.

Chettleborough, J., and R. Jenkins. 2000 Conservation Research and Community Development in the Kilombero valley. The newsletter of the wildlife society Tanzania. Miombo number 21:1-12

Cook, C. K., and J. Stubbendieck . 1986. Range research. Basic problems and techniques. Society for Range Management. Colorado, U.S.A.

Cousins, B. 1996. Conflict management for multiple resource users in pastoralist And agro-pastoralist contexts. Programme for Land and Agrarian Studies School of Government, University of the Western Cape. Third International Technical Consultation on Pastoral Development. Brussels.

Danish Lutheran Mission (DLM). 2000. Report on review of the primary health care project, phase II, Lugala Hospital, Tanzania. Danish Mission Council, Development Jr. No. 104 N. 375.b.2.

Dregne, H. E. 1985. Desertification of arid lands. Cooper station New York, U S. A.

Ellis, J. E., and D. M. Swift.1988. Stability of African pastoral ecosystems: Alternative paradigms and implications for development. *J. Range Management 41: 450-459*.

FAO, 1979. A Zambian handbook of pasture and fodder crops. Rome, Italy.

Farah, K. O. 1991. Natural vegetation. **In:** Environmental change and dryland management in Machakos District, Kenya: 1930-1990 ODI Working paper No. 53, ODI, London.

Fridel, M. H. 1986. The interaction with climate, soil and land use of central Australian tree and shrub population, p.45-46. **In** Jos, P. J., P. W. Lynch, and O. B. Williams. (Eds.), Rangelands: A resource under siege. Proceedings of the second International Rangeland Congress. Australian Academic of Science, Cambridge University Press, Sydney.

Gilles, J. L., and C. Valdinia. 1992. Sustainable crop-livestock systems for the Bolivian highlands. Proceedings of a SR-CRSP workshop, University of Missouri-Columbia, U.S. A.

Grove, L., and C. A. Edward. 1992. Agro-ecological perspectives on agricultural research and development. **In:** Valdivia, C. (ed.) Sustainable crop-livestock systems for the Bolivian Highlands. Proceedings of a SR-CRSP workshop, University of Missouri-Columbia, U.S.A.

Gueye, M. B. 1994. Conflicts and alliances between farmers and herders: A case study of the 'Goll' of Fandene village, Senegal. IIED Issue. Paper no. 49.

Hamerslay, A. 1972. Agriculture and land tenure in Tanzania. **In:** Morgan W.T.W. (ed.). East Africa. Its people and resources. Second edition. Oxford University press, New York.

Haule, K. S. 1997. Wildlife prospects in Kilombero valley game controlled area, Tanzania. Traditional vs state management. Centre for International Environmental and development studies Noragric. Agricultural University of Norway.

Herlocker, D. 1999. Rangeland resources in Eastern Africa: Their ecology and development. GTZ, Nairobi. Kenya.

International Fund for Agricultural Research (IFAR). 1993. Agriculture in Tanzania: The role of International Agricultural Research Centres. *Country Report Number 2.*

Jatzold, R., and E. Baum. 1968. The Kilombero valley: Characteristic features and economic geography of semi-humid East African flood plain and its margin. Wesrforum verlage. Munich, Germany.

Kahurananga, J. 1979. The vegetation of the Simanjiro plains, Northern Tanzania. *African J. Ecology 17: 65-83.*

Kariuki, G. K. 1996. Socio-economic and phytoecological environment of nomads in small holder irrigation schemes in Isiolo District, Kenya M.Sc. Thesis, Department of range management, University of Nairobi, Kenya.

Landon, J. R. 1991. Tropical soil manual. A handbook for soil survey and agricultural land evaluation in the tropics and subtropics. Longman group Ltd, London U K

Lane, C. R. 1991. Alienation of Barbaig pasture land: Policy implications for pastoral development in Tanzania. Ph D Thesis, University of Sussex. U K.

Lane, C., and Moorehead R. 1994. New directions in rangeland and resource tenure and policy **In**: I. Scoones (ed.), Living with uncertainty: new directions in pastoral development in Africa. IIED and Intermediate Technology Publications, London.

Magimbi, S. 1991. The riverside Maasai: Cattle economy, drought and settlement Pattern in the Pangani river valley. **In**: Stone J.C (ed.), Pastoral economies in Africa and long-term response to drought. Proceeding of a colloquium at University of Aberdeen. U K.

Majok, A. A., and C. W. Schwabe. 1996. Development among African migratory Pastoralists. Bergin&Garvey Co. London.

Marc, R. 1995. Interests and Identities in Natural Resource Conflicts Involving Indigenous Peoples. Cultural Survival Quarterly Vol 19, no 3, Fall 1995.

Medina, E. 1987. Requirements, conservation, and cycles of nutrients in the herbaceous layer. **In:** Walker, B.H (ed.), *Determinants of tropical savannas.* IUBS, monograph series no. 3. IRL press, Oxford. U.K. p 39-66

Mpiri, D. P. 1995. Restocking rejuvenated agropastoral areas and sustainable livestock management. *The African Pastoral Forum, PINEP.Working paper No 4.*

Mtengeti, E. J. 2000. Pastoralism in Tanzania. Its sustainability and impact to the environment (unpublished)

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation Ecology.John Willey and Sons, New York. U. S. A.

Mwilawa, A.J. 1996. Traditional rangeland resource utilisation in selected pastoral Communities of Tanzania. M.Sc. thesis, Department of range management, University of Nairobi, Kenya.

Ndagala, D. K. 1990. Pastoralists and the state in Tanzania. **In:** Anders Hjort of Ornas (ed), *Nomadic peoples. Volume 25-27. P. 51-64.*

Ndagala, D. K. 1991. The Unmaking of the Datoga: Decreasing Resources and Increasing Conflict in Rural Tanzania. Nomadic Peoples. Volume 28.

Ndagala, D. K. 1993. Pastoralists and land in Tanzania. NOPA workshops on pastoral Development in Africa, Proceedings of NOPA/UNICEF/UNSO Nairobi, Kenya.

Niamir-Fuller, M. 1994. Natural resource management at local- level, **In**: Pastoral Natural Resource Management and Policy. Proceedings of the Sub regional Workshop, December 1993, Arusha. New York: UNSO.

NOPA. 1992. Pastoralists at cross roads. Survival and development issues in African pastoralism. UNICEF/UNSO project for nomadic pastoralist in Africa. Nairobi, Kenya.

NOPA. 1993. Workshops on pastoral development in Africa. Proceedings of UNICEF/UNSO project for nomadic pastoralists in Africa. Nairobi, Kenya.

Nyariki, D. M. 1998. The role of livestock as capital and in Ex-ante and Ex-post management of food insecurity in Sub-Saharan Africa: The case of agro-pastoralists in southern-east Kenya. *The African Pastoral Forum; PINEP Working Paper Series Number 15.*

Okalebo, J. R., K. W. Gathua and P. L. Woomer. 1993. Laboratory methods of soil and plant analysis: A working manual. Tropical soil biology and fertility programme. Soil Science Society of East Africa Technical Publication No. 1, Marvel EPZ LTD, Nairobi, Kenya.

Oladele, A. T. 1999. Socio-economic impacts of vegetation loss induced by arable farming activities in selected communities of Osun State. MSc. Thesis Department of Forest Resources Management, University of Ibadan, Nigeria.

Ole-Lengisugi. 1994. A Survey of MAA identifies and ancient ethnoveterinary animal husbandry practices among the Maasai pastoralists of Olkonerel: Arusha region. *The African Pastoral Forum; PINEP Working Paper Series Number 3.*

Pendzich, C. 1994. Conflict management and forest disputes - a path out of the wood?. Forest, Trees and People, Newsletter No. 20. Rome: FAO.

Pratt, D.J., and M. D. Gwynne. 1977. Rangeland management and ecology in East Africa. Hodder and Stoughton, London, UK.

Rugege, S.1995. Conflict Resolution in African Customary Law. Africa Notes, October 1995.

Sandford, S. 1983. Management of pastoral development in the third world. ODI and John Wiley, Chichester.

Scifres, C. J. 1974. Range research methods (RS 605). Department of range Science, Texas A & M University College station. Texas 77843. U.S.A.

Scoones, I. 1994. New directions in pastoral development in Africa. In: I. Scoones (ed.), Living with uncertainty: new directions in pastoral development in Africa. IIED and Intermediate Technology Publications, London.

Scoones, I. 1996. Hazards and Opportunities. Farming livelihoods in dryland Africa: Lessons from Zimbabwe. London: Zed Books and IIED.

Scoones, I., and K. Wilson. 1989. Households, Lineage Groups and Ecological Dynamics: Issues for Livestock Research and Development in Zimbabwe's Communal Lands. **In** B. Cousins (ed.), People, Land and Livestock, Proceedings of a Workshop on the Socio-economic Dimensions of Livestock Production in the Communal Lands of Zimbabwe. GTZ and Centre for Applied Social Sciences, University of Zimbabwe, Harare.

Sharpe, C. 1991. Spatial patterns and dynamics of woody vegetation in an arid savanna. Journal of Vegetation Science. 2:565-572.

Shishira, E. K. 1994. Characterization and classification of land cover and land use; Towards standardised hierarchical system(s) for use in Tanzania, Utilizing remote sensing data. Institute of Resource Assessment, University of Dar es salaam, Tanzania. Research No 92.

Skoupy, B. M. 1993. Developing rangeland resources in African drylands. *Desertification control. Bull. 17, 30-16*

Steel R.G.D., and J.H. Torrie. 1980. Principles and Procedures of Statistics: A biometrical approach. Mc Graw-Hill, New York, USA

Swift, J. 1994. Dynamic Ecological Systems and the Administration of Pastoral Development. **In**: I. Scoones (ed.), Living with uncertainty; new directions in pastoral development in Africa. IIED and Intermediate Technology Publications, London.

Sylla, D. 1994. Pastoral organisations for uncertain environments: **In** Scoones (ed.), Living with uncertainty; new directions in pastoral development in Africa. IIED and Intermediate Technology Publications, London.

Tietema, T., D. J. Tolsma, E.M. Venedaal, and J. Schroten. 1994. Plant response to human activities in the tropical savanna ecosystem of Botswana, p. 262-276. **In:** Rozena, J. and J. A. C. Verkleij (eds), Ecological responses to environmental stress. Kluwer Academy of Publishers, The Netherlands

UNEP. 1986. Technical reports on desertification in Tanzania and Ethiopia. UNEP Expert mission.

UNEP, 1998. Tanzania country study on biological biodiversity. Government of the United Republic of Tanzania, Vice-President's office, Dar es salaam, Tanzania

UNSO, 1992. Assessment of desertification and drought in the Sudano-Sahelian region 1985-1991.

UNSO and UNDP. 1994. Pastoral natural resource management and policy. Proceedings of the sub regional workshop held 6 – 10 December 1993 in Arusha, Tanzania.

Vedeld, T. 1992. Local institution building and resource management in the West African Sahel. Pastoral Development Network, Paper 33c. London: Overseas Development Institute.

Walker, B. H., D. Ludwing, C. S. Holling, and R.M. Peterman 1981. Stability of semi-arid savanna grazing systems. *J. Ecology, 69:473-498.*

Walker, B. H., and I. Noy-meir. 1982. Aspects of the stability and resilience of savannah ecosystems. **In:** B.J. Huntley and B.H Walker (eds.), *Ecology of tropical savannahs*. Spring Vertag, Berlin. P. 556-590.

Waters-Bayer, A., and W. Bayer. 1992. The role of livestock in the rural economy. *Nomadic People, 3: 3 – 18*

Westoby, M., B.H. Walker, and I. Noy-Meir. 1989. Opportunistic management for rangelands not at equilibrium. Journal of Range Management 42: 266-274.

WWF, 1992. Kilombero valley conservation and development project, Tanzania. Identification report. Nordic Agency for development and ecology. Tanzania/ Denmark. Profile. President's office, Planning commission, Bureau of statistics, Dar es salaam, Tanzania.

APPENDICES

Appendix 1: Questionnaire

Date ---------- Enumerator/Recorder----------

Village/Location ----------

Name of Respondent ---------- Age ---------- Sex ----------

Education level.....

Occupation.....

Tribe ---------- Clan/Group ----------

(A) HOUSEHOLD INFORMATION

1. Family size ..... Number

   Wives ----------

   Adult males (>18years) ----------

   Adult females (>18 years) ----------

   Boys (7-17 years) ----------

   Girls (7-17 years) ----------

   Boys (0-6 years) ----------

   Girls (0-6 years) ----------

   Total (including the respondent) ----------

2.Where were you (and your parents) from originally? (a) Outside this area-----

(b) This area----------

3.If you or your parents came from somewhere outside:

   Where was it? ----------

What was it like? (a)Land ----(b)Climate ----(c) Land use ----(d) Settlements ----

4.When did you and your parents move to this place? -------and Why? ----------

(B) LAND USE PRACTICE

(I) Crop cultivation (original inhabitant and agro pastoralists)

5. How much land area do you occupy? ---------- Ha.

6. What are the principal crops you grow? ----------

7. What are the functions of the cultivated crops? (a) Subsistence (food) (b) Market

(c) Livestock feed (d) Soil fertility (e) Other (specify)

8. What are the major constraints for crop production (rank)? (a) Rainfall failure ----(b)

Floods----(c) Soil fertility----(d) Soil erosion----(e) Wild animal destruction ----

(f) Livestock destruction ---- (g) Shortage of land ----(h) Other (specify) ----

9. What are the main strategies you employ to conserve or improve soil fertility?

10. What are the strategies you employ to avoid crop failure?

(II) Livestock keeping (Pastoralists and Agro-pastoralists)

11. Livestock ownership

Livestock kept	Amount
Cattle	
Sheep	
Goat	
Others specify	

12. Are the numbers of your animals decreasing? Yes/No.

13. If yes in number 12, what are the reasons?

14. Do you keep aside dry season grazing reserves? Yes/No.

15. Where do you graze your livestock?

16. Which feed sources are reliable during the dry season? (a) Grasses/Forbs ---- (b) Crop residues ----(c) Trees and shrubs ---- (d) Other (specify)----

17. What are the major constraints of livestock production in your community? (a) Shortage of grazing land----(b) Animal diseases---- (c) Unreliable market----(d) Others (specify)------

(III) Uses and exploitation of natural resource (original inhabitant, pastoralists and agro pastoralists)

18. What are the highest priority uses of trees and shrubs? ----------

19. What are the most popular (preferred or important) species for each use mentioned in number 18 above ?----------

20. Are they're any woody species that are extinct or declining from time to time in your community? Yes/no----------

21. If yes, in number 20, list and give reasons----------

22. What are most important woody species that provide edible fruits for man during bad years, and pods and leaves for animals in dry seasons and during drought years? -

23. Do you protect trees? Yes/No----------

24. If yes, in number 23, list the species and give reasons for your protection----------

25. Which trees do traditional laws protect, list and give reasons? ----------

26. Are they're woody species that were introduced in your community? ----------

27. What are the uses of grass in your community, list? ----------

28. What grass species are most preferred for the uses in number 27, list? ----------

29. Are there any species in number 28 that are extinct or declining, yes/no? ----------

30. If yes in number 29, list and give reasons ----------

31. Do you protect grass? Yes/No----------

32. If yes in number 31, why----------.and how? ----------

33. What type of wild animals are common on your area previously, please give names.

34. What wild animal's species in number 33, those are common now?

35. Are the wildlife's commons as before, Yes/No----------?

36. If no in number 35, what do you think is or are responsible for the changes?

a) Loss of vegetation---(b) Intensive hunting----(c) Livestock keeping----(d) Farming activities----(e) Others (specify)---------

37. What major changes in Land-use have taken place? ----------

38. Tick when agreed on the following statement? (a) Woody species are not deteriorating---- (b) There is too much destruction of the natural resources------(c) Large

scale environmental problems such as deforestation and desertification is caused by the society rather than by natural causes------(d) If we continue to put pressure on our environment, we will be unable to sustain our present state of natural resource use------.

39.What measures have been taken too stop degradation of natural resources?

40.What do you recommend to stop environmental degradation? ----------

41. What natural resources are shared between the Ndamba, the Sukuma and the Masai tribes? (a) Land (b) Water (c) Others (specify)

42.How are the natural resources in number 42 shared? ----------

43. What household resources are exchanged between the Ndamba, the Sukuma and the Masai tribes? (a) Food (b) Labour (c) Utensils (d) Others (specify)

44. What social activities your community / tribe benefit from the others?

45. What are your suggestion on the relationship between your community / tribe and others? Good/Bad

46. If good in number 46, explain?----------

47. If bad in number 46, explain? ----------

48. What should be done to improve the relationship between communities/tribes?----

Appendix 2: List of botanical names of indigenous plant species recorded during the study in Malinyi ward, Ulanga district

Tree and shrub	Grass	Forb
Kigelia africana	*Panicum maximum*	*Cucumis meliferus*
Croton sp	*Phragmites mauritianus*	*Sarcostemma viminale*

Bauhinia thonningii	*Hyparrhenia dissoluta*	*Ipomoea sp*
Hyphaene compressa	*Themeda triandra*	*Cyphia sp*
Afrormosia angolensi	*Sporobolus sp*	*Indigofera sp*
Acacia sp	*Acroceras macrum*	*Acanthospermum sp*
Cassia sp	*Panicum repens*	*Bidens pilosa*
Combretum ternifoliur	*Cyperus papyrus*	*Hibiscus sp*
Annona chrysophlla	*Pennistum purpureum*	*Striga asiatica*
Uapaca sp	*Paspalum commersonii*	*Felicia lutea*
Acacia campylacanth	*Chloris sp*	*Euphobia sp*
Borassus aethiopum	*Dactyloctenium aegytium*	*Watheria indica*
Ficus sycomorus	*Lusano	*Commelina sp*
Dalbergia		*Cassia biensis*
melanoxylons		*Leonotis sp*
Strychnos innocua		*Amaranthus sp*
Combretum molle		*Tagetes sp*
Grewia bicolor		*Flaveria bidentis*
Capparis tomentosa		*Datura sp*
Randia taylorii		
Diplorhynchus		
mossambicensis		
Tamarindus indica		
Commiphora sp		
Ficus sp		
Vitex doniana		

Milletia makondensis *Phonex reclinata* *Nsambila *Nkulanhubi		

Note: * local names of the species, trees are 30, grass 13 and forb 19 species

Appendix 3: The density of matured and regenarated of woody species in four land use types

Land use I: Agro pastoral area

Species	Tree and shrub density	Regeneration density
Kigelia africana	1.3	6.3
Croton sp	3.8	0
Bauhinia thonningii	23.8	6.3
Hyphaene compressa	3.8	0
Afrormosia angolensis	2.5	3.8
Combretum ternifolium	222.5	198.8
Annona chrysophlla	8.8	1.3
Uapaca sp	6.3	23.8
Ficus sycomorus	0	1.3
Dalbergia melanoxylon	2.5	16.3
Strychnos innocua	2.5	0

Combretum molle	30	0
Grewia bicolor	6.5	0
Capparis tomentosa	0	1.3
Randia taylorii	25	0
Diplorhynchus mossambicensis	1.3	0
Tamarindus indica	2.5	0
Commiphora sp	1.3	0
Ficus sp	0	1.3
Vitex doniana	0	1.3
Milletia makondensis	7.5	0
Phonex reclinata	1.3	0
Acacia camplylacatha	1.3	0
Cassia sp	2.5	0
*Nkulanhubi	1.3	0
Total	337.6	260

Land use II: Pastoral area

Species	Tree and shrub density	Regeneration density
Kigelia africana	2.5	0
Croton sp	1.3	0
Bauhinia thonningii	1.3	0
Hyphaene compressa	6.3	0
Afrormosia angolensis	1.3	0
Combretum ternifolium	2.5	0
Acacia camplylacatha	6.3	2.5
Cassia sp	0	1.3
*Nsambila	3.6	0
Total	25	3.8

Land use III: Cultivator

Species	Tree and shrub density	Regeneration density
Croton sp	0	1.3
Bauhinia thonningii	1.3	1.3
Hyphaene compressa	1.3	0
Afrormosia angolensis	3.8	0
Combretum ternifolium	8.8	2.5
Annona chrysophlla	1.3	0
Ficus sycomorus	1.3	13.8

Dalbergia melanoxylon	8.8	0
Vitex doniana	6.3	0
Borassus aethiopum	1.3	0
Total	33.8	18.9

Land use IV: Reserve area

Species	Tree and shrub density	Regenseration density
Kigelia africana	2.5	0
Croton sp	1.25	0
Bauhinia thonningii	7.5	0
Hyphaene compressa	1.25	0
Afrormosia angolensis	1.25	0
Combretum ternifolium	5	0
Annona chrysophlla	3.75	1.25
Ficus sycomorus	1.25	0
Acacia sp	5	0
Acacia campylacatha	3.75	0
Borassus aethiopum	1.25	0
Total	35	1.25

Appendix 4: Analysis of variance (ANOVA) tables

Note: In all the following ANOVA tables, ^{ns} =non significant at (p = 0.05); * = significant at (p = 0.05) and ** = significant at (p = 0.01)

4.1 Analysis of variance (ANOVA) tables for *Afrormosia angolensis* Harms, *Bauhinia thonningii* Schumach, *Combretum ternifolium* Engl &Diels density in the four land uses

Afrormosia angolensis Harms

Source of variation	d.f.	Sum of square	Mean square.s.	v.r.	F pr.
Land use	3	0.1375	0.0458	0.34	0.797^{ns}
Residual	76	10.2500	0.1349		
Total	79	10.3875			

Bauhinia thonningii Schumach

Source of variation	d.f.	Sum of square	Mean square.s.	v.r	F pr
Land use	3	10.837	3.612	4.354	0.007**
Residual	76	63.050	0.830		
Total	79	73.888			

Combretum ternifolium Engl &Diels

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	1131.64	377.21	7.27	< 001**
Residual	76	3941.35	51.86		
Total	79	5072.99			

4.2 Analysis of variance (ANOVA) tables for *Afrormosia angolensis* Harms, *Bauhinia thonningii* Schumach, *Combretum ternifolium* Engl &Diels crown cover in the four land uses

Afrormosia angolensis Harms

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	607.9	202.6	0.79	0.501^{ns}
Residual	76	19409.1	255.4		
Total	79	20017.0			

Bauhinia thonningii Schumach

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	20785.	6928.	0.96	0.417^{ns}
Residual	76	548976.	7223.		
Total	79	569761.			

Combretum ternifolium Engl &Diels

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	9034.6	3011.5	6.45	< 001**
Residual	76	35480.7	466.9		
Total	79	44515.3			

4.3 Analysis of variance (ANOVA) tables for *Hyparrhenia dissoluta* (Steud) Hutch, *Themeda triandra* Forsk. var. hispida (Nees) Stapf. and *Panicum maximum* basal cover in the four land uses

Hyparrhenia dissoluta (Steud) Hutch

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	2056134.	685378.	6.68	<.001**
Residual	76	7791899.	102525.		
Total	79	9848033.			

Themeda triandra Forsk. var. hispida (Nees) Stapf

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	155281.	51760.	2.45	0.070^{ns}
Residual	76	1606804.	21142.		
Total	79	1762084.			

Panicum maximum

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr
Land use	3	181054	60351.	5.15	0.003**
Residual	76	890108.	11712.		
Total	79	1071162.			

4.4 Analysis of variance (ANOVA) tables for *Bidens pilosa* L. *Flaveria bidentis* (L) kuntze. and *Watheria indica* L basal cover in the four land uses

Bidens pilosa L

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	6.014	2.005	0.96	0.417^{ns}
Residual	76	159.071	2.093		
Total	79	165.085			

Flaveria bidentis (L) kuntze

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	12.860	4 287	0.94	0.427^{ns}
Residual	76	347 387	4.571		
Total	79	360.247			

Watheria indica L

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	1.3365	0.4455	0.86	0.463^{ns}
Residual	76	39.1469	0.5151		
Total	79	40.4834			

4.5 Analysis of variance (ANOVA) table of sun dried biomas weight in the four land uses

Source of variation	d.f.	Sum square	Mean square	v.r.	F pr.
Land use	3	4073425.	1357808.	21.49	<.001**
Residual	76	4801476.	63177.		
Total	79	8874901.			