THE ROLE OF TRADITIONAL KNOWLEDGE AND LOCAL INSTITUTIONS IN THE CONSERVATION OF MICRO-CATCHMENT FORESTS AMONG THE SONJO AGRO-PASTORALISTS, NGORONGORO DISTRICT, TANZANIA.

BY

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ABSTRACT

Early attempts to solve environmental problems without local people's knowledge and institutions involvement have achieved very little success. Consequently the rate of natural resources degradation particularly in developing countries is still very high despite efforts to halt the situation. This study was undertaken to assess the role of traditional knowledge and local institutions in the conservation of micro-catchment forests among the Sonjo agro-pastoralists in Ngorongoro district, Tanzania. Participatory Rural Appraisal (PRA), household questionnaire survey, participant observation and focus group discussions were the methods used in data collection. Data collected through PRA were analyzed with the help of the participants and Content and Structural-Functional analyses techniques were employed to analyze qualitative data. The Statistical Package for Social Sciences (SPSS 11.5) programme was used to analyze quantitative data. The results revealed that there are two types of micro-catchment forests namely, traditionally managed and formally managed micro-catchment forests. The existence of various tree management practices such as indigenous tree planting and retention and protection of sacred forests were observed and that 98% of the respondents retained trees and 54% carry out tree planting while 46% did not engage in tree planting. Further more, the study revealed that the *Benamijie*, *Batana* and *Baghorowane* were the most prominent internally sponsored institutions whereas village governments, primary schools and village environmental committees were the most important externally sponsored institutions involved in the conservation of micro-catchment forests. The results also showed that age and education level of the respondents had significant ($P < 0.05$) influence on resilience of micro-catchment forests whereas gender inequality was the factor behind the erosion

of the micro-catchment forests. The study concluded by saying that traditionally managed micro-catchment forests were in good condition as compared to formally managed ones probably due to effectiveness of traditional institutions although the local government does not seem to support traditional efforts in micro-catchment forests conservation. The study recommended that there is a need for local government in the district to recognize and support the existing local institutions especially traditional institutions as essential and key partners in the conservation of micro-catchment forests.

DECLARATION

I, MASEGERI TUMBUYA RURAI, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work, and has never been submitted, nor concurrently being submitted for a degree award at any other university.

Masegeri Tumbuya Rurai (Msc. Candidate)	Date

The above declaration is confirmed by;

Prof. G. C. Kajembe (Supervisor)	Date

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DEDICATION

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CAF	Conserve African Forests
FAO	United Nations Food and Agriculture Organization
FGDs	Focus Group Discussions
MNRT	Ministry of Natural Resources and Tourism
NGOs	Non-Governmental Organizations
NORAD	Norwegian Agency for Development Co-operation
PRA	Participatory Rural Appraisal
TK	Traditional Knowledge
VECs	Village Environmental Committees
ha	Hectares
SPSS	Statistical Package for Social Sciences
HH	Household Head
URT	United Republic of Tanzania
IUCN	International Union for the Conservation of Nature
WRI	World Resource Institute
UNEP	United Nations Environmental Programme
WCED	World Commission on Environment and Development

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

1.1.1 Overview

About 27% of 3.5 billion hectares of the earth's surface are covered by forests (Palo and Uusivuori, 1999). In tropical Africa, forests cover about 520 million hectares (FAO, 1997). Tanzania has about 38.5 million hectares of forests and woodlands, representing 40% of the country's total land area (URT, 1998). Over 96% of the forested land in the country is classified as woodlands, 3.5% is closed forests and 0.3% is mangrove. Total gazetted forests and woodlands are about 13 million hectares of which about 1.6 million hectares are under water catchment (URT, 1998). The remaining part of the country is largely bushland ranging from semi-arid to arid environments, which are mostly under agro-pastoral and pastoral land use systems.

The rate of natural resource degradation in developing countries is still very high despite government efforts to halt the situation (Ogungo and Njuguna, 2004). In Tanzania, deforestation is still a major concern particularly in semi-arid and arid areas where water quality and quantity depends to a large extent on the forest cover. In areas where local communities had traditionally protected local natural resources, these traditions have been gradually eroded over time due to pressure for resource exploitation and lack of support from local governments as a result forest cover has increasingly declined. The general overview of the Tanzania forest cover is shown in fig.1.

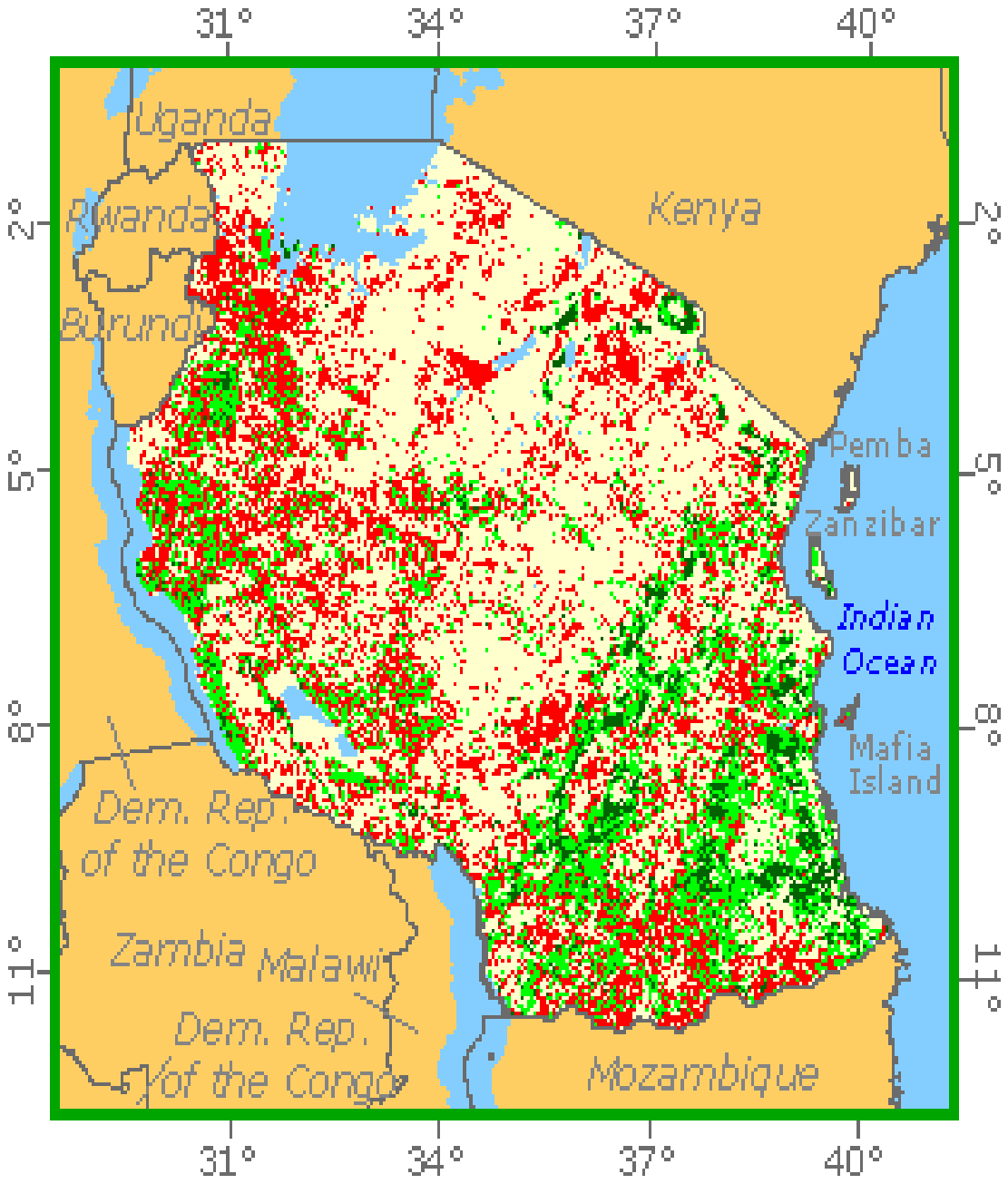

Figure 1: Map of Tanzania - forest cover
Source: Tanzania national website.

The pastoral and agro-pastoral land use systems are predominantly in the semi-arid and arid areas in central, northern and north-eastern regions of Tanzania. According to Haxley and Westly (1989), agro-pastoralism is defined as a land use system with rotational grazing of livestock on fallow areas, and on the farms during off-season to feed on crop residues after crops have been harvested on the farms. Agro-pastoralists differ from pastoralists in that the former have more than 50% of their household gross income coming from farming and 10-50% coming from livestock while the latter have more than 50% of the gross household income from livestock or livestock related activities (Baxter, 1994). Agro-pastoralism involve individually farmed plots and communal grazing land, under it, the most important land use system is the silvopasture that is mostly extensive grazing of livestock on rangelands (Jordan, 1992). Cattle ownership in both pastoral and agro-pastoral systems provides the social status and financial capital to the communities; the animals especially cattle are used for drought power (Mugasha *et al*., 1996).

Traditionally, both pastoral and agro-pastoral societies have evolved different management practices and customary institutions for regulating access and use of natural resources (Kajembe, 1994). Likewise in Ngorongoro District (Sonjo area), there are a long enduring Traditional Knowledge (TK) and local institutions that ensured sustainable conservation of micro-catchment forests which have remained relatively stable. Agrawal (1995) pointed out that institutions; whether formal or informal play a key role in determining the conditions of natural resources by indirectly mediating the effects of social and cultural norms, state policies, and demographic pressures**.**

In recent years scientists have recognized that different communities have valuable traditional knowledge and institutions, which have been used to manage the environment in which they have lived for generations, often without significantly damaging local resources (Emery, 1996). Currently it is widely accepted that TK can provide a powerful basis from which alternative ways of conserving resources can be developed. Traditional technologies and know-how have an advantage over introduced technologies in that they rely on locally available skills and materials and are thus often more cost-effective than introducing exotic technologies from outside (IIRR, 1996). Therefore understanding TK and local institutions, which are applicable in a particular community, is crucial if we are to facilitate local level processes of promoting sustainable resource conservation and community livelihoods (Mbwambo, 2000).

1.1.2 Definitions and explanations

1.1.2.1 Traditional Knowledge

Traditional Knowledge is an accumulative body of knowledge, beliefs and practices handed over through generations by cultural transmissions, with regard to the relationship of living things (including humans) with one another and with their environment. Traditional knowledge is an attribute of societies with historical continuity in resource use practices (Barnaby and Emery, 2002).

1.1.2.2 Institutions

Institutions are complexes of norms and behaviour that persist over time by serving collectively valued purposes. Some institutions have an organizational forms with

rules and structures, whereas others exists as pervasive influences on behaviour (Kingenyi and Mugabe, 2002)

1.1.2.3Traditional Practices

Traditional practices refer to small and large decisions taken on daily basis by the local people in their generation, protection and use of biological resources. This goes beyond descriptive knowledge, to what local man does with his store of knowledge- not just what he/she uses resources for, but also how he/she uses them (Kajembe, 1994).

1.1.2.4 Micro-catchment forests

Micro-catchment forests in this study are considered to be the forests of the size between 0.5 and 5 hectares covered with natural vegetation in which the dominant species are trees, with crowns touching each other to form a continuous canopy and within which water springs emanates.

1.2 Problem Statement and Justification

Early attempts to solve environmental problems without local people involvement have achieved very little success (Mgeni, 1992). Today, TK and local institutions in the conservation of natural resources have become key components in development programmes (Kajembe, 1994; Munyanziza and Wiersum, 1999). The Ngitiri; a traditional agro-pastoral resource management system practised in Shinyanga has been a source of TK for researchers (Kilahama, 1994 and Msangi, 1995). However, most of the traditional knowledge systems and local institutions for the conservation

of natural resources practised in Tropical Africa have not yet been studied in detail and documented and some of them are being lost (CAF, 2001). With regard to the conservation of natural resources, more efforts have been put on the protection of National Parks, Game Reserves and Forest Reserves while such areas might not be necessarily the most important sites for conserving threatened, endangered or endemic plant species (WRI/IUCN/UNEP, 1992). Maenda (1999) emphasizes that the size of protected or conservation area does not always reflect its ecological importance, implying that small traditional forests may be more important ecologically than large and well-known conservation areas. The micro-catchment forests in Ngorongoro district harbours biological resources, which might not be found in other places. By using TK and local institutions of societies living in those areas, scientists can learn a lot on biodiversity values of micro-catchment forests through research.

The Sonjo people, who are agro-pastoralists, live in semi-arid and arid environment of Ngorongoro district where water is a critical resource. Therefore micro-catchment forests in Sonjo land are very important because it is where water resources originates. The Sonjo agro-pastoralists are still leading traditional lifestyle governed by existing functional traditional knowledge systems and local institutions, which are accepted and used by most of the members of the society. According to Barrow (1991) people living in semi-arid and arid areas where environment is harsh, have developed over time conservation strategies to overcome environmental stresses.

Both micro-catchment forests and water resources are utilized under traditional management systems, and have sustained livelihoods of the community living in a hostile environment for many generations. Although traditional knowledge and local institutions still exist in the study area, in recent years there has been a notable destruction of the micro- catchment forests due to probably by weakened local institutions and erosion of traditional knowledge. The knowledge on the status of the existing TK and practices as well as local institutions of the Sonjo agro-pastoralists used in the conservation of micro-catchment forests is rather scanty. Specifically no studies have been conducted that focused on TK and practices and local institutions of the Sonjo agro-pastoralists, which are used in the conservation of micro-catchment forests. According to Langil (2001), researchers can assist in preserving the TK systems and local institutions through documenting them so that both the scientists and local communities can have access to them and can utilize them in the formulation of sustainable development plans. However, relatively little has been done towards that direction. The research aimed at closing this knowledge gap.

1.3 Study Objectives

1.3.1 Overall objective

The overall objective of the study was to assess the role of Traditional Knowledge and Local Institutions in the conservation of micro-catchment forests among the Sonjo agropastoralists.

1.3.2 Specific objectives

Specifically the study intended to: -

i. Identify different types of micro-catchment forests.

ii. Identify traditional knowledge systems and practices that have implications on conservation of micro-catchment forests.

iii. Identify and assess the roles of the existing local institutions (both internally and externally sponsored) in the conservation of micro-catchment forests.

iv Identify the socio-economic factors which influence resilience or erosion of micro-catchment forests.

1.4 Research Questions

i. What are the different types of micro-catchment forests?

ii. What are the traditional knowledge systems and practices that have implications on conservation of micro-catchment forests in the study area?

iii. What are the existing local institutions (both internally and externally sponsored) in conservation of micro-catchment forests?

iv. What are the socio-economic factors influencing resilience or erosion of micro-catchment forests?

1.5 Conceptual Framework

In this study, traditional knowledge, practices and local institutions are considered as instrumental in sustainable conservation of micro-catchment forests. As indicated in fig.2 the community and the micro-catchment forests have direct interactions in which local institutions, traditional knowledge and practices mediate these

interactions. But, the micro-catchment forests are subject to influences of various socio-economic factors. The influence of socio-economic factors may have either positives or negative outcomes on micro-catchment forests. The positive outcome may result into resilience of micro-catchment forests whereas negatives outcomes lead into erosion of micro-catchment forests. Nevertheless, the survival of the micro-catchment forests depends as well on what is happening on the outer environment, that is, presence or absence of external interventions particularly tree planting and retention.

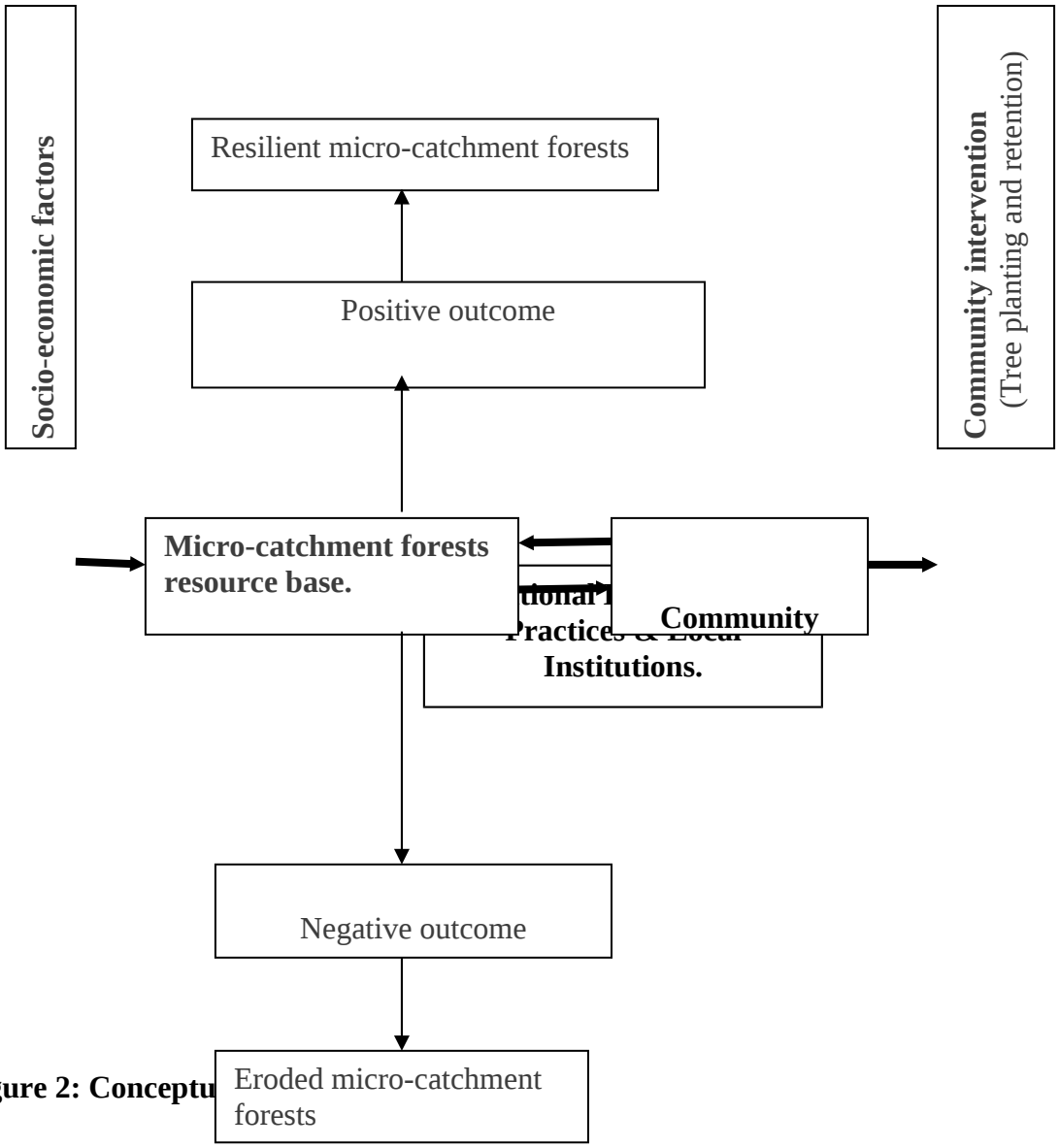

Figure 2: Conceptu

1.6 Study Limitations

1.6.1 Problem of recall data

During the study the problem of recall data was experienced. As a result there were notable difficulties for respondents to give correct answers, for example in household income. Asking similar questions more than once in different ways and through participant observation minimized this problem.

1.6.2 Mixing of measuring units

Some respondents tended to mix between acres and hectares when asked on sizes of their farms and micro-catchment forests. To minimize this problem site observations were made and actual measures taken.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Traditional Knowledge

2.1.1 The Concept of traditional knowledge

Traditional knowledge refers to the knowledge used by local people to make a living in a particular environment (Warren, 1991). According to Johnson (1992), traditional knowledge can be defined as a body of knowledge built up by a group of people through many generations of living in close contact with nature. Generally speaking, such knowledge evolves in a local environment, so that is specifically adapted to the requirements of the local people and conditions. It is also creative and experiencial, constantly incorporating outside influences and inside innovations to meet new challenges. It is a mistake to think of traditional knowledge as 'old-fashioned,' 'backwards,' 'static' or 'unchanging (Langil, 2001).

It is also important not to confuse the term traditional knowledge with indigenous knowledge. The two terms have similar meaning except that indigenous knowledge refers to the knowledge of the original inhabitants of a particular geographic location who have a culture and belief system distinct from the international system of knowledge; while traditional knowledge is a broader term referring to the knowledge possessed by any group of people living in a particular area for a long period of time. In this case it is not necessary to know if the people in question are the original inhabitants of an area, the important thing is to learn how people in a particular area view and interact with their environment (Langil, 2001). In this study the term traditional knowledge is adopted.

According to Thrupp (1989), utilizing traditional knowledge in development projects and management plans give it legitimacy and credibility in the eyes of both local people and outside scientists, increasing cultural pride and thus motivation to solve local problems with local ingenuity and resources. There are large areas of Tropical Africa for which there is little knowledge recorded and processes for this knowledge to be passed on from one generation to another are inadequate (Langil, 2001). The author further urgues that there is an urgent need, therefore, for a systematic approach to halt the loss of traditional knowledge and local institutions . This includes among others through ethno-biological research.

2.1.2 Traditional knowledge and natural resources conservation

The UN Conference on Environment and Development (UNCED) in 1992 vitalized interest in the contribution of traditional knowledge to a better understanding of sustainable development. UNCED highlighted the urgent need to develop mechanisms to protect the earth's biological diversity through traditional knowledge. Many of the documents signed at UNCED reflected the need to conserve the knowledge of the environment that is being lost in the communities (CAF, 2004). Similarly, the World Conference on Science in 1999 recommended that scientific and traditional knowledge systems be integrated in interdisciplinary projects dealing with links between culture, environment and development in areas such as the conservation of biological diversity and management of natural resources and local communities should be involved in these projects. In recent times, development professionals consider traditional knowledge as an invaluable and under-utilized

knowledge reservoir, which provides developing countries with a powerful asset (CAF, 2004).

The use of traditional knowledge in the management of the natural resources has been a matter of survival to the local communities in rural areas. The oral and rural nature of traditional knowledge has made it largely invisible to the development community and to modern science. Traditional knowledge has often been dismissed as unsystematic by some of the scholars. As a consequence, it has not been captured and stored in a systematic way, with the danger that it may become extinct. Traditional knowledge in general has had to meet the needs of the local communities for many centuries, e.g. in relation to health needs. Humans throughout the ages have relied on plants as sources of food, clothing, construction materials, cosmetics and medicines. African traditional knowledge differs according to a given community, culture or society. It is seen to contrast with the knowledge generated within the modern learning system. Traditional knowledge is used at the local level by communities in Africa as the basis for decision-making pertaining to food security, human and animal health, education, natural resource management, and other vital activities (CAF, 2004).

In agro-pastoral areas natural resources are used for both productive and non-productive purposes. Water, perhaps the most important item in an arid environment, is used for both human and animal consumption, cleanliness, and rituals. But by far the most diverse use is made of plant, and to a lesser extent wildlife resources. Plants provide food, fuel, fodder, timber, construction of houses and fences, crafts, dyes,

musical instruments, weapons, utensils and medicines. Therefore, traditional knowledge and local institutions for the management of natural resources are still highly needed today and for many years to come for sustainable conservation of biological resources.

2.2 Institutions

2.2.1 The concept of institution

Institutions are defined as a set of rules that govern activities of individuals or group of people (FAO, 1992). According to Ostrom (1992) institutions are a set of rules used by individuals to organize repetitive activities that produce outcomes affecting those individuals and potentially affecting others. North (1990) defines institutions as humanly devised constraints that shape human interactions. Gunnarson (1991) asserts that local institutions consist of rules, norms and customs with their enforcement characteristics, which determine rights and obligations between people. Institutions are differentiated from organizations in that, organizations are structures of recognized and accepted roles (Mbwambo, 2000). North (1990) defines an organization as a group of individuals bound by some common purpose to achieve certain objectives. An organization operates within rules and constraints provided by institutions, but not all institutions have organizational structures.

There is a great diversity of institutions and the various types can be classified using various criteria. Umans (1993) identified two types of institutions, namely; culturally and politically motivated. Culturally motivated institutions also known as internally sponsored institutions are essentially traditional in nature and do play important roles

in natural resources management. They are used in regulating and utilizing of various natural resources in a given society. Culturally motivated institutions represent the established local system of authority derived from the socio-cultural and historical processes of a given society (Appia-Opoku and Hyma, 1999). They originate from local culture and have firm roots in the past and reflect knowledge and experience of the local people. These include norms, customs, rituals and taboos that regulate behaviour and responsibilities among members of the society in the protection of natural resources. Other institutions included in this type are the traditional chiefs and councilors, clan heads and kraals heads (Kayambazinthu *et al*., 2003) and 'ngitiri' and 'lyabuje' (Kajembe and Kessy, 2000).

On the other hand politically motivated institutions also referred to as externally sponsored institutions represent the formally established rules and regulations that are governed by the state. The state in this case is either local or central government and also donor agencies, which are involved in the management of natural resources in a given locality. Other institutions in this category include village governments, churches, village environmental committees, schools, non-governmental organizations (NGOs) and other civil society organizations established to coordinate community development in a given area (Kayambazinthu *et al*., 2003). Also the centrally established policies such as national forest policy, laws and regulations that govern access to and utilization of natural resources are also considered as externally sponsored institutions (Mayeta, 2004). The government administrative structures at a local level are included in the externally sponsored (politically motivated) institutions due to the fact that they are not rooted in the local community as they are just set and

established by the government for administrative purposes. In many cases the externally sponsored institutions have failed in Tanzania largely due to lack of local legitimacy, institutional overlap with persisting traditional structures and different interpretations by individuals and groups to suit different ends (Kajembe and Kessy, 2000).

2.2.2 The role of local institutions in natural resource conservation

Sustainable conservation of natural resources is dependent, to a large extent, on the collective action of users. According to Oslon (1982) the collective action is dependent on the nature of a group (e.g. size, age, and purpose); the extent to which group characteristics are shared among group members (e.g. homogeneity in origin and in goals); and on the role of selective incentives in realization of collective action and overcoming free-rider problems. The author continues to argue that such incentives may take the form of positive 'joint product' benefits to members who participate in group activities or of 'penalties' imposed on those who fail to contribute to the collective action. Local institutions within the community monitor actions of community members. According to Mbwambo (2000) local institutions constitute an essential component of any attempt to facilitate community engagement in conservation of biological diversity. The author further argues that understanding social institutions that constitute a community is crucial for facilitating local level processes to promote sustainable resource conservation. Local institutions consist of rules, norms and customs with their enforcement characteristics, which determine rights and obligations between people (Gunnarson, 1991).

Many policy studies concerning the relationship between local institutions and natural resources conservation have indicated poor natural resources conservation to be attributed by intrusive state policies which are alleged to have interfered too much on the local scene and undermined local institutions, hence preventing the local institutions from playing their role in regulating resource use. Lawry (1989) pointed out that, however effective they were previously, local institutions currently face significant constraints as far as mobilizing collective actions is concern, and hence they cannot be relied upon alone in natural resources conservation. He suggested a greater balance (relying solely neither on state government nor on local community control) in the form of co-management model. This state of reconciliation between government, private bodies and NGOs and local communities is foremost important in realizing sustainable resource conservation.

The high dependence of local people on natural resources for their livelihoods has influenced designing of appropriate rules, regulations and practices for natural resource use (Heywood, 1992). It is these rules and regulations that are called institutions because they are used to govern human activities and shaping people's behaviour. As a result there is a close relationship between local institutions and daily activities of the people in a community.

In Ghana, Ntiamou-Baidu (1995) reported that there are patches of forests in graveyards that are protected because of the belief that ancestral spirits live there. Entry into such forests is prohibited, and only limited to classes of people such as village elders and clan heads who are allowed access for burial purposes. As a result,

trees and other natural resources in such areas are conserved. Similar cases have been reported in Kenya whereby Odera (1997) when studying on the conservation and utilization of medicinal plants found out that traditional institutions (taboos and social restrictions) were used to limit on gathering and harvesting of medicinal plants and the nature of plant gathering equipments. The author further argues that young people were restricted in cutting *Erythrina abyssinica* tree species in Western Kenya for the reason that in so doing they would reduce the healing power of the medicine. Also *Adansonia digitata* is traditionally protected and worshipped as a fertility tree by communities in Kenya, Sudan and West Africa (Odera, 1997).

In Tanzania several traditional institutions have been reported in various places and play different roles in the restoration and conservation of natural resources. These traditional institutions include; traditional councils, environmental groups, traditional dances, traditional healers, “Ngitiri” systems, and traditional leadership (Kajembe *et al*., 2000). Ngitiri is the local Sukuma word used to describe pasture management whereby areas of grazing land are closed either by the village council or a private landowner during wet season to be used for grazing during dry seasons (Otsyna and Ng’atigwa, 2003). Traditional institutions have great potential to ensure sustainable protection and management of natural resources. For example the Nyumba-Nitu forest in Njombe district, Tanzania, illustrates the effectiveness of traditional institutions in sustainable protection of forest resources (Kajembe *et al*., 2004). This communal forest is used only for rituals and worships, and managed locally by traditional institutions, which guide entrance into the forest.

It is therefore suggested by Furze *et al*. (1996) that sustainable management and conservation of natural resources will only be achieved through building and strengthening existing local institutions. For instance the use of 'ngitiri' traditional institutions has restored the ever-degraded forests lands in Shinyanga region of Tanzania (Otsyna and Ng'atigwa, 2003).

2.3 Traditional Natural Resource Management Practices

The natural resource management practices enhances long term multiple socio-economic benefits to meet the needs of a society (Shemdoe, 2003). These management practices ensure recreation opportunities, cultural and spiritual values and other benefits accrued from the forests conservation at the same time providing economic benefits such as timber and non-wood forests products including fodder for livestock. It has been a tradition that any failure by farmers to adopt new management practices is ascribed to the farmer's beliefs and values. However several other factors like limited access to information, lack of technical know-how and inadequate incentives associated with the farm tenure arrangements are important constraints affecting wider adoption of new technologies (Shemdoe, 2003).

The term traditional practices in natural resources management as used in this study refers to the small and large decisions taken on daily basis by the local people in their generation, protection and use of biological resources (Kajembe, 1994). The author further argues that it is about what local man does with his accumulated knowledge and not just what he uses resources for, but also how he uses them. FAO (1990) identified some of such traditional practices to include harvesting of forests resources

and also manipulation of tree resources through pollarding, pruning and respecting (or not) both formal social controls and common sense rules on harvesting of herbs, shrubs and trees and other forest resources. Kajembe (1994) asserted that traditional practices are both situationally and institutionally dynamic, rather than static. They evolve through time as a result of adaptive strategies of farmers. The farmer develops such adaptive strategies as he/she strives to adjust the use of their household resources to ecological and environmental changes (Kajembe, 1994).

Decisions for or against natural resource management practices for example tree growing and retention are subject to more direct economic factors, absolute and relative availability of land, labour, subsistence needs and capital (FAO, 1991). In addition to these factors they are also influenced by socio-cultural and institutional consideration. Fartman (1984) argued that in many regions, particularly in Africa trees are intrically linked to land rights and existing land tenure systems is a crucial factor in stimulating tree growing.

2.4 Micro-catchment Forests

In a wider perspective, catchment forestry is the management of forest resources to enhance the beneficial uses of water resources generated within the catchment (Mgeni, 1997). The catchment forests of Tanzania have an important role as sources of water. Such forests are either Reserves (state owned) or located in public lands (mostly under open access regimes). In semi-arid and arid areas most of the land is dominated by scattered thicket bush lands except in some small places where there is permanent water springs or seasonal rivers in which one can observe a relatively

dense and evergreen small forests normally with approximate sizes between 0.5 and 5 hectares surrounding the water sources and along river courses. These kinds of forests are the main focus of this study and have been termed micro-catchment forests. Basically the hydrological processes and functions of micro-catchment forests are similar to those of a larger catchment forests only that micro-catchment forests operates in relatively smaller areas.

The variety of climatic and vegetation types of tropical zones results in a variety of distinct and complex hydrological regimes (Oyebanda, 1988 as cited by Munishi, 2001). In most tropical regions, precipitation is the major input of water into catchment forests (Munishi, 2001). The author further emphasizes that precipitation interception, evaporation, through fall, transpiration and stem fall are the major above ground processes of the hydrological cycle that may influence the hydrology of forest catchment and determine the value of a forest ecosystem's ability to conserve and regulate water.

The importance of forests in regulating hydrological cycle and link between water flows in dry season and forests cover has long been known (Hamilton and Pearce, 1986). This is due to the ability of the forests to maximize water storage in the ground by facilitating infiltration and hence regulate, the flow such that water is released over a longer period of time. The maintenance of the forest canopy reduces soil erosion and maintenance of soil surface, ground cover, and slows surface runoff. Various watershed experiments in different catchment forests in Tanzania to show the importance of forests cover and the extent of the problem where cover is reduced or

removed have demonstrated the important role of forests in maintaining soil and water processes (Dumea, 1997). However, it is also noted that different ecosystems have different soils and water processes and that natural forests are superior to plantation forests in this respect (Lundgren, 1978 in Dumea, 1997).

The main objectives of catchment forests are water conservation, biological and gene pool conservation and forest production. Water conservation is by far the most important because at the moment in Tanzania a problem of matching society's demand for water with its availability is a real issue, particularly during dry seasons. The situation is worsening due to the fact that the management of catchment forest reserves has been minimal under the central government and even more limited under local governments. Worst is the situation of catchment forests under general lands where they are used under open access regimes. Exploitative forest utilization especially in catchment areas has greatly reduced forest cover with ensuing soil erosion. It should be recollected that catchment capacity of a forest depends strongly on the structural elements of the canopy and other vegetation layers (Richards, 1983). Destruction of the original highly differentiated natural forest cover in a catchment area normally has a negative effect on catchment capacity. As catchment areas in Tanzania are usually in steep-sloped mountains, the importance of the forest is not only for water conservation but also in preventing soil erosion. This also mitigates siltation of riverbeds and water reservoirs like dams (Mgeni, 1997).

2.5 Socio-economic Factors Influencing Resilience or Erosion of Micro-catchment Forests

Humans depend on biological resources for food, energy, construction materials, medicines and related products (Mbwambo, 2000). However, biological resources upon which people depend have a critical character of being renewable, at least when they are well managed; but biological resources if abused can also be extinct (McNeely *et al.*, 1995). All natural resources including micro-catchment forests are influenced by socio- economic factors including income, education level, gender, age and land size.

2. 5.1 Education level

Education is a tool that can make people manage resources properly including micro catchment forests. According to Rutatora (1993) through education the community may know the rationale for taking care of their environment. The relationship between the level of education and attitude towards natural resources is pragmatic as it provides people with the necessary skills to establish and maintain investment in resource conservation (Fanuel, 2002). However, it is important to note that adoption of skills is not necessary perfectly correlated with years of schooling (Machumu, 1995). Senkondo *et al.* (1998) found that adoption of rainwater harvesting technologies in Western Pare was not significantly explained by the education level but rather by other factors such as experience in farming and perceived technological characteristics.

2.5.2 Income

Income is one of the compelling factors in attaining sustainable management of natural resources (Fanuel, 2002). It has profound effects on the dependency of people to their natural resources (Mbwambo, 2000). The depletion of wood stocks through fuelwood harvesting has an economic implication as people with lower income spend more time in the forests collecting fuelwood than their higher income counterparts (Katani, 1999). Therefore chances to engage in resource management activities like tree planting are higher among the rich than among the poor. Likewise, the existence of micro-catchment forests in Sonjo land among other factors is in some ways influenced by the level of incomes of surrounding community.

2.5.3 Gender

Gender is cultural construction related to the behaviour learned by men and women (Mbwmbo, 2000). The author further emphasizes that gender is not a synonym for women, but it considers both men and women and their interdependent relationship. This social relationship influences roles of men and women play in the conservation of natural resources. These roles are clearly identified on the basis of age and sex (Fanuel, 2002). It affects what they do and how they do it within a specific social group. Katani (1999) argued that unlike men, women are good and active in tree planting and conservation activities. Kenya green belt movement is a vivid example of women participation in tree planting as a means to conserve the environment (Davidson and Dankelman, 1988). However, it is commonly reported that women consistently lack access to and tenure of land and other natural resources (Mehra, 1995). Women's rights to land ownership are often prohibited by traditional norms

and therefore when women don’t control land, they lack the confidence to plant trees and hence to protect the micro-catchment forests.

2.5.4 Land

Land is one of the most important determinant factors in sustainable resource management (Kingazi, 2002). With enough land, people may have opportunities to cultivate a variety of food and cash crops while carrying out conservation activities. Availability of land is one of the determining factors to the success of forest management activity such as tree planting which inturn protects the micro-catchment forests. Farmers with land size available only for agricultural crops are normally reluctant to plant trees (Njana, 1998). In rural areas, land has been a symbol for social wealth to distribute among family members through inheritance and the land is used for various activities including tree planting. Even though, inherited land in the family is used depending on the owner’s use priorities in which tree planting may be or not be the priority.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Area

3.1.1 Location

The study was carried out in Ngorongoro district, Arusha region, Tanzania. The villages involved include Samunge, Kisangiro, Sale and Yasimdito; (Yasimdito is a former satellite village from Samunge village) (Table 1). Ngorongoro is one of the five administrative districts in Arusha region covering 14,036 km^2 of which 8,292 km^2 are covered by Ngorongoro Conservation Area (NCA). The district headquarters is in Loliondo town situated at about 424 km from Arusha City. Ngorongoro district borders the Narok and Kajiado districts, Kenya to the north and to the south it is bordered by Mbulu and Karatu districts, Arusha region. To the west it borders Mara and Shinyanga regions while to the east it borders Monduli district, Arusha region. Administratively Ngorongoro district has 3 divisions, 14 wards and 37 villages. The map of Ngorongoro district showing the location of the study villages is presented in fig. 3.

Table 1: Population profile of the study villages

Village	Total population	Total no. of households	Average household size
Samunge	1297	354	4
Kisangiro	1655	322	5
Yasimdito	1416	281	5
Sale	2902	916	3
Total	**7270**	**1873**	**4**

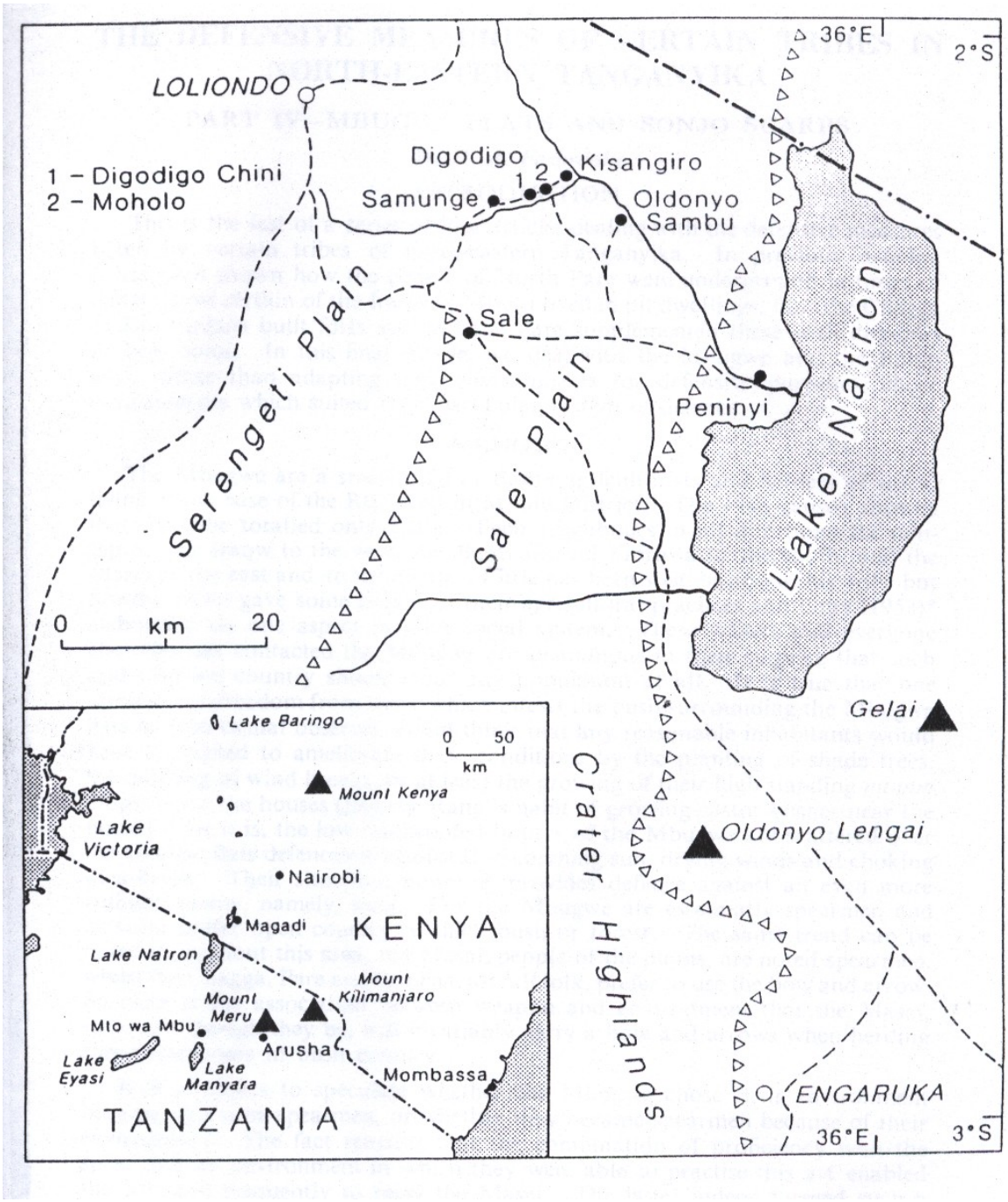

Figure 3: Map of Ngorongoro District showing location of the study villages

Source: Adams *et al.* (1994).

Key: ---------- Roads
……. International boundary

3.1.2 Climate, soils and physical features

Ngorongoro district has two main seasons, rainy and dry. Rainy season starts from November through June while dry season starts from July to October. Rainfall ranges between 800mm and 1200mm per year in highland areas and between 400mm to 600mm per year in semi- arid and arid areas (Thompson, 1997). Temperatures can be as low as 2^0C in the highlands but can often go up to 35^0C in semi-arid areas. The district has been affected by volcanic activities, whereby the only active volcanic mountain (Oldonyo Lengai) in East Africa region lies within the district. Soils are patchy and soil fertility varies greatly depending on volcanic deposits. Water quality is affected by the soils, with a considerable amount of ground water being contaminated by high fluoride levels and salts. Good quality water is tapped from springs in the mountains and dams are constructed in areas with suitable soils in order to trap rainfall run-off. In areas where the Sonjo people live, water is somewhat more abundant and traditionally managed for irrigation.

3.1.3 Population, ethnic groups and socio-economic activities

The population of Ngorongoro District is 129,776 people out of which 49% are males and 51% are females (URT, 2002). The population is predominantly Maasai pastoralists making 75% of population and a smaller group of Sonjo agro-pastoralists in Sale Division contributing 15% of the population as well as very small group of Tatoga pastoralists and Hadzabe hunter-gatherers in Ngorongoro Division both making 10% of the population. The Sonjo people whose economy is primarily based on irrigated and rain fed crop cultivation as well as livestock keeping makes an important contribution to the economy of the district. Major crops include maize,

beans, millet sweet potatoes cassava, fruits and vegetables for both food and cash needs.

3.1.4 The Sonjo ethnic group

The Sonjo are a small Bantu-speaking agriculturalists, although currently is agro-pastoral society. They live in northern Tanzania in Sale Division, Ngorongoro District, Arusha Region. They inhabit the hills between Loliondo and Ngorongoro Highlands, west of Lake Natron, above the western escarpment of the Rift Valley. The area is situated in the semi-arid zone, at the altitude of 1500-1700m, with an annual rainfall of 400-600mm (Adams *et al*., 1998). Sonjo people live in six main villages namely Samunge, Digodigo, Kisangiro, Oldonyo-Sambu, Sale and Mgholo and a number of satellite villages, which administratively (both in customary and modern systems) fall under the main villages. Three of the satellite villages namely, Yasimdito became separate village in 1990 while Tinaga and Mgongo-mageri are in the process of becoming administratively separate villages.

Originally all the main Sonjo villages were situated on the hillsides and had a compact and protected forms, surrounded by the line of planted thorn thickets as well as by the double wooden gates and fences made for security reasons in which until today the relics of these structures can be seen in all main villages. All 6 main villages are situated in places where there are both reliable sources of water in terms of springs or a perennial streams or rivers and where the natural conditions allow for irrigated agriculture. New satellite villages are usually situated in the bush above the

valleys, in places where water is sufficient only for domestic purposes. Rain-fed agriculture and livestock keeping are mainly practised in these satellite villages.

Linguistically, Sonjo belong to the Bantu speaking group, albeit it is almost certain that over several hundred years during which their current ethnicity developed, the Southern-Cushitic and Kalenjin elements had an influence. Like other ethnic groups living in the orbit of Maasai, the Sonjo accepted both some elements of the Maasai culture and social structure and on the other hand successfully struggled to maintain their own identity and political independence, which is difficult indeed due to the fact that Sonjo are surrounded in all directions by Maasai society. Consequently, at first sight they seem to have been colonized by the Maasai ideas and songs, Maasai pattern of social structures, Maasai-like types of clothes and adornments, and even Maasai names of villages and landscape features. For example the commonly used name of the tribe, Sonjo, is also of Maasai origin while the real tribe name is 'Batemi'. Nevertheless, under this outer layer, a solid rock of Sonjo identity is preserved. Instrumental in this process is the Sonjo religion, based on belief in the cultural Hero and God-*Ghambageu*, which unifies the whole society around common values.

Irrigated agriculture was the basis of the Sonjo economy in the past, however, currently rain-fed agriculture and livestock keeping has taken over as the main economic activities due to limited water for irrigation and rapid population growth in recent years. Notwithstanding, irrigated agriculture is still important to the Sonjo economy today. Water for irrigation comes from the traditional protected micro-catchment forests called *Bisonane*. Bee-keeping is another economic activity of

secondary importance to the Sonjo people. This skill is part of the hunting and gathering cultural complex present in the Sonjo society. Honey is used for social occasions and is bartered or sold for cash to the neighboring Maasai. Ownership of beehives is observed as strictly as water rights and ownership of cultivated land.

3.2 Methods

3.2.1 Research design

A cross – sectional design as suggested by De Vaus (1993) was used in this study. The design allowed collection of data at one point in time. The reason for the choice of this design is that it is both easier to conduct and is economical. However, a note is taken that, the design has a limitation that it does not allow a control for a broad range of unobserved characteristics that are omitted in estimation and correlated with the error term.

3.2.2 Data collection

3.2.2.1 Research phases and methods

The study was carried out in two phases. Phase one involved reconnaissance survey of the study area and carrying out Participatory Rural Appraisal (PRA) exercises. Phase two was mainly based on detailed questionnaire survey and participant observations.

3.2.2.2 Phase one and methods employed

Prior to carrying out PRA, a reconnaissance survey was done to provide a general picture of the study area. Reconnaissance survey enabled the researcher to obtain

basic information on population size and economic activities of the study villages. As a research tool, PRA serves the purpose of opening up discussions with villagers on topics of interest in the process of assessing local situations. PRA is based on interactive learning, shared knowledge and yet structured analysis (Devavaram and Johansson, 1993). In PRA exercise, groups of villagers including men and women and also youth (boys and girls) were involved. The methods used in PRA included resource mapping which helped to tap information on resource condition in all the study villages; time lines used to establish important activities done by respondents, Venn diagrams aided in the identification of local institutions and the roles played by them in micro-catchment forest conservation and wealth ranking aided in obtaining the representatives sample for each wealth category. PRA was an important approach, which enabled the researcher, and local people to share knowledge, analyze conditions, assess, plan and acquainted the researcher with real local environmental settings. The data collected were used to identify, implement, evaluate and plan for forthcoming research activities.

Focus Group Discussions (FGDs) with key informants were also carried out. A key informant is an individual who is accessible, willing to talk and has great depth of knowledge about issues in question (Katani, 1999). However, key informants are not only members of the clientele but are most often informed outsiders (Mettrick, 1993).

In each study village two groups were formed for the FGDs. Membership of the group was; men only group and women only group with youth representatives of respective sex. The sex separation was adopted because according to Sonjo customs,

women are not allowed to speak in the presence of men, especially in village settings. Other key informants considered were the village government leaders, traditional leaders and District forest officers. A checklist of questions (Appendix 2) was used to guide the discussions with key informants on various issues related to conservation of micro-catchment forests.

Participant observations were also used. During participant observations the researcher had the opportunity to compare what the respondents had reported with what was really observed on the ground. Mettrick, (1993) argues that it is always good to keep one's eyes open when visiting a study area and check what you are told against what you see. This was a very useful tool for crosschecking information obtained from the questionnaire survey.

3.2.2.3 Phase two and methods employed

The second phase involved questionnaire survey as a tool for data collection (appendix 1). Prior to questionnaire survey, sampling was done. Four out of nine villages primarily inhabited by the Sonjo agro-pastoralists were purposively selected for the study. The selected villages were Samunge, Kisangiro, Yasimdito and Sale. By using random sampling procedure, at least 30 households (Akitanda, 1999) or more than 5% of the total number of households in each village were taken to form a sample (Kajembe and Luoga, 1996). Therefore a total of 136 (7 %) out of 1873 households were selected for questionnaire interviews as indicated in table 2. The sampling units for this study were households. World Bank (1995) defines a household as a unit consisting of one or more persons, related or unrelated who live

together in one or more than one housing/dwelling and have common catering arrangement.

The households were picked from the village register books (sampling frame) in which all members of the villages and the households were listed. The first household was randomly selected followed by a systematic sampling in selecting succeeding households. Interval (I) between households was established systematically using the formula shown below.

I = N/n where **N** = total number of households in the village (as per village register)

n = Sample size

I = Interval between households

The proportions of the sampled households in the study villages are given in Table 2.

Table 2: Households sampled and interviewed

Village	Total no. of households	No. of sampled households	Sampled size %
Samunge	354	30	8
Kisangiro	322	30	9
Yasimdito	281	30	11
Sale	916	46	5
Total	**1873**	**136**	**7**

The household head was the main respondent with other household members supplementing information. Before embarking on the questionnaire survey, a pre-testing of the questionnaires was done to check reliability of the questionnaires, ability and likelihood of the interviewees in understanding and answering questions and minimizing possibilities of missing relevant information. A pre-test was done on 10 randomly selected households from Mgholo village, which was not involved in the

actual survey. The questionnaire method, among others, aimed at getting information on socio-cultural, socio-economics and environmental issues of the community under the study. The sampling scheme for questionnaire survey is given in appendix 3.

Secondary data were obtained by reviewing various publications mainly from Sokoine National Agricultural Library and reports from Ngorongoro district's offices as well as from Websites.

3.3 Data Analysis

3.3.1 Qualitative data analysis

Qualitative data were analyzed through content and structural-functional analyses. The components of verbal discussions with village and traditional leaders and elders as well as extension workers were analyzed in detail with the help of content analysis method. In this way the recorded dialogue with respondents was broken down into smallest meaningful units of information. This helped the researcher in ascertaining values and attitudes of respondents.

Structural-functional analysis sought to explain how social facts related to each other within social system and by the manner in which they related to the physical surrounding. This type of analysis helped the researcher to distinguish between manifest and latent functions. Manifest functions are those consequences, which are intended and recognized by the actors in a system whereas latent functions are those consequences, which are neither intended nor recognized (Kajembe and Luoga, 1996).

3.3.2 Quantitative data analysis

Both descriptive and inferential statistical analyses were carried out. All quantitative analyses were performed by using Statistical Package for Social Sciences for Windows (SPSS 11.5). The first step was to carry out coding so that the data could be in a form suitable for addressing research questions and the method of analysis used. The second step was to explore the data for distribution of responses, central tendency and dispersion. Most of the analysis described above fall under the descriptive statistical analysis. Inferential statistical analysis was done to provide an idea whether the pattern described in samples were likely to apply in the population from which the samples were drawn (Kajembe and Luoga, 1996).

Logistic regression was used as the inferential statistical method because the dependent variable was dichotomous. Binary dependent variable used was the resilience or erosion of micro-catchment forests with value of one if the response is "resilience" and zero if "erosion". Using the logistic estimated probability of events to occur or not to occur i.e odds ratio (β), prediction equations were then developed. The prediction equations developed were then used to estimate the probability of resilience and erosion of micro-catchment forests in the study area. In this study, age, education level, marital status, income, land size and gender were the socio-economic (independent) variables considered to influence resilience or erosion of the micro-catchment forests.

The following prediction model was developed (equation 1).

$$Y_i = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_i)}} \quad \text{.....(1)}$$

Where:

Yi= the i^{th} probability of event to occur for the dependent variable (resilience of micro-catchment forests) and hence a binary variable with values 1 if the respondent reported resilience of micro-catchment forests and 0 if erosion.

$\mathbf{X_i}$ = independent variables (Gender, age, education level, marital status, income, and land size).

$\boldsymbol{\beta_0}$ = the constant term of the model without the independent variables.

$\boldsymbol{\beta_1}$ = are coefficients estimates of the independent variables showing the marginal effects (negative or positive) of the unit change in the independent variables on the dependent variable.

e = the natural logarithms approximately 2.718.

For more than one independent variable the model can be written as:

The probability of event not to occur is estimated as pro (no event) = 1-pro (event).

$$\mathbf{Y_i} = \frac{1}{\mathbf{1+ e^{-z}}} \quad \text{.....(2)}$$

Where

z = Combination of independent variables. i.e. $\mathbf{z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + ß_p X_p}$. The X values (independent variables) included were: X_1= Gender, X_2 =Age of respondents in years, X_3 = Education level of respondents, X_4= Marital status, X_5 = Household income level (in Tshs.) and X_6 = Land size owned by the household in hectares.

Assumptions on the above independent variables are given below.

X_1 = Gender of the respondent. The gender was assumed to have negative sign of estimate β. It was assumed that since according to Sonjo tradition women are not allowed to own resources such as land or plant trees, this situation would lead to erosion of micro-catchment forests in the study area.

X_2 = Age of respondent in years. The age was assumed to have positive sign of estimate β. It was assumed that increase in age of respondent increases the incidences of micro-catchment resilience because older persons are usually assumed to have accumulated enough knowledge and resources to meet their livelihoods. They are also assumed to have much wisdom on how to use resources parsimoniously.

X_3 = Education level of respondent (years spent in school). Increase in education level was assumed to reduce incidences of micro-catchment forests encroachments due to the fact that educated people have options to meet their livelihoods and hence resilience. Positive sign of the estimate β was expected on resilience of micro-catchment forests.

X_4 = Household income level (TShs). This was assumed to have positive influence on resilience of micro-catchment forests as the higher the average income (above 82500 Tsh) of the household, the more likely people would participate in micro-catchment forests conservation (tree planting and retention outside the micro-catchment forests and in the micro-catchment forests).

X_5 = Marital status of respondent (Dummy variable with value of 1 for married and 0 for unmarried). It was assumed to have positive sign on coefficient estimate β. There is a probability of occurrence of resilience of micro-catchment forests

with increase of married heads of households due to the fact that only married people in Sonjo can own resources such as land and trees.

X_6 = Land size in hectares owned by the respondent. This was assumed to have a positive sign on the parameter estimate β, as the higher (>2ha) the land an individual owns the higher the freedom of allocating that land into different uses like cultivation, grazing, agroforestry for multipurpose trees to meet fuelwood demands. This means fewer incidences of encroaching the micro-catchment forests hence resilience. The smaller (<2ha) the farm sizes the higher the erosion of micro-catchment forests.

The hypotheses tested were: -

(Ho): $\beta = 0$ implying that the regression coefficients are equal to zero and thus no correlations between dependent (resilience or erosion of micro-catchment forests) and independent variables (socio-economic factors), against;

(Ha): $\beta \neq 0$ implying that the regression coefficients are not equal to zero and thus there is either a positive or negative correlation between dependent and independent variables.

To test whether the regression coefficients are significantly different from zero, the Wald statistic that asymptotically (i.e. in large samples) follows a Chi-Square distribution was used. The Wald statistic is distributed as Chi-square with degree of freedom (df) equal to the number of constrained parameters (r). With single parameter, the Wald statistic is simply the square of the t-ratio. The odds ratios represented by Exp (β) from logistic regression analysis were used in explaining the

likelihood of resilience or erosion of micro-catchment forests. To assess the goodness of fit of the regression model to the data, two methods were used namely the model chi-square and the log likelihood ratio test denoted by –2LL. By using the model Chi-square test, the significance level of the model was tested at 0.05 probability level. The magnitude of the –2LL value also determined the goodness of fit of the model to the given data set. The smaller value of –2LL, the goodness of fit is the model.

Mayeta (2004) emphasizes that for proper interpretation of logistic regression model results, the researcher needs a careful look at;

- The Wald statistic to see whether the effect of a particular variable is statistically significant or not.
- The sign of effect (β), to see whether the increase in the independent variable increased or decreased the probability of success (resilience or erosion of micro-catchment forests),
- The magnitudes of the similarly measured variables, to determine which of the independent variables seemed to have a greater impact on either the resilience or erosion of micro-catchment forests in the study area.
- The exp (β), to see how much a 1-unit increase in X_p changed the odds of success (this is because the odds of success is not the same as probability of success).
- Finally, assess the results of different values of independent variables (X) and make calculations to see how changes in the value of a particular independent variable affect the probability of success.

Although the Logistic Regression Model (LRM) was chosen for inferential statistical analysis, the model is known to have the weakness of self-selection and therefore the problem is acknowledged

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents the research findings. It is divided into four sections. Section one presents and discuss on types of micro-catchment forests in the study area; while section two discuss on traditional knowledge and practices that have implication on conservation of micro-catchments forests. Section three discuss on the roles of the existing local institutions (both internally and externally sponsored) in the conservation of micro-catchment forests. The last section discuss the socio-economic factors influencing the resilience or erosion of micro-catchment forests.

4.1 Types of Micro-Catchment Forests

Micro-catchment forests refers to any land with the size ranging between 0.5 and 5ha covered by natural vegetation in which the dominant species are trees, with crowns touching each other to form a continuous canopy and within which water springs emanate. During PRA exercises, it was learnt that micro-catchment forests could be categorized based either on their location (i.e. lowlands or uplands) or on the type of management system. This study adopted management systems category. The results revealed that there are two types of micro-catchment forests in the study area. These include traditionally and formally managed micro-catchment forests (Table 3).

Table 3: Awareness about types of micro-catchment forests among the Sonjo agro-pastoralists in Ngorongoro district

Type of Micro-catchment forest	Frequency (n=136)	HH%
Traditionally managed micro-catchment forests	130	96.0
Formally managed micro-catchment forests	122	90.0

Table 3 indicates that 96% of the respondents are aware of the presence of traditionally managed micro-catchment forests, locally known as '*Bisonane*' in the study area. On the other hand, 90% of the respondents acknowledged the presence of formally managed micro-catchment forests. The high responses on different types of micro-catchment forests is attributable to high dependence of local people on micro-catchment forests to meet their needs especially water needs for both domestic and agricultural (irrigation) purposes. This study also revealed that the traditionally managed micro-catchment forests including water sources are owned by the group of traditional leaders called *Benamijie* (*Mwenamijie* singular) reported by 88% of the respondents whereas 74% of the respondents contended that the formally managed micro-catchment forests are owned by the village governments (Table 4). Traditional micro-catchment forests in this case are the forested areas, which are protected for water conservation by the residents of the adjacent area in accordance to customary laws. These kinds of forests have no formally constituted legal basis for their protection but managed under traditional jurisdiction, which include fines (Gerden and Mtalllo, 1990).

Table 4: Ownership of the micro-catchment forests among the Sonjo agro-pastoralists in Ngorongoro district

Response	Village %				
	Samunge (n=30)	Kisangiro (n=30)	Yasimdito (n=30)	Sale (n=46)	All (n=136)
Traditionally managed micro-catchment forests					
District council	3.0	3.0	2.0	3.0	3.0
Village government	0.0	10.0	4.0	17.0	9.0
Traditional leaders	97.0	87.0	94	80.0	88.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Formally managed micro-catchment forests					
District council	27.0	17.0	10.0	11.0	15.0
Village government	63.0	67.0	77.0	83.0	74.0
Traditional leaders	10.0	17.0	13.0	6.0	1.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Through participant observation it was revealed that traditionally managed micro-catchment forests are undisturbed and still intact with permanent water streams flowing through out the year as compared to formally managed micro-catchment forests. Historically, the traditionally managed micro-catchment forests were used as hiding places for Sonjo tribemen from the invasion of the Maasai wariors '*Morani*.' Kajembe *et al.* (2002), reported similar kind of forests in Babati where are known as *Hyamandas*.The water from the micro-catchment forests are mainly used for irrigation of agricultural crops and are managed by *benamijie* who allocates water use to every member of the community for irrigation.

When the researcher visited the formally managed micro-catchment forests the situation was quite different whereby uncontrolled and indiscriminate cutting of trees was evident. The reason given for such a difference was due to the fact that, the *benamijie* being traditional leaders are highly respected in the community and consequently all the traditional rules regarding conservation of micro-catchment

forests are strictly followed. Ostrom (2000) argued that rules and regulations made by community over a long time are effective in natural resource management because they are considered to be more relevant to local situations and legitimate to the local community; consequently the costs of monitoring and enforcement of them are low. Traditional and village government rules governing the conservation of micro-catchment forests are as shown in Table 5.

Table 5:Traditional and village government rules governing conservation of micro-catchment forests in the study area.

Traditional rules	Village government rules
• Prohibition of cutting of indigenous trees in the micro-catchment forests. • Prohibition of fire burning in the micro-catchment forests. • Prohibition of grazing of livestock in the micro-catchment forests. • Prohibition of firewood collection in the micro-catchment forests. • Prohibition of entry of people in the micro-catchment forests without prior permission from the *benamijie.*	• Prohibition of cutting any trees in the micro-catchment forests. • Firewood collection is not allowed in the micro-catchment forests. • Cultivation within or nearby micro-catchment forests boundaries is not allowed • Honey gathering is prohibited in the micro-catchment forests. • Grazing of animals in the micro-catchment forests. • Fire burning is strictly prohibited in the micro-catchment forests.

Table 6 indicates that 97% of the respondents know about traditional rules governing conservation of micro-catchment forests while only about 39% are aware of the village government rules. The plausible explanation in this situation is that the formally managed micro-catchment forests are regarded as being under open-access regime due to laxity of village leaders to implement the rules. Bromley (1991) argues

that open-access regimes have long been considered in legal doctrine as involving no limits on who is authorized to use a resource since no one has legal right to exclude anyone from using it. If such a resource generates valuable products, then one can expect that lack of rules regarding the use leads to misuse and over consumption (Ostrom, 1996). Importantly, it was observed that the traditional rules were more or less similar to those of village government rules, although the enforcement of the same rules was seemingly different among the two sides. The observed relatively poor condition of the formally managed micro-catchment forests is the indication that the local government in the area does not probably work closely with traditional institutions in the conservation of micro-catchment forests and environments at large.

Table 6: Knowledge of rules and regulations among the Sonjo agro-pastoralists in Ngorongoro district

Attribute		**Village %**				
Response		**Samunge (n=30)**	**Kisangiro (n=30)**	**Yasimdito (n=30)**	**Sale (n=46)**	**All (n=136)**
Traditional rules known	YES	97.0	93.0	99.0	98.0	97.0
	NO	3.0	7.0	1.0	2.0	3.0
Total		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Village government rules known	YES	60.0	33.0	30.0	35.0	39.0
	NO	40.0	67.0	70.0	65.0	61.0
Total		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

With regard to knowledge and respect towards micro-catchment forests boundaries, Table 7 shows that 77% of the respondents acknowledged knowing the boundaries of micro-catchment forests, whilst 76% said they respected the boundaries of micro-catchment forests. This implies that there are people who know the micro-catchment

forest's boundaries but they don't respect them. Furthermore during focus group discussions it was learnt that boundaries of the traditionally managed micro-catchment forests were highly respected and no one dared to encroach them as compared to formally managed micro-catchment forests. The reason for high respect to traditionally managed micro-catchment forests boundaries are attributable to the belief that it is in these forests where the Hero God "*Ghambageu*" of the Sonjo people resides. It is only the traditional leaders who are allowed to enter into the inner parts of the forests and to the water source. Any unauthorized person who gets into the forests without special permission from the leaders (*benamijie*) is believed to be liable to death of his/her family or clan members and also precludes the members of the clan to access water for irrigation in their farms.

Table 7: Respondent's knowledge and respect towards micro – catchment forests boundaries among the Sonjo agro-pastoralists in Ngorongoro district

		Village %				
Attribute Response		**Samunge (n=30)**	**Kisangiro (n=30)**	**Yasimdito (n=30)**	**Sale (n=46)**	**All (n=136)**
Boundaries known	YES	77.0	63.0	73.0	89.0	77.0
	NO	23.0	37.0	27.0	11.0	23.0
Total		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Boundaries respected	YES	80.0	83.0	67.0	76.0	76.0
	NO	20.0	17.0	33.0	24.0	24.0
Total		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Generally speaking, it was found that nothing is allowed to be harvested from traditionally managed micro-catchment forests except firewood, which are used to cook food from sacrifice offerings during traditional ceremonies. The micro-catchment forests are therefore protected mainly for ensuring water availability for

human needs, livestock and irrigation purposes. The traditional rules as indicated in Table 5 were found to be stringently enforced in traditionally managed micro-catchment forests while in formally managed micro-forests rules are rather not enforced due to lack of capacities of the village governments.

There are associated penalties attached to violation of the traditional rules regarding micro-catchment forests conservation issues. The penalties range from verbal warning to as severe as offering a bull and excluding the culprits from access to irrigation water. For example it was revealed by one key informant that the punishment for cutting any tree other than sacred trees in the micro-catchment forests is 4 *nzohah* (about 40 litres of honey bee local brew) and 1 goat to be slaughtered and eaten by all the micro-catchment forests custodians, in this case *benamijie.*

Incase of illegal cutting of sacred tree (*Ficus thonningii, Ficus sycomorus, Ficus changuensis and Cordia africana*) or setting fire into the micro-catchment forests, the lawbreaker is considered to have caused a serious problem (bad luck) to his or her entire family and therefore needs to perform what is called family purification (*esabya kaya*) by giving 37 goats (*milonge muhungati*) to all the six main Sonjo village's *benamijie* together with one *nzohah* (10 litres of honey bee local brew). Therefore the total penalty for this particular offence is 222 goats and 6 *nzohah* (60 litres of honeybee brew). Also this kind of punishment is applied to those who conduct murder in the society.

Kajembe, (1994) argued that trees, which have important cultural associations, couldn't be cut down without serious consequences. In the study area it was found

that if the lawbreaker does not pay the fine to the *benamijie*, then the information is conveyed to the *baghorowane* (traditional priests) who would pray for bad omen to the lawbreaker's family/clan and normally the family is sanctioned against other families. The latter alternative, according to Gerden and Mtalllo (1990) has a very strong psychological pressure on the lawbreaker and is normally avoided at any cost.

In probing to find out if this kind of seemingly severe punishment is practical, it was learnt that the punishment is still applicable to date although at the moment an offender can be allowed to pay the equivalent amount of money. It is culturally believed by Sonjo people that any cutting of a tree in the micro-catchment forests would lead to disappointment of their Hero God *Ghambageu* and hence may stop water from flowing and eventually drying out of all water springs in the micro-catchment forests and that will be the end of the Sonjo people in this world. Consequently, these forests by being "sacred" are well conserved to the extent that they are actually intact natural forests. Ningu (1994) argued that traditionally, the elaboration of taboo system with mythical sanctions had been an efficient way for sustainable conservation of the natural forests.

4.2 Traditional Knowledge Systems and Practices that have Implications on Conservation of Micro-catchments Forests

Interviews and observations showed that farmers in the study area have knowledge about trees and performs various practices associated with conservation of their environments. The observed practices include planting and retention of indigenous tree species, live fence and pruning and pollarding. Traditional knowledge systems that seem to have favored micro-catchment forests include recognizing some tree

species as water conservers and hence protecting them from any uses, sacred tree species and trees used for ritual purposes. These knowledge systems and practices have the implications on the conservation of micro-catchment forests in that it restricts uses of some or all tree species in the micro-catchment forests hence conservation of micro-catchment forests. Conversely, if these knowledge systems and practices are not well applied then it means negative consequences to the micro-catchment forests.

Therefore, to maintain micro-catchment forests farmers must be empowered to plant and retain trees in general lands so as to prohibit them from searching their forest related needs from micro-catchment forests. This has the implication that trees from general lands contribute sufficiently to the household needs and hence the future existence of the micro-catchment forests is possible.

4.2.1 Traditional practices

4.2.1.1 Indigenous tree planting and retention

Sustainable management of forest resources is geared towards conservation of the resources so as to meet the present and future needs of the growing populations (Luoga, 1994). Traditionally, the Sonjo people do plant and retain trees in their homestead or farms. Normally it is mainly indigenous tree species, which are planted or retained, nevertheless in recent decades exotic tree species were introduced especially those with horticultural attributes, consequently are now planted widely in the study area. During PRA exercises it was observed and learnt that all members (men) of the society carry out planting of indigenous tree species in the micro-catchment forests. But also some of the indigenous trees and various exotic trees are

planted in the farms and around the homesteads. The practice of planting or retaining indigenous tree species in the study area is very important to the micro-catchment forests because if there is enough tree products available outside the micro-catchment forests then it makes people find no reason to go into the micro-catchment forests to collect those tree products and consequently pressure to the micro-catchment forests is significantly reduced and future existence of the micro-catchment forests is ensured. For this reason the micro-catchment forests in the study area were found to be in good condition with less disturbances from human activities. Table 8 shows that 52% of the respondents practice both tree planting and retention and 46% practised tree retention only while 1% planted trees only. It is therefore deduced that 98% of respondents retain trees whereas only 53% of the respondents carry out tree planting. But when one look at individual villages it is clear that there are great variation with regard to tree planting from one village to another depending mainly on the water and land availability.

Table 8: Tree planting and retention among the Sonjo agro-pastoralists in Ngorongoro district

Response	Village %				
	Samunge (n=30)	**Kisangiro (n=30)**	**Yasimdito (n=30)**	**Sale (n=46)**	**All (n=136)**
Tree planting only	3.0	0.0	0.0	2.0	2.0
Tree retention only	27.0	37.0	87.0	39.0	46.0
Both	70.0	63.0	13.0	59.0	52.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

The respondents in the study area gave various reasons for retaining and/or planting trees. As Table 9 shows, 45% of the respondents planted and retained trees for the

reason of conserving water sources. Occasionally indigenous tree species are planted in the micro-catchment forests to fill gaps and enhance the boundaries. Furthermore, trees are also planted and retained in the farms to provide forest related products. It is important to note that there are no private micro-catchment forests in the study area, instead, all the micro-catchment forests in the study area are collectively owned by the whole society but under different custodians and management systems like formal and informal management systems. In every village it was found that there is time set, once in a year, whereby all men (female don't plant trees in the Sonjo culture) participate in tree planting in the micro-catchment forests (both in the traditionally and formally managed micro-catchment forests). This is due to the fact that the only available water in terms of streams in this semi-arid land comes from these small but highly valued micro-catchment forests. It is the presence of these permanent water streams from the micro-catchment forests that have made life possible in the land, which could otherwise be inhabitable by humans. These findings are in line with the findings by Shelukindo (2000) who reported that people in West Usambara planted trees in order to enhance environmental conditions and improve ecological values of the forests.

Apart from planting trees in the micro-catchment forests, villagers also do plant and retain trees in their farms and around homesteads. Table 9 indicates that 32% of the respondents gave utilitarian (firewood collection, extraction of poles and sales of fruits) as a reason for planting/retaining trees. Demarcation of farms or residential plots was pointed out by 24% of the respondents.

Table 9: Reasons for planting and retaining trees among the Sonjo agro-pastoralists in Ngorongoro district

Response	Village %				
	Samunge (n=30)	**Kisangiro (n=30)**	**Yasimdito (n=30)**	**Sale (n=46)**	**All (n=136)**
Utilitarian	37.0	70.0	20.0	11.0	32.0
Demarcation of farms	3.0	17.0	50.0	24.0	24.0
To conserve water sources	60.0	13.0	30.0	65.0	45.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Although villagers in all the study villages do plant and retain trees, there were notable differences among villages in views on planting/retaining trees, for example in the villages of Samunge and Sale, 60% and 65% of respondents respectively planted or retained trees in order to conserve water sources while 70% of respondents in Kisangiro village gave the utilitarian reason and 50% of respondents in Yasimdito village gave the reason of demarcation of farm boundaries (Table 9). The possible explanation for this difference is attributable to the amount of water available for use in each particular village. For example Samunge and Sale villages both have relatively small amount of water flowing in the streams just enough for domestic and livestock uses, consequently more efforts are devoted to conserving the water sources in micro-catchment forests so that life is possible in these villages. Conversely in Kisangiro village there are plenty of water and therefore more trees are planted in irrigated field for utilitarian purposes while in Yasimdito village due to scarcity of land many people plant or retain trees on their farm boundaries for demarcation purposes.

In Table 10, it is shown that 39% of the respondents in the sampled population planted and retained trees around their homesteads. Planting trees around homestead was ranked high due to the fact that it reduce chances of trees being damaged at earlier stages by stray livestock and also it is easy to manage them and also the need for windbreaks. Preference with farm boundaries planting is associated with land size (those who owns bigger land sizes are more likely to plant trees around their farm boundaries) and serving as security to land rights and settling disputes between neighbours.

Table 10: Sites where trees are planted/retained among the Sonjo agro-pastoralists in Ngorongoro district

Response	Village %				
	Samunge (n=30)	Kisangiro (n=30)	Yasimdito (n=30)	Sale (n=46)	All (n=136)
Home garden	33.0	63.0	37.0	28.0	39.0
On farm	4.0	13.0	43.0	35.0	24.0
Micro-catchment forests	63.0	24.0	20.0	37.0	37.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

The total number of trees planted and those retained in each of the study villages in the last 12 months is given in Table 11. About 37% of the respondents participated in tree planting as collective efforts in micro-catchment forests and other water sources, on school and church grounds. Planting of trees on farm boundaries was mentioned by 24% of the respondents.

Table 11: Number of planted and retained trees among the Sonjo agro-pastoralists in Ngorongoro district

Village	Number of trees	
	Planted	**Retained**
Samunge	445	968
Kisangiro	381	464
Yasimdito	41	987
Sale	226	484
Total	**1093**	**2903**

The study revealed that there are mainly 28 types of indigenous tree species retained and only 5 species are both planted and retained in the study area (Table 12). The most preferred species, which are retained with their household percentage in the brackets, are *Accacia tortilis* (34%) and *Accacia nilotica* (33%). This may be attributed to the fact that these tree species grow fast and fairly well in dry conditions which makes them to be most abundant trees. Also they have multiple uses, especially for medicinal purposes encourage every household to retain these trees. Other retained species include; *Accacia hockii* (29), *Ozoroa insgnis* (24) and *Acacia mellifera* (19).

Planting of indigenous trees species is done in the study area but only few species are involved. The most planted indigenous species are those, which can be propagated through cuttings, with their household percentage in the bracket include; *Ficus sycomorus* (25), *Cordia Africana* (7), *Ficus changuensis* (5), *Ficus thonningii* (4), *Commiphora caerulea* (3), *Commiphora africana* (2) and (Table 12). The most planted tree species in the micro-catchment forests includes *Ficus sycomorus*, *Ficus thonningii*, *Ficus changuensis* and *Cordia africana* in which are planted specifically for water sources conservation. These findings are in line with the findings by URT/DANIDA (1992) who reported that local people in Njombe district retained *ficus spp* and *Erythrina abyssinica* for conservation of surface water sources. It was

further learnt that only indigenous species are allowed to be planted in the micro-catchment forests and this can be done after consultation with the traditional leaders in respective village. *Commiphora caerulea* and *Commiphora africana* are planted in the area as live fences.Other tree species are retained or planted for general purposes like firewood, fodder and building materials, which makes them available outside the micro-catchment forests and hence people don't go to the micro-catchment forests to collect forest products and in this way contributes largely to the conservation of micro-catchment forests in the study area.

On the other hand the most planted exotic tree species with their household percentage in the bracket are *Mangifera indica* (27%) and, S*enna siamea* (23%) (Table 13). Others include *Citrus sinensis* (20), *Grevillea robusta* (13) and *Strychnos innocua* (10). Planting of these exotic tree species has enabled farmers to obtain forest products like fruits in their farms in which case it a relief to the micro-catchment forests as in the past some of these products were collected from the micro-catchment forests. Through participant observation it was learnt that fruit tree planting is done around homesteads and on irrigated fields and also along riverbanks

Table 12: Indigenous tree species retained and/or planted among the Sonjo Agro-pastoralists

Local name	Scientific name	Family Name	HH%
Mkamahe	*Acacia tortilis*[1]	*Mimosoideae*	34
Kijerwe	*Acacia hockii*[1]	*Mimosoideae*	29
Kijemi	*Acacia nilotica*[1]	*Mimosoideae*	33
Mng'ora	*Acacia mellifera*[1]	*Mimosoideae*	19
Mjuiya	*Balanites aegyptiaca*[1]	*Balanitaceae*	2
Mkoyo	*Ficus sycomorus*[2]	*Moraceae*	25
Mgum	*Ficus thonningii*[2]	*Moraceae*	4
Murera	*Ficus changuensis*[2]	*Moraceae*	5
Mgombeha	*Oxyanthus goetzei*[1]	*Rubiaceae*	13

Mtoregai	*Cassisa spectabilis*[1]	*Ceasalopinaceae*	15
Mgalati	*Ozoroa insignis*[1]	*Anacardiaceae*	24
Dughubetu	*Dombeya rotundifolia*[1]	*Serculiaceae*	7
Elama	*Combretum molle*[1]	*Combretacece*	12
Mjorori	*Drypetes gerrardii*[1]	*Euphobiaceae*	5
Mgholoma	*Garcinia livingstonei*[1]	*Guttiferae*	5
Mkinkinywa	*Commiphora mollis*[1]	*Burseraceae*	2
Mdaghamira	*Sorindeia madagascariensis*[1]		7
Mringaringa	*Cordia africana*[2]	*Boraginaceae*	7
Mghelai	*Ziziphus mucronata*[1]	*Rhamnaceae*	5
Kiboboyo	*Pappea capensis*[1]	*Sapindaceae*	2
Msarya	*Lannea schweinfurthii*[1]	*Anacardiaceae*	10
Mlongo	*Zanthoxylum chalybeum*[1]	*Rutaceae*	2
Gwaretu	*Grewia bicolor*[1]	*Tiliaceae*	1
Kidigho	*Euphorbia tirucallii*	*Euphorbiaceae*	1
Kiluba	*Commiphora caerulea*[2]	*Burseraceae*	3
Mrosi	*Commiphora africana*[2]	*Burseraceae*	2
Kijombeta	*Vitex payos*[1]	*Verbenaceae*	1
Mloma	*Ximenia americana*[1]	*Olacaceae*	5

1 = retained indigenous tree species 2 = both planted and retained tree species

- Retaining in this study refers to management of naturally regenerated trees.
- Planting refers to planting of both indigenous and exotic tree species either by seed or vegetative propagation.

It is important to note that most farmers grow different types of tree species depending on farmer's preference and that there might be more tree species especially exotic species in the area but not mentioned here because were not encountered in the sampled population. Therefore planting of exotic tree species also contributes greatly to conservation of micro-catchment forests.

Table 13: Exotic trees species planted among the Sonjo agro-pastoralists in Ngorongoro district

Local name	Scientific name	Family Name	HH%
Gravilia	*Grevillea robusta*	*Proteaceae*	13
Mjohoro	*Sena siamea*	*Caesalpiniodeae*	23
Lucina	*Leucaena leucacephala*	*Mimosoideae*	10
Mtiulaya	*Schnus mole*	*Anacardiaceae*	2
Mgulungulu	*Strychnos innocua*	*Loganiaceae*	10
Mwembe	*Mangifera indica*	*Anacardiaceae*	27
Mchungwa	*Citrus sinensis*	*Rutaceae*	20
Mwarobaini	*Azadirachta indica*	*Meliaceae*	1
Mllimao	*Citrus limon*	*Rutaceae*	4
Mastaferi	*Anona municata*	*Annonaceae*	2
Parachichi	*Persea americana*	*Lauraceae*	2
Mpera	*Psidium guajava*	*Myrtaceae*	2
Katapa	*Terminalia brownii*	*Combretaceae*	1
Mlonge	*Moringa oleifera*	*Moringaceae*	2

Although farmers in one way or another are engaged in tree planting and retention in the micro-catchment forests and in the farms and/or homestead, the real issue should be how many trees individuals or villages plant. It was observed that there is a decline in vegetation cover in the study villages and therefore there is a need to plant more trees. The new forest policy of 1998 (URT, 1998) provides encouragement and opportunity for establishment of woodlots and plantations for woodfuel production by village authorities. Therefore the local government in the district has to take more active involvement not only in providing environmental education but also in supporting the community efforts in terms of providing tree-planting materials.

Also the study revealed that about 46% of the sampled population are not engaged in tree planting instead they do retain trees only as indicated in Table 8. The major reason given for not participating in tree planting was the lack of planting materials such as tree seeds and tree seedlings (Table 14). It was also learnt that there is no arrangement made by the local governments to assist farmers in tree planting. All the necessary materials for tree planting such as tree seeds, polythene tubes and watering

cans were obtained from private resources, which proved difficult for most of the rural farmers. In this case only few members of the community do manage to buy seedlings from individual nurseries and sometimes from Loliondo (district headquarters) located at 70 kilometers.

Table 14: Reasons for not planting trees among the Sonjo agro-pastoralists in Ngorongoro district

Reason for not planting trees	Frequency (n=63*)	HH%
No seedlings	37	58.0
No seeds	25	40.0
No land to plant	1	2.0
Total	**63**	**100.0**

The number is not equal to 136 due to missing values (responses)

4.2.1.2 Live fence

Local communities use live fences to keep animals away from destroying food crops in their farms and also around their homesteads. Live fences also serve as windbreaks especially in Kisangiro and Samunge villages, which are prone to strong winds. The most preferred tree species for windbeak was found to be *Strychnos innocua*. It was revealed by the key informants that this tree species grows very fast in dry environment and it is resistant to diseases and therefore it is ideal for the study area. Other tree species used for live fencing although at very small scale include *Commiphora africana, Commiphora caerulea* and *Acacia mellifera.* In the light of micro-catchment forests conservation, live fences is a good practice in the sense that it encourages tree planting and retention and the trees planted or retained serves many uses such as firewood and fodder for livestock. In this case contributing in mitigating destructive practices to the micro-catchment forests.

4.2.1.3 Pruning and pollarding

Local communities use different techniques in tending and harvesting of trees. The study revealed that normally some of tree branches are removed for the purpose of obtaining fodder, firewood and for making fence to deter livestock from destroying crops. Key informants reported further that they carry pruning in order to remove excessive branches from the trees to avoid creating shade for underneath crops. This practice is particularly done on acacia species to provide fodder and fencing materials around farms and houses. Furthermore it was learnt from this study that pruning time varies from farmer to farmer. Those who keep livestock prefer to prune their trees during dry season in order to obtain green fodder for young animals and farmers prune during rain season to obtain firewood and to avoid shades around their crops. To the micro-catchment forests this practice is of advantage in that during dry season (June –November) almost everything dries out and therefore green palatable materials could otherwise be obtained only from the micro-catchment forests, which could inturn, lead to destruction of micro-catchment forests, but instead is obtained outside it by cutting down some of tree branches.

4.2.1.4 '*Logeri*' as pasture management system

As stated earlier, the Sonjo people are agro-pastoralists whereby both crop cultivation and livestock keeping are the major economic activities. On one side cattle ownership provides the social status and financial capital while on the other agriculture provides food to the Sonjo community; the animals are also used for drought power. The weather conditions of the area are always dry due to insufficient rainfall and therefore

no enough pastures available for livestock throughout the year. This resulted into the invention of '*logeri*' as a coping strategy for the situation. *Logeri* is the Sonjo vernacular to describe a piece of family land set-aside during rainy season to allow growth for use during the dry season. Therefore literally *logeri* is a pasture management system in Sonjo land in order to ensure that livestock can survive during dry season until the next rainy season (Gibaseya, 2005, personal communication).

In this system, during rain season all the livestock are taken to a distant area where there is a common land while concurrently every family establishes a '*logeri*', which are protected from any access to animals. Through focus group discussions it was revealed that there are community rules that govern the use of *logeri* in the study villages. The rules include (i) no one is allowed to use *logeri* belonging to somebody else without the owner's permission, (ii) all the *logeri* in the village are restricted from any use during rainy season (iii) setting fire in the *logeri* is strictly prohibited. Although not compulsory, each family or clan is encouraged to own a *logeri* as strategy for environmental conservation in the village. When one is found of deliberately allowing his or her animals to graze in someone's *logeri*, then has to pay a fine to the owner of the *logeri.* The penalty ranges from a single to several goats or even a cow depending on the severity of destruction. Nevertheless one can use the other's *logeri* freely through mutual agreement or through agreed payments in cash or in material.

The *logeri* management system has been very helpful and beneficial to the people, livestock and to the environment. The movement of livestock between *logeri* in the dry season and the common grazing land in the rain seasons ensures a balanced

utilization of the resources while avoiding over exploitation of the resources in the two sites. *Logeri* management system could be analogous to grazing practises under '*ngitiri*' management system in Kahama district, Shinyanga region as discussed by Kajembe *et al*., (2000). The presence of *logeri* during dry season has been of great importance to the conservation micro-catchment forests because livestock keepers when they find pastures are exhausted in the grazing area, they sometimes tend to opt for illegal grazing of their animals in the micro-catchment forests. Nevertheless, due to presence of *logeri* and availability of pastures in it the frequency of illegal grazing of livestock in the micro-catchment forests is reduced thereby contributing to conservation of the micro-catchment forests and the environments at large.

4.2.1.5 Sacred areas and protected water sources

Water possibly the most important resource in arid environment has been a pivotal instrument for micro-catchment forests conservation issues in Sonjo. Mostly all the sacred areas and ritual sites are established on the slopes of the mountains where water sources are located. These sacred areas are covered with virgin micro-catchment forests with water spring flowing down to the valleys where it is used for various purposes. It is believed that water from these sacred micro-catchment forests is free from evils and when people drink it they receive blessings from God. For example during severe drought, ritual leaders who are the custodians of rituals found in the micro-catchment forests lead the society for prayers and sacrifices for rains to come. Similar observations were made by Paulo (2000) in Uluguru mountain forests that sacrifices and rituals were performed periodically in sacred forest in order to appease the Rain Gods in the forests to ensure that rains are adequate and non-

destructive. It was revealed by the traditional leaders that every year there is a thanksgiving festival called '*mbaribari'* where among other things people are given water of God known as '*mai ja Mugwe'* to either drink or to immerse the right leg and in this case people are believed to be cleansed from evil powers.

Also in the sacred micro-catchment forests there are individual tree species, which are attached to spiritual complex of the society and as a result, these tree species are totally protected from any use. The study revealed that 95% of the respondents acknowledged that there are tree species, which are traditionally protected. These tree species with their household percentage in the bracket are *Ficus thonningii* (90%), *Ficus sycomorus* (71%), *Ficus changuensis* (73%) and *Cordia africana* (12%). These tree species are considered as trees of water and life. They are only used for ceremonial and spiritual purposes. This component of the culture of the Sonjo people has enabled the area to have water sources which is purely undisturbed by human activities. Today, these sacred micro-catchment forests have remained intact and people are enjoying clean and uncontaminated water resources while concomitantly ensuring conservation of the micro-catchment forests.

4.2.2 Traditional Knowledge with regard to tree species and their uses

Table 15 &16 shows that local people in the Sonjo agro-pastoralists system are knowledgeable on different tree species found within their vicinity. Tree species preferences were classified into four categories; highly preferred, average preferred, less preferred and not preferred. Table 15 shows that *Accacia tortilis* is highly preferred indigenous tree species with many uses, followed by *Accacia hockii*,

Ozoroa insgnis and *Accacia nilotica.* The people's understanding of different tree uses and preferences enables them to make maximum and wise use of the trees resources available in their surrounding without the need to go into the micro-catchment forests thereby allowing micro-catchment forests to continue growing undisturbed and hence fostering sustainable conservation of micro-catchment forests in the area. It has been observed in other parts of Tanzania that various highly valued tree species in miombo woodlands and coastal forests in some cases are used by local people for charcoal making and other uneconomical uses. In the study villages the highly valued tree species for timber uses was the *Cordia africana* (Mringaringa) and it was learnt that this tree species is one of the traditionally reserved tree specifically for traditional leaders (benamijie) only for beehives making. No one is allowed to cut or use this tree for anything even if it grows in his/her farm, homestead or in general lands. Therefore Traditional Knowledge in this case has helped the survival of *Cordia Africana* species in all micro-catchment forests and other areas in study villages.

Table 15. Indigenous trees preferences and their uses among the Sonjo agro-pastoralists in Ngorongoro district

Local name	Scientific name	Preference	Main Uses
Mkamahe	*Accacia tortilis*	vvv	fw,ch,ro,fo,fe,wb,md,po,sh
Kijerwe	*Accacia hockii*	vvv	fw,ch,fo,fe,wb,po, ro
Kijemi	*Accacia nilotica*	vvv	fw,ch,fo,fe ,wb, po
Mng'ora	*Accacia mellifera*	vv	fw,ch,fo,fe ,wb,po
Mjuiya	*Balanites aegyptiaca*	v	fw,fo,fe ,wb
Mkoyo	*Ficus sycomorus*	vvv	wc,wb, rs,cs,tds
Mgum	*Ficus thinningii*	v	rs, cs, wb,wc
Murera	*Ficus spp*	v	rs,cs, wb,wc
Mgombeha	*Ehretia amoea*	vv	fw,po,fr,wb
Mtoregai	*Cassia spectabilis*	vv	wb,sh,fr
Mgalati	*Ozoroa insignis*	vvv	sh,wb,hc,md,po,tc
Dughubetu	*Dombea rotundifolia*	vv	fw,ch,wb,po
Elama	*Combretum molle*	vv	fw,ch,wb
Mjorori	*Drypetes gerrardii*	v	fw,fo,wt,md
Mgholoma	*Garcinia livingstonei*	v	wt,fr,sh,fw

Mkinkinywa	*Commiphora mollis*	v	wb,sh,fr,md
Mdaghamira	*Sorindeia madagascariensis*	vv	wc,sh,wb
Mringaringa	*Cordia africana*	vv	wc,tb,wb,bh,
Mghelai	*Ziziphus mucronata*	v	fo,fe ,wb,po,fr
Msarya	*Lannea Schweinfurthii*	vv	wb,sh,md
Mlongo	*Zanthoxylum chalybeum*	v	po,fe,ut,mo,hc
Gwaretu	*Grewia bicolor*	vv	wt,ro
kiboboyi	*Pappea capensis*	vv	fr,fw,po,md,fo
Kiroha	*Euphorbia spp*	x	gl,fw
Mgombeha	*Oxyanthus goetzei*	vv	fw,fr,po,fo
Kiluba	*Commiphora africana*	x	sh,wb

Key: po =pole, wt=withies, sh=shade, fe=fence, ut=utensil, md=medicine, fw=firewood, wb=windbreak, lf=livefence, fr=fruit, fo=fodder, tb=timber, sh=shade, gl=glue, bh=beehive, ch=charcoal, wc=water conservation, ro=rope, mo=mortar (kinu), tc=traditional chair, hc=hair comb, tds=traditional door shutter

vvv = highly preferred tree species

vv = average preferred tree species

v = less preferred tree species

x = not preferred tree species

Nevertheless the key informants revealed that *Azadirachta indica* is gaining popularity in the study area owing to its diverse uses specially its medicinal values and ability to withstand dry conditions. *Mangifera indica* is the most planted by 27% of the respondents (Table 13) and most preferred fruit tree in the study area (Table 16). Other well-planted exotic tree species include, *Gravellea robusta*, *Citrus sinensis*, and *Senna siamea.*

Incase of exotic tree species, *Azadirachta indica* was highly preferred although not widely planted due to the fact that the tree has been introduced relatively recently.

Table 16. Exotic trees preferences and their uses among the Sonjo agro-pastoralists in Ngorongoro district

Local name	Scientific name	Preferences	Main Uses
Gravilia	*Gravellea robusta*	vvv	tb,fw,wb,po
Mjohoro	*Sena siamea*	vvv	fw,wb,sh,po
Lucina	*Leucaena leucacephala*	vv	fw,fo,wb,sh
Mtiulaya	*Schunus mole*	v	wb,sh
Mgulungulu	*Strychnos innocua*	vv	wb,sh,md,lf
Mwembe	*Mangifera indica*	vvv	fr,sh,wb,fw
Mchungwa	*Citrus sinensis*	vvv	fr,fw
Mwarobaini	*Azadirachta indica*	vvv	wb, md, sh,po,fw
Mllimao	*Citrus limon*	vv	fr, fw
Mastaferi	*Anona municata*	v	fr, fw
Parachichi	*Persea Americana*	v	fr,wb,sh
Mpera	*Psidium guajava*	v	fr, fw
Katapa	*Terminalia brownii*	v	wb,sh,or

Key: po =pole, wt=withies, sh=shade, fe=fence, ut=utensil, md=medicine, fw=firewood, wb=windbreak, lf=livefence, fr=fruit,fo=fodder, tb=timber, sh=shade, gl=glue, bh=beehive, ch=charcoal, wc=water conservation, ro=rope, or=ornament

vvv = highly preferred tree species.
vv = average preferred tree species.
v = less preferred tree species.
x = not preferred tree species.

Exotic tree species provides a great deal of forest products such as fruits and firewood to the communities especially around homes and in the farms. Consequently people don't go to the micro-catchment forests to collect various forest products, as these products are available in their farms within short time and at shorter walking distances, which inturn helps the conservation of micro-catchment forests.

4.3 Types and Roles of Local Institutions in the Conservation of Micro-catchment Forests

In this study both internally (informal) and externally (formal) sponsored local institutions were found to be present in the study area. Local institutions whether

internally or externally sponsored do play important roles in the conservation of micro-catchment forests and are used in regulating access to and utilization of forest resources in the society in general.

4.3.1 Internally sponsored institutions

Internally sponsored institutions encountered in this study which are engaged in the conservation of micro-catchment forests are mainly traditional institutions. Table 17 shows internally sponsored institutions. These include the traditional leaders (*benamijie)*, which were reported by 82% of respondents whereas 73% of respondents reported about the traditional warriors (*batana)* as one of the internally sponsored institutions in the study area and 64% of respondents acknowledged existence of the Priests (*baghorowane*). Mbwambo (2000) argued that internally sponsored institutions which are essentially traditional are important in natural resources conservation and play a greater role in regulating access and utilization of various natural resources in a given society. The author further emphasizes that identification of internally sponsored institutions can serve as a point of entry in the search for local level and broad based approaches in the conservation of natural resources.

Table 17: Internally sponsored institutions among the Sonjo agro-pastoralists in Ngorongoro district

Institutions	Frequency (n=136)	Percent (%)
Benamijie	111	82.0
Batana	99	73.0
Baghorowane	87	64.0

4.3.1.1 ‘*Benamijie*’ Traditional leaders

The *benamijie* (*mwenamjie* singular) are the traditional rulers of the Sonjo society. They are the *de facto* owners of the water sources in all the traditionally managed micro-catchment forests in Sonjo villages. All Members of the community have user rights of the water for irrigation although there are some payments to be made to the *benamijie* either in kind or in cash. Each of the Sonjo village has its own autonomous traditional leadership of *benamijie* whose member ranges between 12 and 20. Usually each *mwenamijie* has assistants called *bakiama* (*mukiama* singular). In rotation of 24 hours, each *mwenamjie* controls the use of irrigation water in which after he allocates time of irrigation for his own family then the allocation goes to his *bakiama* and then to other members of the society. The *bakiama* assists the *benamijie* in all issues related to water management including resolving disputes due to water stealing. It is important to note that the issue of water ownership is attached to the clan, although in actual situation it is only one individual in the clan who owns the water and this prerogative is obtained through inheritance after performing the process known as *esabya mai* (water purification) after the predecessor has passed away.

In all the Sonjo villages the *benamijie* are responsible in ensuring that traditional rules are properly enforced and followed on all aspects of life of the community including protection of micro-catchment forests and water sources in the area. The *benamijie* are the custodians of the traditionally managed micro-catchment forests and therefore are pivotal in all successes of the micro-catchment forests in the Sonjo land. Basically, the *benamijie* are the ones to be commended for their tireless efforts towards the conservation of the micro-catchment forests in the study area.

4.3.1.2 *'Batana'* Traditional warriors

This is a group of young men with the age ranging between 18 and 40 years. They are the defence force of the community. On average, after every ten years a new generation of young men called S*ingirya* (age mates) are brought to power taking over from their elder brothers whom at that time enters in another stage of respectable adulthood called *Bamalakolo* (the elders). The *Singirya* is inaugurated in highly respected religious ceremony called *masse*. This annual religious event is very popular and rotates among the main Sonjo villages while the satellite villages join their brothers in the main villages for celebrations. This cultural occasion also involves purification of water sources whereby a sheep is slaughtered at the water source and its blood mixed with water and allowed to flow down stream. A very old person or young one at the age of twelve years who is considered clean does the act of water purification under the supervision of the *benamijie*. The meat of the sheep is roasted and eaten at the water source by all *benamijie* and the one who did purification.

All these activities are closely monitored by *batana* (*mutana* singular) through their leaders called *bekorani (mwekorani* singular) who are elected based on clans. The *batana* have been given the mandate to apprehend any individual who in one way or another contributes to the destruction of micro-catchment forests and water sources either by cutting trees or setting fires. Also *batana* are the ones responsible for fighting forest fire incase happens. If the offender is identified then he/she immediately reported to the *benamijie* for further disciplinary actions. However,

among the *batana* themselves if one is found not participating actively in collective works then he is subject to penalty which could be a goat or two or even a bull depending on the seriousness of the offence. The animal is slaughtered at a gathering which the offender and the meat is roasted on open fire and is eaten by all members (*batana*) without carrying any meat back home except the skin which is given to the owner. Banana *et al.*, (1999), reported similar observations in Uganda and also by Maenda (1999) when studying on *mlimbiko* indigenous conservation system in Pare lowlands in Tanzania. The *batana* institution as law enforcers has contributed significantly to the conservation of micro-catchment forests in the study area.

4.3.1.3 *'Baghorowane'* The Priests

The *baghorowane* are the custodians of all the sacred areas, which are mostly found in the micro-catchment forests. The sacred places in the micro-catchment forests are known as *bugwene*. The *baghorowane* are also the priests whom are found in all Sonjo main villages and are responsible for taking care of all sacred places in each particular village. Their homes are the shrines in which other community members take their first crop harvests and animals as offerings to God, *Ghambageu*. These people in the past didn't own or engage themselves in any kind of economic activity. They did not possess fields or produce their own food instead they depended on offerings to the *Ghambageu* shrines. However, at the time of this study it was learnt that in some villages except Kisangiro, *baghorowane* have started to own farms and livestock and this is explained by their increase in number to the extent that the offerings given to the shrines can no longer support them.

The role of *baghorowane* is to give advice for *benamijie* on handling the community matters especially on religious issues, water purification and conservation of micro-catchment forests as most of the sacred areas are found in the micro-catchment forests. All the sacred places in the study villages are highly respected and were found to be intact compared to surrounding areas. This is due to the fact that no one is allowed to touch or take anything from those places. Normally these sacred places are found within giant fig trees in which are also regarded as sacred trees. Gerden and Mtallo (1990) argues that among the local populations in the tropics the protection of trees and shrubs has seen to take two forms; prohibition and restrictions on the use of some highly valued individual species and the protection of all trees and shrubs in sacred forests. Therefore the *baghorowane* institution plays a major role in the protection of the micro-catchment forests within which sacred places and water sources are conserved.

As reported by Kajembe and Kessy (1999), Mayeta (2004) and Kajembe *et al.*, (2004), the study has also confirmed the fact that local communities are the best assessors of the relative importance of various local institutions on the basis of their functions. Likewise, they are the best conservators and managers of the existing natural resources due to diverse knowledge on conservation values of these resources. Apart from internally sponsored institutions, there were also externally sponsored institutions documented in this study.

4.3.2 Externally sponsored institutions

In the study area there are externally sponsored institutions which in one way or another are involved in the conservation of micro-catchment forests. The externally

sponsored institutions encountered with their household percentage in the bracket are Village governments (80%), Primary Schools (78%), Village Environmental Committees (71%), *Ereto* project (39%), Churches (27%), Secondary School (26%) and Police Force (15%) (Table 18). The village governments and primary schools are supported by district governments on environmental conservation issues through provision of tree seedlings for planting and extension education. Likewise Village Environmental Committees (VECs) are supported by district government through seminars and training on conservation of micro-catchment forests. *Ereto* (Self Help) project is funded by Norwegian Agency for Development (NORAD) through country office based in Dares Salaam. This donor-funded project is supporting and facilitating communities on water development programmes in the study villages. Although, NORAD project is still in its infant stage, the fruits can easily be recognized especially in Sale village where a reservoir costing about 300 millions shillings is being constructed. In completion, this reservoir, which is built at a distant from the micro-catchment forests, Sale village and the surrounding areas will have sufficient water for irrigation and livestock uses. Consequently, livestock and people will no longer need to go into or near the micro-catchment forests for water, which inturn will save the micro-catchment forests from further encroachments and associated destructions such as soil erosions.

Table 18: Externally sponsored institutions among the Sonjo agro-pastoralists in Ngorongoro district

Institutions	Frequency (n=136)	HH%
Village government	109	80.0
Primary school	106	78.0
Village environmental committee	97	71.0
Ereto project	53	39.0

Church	36	27.0
Secondary school	35	26.0
Police	21	15.0

All the study villages were found to have Village Environmental Committees (VECs), which specifically deals with environmental issues in the villages. These VECs have been formed through a facilitation from the District Council. The functions of these VECs are to establish by-laws that promote environmental conservation, enforcing by-laws, setting fines for breeching by-laws, coordinating communal activities related to environmental conservation such as tree planting and fire fighting especially in the micro-catchment forests and provide linkage with other institutions outside the villages. However, it was found that most of these VECs were not functioning properly due to lack of motivation and incentives from the local government at district level. It is important the VECs to be empowered through training and exchange visits so as to strengthen their capability in performing their duties.

Primary schools in all the study villages and the only secondary school in the area were actively involved in tree planting especially around their school compounds. Also churches are engaged in environmental protection activities, for example in Samunge village the researcher was informed that the Lutheran church brings fruit tree seedlings from Arusha and distribute them free of charge to the farmers. This is a friendly relationship of the church to the environment and needs to be encouraged for other institutions to follow in the area. Externally sponsored institutions are in most cases engaged in tree planting and provision of environmental education to the communities. Sustainable conservation of the micro-catchments forests will be achieved if outside environments surrounding the micro-catchments forests are well

planted with trees and that is the basic challenge to the local institutions in the study area.

4.3.3 Functions of the local institutions

Respondents in the sampled population had different opinions regarding the function of local institutions (both traditional and formal). Table 19 shows that 21% of the respondents mentioned the role of these local institutions to be law enforcement whereas 17% of the respondents said tree planting and retention as their main function and about 62% of the respondents mentioned the role of these institutions to be both tree planting/retention and law enforcement.

Table 19: Percentage Responses on the functions of local institutions among the Sonjo agro-pastoralists in Ngorongoro district

Response	Village%				
	Samunge (n=30)	**Kisangiro (n=30)**	**Yasimdito (n=30)**	**Sale (n=46)**	**All (n=136)**
Both	53.0	67.0	63.0	65.0	62.0
Law enforcement	30.0	20.0	17.0	17.0	21.0
Tree planting/retention	17.0	13.0	20.0	18.0	17.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

4.4 Socio-economic Factors Influencing Resilience and Erosion of Micro-catchment Forests

4.4.1 Overview

The Logistic Regression Model (LRM) was used to assess the influence of socio-economic factors on resilience and erosion of micro-catchment forests. The socio-economic factors considered include education level (number of years spent in school), household income, land size owned by the household, sex of the household

head, marital status of the household head and age of the household head. In terms of goodness of fit, the logistic regression model (LRM) fitted well to the data by 99%, which is shown by a constant 0.001 and also a chi-square value of 25.97 which was significant at 1% probability level (P=0.001) and -2LL (-2 times the log of the likelihood) had a good fit to data since it was 124.91. This is because statistically –2LL is a badness of fit indicator, that is, large numbers means poor fit of the model to the data. Table 20 summarizes the results.

Table 20: Socio-economic factors influencing resilience or erosion of micro catchment forests among the Sonjo agro-pastoralists

Socio-economic factor	ß	S.E.	Wald	df	Sig (P-values)	Odds Ratio (Expß)
Gender	-0.293	0.566	.0267	1	0.605ns	0.746
Age of household heads	0.053	0.023	5.267	1	0.022*	1.055
Income	0.000	.000	0.301	1	0.583 ns	1.000
Education level	0.245	0.095	6.711	1	0.010*	1.278
Land size	0.137	0.108	1.596	1	0.206ns	1.147
Marital status	0.534	0.615	0.753	1	0.386ns	1.705
CONSTANT	-4.536	1.292	12.284	1	0.001	0.011

Number of cases =136, Exp (ß**)** = odds ratio (probability of success/probability of failure), SE= standard error of the estimate, *Statistically significant at 0.05 level of significance, ns = statistically non significant at 0.05 level of significance, Sig = significance or P – values, e = 2.718, ß = regression coefficients which stand for the

odds ratio of probability of success to the probability of failure and Wald statistics = ß/$(SE)^2$ according to (Norusis, 1990 cited by Mayeta (2003).

The Wald statistics was used to test the hypothesis and it indicated non-zero values, which implies that there is interaction between the dependent and independent variables.

According to Xie (2000) cited by Mayeta (2004) the non-zero Wald statistic values indicates the presence of relationships between the explanatory variables. From the results in Table 20 it shows that all the independent variables included in the logistic regression model have non-zero regression coefficients which entails the existence of relationship between dependent (i.e. resilience of micro-catchment forests) variable and independent (i.e. socio-economic factors) variables. Based on these observations therefore, the null hypothesis was rejected in favour of the alternative hypothesis at 5% level of significance. The logistic regression analysis results revealed that education level (P = 0.010) and age of the household head (P = 0.022) had significant influence on resilience of micro-catchment forests (Table 20).

4.4.2 Socio-economic factors influencing resilience of micro-catchment forests

4.4.2.1 Age

Table 20, indicates that age of the household head has a positive regression coefficient (β) as it was expected. This implies that by increasing the age of the household head by one unit (one year) it increases the resilience of the micro-catchment forests by a factor of 1.055. The plausible explanation could be the fact

that the Sonjo people being practising traditional lifestyle have strong adherence and respect of their traditional taboos and norms including those related to micro-catchment forests conservation. It was revealed by the traditional leaders '*benamijie*' that at the end of each year all the Sonjo villages undertake a traditional ceremony called *masse* which is specifically designed for teaching the young people entering mature age about the Sonjo identity and values. This yearly event serves as a platform for elders to pass their accumulated traditional knowledge to the young generation. Table 21 shows the age structure of the sampled population in the study villages.

Table 21: Age structure of the respondents among the Sonjo agro-pastoralists in Ngorongoro district

Age class (years)	Female	Male	Total	Percentage
20-40	26.0	39.0	65.0	48.0
41-60	10.0	47.0	57.0	42.0
>60	3.0	11.0	14.0	10.0
Total	**39.0**	**97.0**	**136.0**	**100.0**
Percentage	**29.0**	**71.0**	**100.0**	

During FGDs it was further learnt that older people are rigid on the use of natural resources. In most cases older people advice young people to build their houses by use of bricks and other durable materials instead of using poles which are sometimes taken illegally from micro-catchment forests. Also it was found that older people were engaged in conservation activities such as tree planting since they owned bigger lands than young people. Similar observation was reported by Paulo (2004) in Uluguru Mountain Forests, Morogoro, Tanzania that older people were engaged more in conservation activities than young people. Kajembe *et al.* (2002) commented that

age in most cases influence awareness on traditional institutions since elders in the community tend to safeguard traditional ways of lifestyle.

4.4.2.2 Income

Table 20 shows that the income of the household has zero logistic regression coefficient (β). This is to say that the income of the household in the study area exerts no effects on odds ratio over the resilience of micro-catchment forests. In other words the income has 50% favouring the resilience and 50% influencing the erosion of micro-catchment forests. As indicated in Table 20, the household income had no significant (P = 0.583) influence on the resilience of micro-catchment forests. Table 22 shows the average minimum and maximum income per households per year among the Sonjo agro-pastoralists in Ngorongoro district. Therefore, probably when the household income is above the minimum average household income which is 82 500/= Tanzanian shillings then the household has alternative livelihood activities to sustain their daily life and also could engage in conservation activities such tree planting and hence contributes to resilience of the micro-catchment forests.

Table 22: Average minimum and maximum income (000) per households per year among the Sonjo agro-pastoralists in Ngorongoro district

Village	Minimum income per household	Maximum income per household
Samunge	120	3 500
Kisangiro	60	1 400
Yasimdito	50	2 000
Sale	100	1 800
Average	**82. 5**	**2 175**

Kihiyo and Monela (1999) argued that as people's income improves they shift from fuelwood to other forms of fuel such as kerosene and hence allows the growth of forests.

4.4.2.3 Education

Table 23 indicates that 54 % of the respondents in the sampled population have primary education, whereas 17% attended adult education and 9% had secondary and tertiary education. About 20% of the sampled population did not receive any formal education.

Table 23: Literacy level of respondents among the Sonjo agro-pastoralists in Ngorongoro district

Education level	Frequency (n=136)	Percentage
Primary education	73	54.0
No formal education	27	20.0
Adult education	23	17.0
Secondary and tertiary education	13	9.0
Total	**136**	**100.0**

The positive regression coefficient as expected of education level (number of years spent in school) implies that an increase in education level of the respondent significantly (P = 0.010) increases the odds ratio of micro-catchment resilience by a factor of 1.278 (Table 20). The plausible explanation of this is that an increase in number of years spent in school tends to increase people's awareness in the importance of sustainable natural resources (micro-catchment forests) conservation. Increase in number of years in school also increases the willingness of local people to participate in natural resources conservation activities like tree planting and tree

retention. Involvement of local communities in the conservation of natural resources reduces chances of resource abuse because the practice imparts a sense of ownership and benefit sharing at the local level (Mayeta, 2004). It also implies that formal education has influence towards people's participation in conservation activities such as tree planting or retention.

The significance of education in explaining the awareness of people on the importance of natural resources conservation and development is well documented (Kajembe and Luoga, 1996; Katani, 1999; Mbwambo, 2000). It is argued by Kajembe and Luoga (1996) that there is no development without education. An increase in education level increases the level of awareness and thereby creating positive attitudes, values and hence motivating people to manage natural resources sustainably (Katani, 1999). Mbwambo (2000) reported that respondents who are educated tend to plant more trees for their own uses at their homesteads as opposed to less educated ones and hence contribute in resources conservation. Planting or retaining of trees around homesteads reduces pressure on micro-catchment forests thereby contributing to their resilience.

4.4.2.4 Marital status

Table 20 shows that marital status of the household head has a positive regression coefficient (β), implying that increasing the number of married persons in the study area increases the odds ratio of resilience of micro-catchment forests by a factor of 1.705. This means that married heads of the households contribute more to resilience of micro-catchment forests as compared to unmarried people. This is because

according to the Sonjo customs and values only the married people are allowed to own resources such as land and also are the ones who participate fully in traditional and cultural issues including protection of micro-catchment forests. In this case married people are mostly involved in conservation of forest resources. For example they plant and retain trees in their farms in order to get fuelwood, building poles, fodder, medicinal herbs and other related forests products. Consequently, people don't go to the micro-catchment forests to collect forest products since those products are available outside the micro-catchment forests.

Unmarried people on the other hand have fewer responsibilities since they do not own any land and they also don't plant trees and therefore they always obtain their needs such as forest products from the general lands and other public places in which case sometimes end up entering the micro-catchment forests illegally. This result concurs with the findings by Mayeta, (2004) who reported that unmarried people in communities around Rungwe National parks were not engaged in conservation related activities. Nonetheless, the effect of marital status was not significant (P = 0.386) on resilience of micro-catchment forests.

4.4.2.5 Land size

Figure 4 shows that 39% of the sampled population had a land size ranging between 0.5 and 1.5 ha while 33% had land size between 1.6 and 2.5 ha and 13% had a land size of between 2.6 and 3.5 ha and 15% had land size above 3.5 ha. Table 20 indicates that land size owned by the household has positive regression coefficient (β). This

implies that as land size owned by the household increases, the odds ratio of resilience of the micro-catchment forests is increased by a factor of 1.147.

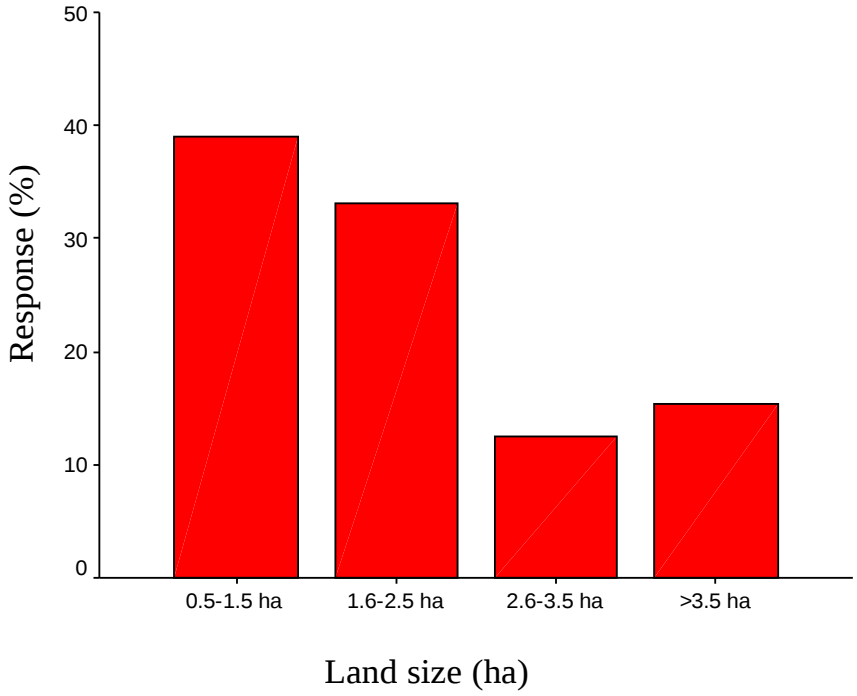

Figure 4: Land size owned by the households among the Sonjo agro-pastoralist in Ngorongoro district

The plausible explanation is that most of the villagers had retained trees in their farms and around their homesteads that enable them to obtain essential forest products like firewood and construction materials, as a result they don't go to micro-catchment forests to collect those products and therefore contributes to resilience of the forests. It was further observed that the households with bigger land sizes retained and/or planted more trees that those with smaller farms. This observation is in consistent with earlier study by Kajembe and Luoga (1996) who argued that farmers with smaller land sizes were normally reluctant to plant and retain trees or to have prolonged fallow as compared to farmers with bigger farms. However, land owned by

the household had no significant (P = 0.206) effect on resilience of the micro-catchment forests.

4.4.3 Socio-economic factors influencing erosion of micro-catchment forests

4.4.3.1 Gender

Table 20 shows that gender has a negative regression coefficient (β). This implies that both men and females don't participate equally in the conservation of micro-catchment forests, the situation which contributes to erosion of micro-catchment forests. The plausible explanation is attributable to gender inequalities in the study area. It is unfortunate that, according to the Sonjo culture, women have no right to own resources such as land or any other family assets, and therefore, this discourages them to participate in conservation activities such as protection of micro-catchment forests and tree planting. As indicated in Table 24, about 92 % of the respondents reported that males planted trees, whereas only 1% said that females planted trees and 7% of the respondents said that both sexes planted trees.

Table 24: Gender roles in tree planting and management among the Sonjo agro-pastoralists in Ngorongoro district

Gender	Responsibilities	
	Planting %	Tending %
Male	92.0	3.0
Female	1.0	10.0
Children	0.0	7.0
Male + Female	7.0	0.0
Male + female + children (all)	0.0	80.0
Total	**100.0**	**100.0**

The plausible explanation for men to plant more trees than women is due to the fact that men owns more land than women whereby men usually obtain land through inheritance (Fig. 5). As women do not own land, they only access user rights through their husbands and if not married have to borrow land from the male. Therefore as women do not own land they are usually reluctant to participate actively in the conservation activities such as tree planting. Only very few women who were employed or educated owned land which is obtained through purchasing. These findings concur with the results by Mhaville, (1996) who argued that women, especially married ones, were not ready to plant trees because they did not own the land and they did not benefit from the income obtained from trees. Mehra (1995) also reported that women consistently lack access to and tenure of land and other natural resources, which is often prohibited by traditional norms and therefore when women don't control land, they lack the confidence to plant trees. Nevertheless, when asked on tree tending responsibilities, 80% of the respondents mentioned tree tending and care to be done by all members of the family and only 2% mentioned men to do the tending of trees.

The role of women in tree management and conservation cannot be overstressed. Mbwambo (2000) reported that women adjacent to Udzungwa mountain forests tended trees more than men due to the fact that women are responsible for fetching water, which could be combined with watering of seedlings. The author further argued that women have patience and nursing instincts and therefore more adapted to tending delicate tree seedlings as compared to men.

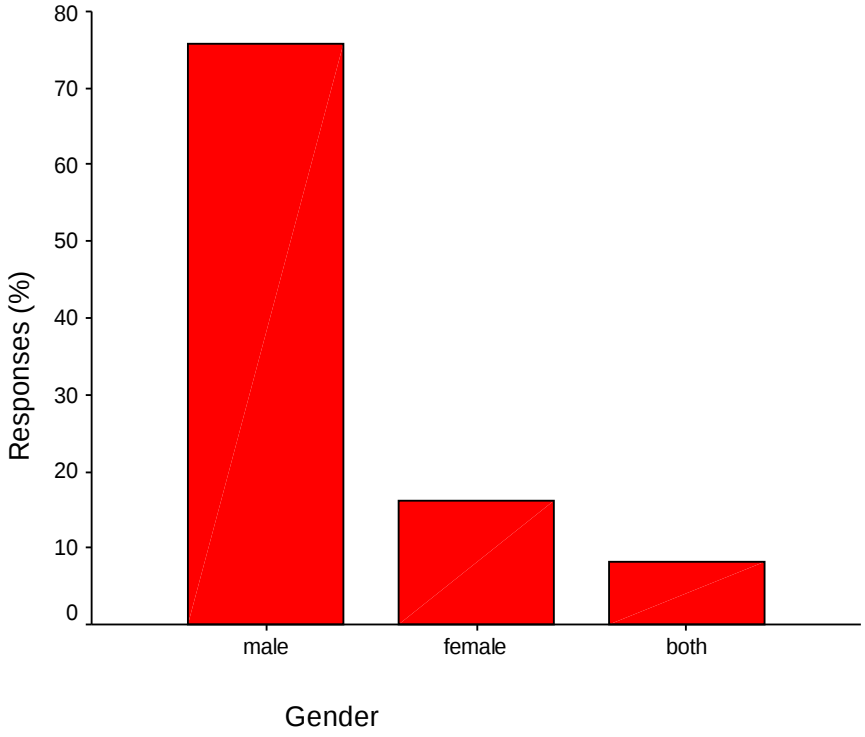

Figure 5: Family land ownership by gender among the Sonjo agro-pastoralists in Ngorongoro district

Deller'e (1989) cautioned that without the active involvement of women most of efforts to increase and promote environmental conservation are unlikely to succeed. Based on this reality, more is needed to be done on facilitations of those communities like that of Sonjo, which has always undermined women's productive roles hence resulting into undervaluing their contribution in the conservation efforts and community development at large.

4.4.3.2 Income

As Table 20 shows, the income of the household has zero logistic regression coefficient (β) that means income of the household can have dual effects of erosion and/or resilience of micro-catchment forests. In this case income is considered to

cause erosion of the micro-catchment forests when the household income goes below the minimum average income which is 82500/= Tanzanian shillings as indicated in Table 22. During this time it is possible that people encroach the micro-catchment forests especially those which are formally managed to find it as an alternative to their livelihoods. Consequently, it causes the erosion of micro-catchment forests. Furthermore in FGDs it was revealed that during times of severe and prolonged drought, grazing pastures becomes very scarce, consequently some people do deliberately or accidentally allow their animals which are weak and unable to travel long distances to enter into micro-catchment forests for grazing. This contributes to erosion of micro-catchment forests. These results concur with those reported by Cavendish (1996) working in southern Zimbabwe that, the low-income households derived more of their income from forest resources than their counterpart who are relatively rich.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Traditional knowledge, practices and local institutions have been used successfully and are still observed by the Sonjo agropastoralists **with regard to conservation of micro-catchment forests**. Traditional rules have made the traditionally managed micro-catchment forests to exist in the heart of ever dry lands while government rules have not done much for formally managed micro-catchment forests. The functional traditional rules include prohibition on; cutting of indigenous trees, fire burning, grazing, firewood collection and entry of people in the micro-catchment forests without prior permission from the *benamijie*. Behind the effective traditional rules are the local institutions, which are internally sponsored namely, *benamijie*, *batana* and *baghorowane.*

Logeri pasture management system, which acts as a coping mechanism during dry season has proved to be effective conservation practice in regulating utilization of fodder resources while avoiding overexploitation of the resources in the area. Also sacred forests and individual sacred trees have played a major role in protecting not only the micro-catchment forests but also other biological resources in the area. Although the micro-catchment forests are still resilient in the study area, gender and income inequalities were found to contribute to their erosion. Community's efforts in the conservation activities such as tree planting and retention were evident, however local governments do not well support these local people's initiatives.

Generally, it is concluded that traditional knowledge and practices have an active roles in micro-catchment forests conservation. Similarly, traditionally managed micro-catchment forests were seen to be in a good condition as compared to formally managed micro- catchment forests plausibly due to effectiveness of traditional institutions.

5.2 Recommendations

Based on the findings of the study, the following recommendations are pertinent in ensuring future existence of micro-catchment forests.

(i) There is a need for the local government in the district to recognize traditional institutions as key partners in the conservation of micro-catchment forests. This can be achieved by integrating formal and traditional management systems as a way of coming up with more comprehensive and sustainable strategies of conserving micro-catchment forests.

(ii) Though communities are actively engaging in environmental restoration practices including tree planting and retention, their capacities are limited by inadequacy of resources; hence the support from the local government is highly needed particularly on the issue of environmental education and tree planting materials.

(iii) There is a need for community mobilization and sensitization on gender roles in the conservation of natural resources activities. Emphasis should be put on women’s contribution and participation in the conservation of micro-catchment

forests and other conservation activities such as tree planting, land tenure and ownership rights.

(iv) Due to both financial and time constraints detailed study on the identification of individual plant species of the micro-catchment forests were not conducted. Therefore research should be conducted on botanical surveys to establish species richness and diversity of micro-catchment forests in the study area.

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APPENDICES

APPENDIX 1. QUESTIONNAIRE FOR HOUSEHOLD

Village name----------
Date ----------
Name of the recorder ----------
Household number ----------

1.0 HOUSEHOLD DATA

1.1 Name of the household head……
1.2 Gender: 1.2.1 Male
1.2.2 Female
1.3 Marital status
1 Single…….
2 Married……..
3 Divorced…….
4 Widowed……
1.4. Educational level
1. No formal education……years
2. Adult education…… years.
3. Primary education…… years
4. Secondary…… years
1.5 Age of the household head in years……
1.6 Household composition.

Age (years)	**Male**	**Female**
<18		
18 – 55		
>55		

1.7 Household main economic activities.
1.Farming……..
2.Business…….
3.Both……
1.8. Estimated annual income (Tshs)……..
1.9.Main source of Labour for household
1. Family/household……
2. Hired labour only……
3. Both……

2.0 LAND USE SYSTEM

2.1 Residence duration in the village in years……
2.2 Born in the village. YES ( )/NO ( )
2.3 What size of land in hectares does your family own……..
2.4 How is land ownership?
1 Private……..
2 Communal……
2.5 Who owns land in your family?

1 Male…….
2 Female……..
3 Both…….

2.6 How is land acquired?

1. Inheritance……
2. Buying……..
4. Borrowing……...
5. Given by village government…….

3.0 FOREST ACTIVITIES

3.1 Do you plant trees in your own land?

1 . Yes……...
2 . No……

3.1 Do you retain trees in your own land?

1 . Yes……..
2 . No…….

3.2 If yes how many do you plant/retain per year, what uses ,which spp?

Species	**Planted**	**Retained**	**Number**	**Uses**

3.3 Where do you get seeds/seedlings/materials for nursery (specify)

Material	**Individual sources**	**Group**	**Distr.Council**
Seeds Seedlings Polythene tubes Others (specify			

3.4 Where do you plant /retain your trees?

Home gardens……..
On farm……
Others specify……..

3.5 What are the reasons for planting /retaining trees?

1. To get trees product……
2. Demarcation of farms boundaries……...
3. To get income……
4. Other specify…….

3.6 If you don't plant/retain trees, what is the reason?

1. No seedlings……..
2. No seeds……
3. No land to plant……..
4. Others (specify)……..

3.7 Who participate in nursery activities and tree planting?

Activity	Male	Female	Children	All
Seedling tending Tree planting Tree tending				

4.0 FOREST RESOURCES UTILIZATION

4.1 What forest products do you know and where do you get them.

Product	Uses	Sources

4.2 Do you go to micro-catchment forests to collect forest products?

1. Yes……..
2. No……...

4.3 If yes, how do you get access to the micro-catchment forests?

1. Free…….
2. Permission……..
3. Illegal……..

4.4 What is the main fuel energy do you use?

1. Fire wood……
2. Charcoal……...
3. Kerosene……..
4. Others (specify)

4.5 What is the distance to the nearest micro-catchment forests?……Km

4.6 Who is responsible for forest product collection?

Who collect the products	Male	Female	Children	All

4.7 Are their any ritual sites in the micro-catchment forests?

1.Yes……...
3. No…….

4.8 If yes, how do you get access to ritual site in the micro-catchment forests?

1. Permission…….
2. Free……
3. Illegally……..

4.9 What main activities are done on the ritual site? ……..

4.0 LOCAL PEOPLE PERCEPTION ON MICRO-CATCHMENT FOREST RESOURCE MANAGEMENT

5.1.0 Who own the micro-catchment forests and water sources?

1. District council……..
2. Village government……...
3. Traditional leaders…….
4. Others (specify)…….

5.1.2 Did, the owner above appropriated the micro-catchment forests 15 years ago?

1. Yes…….
2. No……..

5.1.3 If no, why there is change in ownership?…….

5.1.4 Do you know the boundaries of micro-catchment forests?

1. Yes……..
2. No……...

5.1.5. If yes, are they respected?

1. Yes……...
2. No……

5.2.0 List all the rules that you know regarding protection of the micro-catchment forests?

Traditional rules	Village government rules

5.3.0 Are there any traditional practices, which have been used in managing and protecting the micro-catchment forests?

1. Yes……
2. No…….

5.3.1 If yes what are they? And what role are they playing in managing the micro-catchment forests?…… …

5.3.2 Are there any traditional practices, which existed in the past and are no longer in use today?

1. Yes……..
2. No……

5.3.3 If yes what were they and what roles did they play in conserving micro-catchment forests……...

5.3.4 Can you suggest how to preserve the positive traditional practices? ……..

5.3.5 Do you know any case of encroachment to the micro-catchment forests?

1. Yes……..
2. No……...

5.4.1 If yes, mention reasons for encroachment to micro-catchment forests?

1. Boundaries not known……...
2. Poor pastures/fertility out side the micro-catchment forests…
3. Land scarcity……
4. Others (specify)……

5.5.0 Do you know any case of fire outbreak in the micro-catchment forests?

1. Yes……..
2. No……...

5.5.1 If yes, what are the reason of fire in the micro-catchment forests …….

5.6 Are there any trees/animals species, which are traditionally protected?

1. Yes……
2. No…….

5.6.1 If yes, list them and reason for protection …….

Tree species	Reason	Animal species	Reason

5.6.1 What happen to a person who cut/hunt illegally……..

5.7 Are people being involved in management of micro-catchment forests?

1. Yes……...
2. No……

5.7.1 If yes, how……...

5.7.2 If no, do you think the government/project organization should involve local people in conservation and management of micro-catchment forests?

1. Yes……
2. No……

5.7.3 Do you have further comments on how micro-catchment forest be best managed…….

5.0 LOCAL INSTITUTIONS AND THEIR ROLE IN MICRO-CATCHMENT FORESTS MANAGEMENT.

6.1.0 Can you list local institutions dealing with micro-catchment forests in this village?

1……
2……
3……

6.1.2 Are there local institutions which used to exist in the past and which now are non existent?

1. Yes……...
2. No……

6.1.3 If, yes what are they and what role did they play in micro-catchment forests conservation?

1……
2……...

6.1.4 In your opinion what made/caused the institutions above to varnish?….

6.1.5 Do you think there is a need to legitimize or empower local institutions?.

1. Yes……..
2. No……...

6.1.6 If yes, why?…… ……

6.2.1 Are there any cultural values that the micro-catchment forests offers (offered)?

1. Yes……
2. No……

6.2.1 If yes what are they

1. Traditional ritual……..
2. Initiation of teenagers……..
3. Others (specify)……...

6.3 Are there any outside institutions involved in conserving micro-catchment forests?……..

1. Yes……...
2. No……

6.3.1 If yes, describe briefly the type of institutions, who initiated it, when and what was done…….

6.3.2 Are there interest that these externally sponsored institutions overlook some interest and which you feel the local institution would take care of them>

1. Yes…….
2. No……..

6.3.3 If yes what are they?……...

6.3.4. Do you think the local can work hand in land with the professional forest institutions

1 1. Yes……...
2.No…….

6.3.6 If yes suggest how can this be achieved……..

7.0 STATUS OF ENDEGERED SPECIES IN MICRO-CATCHMENT FORESTS

7.1.1 Please list any plant/animal species that were harvested from the micro-catchment forests approximately 10-20 years ago that are no longer available and list the reason for their disappearance……..

Name of species		
Local name	Botanical name	Reason for disappearance.

APPENDIX 2: CHECKLIST FOR KEY INFORMANTS

1. FOREST OFFICIALS

- Management objectives of the micro-catchment forests.
- Management problems and underlying causes.
- Strategies to improve conservation of micro-catchment forests and forest resources in general.
- Forest conservation rules and regulations.
- How frequent are local people allowed into micro-catchment forests.
- What products are allowed and how sustainable is the exercise
- General responsibilities
- Suggestions on community participation

2.VILLAGE LEADERS AND TRADITIONAL LEADERS

- Awareness to the importance of the micro-catchment forests
- Village strategies in conserving micro-catchment forests
- Tree planting
- Enforcement of rules and regulations
- Existing local institutions (both formal and informal)
- How are village conservation activities tied with external interventions
- Socio - economic factors constraining or favoring sustainable conservation of the and resilience of micro-catchment forests
- Custodians of Ritual activities

APPENDIX 3: SAMPLING SCHEME FOR QUESTIONNAIRE SURVEY.