

**INDIGENOUS KNOWLEDGE SYSTEM AND FACTORS LIMITING ITS
INTEGRATION INTO BIODIVERSITY CONSERVATION METHODS IN
SOUTH NGURU MOUNTAIN FOREST RESERVE, TANZANIA**

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ABSTRACT

This study sought to explore the existing indigenous knowledge system (IKS) in four villages bordering the South Nguru Mountain Forest Reserve; to find out its significance in the conservation of biodiversity and to examine factors that influenced the system's integration into biodiversity conservation methods in the area. Using the exploratory cross-sectional research approach, and guided by the political ecology theory, this study triangulated interviews, focus group discussions (FGDs) and field observation to collect data from 240 randomly selected indigenous people; 60 from each study village. The Statistical Package for Social Sciences (SPSS) and content analysis were used to analyse quantitative and qualitative data respectively. This study revealed that IKS was embedded in the indigenous social structure and local politics, cultural norms, values and spiritual beliefs, with selective conservation. Social, demographic and economic factors were also seen to overtly influence integration of IKS into conservation methods, so was the lack of official recognition and capacity building of the indigenous social structures. In conclusion, despite Tanzania being a signatory of the 1992 Rio De Janeiro Convention on Biological Diversity (CBD) and the Tanzania Forest Act of 2002 on active participation of indigenous people in biodiversity conservation, IKS and biodiversity conservation methods operate in a parallel and win-lose, rather than a win-win relationship. Recommendations put forth focus on official recognition of the IKS and active participation of the actors; motivation and capacity building; training on the significance of the IKS and addressing the problem of household-level poverty, while considering the demographic and socio-economic contexts of the local population.

DECLARATION

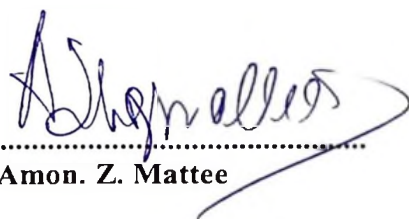
I, Sosthenes Ruheza, hereby declare to the Senate of the Sokoine University of Agriculture that this thesis is my own original work, and that it has not been submitted for a higher degree award in any other university.



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Date..... 10. 11 / 2014

The above declaration is confirmed



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Ishimwe”.**

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ABBREVIATIONS AND ACRONYMS

CBD	Convention of Biological Diversity
DIIS	Danish Institute for International Studies
FAO	Food and Agriculture Organization of the United Nations
FBD	Forestry and Beekeeping Division
FGD	Focus Group Discussion
ICSU	International Council for Science
ICT	Information and Communication Technology
IEK	Indigenous Ecological Knowledge
IFAD	International Fund for Agricultural Development
IKS	Indigenous Knowledge System
IMP	Integrated Management Practices
ITK	Indigenous Technological Knowledge
IUCN	International Union for the Conservation of Nature
JFM	Joint Forestry Management
NFDIN	National Foundation for Development of Indigenous Nationalities
PEMA	Participatory Environmental Management
SEEM	Socio-Economic and Ecological Model
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Sciences
TEK	Traditional Ecological Knowledge
TFCG	Tanzania Forestry Conservation Group
Tshs	Tanzanian shillings
UNEP	United Nations Environment Programme

UNESCO	United Nations Education, Scientific and Cultural Organization
URT	United Republic of Tanzania
USD	United States Dollar
WWF	World Wildlife Fund for Nature

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Biodiversity decline is increasingly becoming one of the major concerns of humankind since the last quarter of the last century (Hens, 2006; Meffe *et al.*, 2006 cited in Fitzgerald and Stronza 2009). In highlighting this fact, the World Summit on Sustainable Development held in Johannesburg, South Africa in 2002, declared that despite significant efforts, the decline of biodiversity worldwide was continuing at an unprecedented speed and that a reversal of this on-going decline should urgently be realized (Hens and Nath, 2003 cited in Hens, 2006). Similarly, UNESCO (2010) argued that the reversal of biodiversity decline has become one of the major challenges that the world faces today. It is from such reality that biodiversity decline is increasingly becoming a worldwide challenge that requires collective and urgent efforts at local, national, regional and international level.

Like other countries, the Tanzanian government has been attempting to address the problem of biodiversity decline with very little success. For example Gibson *et al.* (1999), cited in Kweka (2004) reported that deforestation through encroachment, overgrazing, wildfires and general over-exploitation of wood resources continued and tends to generate significant problems that have been leading to unaccomplished forest conservation goals. It has to be noted that deforestation has been threatening both flora and fauna biodiversity as a result of destruction of ecological systems within which life forms depend.

In addressing the problem of biodiversity decline, most of the efforts have relied on the use of modern scientific and sophisticated approaches and practices (biodiversity conservation methods), while the indigenous knowledge system (IKS) has been considered primitive, simple and static, a situation that might have caused poor performance of most of such initiatives. Echoing the same view, Mander (1991) cited in McGgregor (2004) and Sobrevilla (2008) argued that the current modern development models that have mostly been relying on the use of scientific methods and practices mostly for commercial production and ignoring the use of IKS that has been mostly principled by subsistence livelihood strategies has brought us to many of the global problems we are facing today such as extinction of species and climate change. Along a similar vein, it has been widely argued that rapid development activities that are governed by market economy using modern technologies have been linked to six major problems that are global warming, biodiversity decline, crisis-prone financial support to conservation, growing international inequalities, emergence of new drug-resistant diseases and strains and genetic engineering (Gruberg, 1999; Kanl and Stern, 1999 cited in Das Gupta, 2011).

Quite recently, there have been several calls for the integration of IKS into biodiversity conservation methods. Such calls stem from the fact that these knowledge systems complement each other in their strengths and weaknesses and it has been argued that their combination may achieve what neither would achieve alone (Stevenson, 2005; Nganje, 2009; Fitzgerald *et al.*, 2009; Cobb, 2011 and Das Gupta, 2011). In further emphasizing on the need of integrating IKS to address the overwhelmingly worldwide problems, Mutta *et al.* (2009) and Das Gupta (2011) very persuasively argued that as the planet is currently faced by the problems of air pollution, global warming and biodiversity decline among others, scientists have more to learn from IKS that enabled its custodians to live in harmony with their supporting ecosystem for generations. Integration of IKS and scientific

of IKS and scientific methods and approaches apart from being more valuable than either one on its own, it can also create a mechanism of dialogue between indigenous people and scientists that will result into designing of programmes that reflect people's aspirations and are participatory (Nyong, Adesina and Elasha, 2007).

However, despite such emphasis and calls for the integration of IKS into biodiversity conservation methods, most studies have been concentrating on documentation IKS, and therefore, very little is known about integration of IKS into biodiversity conservation methods. In subscribing this view, authors such as Zazu (2007); De Kruist *et al.* (1998), Caheiros *et al.* (2000), Hunting *et al.* (2000), Mackinson (2001, Klooster 2002, Davis and Wagner (2003), Ericksen and Woodley (2005), Schutz *et al.* (2007) cited in Ballard, Fernandez-Gimenez and Sturtevant (2008) argued that despite being emphasized, integration of IKS into biodiversity conservation methods contain very few examples of the process and very little evidence of how these knowledge systems can be integrated. In further extending this discussion, Maila and Loubser (2003) and Briggs (2005) pointed out that most studies on IKS have focused on empirical and practical knowledge of biodiversity and how the knowledge can be tapped and used.

Very little empirical evidence on the integration of IKS into biodiversity conservation methods suggests that there might be some factors limiting the integration of these knowledge systems for conservation of biodiversity.

1.2 Problem Statement

The South Nguru Mountains are not excluded from the increasing worldwide problem of biodiversity decline, a problem that poses the greatest challenge to human survival and development (TFCG, 2007). The Mountains harbour one species which is critically

endangered, eight endangered, ten vulnerable, two near-threatened, one data deficient animal species and twenty vulnerable plant species based on International Union for the Conservation of Nature (IUCN) threat classification (TFCG, 2007). However, the level of biodiversity decline in South Nguru Mountains has reached critical levels and that urgent action is needed to address the increasing problem (TFCG, 2007; Menegon *et al.*, 2008).

IKS is widely known for its roles in the conservation of natural resources such as biodiversity although it has been considered primitive and barbaric. For example, McGregor (2004) and Sobrevilla (2008) argued that many of the global environmental problems such as decline of biodiversity have been attributed mainly to the failure of most biodiversity conservation initiatives to efficiently use IKS.

To date, the increasing worldwide concern on the need of integrating IKS among others is due to lack of confidence in modern scientific methods and practices in addressing the increasing problem of biodiversity decline and hence the need of considering other knowledge systems such as indigenous knowledge. Similarly, Warren (1992) emphasized that understanding and consideration of the IKS that foster biodiversity in domesticated and wild species can help in the establishment of a collective and comprehensive programme through integrating the IKS into biodiversity conservation methods for sustainable management and use of biodiversity.

However, despite several recommendations for the integration of IKS into biodiversity conservation methods (Chambers, 1983; Warren, 1992; Kajembe, 1994; Msuya, 1998; Stevenson, 2005; Mokuku and Mokuku, 2004 and Nganje, 2009), very little of the findings on IKS have been implemented and very little is known about the integration of the IKS into biodiversity conservation methods (Zazu, 2007 and Caheiros *et al.*, 2000;

al., 2000; Hunting *et al.*, 2000; Mackinson, 2001; Klooster, 2002; Davis and Wagner, 2003; Ericksen and Woodley, 2005; Schutz *et al.*, 2007 cited in Ballard, Fernandez-Gimenez and Sturtevant, 2008).

Limited examples of successful integration of IKS into biodiversity conservation methods suggests that there might be some factors limiting integration of these knowledge systems for conservation of biodiversity as it has been emphasized as remedy for addressing the worldwide problem of biodiversity decline. In a related view, Kideghesho (2008) and UNEP (2008) argued that despite several calls and suggestions for the wide use and application of indigenous practices, the social, economic and political realities in many parts of Africa may have been limiting its wide use and application, and ultimately to the lack of successful integration of IKS into biodiversity conservation methods.

It is from these facts and recommendations that this study was carried out in South Nguru Mountain Forest Reserve of Tanzania to analyse the demographic and socio-economic factors influencing the integration of IKS into biodiversity conservation methods.

1.3 Study Justification

Using South Nguru Mountain Forest Reserve as the case, this study is critical and timely because: (i) The study is in line with Article 8(j) of Convention of Biological Diversity (CBD) of 1992 that emphasis on respecting, preserving and maintaining of indigenous knowledge innovations, and practices of the knowledge system equitable sharing of benefits among stakeholders and its integration into other knowledge systems (ii) The level of biodiversity loss has reached a critical level that demands urgent action; with the forest reserve being having harbour one critically endangered species, eight endangered,

ten vulnerable, two near-threatened, one data deficient animal species and twenty vulnerable plant species based on International Union for the Conservation of Nature (IUCN) threat classification; (iii) identification of IKS and how it contributes to biodiversity conservation will add new body of knowledge to be integrated into biodiversity conservation methods; (iv) documentation of demographic and socio-economic factors limiting integration of IKS into biodiversity conservation methods will form a basis for the integration of IKS; (v) it will help stakeholders in conservation of biodiversity discourse in formulation of projects and programmes that bear the aspects of factors that have been limiting integration of IKS into biodiversity conservation methods; (vi) it will provide necessary information to the policy makers through which appropriate conservation policies and strategies calling for the integration of IKS into biodiversity conservation methods will base, and (vii) recommendations of the study will be used for the future analysis and research in the study area.

1.4 Objectives

1.4.1 Overall objective

The overall objective of the study was to explore the IKS and the demographic and socio-economic factors limiting its integration into biodiversity conservation methods¹ in South Nguru Mountain Forest Reserve.

1.4.2 Specific objectives

Specifically the study intended to:

- i. Determine the existing IKS for biodiversity conservation;
- ii. Establish the significances of IKS on conservation of biodiversity; and
- iii. Determine the influence of demographic characteristics on integration of IKS into biodiversity conservation methods.

- iv. Examine the influence of socio-economic characteristics on integration of IKS into biodiversity conservation methods.

1.5 Research Questions

The study aimed at answering the following research questions: -

- i. What is the existing IKS for biodiversity conservation in the South Nguru Mountain Forest Reserve?
- ii. What are the significances of IKS on conservation of biodiversity in South Nguru Mountain Forest Reserve?
- iii. How do indigenous people's demographic characteristics limit the integration of IKS into biodiversity conservation methods?
- iv. How do indigenous people's socio-economic characteristics limit the integration of IKS into biodiversity conservation methods?

1.6 Hypotheses Tested

H_0 : ($\beta = 0$ (meaning that there is no relationship between integration of IKS into biodiversity conservation methods and independent variables (sex, age, level of education, household income, years of residence, household labour, farm size)).

H_1 : ($\beta \neq 0$ (meaning that there is a positive or negative relationship between dependent and independent variables)).

1.7 Theoretical Framework of the Study

The political ecology framework and the Socio-Economic and Ecological Model (SEEM) (Fig. 2) by Roba (2008) were used to guide this study. Political ecology refers to a loose bundle of theories which analyse environmental issues from a wider political point of view that also investigates how the cultural, ecological, social and political issues conflate in environmental issues such as biodiversity decline (Korhonen, 2009). Korhonen (2009), further, added that the recognition of different positions, perceptions, interests and rationalities among different actors interested in conservation of biodiversity was necessary. In fact, biodiversity being a broad concept that encompasses social, economic, ecological and political aspects, its management, uses and conservation should, therefore, consider the broad nature of the concept, which makes the political ecology model the most appropriate in critical analysis of the conservation of biodiversity.

Within a political ecology framework, an actor-oriented model of Wiesmann (1998) (Fig. 1) was chosen to examine the influence of socio-economic and political factors influencing different actors concerned into management and use of biodiversity in the South Nguru Mountain Forest Reserve. The choice of the actor-oriented approach, among several other approaches of political ecology, gets support from Kajembe and Kessy (1999) and Schubert (2005) who argue that an actor-oriented approach is useful when dealing into several actors interested in a certain aspect such as biodiversity conservation, as it emphasises discussions on plurality of actors who are related to conservation interventions as well as their socio-economic characteristics, perceptions and the political influence that occurs between the actors: these differences affect access to and control over biodiversity among different actors.

In light of the existence of different actors and power each actor exerts, citing Nygren (2000, 2004); Brechin *et al.* (2002) and Alcorn (2005), Korhonen (2009) put it that conservation has to be regarded as a social process in which there are different actors into different interests and unequal power, among them, which determine the outcome of the conservation process. Such relations, however, rarely have been taken care of. Arguing on the existence of power relations in a social group, such as indigenous people, citing Greider and Garkovic (1994), Boillat (2007), pointed out that individuals inherited socially constructed symbols, concepts and meanings that were continuously negotiated, renegotiated and imposed through the use of power, in a daily social interaction (Darre, 2000 cited in Boillat, 2007). This suggests that power relation among members of a social group determine individuals and household level activities and actions and interactions with their supporting ecosystem.

According to Vihemäki (2009), biodiversity conservation efforts have to recognise and address economic, power and other social relations within and between actors involved in conservation of biodiversity, as all actors, regardless of the degree of their subordination, do exercise some kind of power (Kajembe *et al.*, 1999). Those subordinate actors do influence the activities of the superiors (Giddens 1987 cited in Kajembe *et al.*, 1999), leading to increased costs of conservation as a result of the conflicts among actors, which result into unintended outcomes.

Ignoring the perpetuation of unequal power relations between indigenous people and other actors has been limiting integration of the IKS into other forms of knowledge systems (Chapekie, 1995; Lukey, 1995; Stevenson, 1997 cited in McGregor, 2004; Ossai, 2010; Nadasdy, 1999 cited in Cobb, 2011), as such power imbalance has been fostering rejection of the IKS, its transformation and its integration into ways of knowing and doing (Ellis,

2000). Moreover, indigenous people have been obliged to present their knowledge in a scientific manner, using foreign languages, limiting their active participation (Holt, 2005).

The actor-oriented approach enables understanding of the community perceptions and practices regarding management and use of biodiversity (Long, 1989 cited in Wiersum, 2000). For example, the term biodiversity has been perceived and conceptualized differently by different people, resulting into conflicts among them, on the goals and means for its conservation (Charnley, Fischer and Jones, 2007 and Shrestha *et al.*, 2010). In favour of this view, Holt (2005) put it that while indigenous people believed that biodiversity is “a God given resource”, and has to be used, otherwise, they would not be provided, most of the biodiversity conservation methods have emphasized on the pro-nature conservation, whereas more often than not, indigenous people have been excluded from biodiversity conservation initiatives.

Reporting on the existence of different views on the management and use of biodiversity, a study by Kweka (2004) in the Usambara Mountains in Tanzania reported that, while customary laws allowed people to use biodiversity such as entering into forests after performing some rituals, the colonial and post-colonial conservation initiatives have been restricting the indigenous people from entering into the forests with clear boundaries separating the forest reserves and farms. This situation has been reported to be behind the intentional destruction of biodiversity by the indigenous people as their incursion against the imposed unpopular rules (Mbwambo, 2000; Mapara, 2009).

The actor-oriented model was also used to take into account that the nature of the IKS varied among indigenous people of the same communities based on sex, age, social classes and other disparities in power relations (Sillitoe, 2002 cited in Roba, 2008), such

as intellectual capability and profession (Ylhäisi, 2006; McGregor, 2004). Citing Pakhrel (2001), Shreshra *et al.* (2010) added that community heterogeneity has a great influence on conservation of biodiversity, as different ethnic groups, sex and economic class have different interests and preferences on biodiversity.

It is worth noting that actors' activities were exposed to dynamic conditions of actions that included all factors in the actors context, which determined their perceptions, valuation and interpretation of these conditions: under the influence of social values and norms (Wiesmann, 1998). Moreover, the indigenous social structures, rules and values determined the structure of meanings and aims of the social group, whereas, the wider social and economic forces changed social structures that generate, store and enforce the IKS resulting into its decline (McGregor, 2004; Tanyanyiwa and Chikwanha, 2011).

In light of the effects of change of indigenous social structures on the IKS, Mokuku and Mokuku (2004) put it that some of the IKS have been declining as a result of changes of social structures that fostered the knowledge system through religions, beliefs, taboos and myths. This implies that recognition, enhancement and sustainability of the indigenous social structures which safeguard, generate and enforce the IKS is of significant importance for the sustainability of the knowledge system and for sustainable conservation of biodiversity, as it reduced the costs and conflicts among actors interested in the management and use of the same.

According to the actor-oriented model, individual actions are embedded in value systems and social norms shaped by the social context, through a social standard of evaluation of actions, strategies and outcomes of their actions (Weismann, 1998). The authors added that actions and strategies of the social group were determined by social networks, social

controls and social hierarchies aimed at ensuring social security balances necessary for the survival of the group and of their knowledge system.

The actor-oriented approach to exploring the relationship between actors interested in conservation of biodiversity was used. This allowed for critical analysis on the relationships between different actors within different socio-economic and political contexts that determined their interaction with their supporting ecosystem in the South Nguru Mountain Forest Reserve: such interactions determined the management and use of biodiversity at their disposal. Moreover, understanding of the existence of social structures, networks and power relation within and between actors are the cornerstones for collective and comprehensive strategies and practices for sustainable management and use of biodiversity. Others include respect of other actors' views, perceptions, values and interpretation, such as of the indigenous people, so to reduce conflicts among different actors. This view gets support from Kohornen (2009), who noted that ignoring multiple interests, views and power among actors has been affecting biodiversity conservation initiatives, as most of such initiatives have been mostly based on the biological criteria, making them socially unsustainable and, as such, they have been endangering livelihoods of the indigenous population.

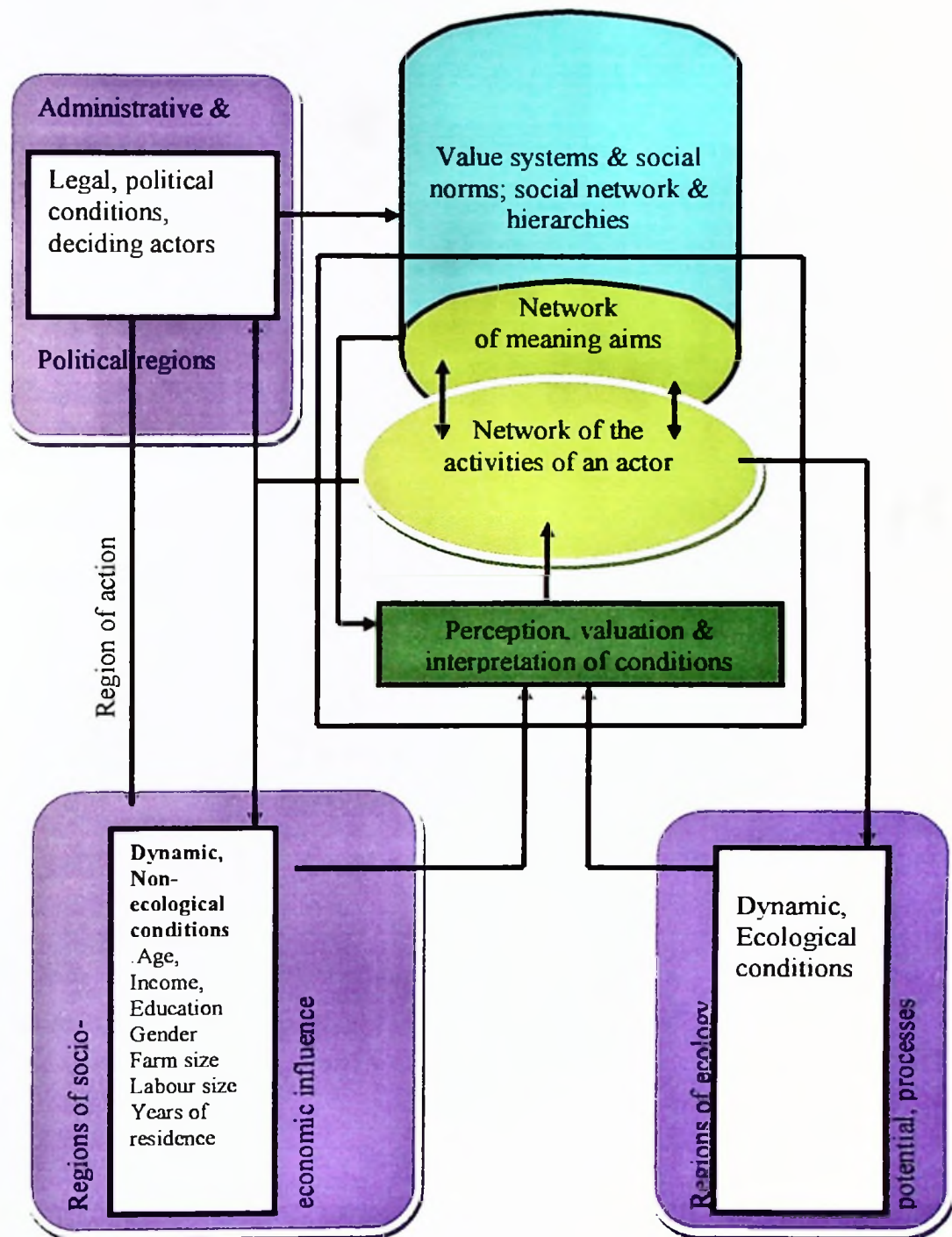


Figure 1: A General Structure of the Actor-oriented Model (Wiesmann, 1998)

The Roba's (2008) Socio-Economic and Ecological Model (SEEM) (Fig. 2) was used to complement the actor-oriented approach, as this model emphasizes on consideration of the diversity of ecological, production patterns, and socio-cultural systems and the use of the IKS for resource assessment and monitoring, particularly, when implementing global

conventions such as the Convention on Biological Diversity (CBD). What the actor-oriented model and SEEM share, is their emphasis on the understanding of actors' views, perceptions and the socio-economic, cultural and political context, just to list a few, within which actors operated: as they determine actors' activities, actions and strategies of aims.

Therefore, while the actor-oriented model was used to examine the influence of demographic and socio-economic factors on different actors, which determine their interaction with their supporting ecosystem, the SEEM was used to examine how demographic and socio-economic characteristics and ecological factors limit integration of the IKS into biodiversity conservation methods in South Nguru Mountain Forest Reserve.

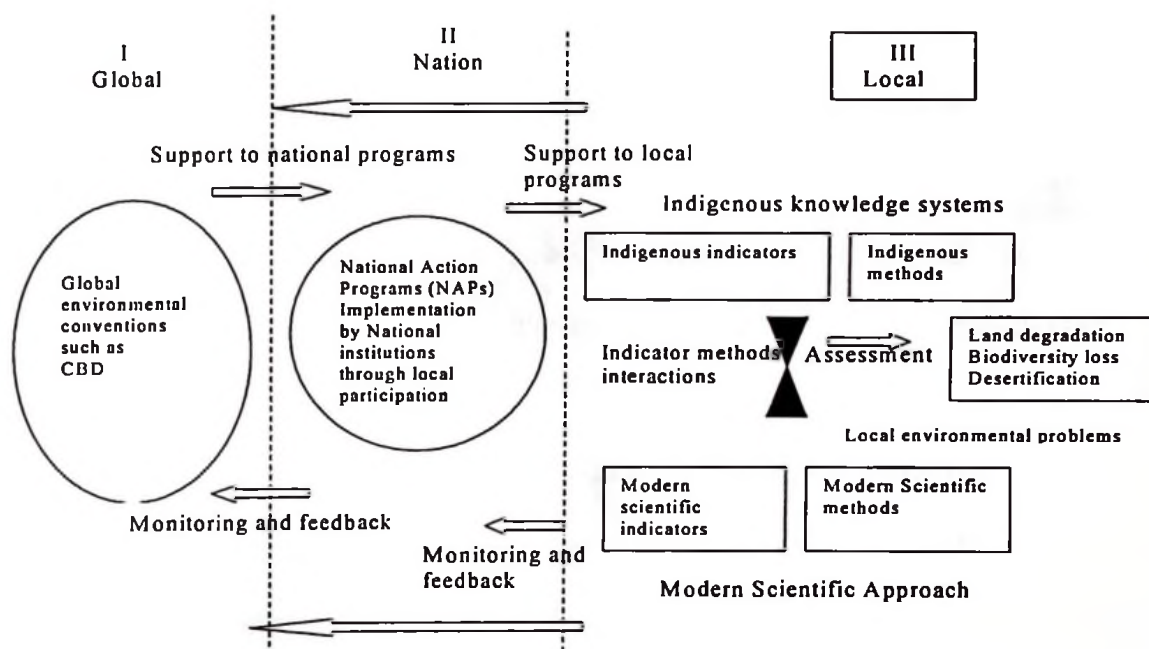


Figure 2: Socio-economic and ecological model (SEEM) for integration of the indigenous knowledge system (Roba, 2008).

Based on ideas from the Actor-oriented approach, SEEM model and from the literature, a conceptual framework (Fig. 3) was hypothesized to guide understanding of the IKS and

factors limiting its integration into biodiversity conservation methods in the South Nguru Mountain Forest Reserve.

1.8 A Conceptual Framework

It is the assumption of this study that integration of the IKS into biodiversity conservation methods in the South Nguru Mountains Forest has been underpinned by demographic and socio-economic characteristics context within which this knowledge system exists.

Several authors such as Ortiz (1999); Rahman (2000) and Sharva (2005) cited in Zazu (2007) argue that while there is informal and ad hoc exchange of knowledge and information between indigenous people and scientists, where the former has been used to enrich technocratic strategies, approaches and activities, such a relationship, at the same time is influenced by socio-economic and political contexts within which they are found. In highlighting on the existence of limited exchange between the IKS and biodiversity conservation methods, Chambers (1993) cited in Kajembe (1994), argued that, despite the synergistic relationships between the indigenous knowledge and biodiversity conservation methods, there are no clear lines of communication that have been effectively opened in either direction. Such limited exchange of information among these synergistic knowledge systems limits meaningful development of these knowledge systems and their integration. Along the same view, Stevenson (2005) further asserted that effective and meaningful integration of the IKS into sustainable management and use of biodiversity will not be realized if the IKS continue to be treated as just some other category of information to be integrated into biodiversity conservation methods without being fully applied in its full meaning, merits and efficacy.

An ad hoc relationship between the IKS and biodiversity conservation methods, whereby, the IKS has been perceived as being valueless, has resulted into the persistence of power struggle among them. Such antagonistic relationship between these knowledge systems has resulted into application of parallel rather than Integrated Methods and Practices (IMP) in dealing with environmental issues such as biodiversity decline. Therefore, while it has been widely argued and emphasized that integration of the IKS and biodiversity conservation methods is an underutilized alternative in dealing with the worldwide challenge of biodiversity decline, lack of such integration of these knowledge systems among other factors, has led to unsustainable management and use of biodiversity. The detailed discussion of the relationships between different variables is covered in Chapter Two of this study.

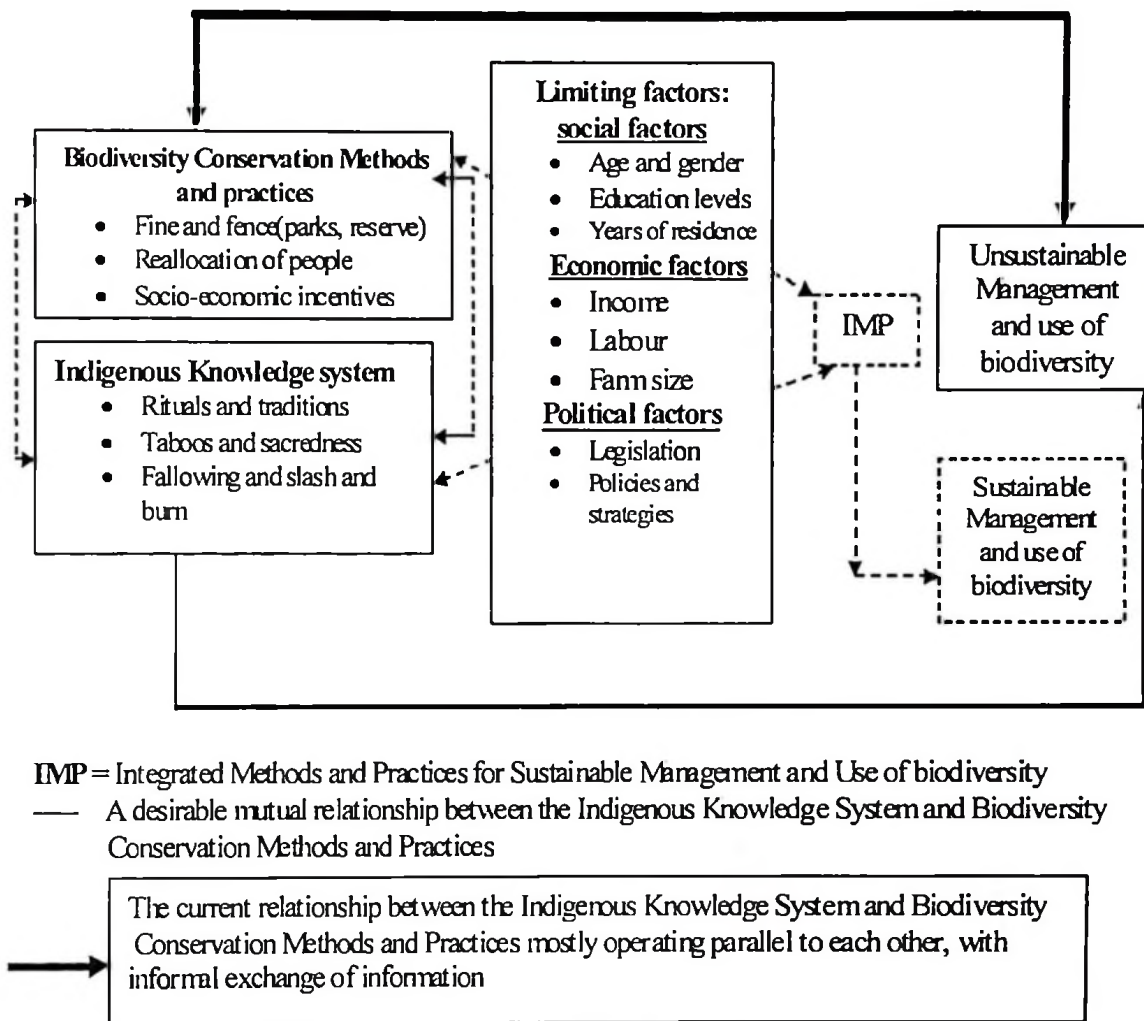


Figure 3: A conceptual Framework Showing Relationship between Variables

1.9 Variables Measured in the Study

The dependent variable of the study was the integration of the IKS into biodiversity conservation methods, whereas as intermediate variable were the IKS and the biodiversity conservation methods. Independent variables were age, education, sex and years of residence. Other factors were household income, farm size and household labour (Table 1).

Table 1: Variables measured by the study

Variables	Indicators/Labels
Dependent variable	
Integration of IKS into biodiversity conservation methods	- The mutual application of both IKS and biodiversity conservation methods that are governed by systematic approaches and strategies for conservation of biodiversity with full consideration of each of these knowledge systems
Intermediate variables	
Indigenous knowledge system	- Refers to any activity and practice that is spiritual and builds into people's culture that has been developed based on one's interaction with his/her environment. i.e. rituals, taboos, indigenous fire control
Biodiversity conservation methods	- In this study biodiversity conservation methods will refer to any activity and practice that is governed by systematic studies and principles and/or western worldview's ideas such as fine and fence, reallocation of people and provision of incentives for conservation of biodiversity, enforced by policies, bylaws.
Independent variables	
Demographic factors	
Age	- Number of years that a person has lived
Sex	- Male or female
Social factors	
Years of residence	- Number of years someone has lived in an area
Education	- Numbers of years in school
Economic factors	
Income	- an average annual household income in Tshs
Household labour	- Number of working people in a household
Farm size	- A household's total farmland measured in acres

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of Key Terms and Concepts

In this study different terms are used in relation to IKS and factors limiting its integration into biodiversity conservation methods. The terms are explained into the context of their use, and therefore the universal acceptance/agreement on definitions of the key terms and concepts is not presumed. The section covers operational definitions of an indigenous person/people; IKS and biodiversity. Others include biodiversity conservation methods, sustainable management and use of biodiversity, unsustainable management and use of biodiversity and integration of IKS into biodiversity conservation methods.

2.1.1 Indigenous person

As it has been difficult in having a common definition of IKS, there have been different perceptions of who is/are an indigenous person/ people. For example, Melchias (2001) cited in Nyong, Adesina and Elasha (2007) identify indigenous people as those who are culturally distinct ethnic groups with a different identity from the national society, derive their livelihood from local resources and are politically non - dominant. Along a similar vein, IFAD (2000) cited in Shreshra *et al.* (2008) further perceived indigenous people as being people with a social and a cultural identity that are distinct from the dominant groups in a society that make them vulnerable to being disadvantaged in development processes.

Eyong (2002) and National Foundation for Development of Indigenous Nationalities (NFDIN) Act of (2002) cited in Shreshtra *et al.* (2008) further asserted that indigenous people are a distinct group of people that have their own tongue, traditional culture,

written and unwritten history, traditional homeland and geographical areas, and egalitarian social structures. Based on the above perceptions on indigenous people, the following generalization can be made. First, indigenous people are people who have lived in an area for a good number of years that they can associate themselves with it, have their own language, culture and beliefs that have been safeguarding their interactions with the supporting ecosystem. Secondly, indigenous people are perceived as being politically and economically disadvantaged compared to other members of the society. Similar to this view, Ocholla (2007) put it that IKS is embedded in the culture and religion of the poor than by the economically provided communities; and it is a social capital of the people, in their struggle for survival (The World Bank 1998 cited in Ocholla, 2007).

In this study therefore, indigenous people refers to people who have lived in the study area for more than 20 years. It is presumed that for a period of 20 years, one could have been exposed and accumulated a reasonable quantity and quality of IKS as a result of his/her interactions with the society that has its own culture and language. This conceptualization of who is an indigenous person concurs with the views of Zamparo (1996), Huntington, (1998), Ellis (2000) and Berkes *et al.* (2000) cited in Tanyanyiwa and Chikwanha (2011), who pointed out that an IKS is a cumulative, collective body of knowledge, experience, and values held by a given society with a history of existence that have been used for safeguarding human interaction with their supporting ecosystem and decision making for a period of more than 20 years. In their study, Kalanda-Sabola *et al.* (2007) considered as person who lived in the study for a period of at least 10 years, as an indigenous person. Similarly, Das Gupta (2011) puts it that for a person to qualify as indigenous, not necessarily being a person who trace his/her origin to such a location, but rather being a long inhabitant of a particular place with intimate understanding of the nature/ecosystem/biodiversity.

2.1.2 Indigenous knowledge system

In this study the term IKS is used interchangeably with Traditional Ecological Knowledge (TEK), Indigenous Environmental Knowledge (IEK), Traditional Knowledge (TK) and Indigenous Technical Knowledge (ITK). Similarly, Oviedo *et al.* (2007) put it that such terms have been used interchangeably to refer to bodies of knowledge that communities have developed on the basis of their own cultures and interactions with their environments.

IKS is basically local knowledge that is unique to a given culture, and is a science that is user-derived, not scientifically derived, and its use complements and enhances the gains made by modern-day innovations (Flavier, and Navarro 1999 cited in Maila and Loubser 2003). In light of a similar view, Flavier *et al.* (1999) cited in Maila and Loubser (2003) and Cobb (2011) consider IKS to be local science derived to meet local needs and challenges, and derived based on both science and spiritual aspects of the people concerned.

Arguing on indigenous system in its broadest sense, Tanyanyiwa and Chikwanha (2011) asserted that IKS is cultural knowledge including all of the social, political, economic and spiritual; kinship, local politics and other factors tied together and influence one another, whereas it's spiritual nature influences how resources are managed and used by the people of that society.

IKS is characterized by being a knowledge-practices-beliefs that is interweaved in social institutions, provide norms and rules, and a worldview that shapes perceptions and provides meaning, viewing humans as being part of the supporting ecosystem rather than a manager, whereas respect for the land and other living organisms is emphasized (Berkes,



et al., 2000; Fernandez-Gimenez, 2000 and Berkes, 2008 cited in Tanyanyiwa and Chikwanha, 2011). Similarly, Zweifel (1997) argued that IKS is less put into practice as a result of biodiversity decline, limiting the teaching and learning from one generation to another. The author also added that, breakdown of indigenous social structures and networks, spearheaded by devaluation of the knowledge system have been further limiting the teaching and learning of the knowledge system.

It is from these views it is argued by the present study that IKS is a knowledge-practices-beliefs, and its learning and teaching to young generations mostly, if not solely, rely on its wide use and application. Based on such a view, it is argued that a household that does not pass on the IKS to its descendants is that which does not practice the same, and factors that influence a wide use and application of the knowledge system are also not only influencing its integration into other knowledge systems but also its teaching and learning, as the knowledge is practices-beliefs based.

IKS is adaptive and dynamic in that it responds to external forces, either resulting into promotion or declination of such knowledge system necessary for conservation of biodiversity (Tanyanyiwa *et al.*, 2011). Moreover, the quality and quantity of IKS varies among indigenous people of the same community according to sex, age, social class and other disparities in power relations (Sillitoe, 2002 cited in Roba, 2008), such as intellectual capability and profession (Ylhäisi, 2006; McGregor, 2004).

From the above views on IKS, in this study IKS refers to a body of knowledge that has been generated, tested, improved over time through human interactions with their supporting ecosystem and that has been enhancing and has been safeguarded by norms, values, taboos, rituals and sacredness, that is interweaved within the context of local

politics, spiritual, demographic and socio-economic characteristics of the people concerned. Furthermore, an IKS is adaptive and dynamic to external forces, such as social, economic, environmental and political forces.

2.1.3 Biodiversity and biodiversity monitoring

The term biodiversity is the shortened form for biological diversity and it has been defined in various ways depending on user's agenda. Charnley, Fischer and Jones, (2007) asserted that the term biodiversity has been perceived and conceptualized differently by different people, resulting into conflicts among different stakeholders on goals and means for its conservation.

According to Wilfred, Madoffe and Luoga (2007), biodiversity is a variety of life forms (animals, plants and micro-organisms), ecosystems and the ecological process in which these components are interacting. In further broadening the meaning of the term biodiversity, American Indians consider biodiversity as being a reciprocal relationship between human and non-human entities that include plants, animals, minerals; the concepts that also include spiritual consciousness of the people concerned on such a relationship (Kimmerer, 2002). This implies that for indigenous people such as American Indians, biodiversity is synonymous to a scientific view of ecosystem with spiritual value attached to it.

In this study biodiversity is perceived as abundance and number of different species of wild species of plants and animals and the non-living organisms in a given geographic area, living in spiritual and reciprocal relationships between the living and the non-living things, whereas humans are perceived as being part and parcel of the supporting ecosystem.

In this study all the discussions around the abundance and number of wild species of plants and animals (biodiversity) will be based on indigenous monitoring system. Along a similar view, Roba (2008) emphasized on the use of IKS on resource monitoring and assessment in implementing global conventions, such as Convention on Biological Diversity (CBD). Several authors on IKS such as Berkes *et al.* (2004); Pearce (2003); Moller (2004) and Smith *et al.* (2007) cited in Cobb (2011) also underscore the use of empirical knowledge systems in wildlife harvesting and monitoring of vegetation.

Indigenous knowledge monitoring system, the land history and the past experiences are used as a baseline for comparing current changes that have been attributed to humans interaction with their environment (Roba, 2008), as well as causes and magnitude of such changes (Hughes, 2001 cited in Roba, 2008). For example, local vegetation has been used to monitor change in plant species composition (Bolling and Schutle, 1999; Mapinduzi *et al.*, 2003; Gemedo *et al.*, 2006 cited in Roba, 2008), whereas there have been continuous monitoring of the abundance and number of wild species of animals in a given geographic area. For example, in his study in Amazon Mountains of Ecuador, Holt (2005) found that Huaorini residents who are indigenous people in Amazon mountains claimed that in 20 years to come there will be a problem of game, as a result of rapid population increases whereby some animals species such as preceary and monkeys are going to become hunted a bit, “Pacas” and “Agonti “ are going to tolerate the pressure more, while ‘trumpeters’ and “guans” are going to disappear more quickly.

Similarly, Nadasdy (1999), Larochelle and Berkes (2003), Moller (2004) and Berkes (2004) cited in Tanyanyiwa and Chikwanha (2011) put it that in the course of continuous observations indigenous people apply thorough counting and monitoring techniques to understand species dynamics, which is very similar to ecological monitoring in what is

regarded as scientific approach. One of the eminent examples to cite is that reported by Quaye (2005) who found that apart from indigenous monitoring system, indigenous people were also able to recognize plant species on the basis of their morphological, ecological, agronomical, and even culinary characteristics, results that showed IKS to be more detailed than Linnaean system of plants identification.

From the above argumentations and evidences, in this study all issues related to the abundance, number and change of biodiversity will be based on indigenous monitoring system that commonly relies on sustainable observations of the abundance, number and the distribution of wild species of plants and animals. It is therefore argued that the use of indigenous knowledge monitoring system will add extra information, as the monitoring system is broader as it includes other aspects such as spiritual and mythical values of the supporting ecosystem.

2.1.4 Biodiversity conservation methods

In this study biodiversity conservation methods refer to all forms of rules and regulations that are derived from the scientifically derived approaches, and that perceive human beings as managers and not part and parcel of the broader ecosystem. In light of the same view, Adams and Mulligan (2003) cited in Vihemäki (2009), argued that the western conservation still remained preservationist, separating humans and nature, and classify species diversity as being hierarchical, with different levels of sophistication and humans being perceived as distinct and superior to other species (Anis, 1994 cited in Mokuku and Mokuku, 2004).

Biodiversity conservation methods tend to be driven by theoretical models that are governed by testing of hypotheses and not necessarily utilitarian, often generalizable and

not always location-specific (Charnley, Fischer and Jones, 2007), while IKS is mainly based on one's experience (Ellis, 2000). In further differentiating between biodiversity conservation methods and IKS Jostad *et al.* (1996) cited in Charnley, Fischer and Jones, (2007) and Berkes (2008) cited in Tanyanyiwa and Chikwanha (2011) argued that while biodiversity conservation methods tend to consider humans as being managers and superior to other living and non-living organisms, IKS consider humans as being part and parcel of the supporting ecosystems and each of the ecosystem components, including humans are interconnected and affect one another, and therefore deserve equal valuation.

It is from the above elaborations, this study considers biodiversity conservation methods as all scientific principles, strategies and approaches such as conventions, government policies, strategies, rules and regulations that altogether govern humans' interaction with their livelihoods' supporting ecosystem.

2.1.5 Sustainable and unsustainable management and use of biodiversity

The term sustainable management and use of biodiversity has been perceived and defined differently among people based on their different worldviews and agenda. Such differences in perception have resulted in different approaches and strategies to achieve the same. In light of this, most of biodiversity conservation methods still remained preservationist, believing that sustainable management and use of biodiversity can mostly be achieved through preventing humans from using the available biospheres (Adams and Mulligan, 2003 cited in Vihemäki, 2009). In contrast, indigenous people believe that natural resources should be used within their regeneration capacity (Charnley, Fischer and Jones, 2007), as a way of honouring the earth's god's gifts and if not used they will not be offered again (Jostad *et al.*, 1996 cited in Charnley, Fischer and Jones, 2007).

According to Encyclopaedia Britannica (2007) cited in Tui (2007), sustainable management and use of biodiversity is humans' use of the biodiversity in such a way that it yields the greatest sustainable benefit to the present generation, while maintaining its potential to meet the needs and aspirations of the future generations. Although in her study McGregor (2004) found that indigenous people in their own language (Ojibway language) had no single word to mean sustainable management and use of biodiversity they simply believe that there should be a mutual taking and giving back to nature for the benefit of all components of the supporting ecosystem, and such duty is for each of the creation from the tiniest animals to the powerful sun and the spirits. This implies that according to IKS, sustainable management and use of biodiversity can be realized if all the creations are equally and actively involved in the process of achieving the same with reciprocal benefits of the process.

Therefore in this study sustainable management and use of biodiversity simply means management of humans' interactions with the various forms of ecosystems such as wild species of plants and animals and non-living things to ensure there is a reciprocal taking and giving back to nature so as to meet the needs and aspirations of the present and future generations of all creations, whereas such practices and activities are obligatory to all the creations in a spiritual context of the supporting ecosystem.

In this study, the term unsustainable management and use of biodiversity means the opposite of the above conceptualization of sustainable management and use of biodiversity. Therefore, while sustainable management and use of biodiversity refers to a mutual relationship so as to meet the needs and aspirations of the present and future generations of all creations, whereas such practices and activities are obligatory to all the creations in a spiritual context of the supporting ecosystem, unsustainable management

and use of biodiversity implies unequal interactions of humans with the various forms of ecosystems such as wild species of plants, animals and living, and non-living things where there is excessive taking than giving back to nature and where human beings are elevated over other creations and being considered as a manager rather than a part and parcel of the supporting ecosystem, resulting with increasing decline of biodiversity.

2.1.6 Integration of indigenous knowledge system into biodiversity conservation methods

Different terms such as co-management, joint management and participatory management have been used in elaborations of the so perceived active inclusion of different actors such as indigenous people and their knowledge systems to achieve a desired goal. As a matter of fact, Ellis (2000) eloquently put it that formulation of collaborative rules and regulations among indigenous people and the western based professional is not a justification for the integration of IKS, as the problem of power imbalance between indigenous people and the scientists has limited meaningful participation of indigenous people and their knowledge systems.

According to Tanyanyiwa and Chikwanha (2011) integration of IKS is a process of blending IKS with other forms of knowledge systems such as biodiversity conservation methods, resulting into rational decision making, sharing of information and understanding of different viewpoints between the indigenous communities and the scientifically trained technicians (Roba, 2008). Moreover, integration of IKS into biodiversity conservation methods should insist on active participation of indigenous people and their knowledge, while insisting on equal sharing of power and responsibilities between the government and the indigenous people (Berkes, 2007 and Berkes *et al.*, 2007 cited in Cobb, 2011).

In this study therefore, integration of IKSs into biodiversity conservation methods means a reciprocal wide use and application of both IKS and biodiversity conservation methods without any form of subordination, such as the use scientific approaches to validate of the IKS.

2.2 Indigenous Knowledge System and Conservation of Biodiversity

To date, some professionals still do not appreciate the significance of IKS on sustainable development, and that is why most initiatives have been relying on formal scientific knowledge (Bisong and Andrew- Essien, 2010), biodiversity conservation initiatives being among such initiatives. Moreover, despite several worldwide examples of the significance of IKS on conservation of biodiversity (Berkes, 2000; Berkes *et al.*, 1994, Minnis and Elisen, 2000, Peacock and Turner, 2000, Carson and Maffi, 2004, Anderson, 2005 cited in Charnley, Fischer and Jones, 2007; Kideghesho, 2009; Mutta, *et al.*; 2009; Darr, Pretzsch and Dresden, 2009), and notable geographical overlap between the world's biodiversity and cultural diversity hotspots (UNESCO, 2007; Shresthra *et al.*, 2008), consideration of such knowledge system being whether conservational/or not is increasingly debatable.

Opponents of the significance of the IKS argue that, for any practice to be considered as conservational, such practice has to be intended for such conservation activities (Alvard, 1998 cited in Kideghesho, 2008). So being conservational is both a practice and an ideology (Cunha and Amelada, 2000 cited in Kideghesho, 2009). For example, Saj, Martha and Sicotte (2006); Alvard (1998); Mwihomeke *et al.* (1998); Lean (2006) and WWF (2006) cited in Kideghesho (2008), maintain that, although sacred groves and forests and taboos have contributed to conservation of biodiversity, they cannot be considered as conservational as they were not intended for such conservation.

Using examples of bush pig (*Potamochoerus spp*) and warthogs (*Phacochoerus aethiopicus*), Kideghesho (2008) argued that although prohibitions of the above animals by the modern religions reduce their demand, such a situation cannot be considered conservational as believers of these religions have of no concern for these animal species, as they are considered unclean, and such taboos and religions have goals other than conservation. It is worth noting that though Kidegesho used an example of modern religions showing that for a practice to be considered conservational it must include both an ideological aspect and conservation activities, modern religions are not IKS, and have actually been contributing to the decline of the same. For example, Kweka (2004) and Tui (2007) found that modern religions have been significantly contributing to decline of ritual activities that have been fostering conservation of biodiversity.

On the other side of the coin, proponents of IKS as being conservational, such as Berkes *et al.* (2000) cited in Tanyanyiwa and Chikwanha (2011) argued that the practice of conserving biodiversity should not necessarily be the objective of such a practice but a consequence of it, and therefore, any practice that contributes to conservation of biodiversity whether such a practice has a conservation ideology or not, is conservational.

Another important but often neglected reality is that IKS is a bundle of knowledge that has been developed over time through human interactions with nature and interweaved within local politics; social, spiritual, economic and environmental aspects with each one affecting the other, and capturing a single aspect of IKS is almost impossible (Roberts 1996 cited in McGregor, 2004), and therefore it has to be understood in its wholeness (McGregor, 2004). For example, in their studies Mwale and Malekano (2000) cited in Kalanda-Sabola *et al.* (2007) found that chiefs were restricting over-fishing to avoid degradation and to conserve fish for future generations and such indigenous regulations

included freeing surplus fish during spawning migration and during spawning seasons people were restricted from fishing. The authors further found that expulsion from the village was used to enforce such taboos, showing enhancements of several aspects of IKS that otherwise cannot be compartmentalized.

A similar study by Kideghesho (2008) found that indigenous conservation regulations such as hunting of adult and male animals and restriction of hunting wild animals during breeding seasons have been contributing to conservation of biodiversity. This implies that IKS such as taboos on restrictions of fishing during spawning season; hunting of adult males and not hunting during breeding seasons involve both a conservation ideology and a practice that is why they have been imposed during a specific period of time and/or on specific sex of animals.

Effectiveness of IKS on conservation depends on the enforcement among components of the knowledge system, and therefore separation of the spiritual aspect of IKS from the matter, of the religion from knowledge and of culture from nature is not accepted as IKS philosophy is holistic in nature (Nakashima and Marie, 2002). For example, a study in Northern Ghana found that for indigenous people gods, spirits, ancestors, spiritual and indigenous leaders, sacred groves, lands, shrines, ritual crops and animals, food items and cash crops are all interrelated, forming a bundle of a specific IKS (Millar, 1993 cited in Millar, 2004), the knowledge system that determine people interaction with their supporting ecosystem.

Based in the above argumentations and findings this study argues that IKS is conservation based on its wholeness and in its indigenous worldview of nature. Similar view was also put forward by Kideghesho (2008) who argued that whether the traditional and mythical

values are conservation-oriented or not their influence on conservation of biodiversity should not be ignored as what matters is the success of whatever system is used, and at this era of biodiversity decline, arguing whether indigenous people and their knowledge system is conservational or not rather than fostering them is pointless (Holt, 2005; Kalanda-Sabola *et al.*, 2007).

2.3 Synergy between Indigenous Knowledge System and Biodiversity Conservation

Methods

According to Chambers (1983) both scientists and indigenous people managed to propagate yams that are normally vegetative, by seeds with first generations being smaller, while other generations were of the same size, each using their own means. Similarly, ICSU (2002) reported that many species new to science have been pointed out by indigenous people knowledgeable on flora and fauna of their environment.

Synergistic relationship between IKS and biodiversity conservation methods are well documented. For example, a study carried out in Xishuangbanna Southwest China from 1993 to 1999 revealed that reduction of taboo practices resulted in the decline in revered plant species, despite legislation for their conservation (Hongmao *et al.*, 2003 cited in Nganje, 2009). Similar findings were reported by Nganje (2009) in his study carried out around the Ankassa, Bia and Kakum forest conservation areas in Ghana which revealed that neither conventional forest management nor taboos alone can conserve elephants and forests, but rather their combination can achieve what neither can alone. Similarly, Stevenson (2005); Fitzgerald *et al.* (2009) and Cobb (2011) insisted that IKS and biodiversity conservation methods are complementing each other on their strengths and weaknesses and their integration would achieve more than neither in their separation.

their strengths and weaknesses and their integration would achieve more than neither in their separation.

Both IKS and biodiversity conservation methods share some common sources of understanding, as they both rely on direct observation, experience, experimentation and interpretation, and what the later has to offer that IKS lacks is a broader appreciation of the context beyond the local level (“one size fits all” ideology) that may actually favour local sustainability (Becker and Ghimire, 2003). In favour of this view, Hens (2006) persuasively argued that both scientific and IKS are closer and synergistic to each other than hardliners of both sides would like to believe.

Therefore, with no doubt it can be argued that IKS and biodiversity conservation methods are synergistic and complement each other on their strengths and weaknesses, and their integration will achieve what cannot be achieved by either in their separation. It is from this reality it has been widely argued that developmental challenges that the planet is facing today, among other factors have been a result of the dominance of scientific approaches and strategies, such as those of conservation of biodiversity, whereas IKS has been excluded from the realm of the practices.

2.4 Integration of Indigenous Knowledge System into other Knowledge Systems: A Theoretical Process

In a discussion on integration of IKSs, Tanyanyiwa and Chikwanha (2011) argued that as IKS is continuously changing and adaptive to context changes, such adaptability characteristics can be capitalized to facilitate its integration into other forms of knowledge systems.

Of recent, there have been propositions of several theoretical models and processes for the integration of IKS into other knowledge systems. For example, Ossai (2010) in his study on the integration of IKS into Information Communication Technology (ICT) proposed six steps that include recognition and identification of the IKS, validation and recording and documentation. Others include storage in retrievable repositories, transfer and dissemination. Contrary to the view of Ossai (2010), with reference to the integration of IKS into climate change discourse, Cobb (2011) proposed four steps that include documentation, valuing, stewardship and co-management and discourse.

From the above processes of IKS integration, a four Cobb's stages of IKS integration are adopted by this study based on the following reasons. Firstly, validation of IKS using scientific approaches is highly criticized, as these knowledge systems are originating from different worldviews, having different principles and each is a complete knowledge on its own and therefore validating one of them using the other knowledge's methods and approaches is unacceptable. According to Ossai (2010) validation process involves an assessment of indigenous system knowledge's significance and relevance, functionality, effectiveness and transferability of such knowledge system. Based on wholeness of IKS that include, but not limited to, indigenous legal systems, norms, values, beliefs, sacredness, rituals, just to name a few, Robert (1996) cited in McGregor (2004), argued that a meaningful validation of IKS in its wholeness is almost impossible.

Arguing against the validation of IKS using scientific approaches and methods, Maila and Loubser (2003) persuasively put it that illiterate people are illiterate based on the scientific standard of evaluating their knowing, but based on indigenous standards, indigenous people are also intellectuals in their own worldview of knowing and doing, and that is why

several intellectuals and academics do consult traditional healers who, it is assumed, are illiterate according to scientific standards (Ntuli, 1999 cited in Maila and Loubser 2003).

Secondly, according to Ossai (2010) transferability of a knowledge system beyond its area of origin is one of the prerequisites for meaningful integration into other knowledge systems. Contrary to the view of Ossai view, it has been widely accepted that IKS is location-specific and the same IKS cannot effectively and meaningfully be applied in a different socio-economic and cultural context, as the knowledge is a product and part of human interactions with their supporting ecosystem. For example, Thrup (1989) cited in Tanyanyiwa and Chikwanha (2011) very clearly pointed out that IKS that was adopted in a particular environment becomes inappropriate in a drastically changed environment, implying that IKS can only be meaningfully transferable in the same or similar context from which that knowledge system has evolved.

Contrary to his own view, on transferability of IKS as a prerequisite for its integration into other forms of knowledge systems, Ossai, (2010) also pointed out that IKS is rooted in particular cultural traditions, and transferring it to other places could result into dislocation of the same knowledge system. This suggests that as IKS being a knowledge that is generated as a result of human interactions with their supporting ecosystem, any knowledge integration initiative should be designed to match with the context within which such knowledge evolved, and such integrated knowledge system should be applied in a specific location rather than be “one size fits all methods.

It is from the above argumentations and with the support from other researchers and scholars on IKS, a Cobb's four steps of integrating IKS is adapted by this study to guide the discussion around indigenous knowledge integration process.

Step one: Documentation

Documentation of IKS in a way that captures both empirical and ecological elements, while retaining the evolutionary and adaptive nature of these knowledge systems is an important asset for its integration with other knowledge systems (Msuya, 2007; Ossai, 2010; Cobb, 2011). For example, it is argued that documentation of IKS will motivate wide use, application and easy integration of such knowledge system into other forms of knowledge systems (Msuya, 2007 and Shresha *et al.*, 2008).

Lack of documentation has been contributing to the decline of IKS, as elders die without passing on their knowledge system to their grandchildren (Ellis, 2000; Kalanda-Sabola, *et al.*, 2007), threatening its wide use, application and its integration into other forms of knowledge systems (Msuya, 2007). However, documentation of IKS using signs and codes that are used in documentation of scientific methods is not effective (Beckes and Ghimire, 2003), as IKS is normally gained and easily understood orally, and such documentation may weaken the social process of teaching and learning of the knowledge system (Gupta, 1994 cited in Zazu, 2007).

Based on holistic and interweaved nature of IKS that include taboos, beliefs, sacredness, myth, indigenous politics and gods, just to name a few, will further complicate the documentation process, a situation that might lead to distortion of indigenous knowledge learning process. A similar view was put forward by Holt (2005) who found that the use of modern communication facilities, formally controlled learning and teaching environments and the use of foreign languages further limited meaningful sharing of information between indigenous people and the so called “scientists”, and that is why in most cases indigenous people have been failing to report back to their fellow community members on what issues were discussed in co-management meetings.

It is from the above arguments this study argues that despite the importance of continuous documentation of IKS, such documentation should be highly and critically scrutinized, as such documentation might lead to further distortion of the knowledge system considering the wholeness of the knowledge system. In such a situation, rather than aiming at documentation of IKS, promotion of such knowledge system using its indigenous ways of teaching and learning has to be adopted, as such promotion will consider both teaching and learning contexts and processes of IKS. Along a similar vein, Rahman (2000) asserted that the amount of IKS expressed by indigenous people in words and numbers represents just a fraction of their knowledge, implying documentation using scientific codes and signs will capture only such a fraction, leading into further decline of the knowledge system.

Step Two: Valuing Indigenous Knowledge System

It has been widely connoted that equal valuation of indigenous knowledge will increase its wide use, application and therefore its integration into other forms of knowledge systems, as stigmatization has significantly caused its decline (Cobb, 2011). For example, equating IKS with witchcraft, poverty, primitiveness, pagan and the like, has prompted abandonment of IKS by its custodians in favour of technocratic approaches in conservation of biodiversity.

Using the term “self-validating reductionism” Le Roux (1999) cited in Zazu (2007) argued that integration of IKS suffers the setback of indigenous people themselves not accepting usefulness of their own knowledge system as a result of their knowledge being labelled valueless by colonial systems, leading into decline in its use and application.

In highlighting the relationship between wide use, application and integration of IKS, several studies revealed that integration of IKS with other knowledge systems has been undermined by the increasing decline of IKS (Zazu, 2007; Ocholla, 2007 and Reid *et al.*, 2004; Chirwa, 1996 cited in Kalanda-Sabola *et al.*, 2007). Similarly, Ellis (2000) in his study found that integration of IKS into formal environmental decision-making has been possible in such territories where indigenous people form a majority of the population and maintain close relationship with their traditional land and their knowledge system. This implies that the more the knowledge is applied and used, the more the knowledge grows and become available for its integration.

From the above findings and argumentations this study argues that equal valuation of IKS as a complete body of knowledge system will stimulate wide use, application and its integration into other forms of knowledge systems.

Step Three: Stewardship and Co-management

Sharing of power and benefits has been one of the worldwide agenda between indigenous people and other potential actors. For example, Article 8(j) of the Rio CBD of 1992 insisted on equitable sharing of the benefits accrued from utilization of IKS.

Unequal power relations between indigenous people and land managers (scientists) has been undermining integration of the knowledge system into other knowledge systems (Chapekie, 1995; Lukey, 1995; Stevenson, 1997 cited in McGregor, 2004; McGregor 2004; Ossai, 2010; Nadasdy, 1999 cited in Cobb, 2011), as such power imbalance has fostered rejection of the IKS, its transformation and its integration with ways of knowing and doing and a meaningful sharing of information between these potential stakeholders (Ellis, 2000). Moreover, power imbalance between indigenous people and non-indigenous

people has been limiting, and ultimately undermining integration of these knowledge systems (Ellis, 2000).

IKS conforms very well with the philosophy of knowledge integration that advocates for sharing of power, responsibilities, rights and duties between indigenous people and other potentials actors, whereas this capital can effectively be utilized to facilitate integration of this knowledge system into other knowledge systems (Msuya and Kideghesho, 2009 and Berkes, 2003 cited in Cobb, 2011).

This study argues that equal respect, acceptability and applicability of IKS with mutual benefits with other forms of knowledge systems such biodiversity conservation methods, is a necessary pre-requisite for prosperity of IKS and ultimately for its integration into other knowledge systems.

Step Four: Discourse

Creation of public awareness on the significance of IKS is a cornerstone for its integration into other forms of knowledge systems (Cobb, 2011). As the IKS has been considered valueless and equated with primitiveness, backwardness, archaic, paganism and barbaric, and a community or a person mostly relying on such knowledge system as being inferior to those who practice the opposite, have been other factors limiting its wide use, application and its integration into other forms of knowledge systems (Reid *et al.*, 2004 cited in Kalanda-Sabola *et al.*, 2007; Ocholla, 2007 and Zazu, 2007). In such a reality, public awareness is necessary to change people's attitudes and perceptions on the significance of IKS, as the knowledge has been negatively labelled (Cobb, 2011), leading into its decline.

Several studies revealed that factors that have undermined wide use and application of IKS are also responsible for limiting its integration into other knowledge systems (Egneus *et al.*, 2000 cited in Knutsson, 2006; Charnley, Fischer and Jones, 2007; Ocholla, 2007; Darr, Pretzsch and Dresden, 2009; Ossai, 2010; Cobb, 2011). Arguably, in a society in which, IKS is widely used and applied normally has an indigenous social solidarity, within which the knowledge system is interwoven. In such a situation, effective adoption of new knowledge system, such as the scientific knowledge will effectively and successfully be through such a social solidarity, otherwise, it would result into several conflicts among these knowledge systems. Such a process of introducing the scientific knowledge system if it observes the above four steps of knowledge integration; such integration is more likely to be realized. This implies that integration of IKS into other forms of knowledge systems is more likely to be a success in a situation whereby IKS is recognized, widely used and applied and there is a reciprocal relationship among potential actors with no one knowledge system being elevated over other.

2.5 Status of Research on Indigenous Knowledge System and on its Integration into Biodiversity Conservation Methods

Emphasis on the importance of integrating IKS into development and conservation projects started since 1970s, as a result of increasing awareness of the value of the knowledge system on biodiversity conservation (Mercer, *et al*; 2009). However, despite the increased awareness on the value of IKS, most of worldwide studies on IKS have mainly focused on the documentation of the significance of IKS for conservation of biodiversity (Warren, 1992; Berkes, 1993; Kajembe, 1994; Boaten, 1998; Mbwapbo, 2000; Kweka, 2004; Mokuku and Mokuku, 2004; Steiner and Oviedo, 2004 cited in Hens, 2006; Stevenson, 2005; Nganje, 2006; Kalanda-Sabola, 2007; Kideghesho, 2008).

Most of the studies on IKS have been dealing with empirical evidence of the knowledge system (Briggs, 2005; Mercer *et al.*, 2009; Bonny and Berkes, 2008 cited in Cobb, 2011), in wildlife harvesting (Moller, 2004, Berkes *et al.*, 2004 and Smith *et al.*, 2007 cited in Cobbs, 2011) and vegetation monitoring (Berkes, 1998; Kislalioglu *et al.*, 1998, LaRochelle and Berkes, 2003; Garibaldi and Tunner, 2004 cited in Cobb, 2011).

Compounding on the orientation of studies on IKS, several scholars and researchers such as Briggs (2005) and Gadgil and Berkes (1991); Berkes (2001); Long (2003); Watson (2003); Alessa *et al.* (2003); Tecle *et al.* (2004); Davidson-Hunt (2006); Berkes and Davidson-Hunt (2006); Parless (2006); Berkes, (2007); Berkes *et al.* (2007); Marie (2009) and Sibelet *et al.* (2009) cited in Cobb (2011) have argued that most of the research on IKS has concentrated on environmental management.

Narrow scope of studies on IKS beyond their significance to the conservation of biodiversity to their integration into biodiversity conservation methods might have been a result of the negative perceptions of most studies on IKS and economic returns to be accrued from those studies. Arguing along a similar view, Tanyanyiwa and Chikwanha (2011) in their study revealed that personal discrimination has been leading to perception that IKS not being considered as fundamental compared to other forms of knowledge systems, and that is why IKS has been accorded low status assumed to belong to a particular racial or ethnic group that lacks the necessary cultural capital (Maila and Loubser 2003).

Quite recently, while there has been concern among researchers on integration of IKS into biodiversity conservation methods, there have been very few studies on integration of these knowledge systems (Ortiz, 1999; Higgins, 2000; Becker and Ghimire 2003; Kelsey,

2003; Rahman, 2000; Dahl, 2002 cited in Hens, 2006; Ballard, Fernandez-Gimenez and Sturtevant, 2008; Gadgon and Berteaux, 2009) in this paradigm. However, none of these studies focused on integration of IKS into biodiversity conservation methods at large or on socio-economic and political factors undermining such integration, but have been mainly concerned with conservation of specific individual wild species of either flora or fauna and/or focusing on the significance of a single aspect of IKS, such as indigenous institutions, taboo, sacredness just to list a few, on conservation of biodiversity.

Arguing on scope of most of studies on IKS, Dekens (2007a) cited in Mercer *et al.* (2009) argued that while in theory the importance of integrating IKS has been internationally recognized, generally such integration occurs on a small scale within indigenous communities. Moreover, most of the studies on IKS have been focusing on the content of the knowledge system (Briggs, 2005; Mercer *et al.*, 2009), at the expense of economic and socio-cultural contexts of such knowledge system that have been thought of lesser importance (Briggs, 2005). Furthermore, to the body of knowledge there have been no such kinds of studies on the South Nguru Mountain Forest Reserve.

2.6 Synthesis of Literature Review

The review of literature has shown that IKS is a body of knowledge that has been generated, tested, improved over time through human interactions with their supporting ecosystem and that has been enhanced and safeguarded by norms, values, taboos, rituals and sacredness, that is interweaved within the context of local political and spiritual values, each of the components being enforced by the other. The literature demonstrates that IKS is adaptive and dynamic in that it responds to external forces, either resulting into promotion or decline of such knowledge system necessary for conservation of biodiversity. Moreover, the quality and quantity of IKS varies among indigenous people of

the same communities by the sex, age, social classes and other disparities in power relations intellectual capability and formal education levels.

The review of literature has shown that IKS and biodiversity conservation methods are synergistic and complementary to each other on their strengths and weaknesses on addressing the problem of biodiversity decline, and their integration will achieve what cannot be achieved by either in their separation. Furthermore, the literature has shown that the existing problem of increasing biodiversity decline has been prompted by the exclusion of the IKS in conservation of biodiversity, as the knowledge has been considered primitive, barbaric and valueless.

The literature has shown that despite integration of IKS into biodiversity conservation methods having received global political emphasis, such as the Rio CBD of 1992, emphasis on respecting, preservation, wide use, application and mutual sharing of benefits among stakeholders, IKS has remained excluded from the realm of the practices. Moreover, from the literature it was revealed that despite global recognition of IKS in conservation of biodiversity, lack of government rules and regulations and political commitment that could otherwise foster the IKS and facilitate its integration into biodiversity conservation has led to increasing biodiversity decline that the world is experiencing currently.

Imposition of unfavourable policies has threatened the viability of IKS and implementation of IKS and scientific knowledge system with diverse environments and its integration into biodiversity conservation methods. Moreover, the literature review has revealed that the survival, flourishing and integration of IKS into biodiversity conservation methods rests on the presence and application of appropriate government policies and

strategies at all levels that consider cultural and spiritual values of the ecosystems from which the IKS evolved, is enhanced and sustained with active participation of potential stakeholders.

Literature has further shown that most studies have been concentrating on documentation of the IKS, and mostly in the field of medicines, and therefore, very little is known about factors limiting integration of IKS into biodiversity conservation methods. It is from the literature, using South Nguru Mountain Forest Reserve as a case, this study aimed at documenting the IKS and demographic and demographic and socio-economic factors limiting integration of the knowledge system into biodiversity conservation methods.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of the Study Area

This section describes the geographical location of the study area, its climatic conditions, biodiversity status of the South Nguru Mountain Forest Reserve and socio-economic characteristics of the villages bordering the forest reserve.

3.1.1 Geographical characteristics of the study area

The South Nguru Mountain Forests Reserve (Fig. 4) is situated roughly at the centre of the Eastern Arc Mountain chain of Tanzania, lying between S 05° 53 S - S 06° 17 and E 037° 27 - E 037° 45 in Mvomero District, Morogoro Region. The Mountain covers an area of 184 km² (DIIS, 2007), with an altitude ranging between 760 and 2400 meters above sea level (Menegon, Doggart and Owen, 2008).

3.1.2 Climatic conditions of the study area

The estimated rainfall in South Nguru Mountains is around 2000 mm per annum with an increase of up to 3000 – 4000 mm at 2000 meters above sea level (Lovett and Pocs, 1993 cited in Menegon, Doggart and Owen, 2008). According to PEMA (2003) cited in DIIS (2007), the South Nguru Mountain Forest Reserve has a bimodal rainfall with a quantity of 1200 mm – 4000 mm on the eastern and south eastern side, while the western and north western part is slightly drier with rainfall ranging between 800 and 2100 mm per annum.

The climate of the South Nguru Mountain Forest Reserve is influenced by the Indian Ocean, having rainfall almost throughout the year with the driest period being between

June, July and August with highest rainfall in March and April (TFCG, 2007). The authors further point out that the mean annual temperatures vary with the attitude from 24° C to 12° C, with temperature falling close to 0° C in higher altitudes in July and August.

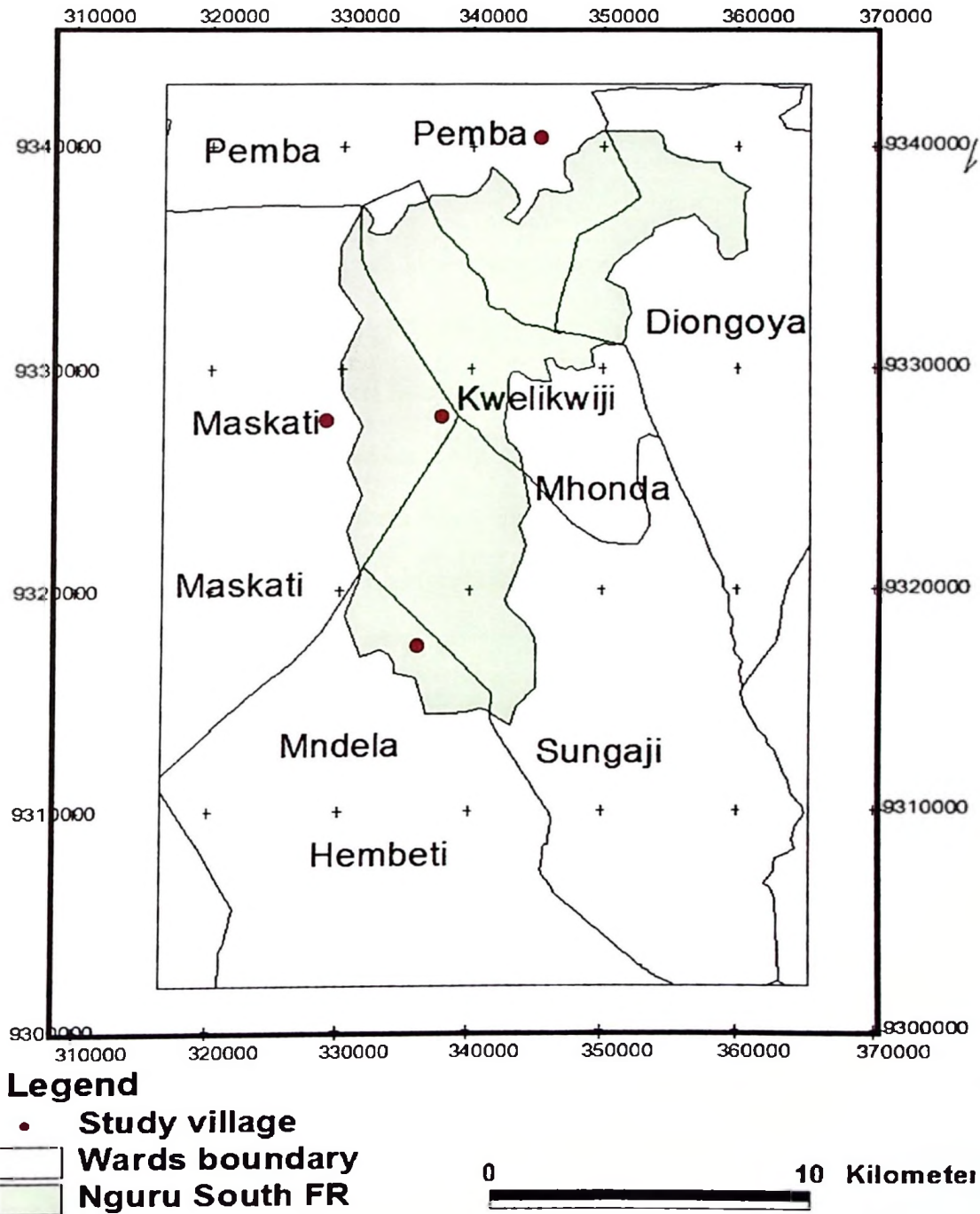


Figure 4: A Map Showing Location of the Study Villages

3.1.3 Biodiversity values of the South Nguru Mountain Forest Reserve

The South Nguru Mountain Forest Reserve is part of the Eastern Arc Mountains forests known for being one of the world's biodiversity hotspots (Mittermeir *et al.* 2004 cited in Menegon, Doggart and Owen, 2008). As a matter of fact, the South Nguru Mountain Forest Reserve possesses many rare species, although the actual biodiversity richness of these Mountains is poorly known (DIIS, 2007; Burgess *et al.*, 2007; Lovett and Thomas 1998 cited in Menegon, Doggart and Owen, 2008).

A recent study reported that South Nguru Mountain Forest Reserve harbours one species which is critically endangered, eight endangered, ten vulnerable, two near-threatened, one data deficient animal species and twenty vulnerable plant species based on IUCN threat classification (TFCG, 2007). Another study by Menegon, Doggart and Owen, (2008) also revealed that South Nguru Mountain Forest Reserve has the highest hertofauna species in Africa. Locally, the South Nguru Mountains Forest Reserve provides wood products, medicinal plants and haS cultural values (Menegon, Doggart and Owen, 2008). Other benefits include ecological services, non-timber products, and agricultural land and water sources (DIIS, 2007).

3.1.4 Socio-economic characteristics of the study area

Agricultural and allied activities are the major means of peoples' livelihoods in the South Nguru Mountain Forest Reserve (TFCG, 2007; DIIS, 2007; Menegon, Doggart and Owen, 2008). At higher altitudes, farmers grow yams, bananas, sweet potatoes, maize and coffee with plentiful plots of yams and cardamom in the forest reserve (Menegon, Doggart and Owen, 2008). According to DIIS (2007) the eastern part of the South Nguru Mountain Forest Reserve has accessible roads, market and is a major trading centre of the South Nguru landscape. The southern, western and north sides of the forest are having poor

accessibility, isolation from the market and poor social services, and generally people in these areas have a lower well-being compared to the eastern side (DIIS, 2007). The detailed socio-economic characteristics of the study population are presented in Chapter Four of the study.

3.2 Research Design and Data Collection Procedures

3.2.1 Research design

An exploratory cross-sectional research design was used. According to De Vaus (2002), a cross-sectional research design involves collection of information from a representative population sample in one time duration at a single point. The choice of this research design is grounded on the fact that it is more flexible to provide opportunity for considering different aspects of a problem under study (Kothari, 2004), such as socio-economic characteristics and political factors limiting integration of IKS into biodiversity conservation methods.

3.2.2 Population of the study

The population for this study was made up of indigenous people from the villages bordering the South Nguru Mountain Forest Reserve. Four villages were purposively selected, one village from North, South, East and West parts of the mountain landscape, representing different socio-economic characteristics of the study population, as described in Section 3.1.4. The study villages included Pemba (north), Mandela (south), Maskati (west) and Kwelikwiji (east) of the South Nguru Mountain Forest Reserve. According to PEMA (2003) cited in DIIS (2007), a total of 20,000 inhabitants are estimated to be living in villages around the South Nguru mountain forests reserve, the population density of the South Nguru landscape stood at 75 - 125 people per km².

3.2.3 Sampling procedures

Based on socio-economic differences among villages bordering the South Nguru Mountain Reserve, a purposive sampling was used to select 4 villages out of 25 villages bordering South Nguru Mountain Forests Reserve, each representing one ward within the landscape. Based on the criteria of being an indigenous person, as being a person who has lived in an area for not less 20 years (Section 2.1.1.); a sampling list was created using the 2005 voting list. A sample of 60 interviewees was randomly selected from each of the four village's sampling list, making a total of 240 interviewees. A sample size of 60 interviewees from each of the villages gets support from Bailey (1998) cited in Mbwambo (2007) who argued that a sample of not less than 30 is the minimum acceptable size for statistical analysis.

To ensure wider participation, respondents were selected from each of the sub villages, as there were variations among sub villages not only on their socio-economic characteristics, but also their closeness to the natural forests (sacred groves and / the forest reserve) which determine their views and perceptions on conservation of biodiversity and the knowledge system. It is therefore envisaged by this study that the study covers a large population of people who are knowledgeable on IKS that has been determining their interactions with their supporting ecosystems for the period of not less than 20 years.

3.2.4 The sample size

The total sample size of this study was 240 respondents. It is envisaged that the proposed sample size is adequate to gain an understanding on IKS and factors limiting their integration into biodiversity conservation methods.

3.2. 5 Data collection methods and instruments

This study used both primary and secondary data. Primary data were collected through semi-structured and a key-informant interview, field observations and Focus Group Discussions. Different questionnaires with both closed and open-ended questions were administered to indigenous people and key-informants. A total of four Focus Group Discussions (FGDs) (one in each of the four selected villages) that included *walukolo*, members of village environmental committees and the village chairperson and/or the Village Executive Officer were organized to crosscheck and complement information collected through interviews with indigenous people and field observations. A key-informant interview with the Conservator of the Mkingu Nature Reserve was also held to complement information collected through semi-structured interviews, Focus Group Discussions and field observations. Secondary data were obtained from review of documents from the Morogoro region catchment office and Sokoine National University Agricultural Library (SNAL). The methods used for data collection for each of the specific objectives of the study and analysis are presented in Table 2.

Table 2: Specific objectives, research questions, methods of data collection and type of data analysis

Specific objective one: Determine existing IKS for biodiversity conservation

Research question	Measurable variable	Methods/tool of data collection	Type of data analysis
i. What is the existing IKS for conservation of biodiversity in the South Nguru Mountain Forest Reserve?	i. Information on the IKS for conservation of biodiversity in South Nguru Mountain Forest Reserve established	<ul style="list-style-type: none"> - Review of document - Focus Group Discussions - Semi-structured interviews - Key-informant interview - Field observations 	<ul style="list-style-type: none"> - Descriptive analysis - Content analysis
Specific objective two: Establish the significance of IKS on conservation of biodiversity			
ii. What are the significance of IKSs on conservation of biodiversity?	ii. Information on the contribution of the IKS on conservation of biodiversity established.	<ul style="list-style-type: none"> - Documents review - Semi-structured interviews - Key-informant interview - Field observations - Focus Group Discussions 	<ul style="list-style-type: none"> - Descriptive analysis - Content analysis
Specific objective three: Determine the influence of socio-economic characteristics on integration of IKS into biodiversity conservation methods			
iii. How do indigenous people's socio-economic characteristics limit the integration of IKS into biodiversity conservation methods?	iii. Information on how age, gender, education, and years of residence income, household labour and farm size limit integration of the IKS into biodiversity conservation methods established.	<ul style="list-style-type: none"> - Documents review - Semi-structured interviews - Field observations - Focus Group Discussions 	<ul style="list-style-type: none"> - Descriptive analysis - Dummy multiple regression - Content analysis

3.2.6 Pre - testing of instruments

A pilot survey was made in the study area to test the instruments of data collection for their clarity and adequacy of time allocated. In pre-testing of instruments a total of thirty (30) indigenous people were purposively selected based on criteria of being a head of household or his female spouse. According to Akkerboom and Dehue (1997) a sample size of between 10 and 20 is adequate when pre-testing of instruments of data collection for interview and Focus Group Discussion (FGD). However, these people were not included in the sample of interviewees for the study.

3.2.7 Phases of data collection

To meet the objectives of this study, three phases of data collection were involved. While review of literature and field observation (Appendix: 2) were included within all phases of data collection, the phases included:

First phase

The first phase of data collection involved face to face interviews with indigenous people, whereas a total of 240 indigenous people were involved: an indigenous person was a person who has lived in the study area for at least 20 years. An interview questions with both open and close ended questions was used to explore the perceptions of the respondents on IKS, conservation of biodiversity, biodiversity conservation methods and the integration of these knowledge systems. The interview was guided by, but not limited to, an interview questions (Appendix 1). During an interview, normally a person being interviewed was insisted to be alone, so as to ensure secrecy and increase freedom of expression of the interviewee, based on the fact that conservation of biodiversity in the South Nguru Mountain Forest Reserve is a sensitive issue as a result of increased encroachment in the South Nguru Mountains. However, in some instances particularly

when an interviewee is very old, assistance from a relative to clarify and stimulate the conversation was inevitable.

Second phase

The second phase of data collection involved Focus Group Discussions, whereas some issues that were discussed during household interviews were discussed in detail in the FGDs. The household interviews preceded the FGDs to ensure that the information that was collected through interviews was individual and reliable for comparison with the FGDs, field observation and key-informant interviews. Participants of FGDs included the Village Environmental Committee, *walukolo* and village chairpersons and/or Village Executive Officers (VEOs). While it was expected such discussions would involve other non-governmental organizations working in the study area, unfortunately, during data collection there was no active formal organizations working directly on conservation of biodiversity. The Focus Group discussions were guided by, but not limited to a list of questions (Appendix 3).

Third phase

The third stage of data collection involved an interview with the Conservator of the currently known the Mkingu Nature Reserve: the South Nguru Mountain Forest Reserve and the Mkindu Mountain Forest Reserve were recently joined and upgraded to a nature reserve. The Conservator, under the Tanzania forestry is officially responsible for overseeing conservation of the natural reserve under the Ministry of Natural Resource and Tourism, within the Forestry and Bee-keeping Division. The key-informant interview was guided by, but not all, of the questions (Appendix 4).

3.3 Data Processing and Analysis

3.3.1 Descriptive and inferential statistics

Data collected in phase one were analysed using both qualitative and quantitative methods. The Statistical Package for Social Sciences (SPSS) was used to analyze the quantitative data whereas content analysis was used to analyze the qualitative data. Coding and changing of order categories and grouping of some variables was the first step in preparing the variables to make them suitable for addressing the study questions and the computer programme. While coding refers to the process of assigning numerals or other symbols to classes (Kothari, 2004), classification of data refers to the process of putting responses of the same traits into the same group or class (Adam and Kamuzora, 2008). Each of the questions was analyzed to show range of distribution of responses, the extent of any concentrations or central tendency in those responses and the shape of the distribution or the extent to which the replies were clustered around the central point, which are the descriptive analysis.

Inferential statistics was used to provide an idea about whether the patterns described in the sample were likely to apply in the population from which the sample was drawn (De Vaus, 1986 cited in Mbwambo, 2000). Dummy multiple regression was developed to show the relationship between demographic and socio-economic on the integration of the IKS into the biodiversity conservation methods. A dummy multiple regression model was used to establish the relationship between the dependent and a set of independent variables, through explaining a proportion of the variance in a dependent variable at a significance level and predict the influence of each of the independent variables to the dependent variable through comparing beta weight of the independent variables.

A two-tailed t-test at 5 % level of significance was used to accept or reject the tested hypothesis, in this case, H_0 is rejected only when $p < 0.05$. To assess the goodness of fit of the regression model, a coefficient of determination (R^2) was applied. In light of this De Vaus (2002) elaborated that the higher the R^2 the more powerful the model is. Information disclosed through content analysis was used to complement the quantitative data to capture the IKS based on its own ways of knowing and doing.

The general multiple regression model used is in the form of:-

$$y_n = a + b_1x_1 + b_2x_2 \dots b_nx_n + e_i$$

Dependent variable was: Y_i = the mutual application of IKS and biodiversity conservation methods.

a = intercept

b = coefficient of the independent variables

e = *Random error*

Whereas independent variables considered (x) were sex, age group, level of education, household income, years of residence, household labour and farm size.

3.3.2 Variables used for dummy multiple regression analysis

Variable used by the study are presented in Table 3. As it was established in Section 2.1.2 that factors influencing wide use and application of IKS are also influencing its teaching and learning and its integration into other knowledge systems, such as biodiversity conservation methods. Moreover, a household that does not pass on the knowledge system to its descendant(s) is argued to be not practising the knowledge system. In favour of this view, citing Abromvitz, (1994) and Zweifel (1997) argued that as a result of parents spending less time at home there has been a decrease in transmission of IKS to their descendants.

Table 3: Variables used for the dummy multiple regression analysis

Variables	Indicators/Labels
Dependent variable	
Integration of IKS into biodiversity conservation methods	- The mutual application of both IKS and biodiversity conservation methods that are governed by systematic approaches and strategies for conservation of biodiversity with full consideration of each of these knowledge systems
Independent variables	
Demographic factors	
Age	- Number of years that a person has lived
Sex	- Male or female
Social factors	
Years of residence	- Number of years someone has lived in an area
Education	- Numbers of years in school
Economic factors	
Income	- an average annual household income in Tshs
Household labour	- Number of working people in a household
Farm size	- A household's total farmland measured in acres

3.3.3 Limitations of the study

Although the study was successfully completed, the following limitations were encountered:

Unreliable funding for the study was the major limitation in completion of the study as scheduled, whereas individual sources of funds were alternatively used for a successful completion of the study.

Most people were reluctant to provide information related to their use of the forest products from the South Nguru Mountain forests reserve, as most of the products were illegally harvested and/collected, and there have been increasing conflicts of interests between the indigenous people and the government authorities on the best approaches to

the conservation of biodiversity, making biodiversity conservation related questions rather sensitive to the respondents. However, as a result of rapport building, probing, triangulation and privacy assurance during the interviews, the respondents' activeness and freedom of expression increased, and so did the validity and credibility of the collected information.

Responses to questionnaires mostly relied on the individual respondent's memory, especially, on the household annual income, as respondents were not keeping records of their actual annual income and products locally harvested for home consumption as they were not valued in cash. The annual incomes of the respondents were based on estimation, and;

Some of the respondents were less willing to spend their time for the interview, as they complained that though they provided useful information, they earned no positive outcomes so far, as far as previous researches were concerned. Some token amounts were thus paid to the respondents for their time.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Respondents' Demographic and Socio-economic Characteristics

As it was earlier observed in Chapter Two of this study, people's demographic and socio-economic characteristics greatly influence the wide use, application and integration of the IKS into biodiversity conservation methods, among others. This section describes age, sex and years of residency of the respondents. Other characteristics include level of education, income levels, household labour and household farm size. The demographic and socio-economic characteristics of the respondents are presented in Table 4.

4.1.1 Age group of the respondents

Results (Table 4) show that a little over half of the respondents (57.1%) were aged between 41 and 71 years, while 23.3% of the respondents were aged above 71 years. Of all the respondents, 19.6% were aged below 41 years. The study further revealed that the mean age group of the respondents was 59.64 years, while the minimum and the maximum years of age of the respondents were 20 years and 98 years respectively. According to Mbwambo (2007), age is an important demographic variable, as it determines various inter-household and intra-household characteristics such as ownership and control of resources. Shiferaw and Holden (1998) cited in Ruheza (2003) contended that age determines risk aversion and in most cases older people are comparatively less adoptive of new innovations than young people, making them mostly reliant on their IKS, as in biodiversity conservation.

Arguing on the relationship between IKS and the age of an individual, Mayetta (2007) observed that in most cases, older people were more knowledgeable in IKS with regards to

the management and values of biodiversity as a result of years of their interaction with the ecosystem. Furthermore, Mapara (2009) also disclosed that elders were responsible for provision of indigenous knowledge to youth through forums and meetings, and through their uncles and aunts (more often for the boys and girls respectively) the knowledge that was utilitarian and value-based. Based on the above contention and views, this study enlisted respondents most of whom were old enough to have been exposed to a considerable amount of IKS that determines human interactions with biodiversity. The respondents' perceptions, attitudes and application of the knowledge system, however, might be influenced by other factors.

4.1.2 Sex of the respondents

Results (Table 4) have shown that almost three quarter of the respondents (73.3%) were males and only 26.7% of respondents were females. In cases where a husband was absent at home, and in cases a wife met the criteria of having lived in the study area for more than 20 years, the wife was interviewed on behalf of her male spouse. According to Semisi (1991) cited in Mbwambo (2007), in most African societies, women are mostly left at home doing household activities, making them more available than their male spouses.

This study also observed that women, particularly those who were interviewed on behalf of their husband, were less comfortable in discussing issues related to the conservation of biodiversity compared to their male spouses and women heads of household. Probably this might be because the issue is very sensitive, coupled with increasing conflicts of interests between the indigenous people and the government officials on the conservation of biodiversity. In such a context, female spouses were less confident most probably because they were afraid of exposing their spouses' activities and practices inside the South Nguru Mountain Forest Reserve, from which they make a living (PEMA, 2006). In minimizing

the problem of confidence amongst the female spouses, rapport building with the respondents, probing and assurance of privacy and triangulation of questions were the techniques applied by the researcher.

Table 4: Demographic and socio-economic characteristics of the respondents

Characteristics	Frequency (n= 240)	Percentage
Age group		
≤ 40 years	47	19.6
41- 71 years	137	57.1
> 71 years	56	23.3
Total. Mean. 59.64 Min. 42 Max. 98 SD 1.44	240	100
Sex		
Male	176	73.3
Female	64	26.7
Total	240	100
Years of residency		
20- 40 years	53	22.1
41- 61 years	109	45.4
Above 61 years	78	32.5
Total. Mean 54.5 Min. 20 Max. 98 SD.1.68	240	100
Education level		
No formal education	56	23.0
Middle school standard four	84	35.0
Standard seven	100	42.0
Total	240	100
Estimated annual income (Tshs)		
≤ 300 000/=	173	72.1
300 001- 400 000/=	49	20.4
> 400 000/=	18	7.5
Total Mean. 274 250. Min.120 000. Max. 900 000. SD. 9.6	240	100
Household man labour		
1 - 6 man labour	226	94.2
7 - 12 man labour	13	5.4
> 12 man labour	1	0.4
Total Mean 3.64 Min. 1 Max. 18 SD 2.02	240	100
Household's farm size (Ha)		
0.4 - 2	135	56.3
2.2 – 4	70	29.1
> 5	35	14.6
Total Mean. 2.7 Min. 0.4 Max 12.4 SD 6.25	240	100

4.1.3 Years of residency of the respondents

Results (Table 4) have shown that almost half (45.4%) of the respondents had been residing in the study area for between 20 and 40 years, while 32.5% of the respondents had lived in the study area for a period of between 41 and 61 years, and 22.1% of the respondents have lived in the study area for more than 61 years. Results also reveal that the mean years of residency were 54.5 years, with the minimum and the maximum period of residency being 20 and 98 years respectively. Based on these findings, it is assumed in this study that most of the respondents might have accumulated plenty of IKS on the conservation of biodiversity, as a result of their interactions with their supporting ecosystem that is interwoven within a particular socio-economic and political context, among other factors. Tanyanyiwa and Chikwanha (2011) observed that there is a correlation between the number of years one has lived and interacted with their supporting ecosystem and the quantity and quality of IKS one possesses, and that, in most cases, a particular IKS is found amongst societies that have engaged in human-ecosystem interactions in a particular place over a long period of time (Berkes, 1999).

A study by McGregor (2004) also observed that indigenous people were very helpful in enabling immigrants who lacked IKSs of their new environments. Several authors such as Holt (2005); Kalanda-Sabola *et al.* (2007) and Sarfo-Mensah and Oduro (2007) have also noted that, in most cases, immigrants have been responsible for abusing the IKS that determined humans' interaction with biodiversity and its conservation, as a result of lacking and/or not respecting the IKS of their new habitat.

It is from the above observations, this study presupposes that most of the respondents were knowledgeable of their IKS for the conservation of biodiversity, as a respondent of this study was a person who has lived in the area for more than 20 years, and thus their limited

use and application of the knowledge system might be influenced by other factors rather than their ignorance of it.

4.1.4 Education level of the respondents

Table 4 shows that almost 42.0% of the respondents had primary education, while 35.0 % had standard four education and almost a quarter of the respondents (23.0%) had no formal education. This implies that most of the respondents had at least a minimum level of formal education. As it was reported in previous chapters of this study, most of the villages adjacent to the South Nguru Mountain Forest Reserve are characterized by poor social and economic infrastructure and services, such as roads, schools and quality education.

Mbwambo (2007) elaborated that the level of formal education influences diversification of people's livelihood strategies such as off-farm employment to substitute household's income from agricultural activities and/ or support from other members of the household through remittances. Arguably, engagement in off-farm enterprises is more likely to reduce reliance, on and over exploitation of, biodiversity through reduction of pressure on the biodiversity from the people living in villages adjacent to the South Nguru Mountain Forest Reserve.

4.1.5 Respondents' estimated annual income

Results (Table 4) have shown that most of the respondents (72.1%) had an average annual income of not more than 300 000/= Tshs, while 20.4% of the respondents had income ranging between 300 001 and 400 000 Tshs and, only 7.5% of the respondents had an estimated annual income of greater than 400 000 Tshs. Results have further shown that the minimum annual income of the respondents was 120 000 Tshs, the maximum annual

income being 900 000 Tshs and an average annual income was 274 250 Tshs. A study in villages adjacent to the South Nguru Mountain Forest Reserve by DIIS (2007) also disclosed that the southern, western and northern sides of the landscape were characterized by poor accessibility, isolation from markets and poor basic social services, into the population having low well-being compared to the eastern side of the mountain, indicating variations in economic well-beings amongst villages. It was also observed by this study that poor/or lack of roads has not only been limiting market access, but also significantly increased transport costs, and ultimately decreased income. This has exacerbated poor economic well-being of the indigenous people residing in the areas coupled with high dependency on agricultural and allied activities, further perpetuating the increasing demand of natural resources, resulting into biodiversity declination. However, it is worth noting that poverty may not be easily measured and is difficult to define. But based on economic measures of poverty, and the World Bank conceptualization of the term poverty, it can generally be argued by this study that most of the respondents were living below the poverty line of less than one USD per day.

4.1.6 Household labour

Table 4 shows that most of the respondents (94.2%) had household labour of between 1 and 6 man labour, while only 5.4% and 0.4% of the respondents had man labour of between 7 and 12 and of greater than 12 man labour respectively. Results have also shown that the mean household man labour was 4 man labour, while the minimum and the maximum household man-labour were 1 and 18 man labour respectively. Arguing on household man labour, Monela (1995) pointed out clearly that household man labour among other factors, is determined by the size of the family, sex and age distribution. However, it is worth noting that working capabilities and knowledge skills of the

household members have a lot to do with the household's man labour, rather than the family size, age and sex of the members of a household.

Mechanization of agricultural activities in the villages adjacent to the South Nguru Mountain forests reserve being limited, the size of household's man labour is of significant importance, as most of the operations are done manually; hiring of man labour deemed too expensive for many of households to afford and that is why most of households rarely hire extra man labour (Monela, 1995).

4.1.7 Household's farm size

Results (Table 4) have shown that more than half (56.3%) of the respondents had farm sizes ranging between 0.4 and 2 ha, while only 29.1% and 14.6% of the respondents had farm sizes of between 2.2 and 4 ha and greater than 5 ha respectively. Results have also shown that the mean farm size of respondents was approximately 2.7 ha, while 0.4 ha and 12.4 ha were the minimum and the maximum farm sizes respectively. A study in South Nguru Mountains Forests by DIIS (2007) also found that nearly half of the poor households within the South Nguru landscape owned less than 0.4 ha of farm land, usually held on customary basis, whereas in the eastern side of the mountain forest, most people are leasing additional farm land which is normally costly and insecure. It is from the above findings, this study argues that farmland is increasingly becoming scarce as a result of increasing population, soil erosion and unequal distribution of land, coupled with extensive production with unimproved techniques (such as slash and burn practices) rather than the intensification and diversification of production amongst members within and between villages adjacent to the South Nguru Mountains Forest Reserve.

4.1.8 Household members and man labour characteristics, major economic activities and land tenure systems

Results on household members, household man labour and satisfaction to household man labour and strategies to man labour shortage are shown in Table 5. Results have shown that more than a half of the respondents (60.8%) had household members of between 1 and 6 members, while 36.7% of the respondents had a range of household man labour of between 7 and 12 and only 2.5% of respondents having more than 12 household members.

This study also found that most (93.4%) of the households had household non-labour of between 1 and 6 members, while 5.9% of the respondents had household non- labour of between 7 and 12 members with only 0.7% of respondents having more than 12 household non-labours. In this study, a household was perceived as a group of people living in the same compound, sharing the same cooking pots, but not necessarily having blood relations. This study revealed that most of household non-labour comprised of children, old people and the disabled. Children, however, and particularly students, contributed to household's man labour during the high labour demand seasons and during weekends. Results on household members and labour characteristics, major economic activities and land tenure systems are presented in Table 5.

Table 5: Household members and labour characteristics, major economic activities and land tenure systems

Characteristics	Frequency (n= 240)	Percentage
Household members		
1 – 6	146	60.8
7 – 12	88	36.7
< 12	6	2.5
Total	240	100
Household non labour (n = 152)		
≥ 6	142	93.4
7 – 12	9	5.9
< 12	1	0.7
Total	152	100
Satisfaction with household labour		
Yes	118	49.2
No	122	50.8
Total	240	100
Strategies to offset labour deficit (n= 122)		
Hiring extra labour	80	66.0
Assistance from relatives	10	8.0
Extending working hours	32	26.0
Total	122	100
Major economic activity		
Farming	229	95.4
Farming and livestock keeping	11	4.6
Total	240	100
Owner of farmland		
A family	139	58.0
A husband	64	27.0
A wife	37	15.0
Total	240	100
Satisfaction to farmland size		
Yes	155	64.6
No	85	35.4
Total	240	100
Strategies to shortage to farmland (n = 85)		
Renting	45	52.0
Buying from other village	12	14.0
Farming on the same farmland	19	22.0
Borrowing from relatives	9	11.0
Total	85	100

Results (Table 5) show that of all the respondents, 51.0% were satisfied with their household's man labour, while 49.0% of the respondents were not satisfied. Results have further shown that most of the respondents (66.0%) were hiring extra man labour, while 26.0% of the respondents were extending their working hours and only 8.0% depended on assistance from relatives. The results imply that man labour in the study area is among the factors limiting household's production strategies; with hiring of extra man labour being the most adopted strategy to address the problem of labour shortage, despite being expensive for many households to afford (Monela, 1995).

Moreover, through personal communications and observations, it was further revealed by this study that households with good economic well-being hired extra man labour particularly for commercial production, as such production met the costs of hiring expensive man labour, whereas households that were either extending their working hours and/or getting assistance from their relatives were mainly producing food crops, mostly for subsistence use.

Results (Table 5) show that crop production was the most important economic activity for 95.4% of the respondents, while livestock production was practiced by only 4.6% of the respondents. This study further observed that in Pemba village, the northern part of the South Nguru Mountain Forest Reserve, crop production and livestock keeping had greater contributions to the livelihoods of most people, the later being the major economic activity among the Maasai ethnic group. Similar findings were reported by Monela (1995) in his study in the South Nguru Mountain Forest Reserve, which revealed that 90.0% of people living on mountain slopes were peasant farmers, keeping no or very few livestock.

According to DIIS (2007), in north-western side of the South Nguru Mountain Forest Reserve there is a decrease in farming activities due to drier ecological characteristics making it more suitable for livestock rearing, mostly done by the Maasai, which accounts for up to 70.0 % of their income (Monela, 1995). However, contrary to the observation made by Monela (1995) that the Maasai ethnic group were nomadic, this study found that in Pemba village, the Maasai had settled for over 30 years, forming their own hamlet. It was further observed in this study that the hamlet inhabited mostly by the Maasai ethnic group and other livestock keepers was covered with natural forests with big natural trees in which a large number of wild animals such as duikers (*C. harveyi*), bush pigs (*P. spp*) and black and white Colubus monkey (*Colubus angelensis*) could easily be found. Through personal communication with the Maasai (16. 02. 2012), it was revealed that traditionally, the Maasai did not consume wild meat. This, coupled with their little engagement in crop production, has resulted with less forest destruction and no hunting of wild animals. The Maasai, however, complained that other ethnic groups particularly the Nguu ethnic group practiced illegal hunting and encroachment of the South Nguru Mountain Forest Reserve and other natural forests, significantly resulting in the decline of rainfall and water for their livestock and crops.

Results (Table 5) show that more than half of the respondents (58.0%) mentioned that land was jointly owned by males and their female spouses, while 27.0% of the respondents said that land was owned by male household heads and 15.0% of the respondents claimed that land was owned by female spouses. These findings show a great variation from the past seventeen years findings reported by Monela (1995) who found that 77.0% of farmland was owned by male heads of household, 13.0% of farmland being owned by female spouses and only 10.0% was jointly owned. Such variations might be attributed, among others, to increased human population, decline of clan land that had been traditionally

inherited mostly from father to sons; increased commercialization of land, whereby people can buy farmland, though selling of land very rarely occurred amongst the Nguu ethnic groups. Moreover, variations in land ownership do exist between villages of the South Nguru Mountain Forest Reserve, particularly on lowlands as a result of immigration (PEMA, 2006).

Results (Table 5) have also shown that (64.6%) of the respondents were satisfied with the size of their farmland, while 35.4% of the respondents were not satisfied. Of the respondents who were not satisfied with the size of their farmland, 53.0% were renting extra farmland, whereas 22.0% of the respondents were farming on the same piece of farmland and 11% of the respondents were borrowing farmland from their relatives. Results further show that 14.0% of the respondents bought farmland in other villages outside the South Nguru Mountain landscape as a strategy to offset the problem of shortage of farmland. The findings imply that households' farmland sizes vary among members within and between villages and that is why there are possibilities of renting/buying and borrowing extra farmland. Similarly, DIIS (2007) put it that increasing pressure on agricultural land, decrease in soil fertility and expansion of agricultural activities inside the forests reserve, the Miombo woodlands, the traditional woodlots and clan forests, which have been considered sacred, result from increased population, coupled with limited alternative ways of sustaining livelihoods apart from agricultural activities and excessive extraction of natural forests and sacred places, further accelerating biodiversity decline and household level poverty.

It is worth noting that Nguu people trace their descent through their male line, thus rights to land and livestock are vested in the line of males, through father handing property to son (patrilineal inheritance system) (Monela, 1995). Quoting Baland and Platteau (1996),

Ylhäisi (2006) added that land is emotionally identified with ancestors who are buried in it and who need to be continuously addressed through appropriate rituals and therefore land inheritance from father to son is an inescapable way of maintaining such social integrity between people of a particular clan and/ ethnic group, the land and their ancestors (Ylhäisi, 2006).

It is from such strong relationship between the inherited land and people, that such lands are rarely sold, and as such land in which ancestors were buried are considered sacred and therefore selling it would mean selling of ancestors' spirits and supernatural powers on which those people depend for their livelihood through ritual practices. Apparently, land obtained through clearance of forest is rarely sold, that is why buying of farmlands in lowlands of the South Nguru Mountain Forest Reserve landscape is mostly preferred to villages adjacent to the forest reserve.

Likewise, the Wasambaa ethnic group that is culturally related to Wanguu ethnic group, a first clan to settle in the area, did establish their land territory that, among others, include farmlands, sacred forests/groves and/sacred places (DIIS, 2007), making selling of land to be very difficult with the first clan to settle in the area being in advantage having relatively large land. It was also observed by this study, that some of farm lands were in long fallow, particularly in Mandela village, while there are increasing encroachments inside the forest reserves for agricultural practices. Adding on the factors behind increased encroachments of the forest reserve, DSII (2007) further observed that the forests had fertile soil and cool climate that favoured cultivation of cash crops such as cardamom and coco yams.

A study by Mbwambo (2000) disclosed that sacred forests/groves were associated with the past community initiation, in localities where social and political values, morals, cultural

norms, secrets and laws and traditions are passed to the younger generations. The author further elaborated that sacred groves were also places used for communications between the indigenous people and their ancestral spirits and gods, and were the link between the past, the present and the future of the clan.

Thus, it is argued by this study that land tenure among Nguu people is a complex issue, as it also comprises social integrity of the clan, normally considered sacred as ancestors are normally buried in it and they are normally remembered through ritual practices, forming a strong social IKS related to the management and use of the land and natural forests and /or sacred groves and places on it: human activities in the sacred groves and places are highly prohibited.

4.2 Indigenous Knowledge System and Conservation of Biodiversity in South Nguru Mountain Forest Reserve

4.2.1 Ethnic groups of the respondents

Results on the ethnic groups of the respondents are represented in Table 6. Results have shown that most of the respondents (92.0%) belonged to the Wanguu ethnic group, while 3.3% and 1.7% of the respondents were Wamasaai and Wazigua ethnic groups respectively. The Wakaguru represented 1.2% of the respondents, while the Wasambaa constitute 1.0% of all the respondents, and the Wahehe and the Wabena ethnic groups represent only 0.4%.

Table 6: Ethnic groups of the respondents

Ethnic	Frequency (n = 240)	Percentage
Wanguu	221	92.0
Wamasai	8	3.3
Wazigua	4	1.7
Wakaguru	3	1.2
Wasambaa	2	1.0
Wabena	1	0.4
Wahehe	1	0.4
Total	240	100

In his study in the South Nguru Mountain Forest Reserve, Monela (1995) also found that 95% of the population was constituted by the Wanguu ethnic group, mixed with Wazigua, Wasambaa, Waluguru and Wachagga ethnic groups. Other ethnic groups included Bena, Kinga and Hehe. The author further noted the increased mixed ethnic groups, mostly in the villages in the lower landscapes of the eastern side of the South Nguru Mountain Forest Reserve and relatively better socio-economic infrastructure and services in the villages favoured immigrations. According to PEMA (2006) the wanguu people tended to dominate upland villages, while other ethnic groups dominated different lowland villages.

During interviews, as it was reported by Monela (1995), most often the respondents used Wanguu and the Wazigua ethnic groups interchangeably to identify their ethnicity, more likely because the two ethnic groups are closely related to each other. Similarly, Monela (1995) also reported that the Wanguu ethnic group is closely related to the Wazigua ethnic group, with the two ethnic groups speaking closely related languages, with closely related social and cultural characteristics. Moreover, similar to what was reported by Monela

(1995) and DIIS (2007), this study also found that the Masaai were mostly settled in Pemba village in northern parts of the South Nguru Mountain Forest Reserve.

In light of these findings, this study argues that villages adjacent to the South Nguru Mountain Forest Reserve are mostly inhabited by the Nguu ethnic group, which is reflected in the domination of their norms, values, taboos and traditions governing, among others, management and use of biodiversity. According to Monela (1995) the Nguu people had strong adherence to their culture and traditional values, whereby culture comprises of values, beliefs and norms shared by a particular group of people (Kideghesho, 2009). Similarly, Shemdoe (2003) observed that IKS that favours conservation of biodiversity was pronounced in the villages which were dominated by a certain ethnic group, while in villages with no one dominant ethnic group, the political institutions, such biodiversity conservation methods, took control of the conservation of biodiversity. Kweka (2004), in his study in East Usambara Mountain Forests also found that in Mwembe-Magoroto village which was dominated by the native Wasambaa ethnic group, most villagers were knowledgeable in IKS for the conservation of biodiversity as compared to the Potwendondondo village that had no dominant ethnic group, as a result of immigration.

It is worth noting that the IKS is interwoven with a specific culture, from which the knowledge evolved, was enhanced and improved overtime. Quoting Millennium Ecosystem Assessment (2005), Kideghesho (2009) argues that the culture controls individuals perceptions of the world through influencing their perceptions on what are important and what are not important, and categorizing courses of actions with appropriate and inappropriate strategies on management and use of biodiversity that support their livelihood. Moreover, culture influences and regulates people's behaviour toward certain species and their habitats and therefore predicting their consumption pattern (Kideghesho,

2009). Generally, traditional African cultural practices are built with ways of conserving and protecting biodiversity against overexploitation through the use of taboos and totemic affiliations with localities and the wild species of flora and fauna (Kideghesho, 2009). Moreover, the IKS that is interwoven with cultural values, is economically affordable, reliable and sustainable (Colding and Folke, 2001, Infield, 2001, Mgumia and Oba, 2002 and Kideghesho, 2008 cited in Kideghesho, 2009).

These findings and literature indicated that villages adjacent to the South Nguru Mountain Forest Reserve are mostly inhabited by the Wanguu ethnic group, with a strong affiliation to their cultural practices from which the IKS evolved, was enhanced and sustained. Furthermore, the knowledge is normally associated with taboos, norms and local politics that determine management and use of biodiversity. Arguably, recognition, wide use and application of the IKS among the Nguu ethnic groups might be mostly influenced by socio-economic and political factors, among others, rather than people's ignorance of the IKS for conservation of biodiversity.

4.2.2 The respondents' views on the origin of, current status, importance and management of biodiversity in the South Nguru Mountain Forest Reserve

The results on the origin of the biodiversity, current status, importance and management and use of biodiversity are shown in Table 7. According to Kimmerer (2002), generally indigenous people perceive biodiversity as being a reciprocal relationship between human and non-human entities that include plants, animals and minerals; the concepts that also include spiritual consciousness of the people concerned on such a relationship, synonymous with a view of an ecosystem with spiritual value attached to it. Similarly, results from this study (Table 7) have shown that most of the respondents (90.0%) believed that biodiversity was created by God/gods, while only 10.0% of the respondents

did not know the origin of biodiversity. Based on these findings, it is apparent that there is spiritual belief amongst most of the respondents that biodiversity is God's/god's creation. Similarly, Anis (1994) cited in Mokuku and Mokuku, (2004), added that most indigenous people believed that all living organisms share a creator and the creative process and therefore they relate to one another, and such spiritual relationship has been determining human's relations with other living things. Contrary to the view of the indigenous people, through a key-formant interview, foresters as professionals, trained in formal education believed that biodiversity is a result of the evolution process. However, based on individual spiritual belief of the conservator of the Mkingu forest reserve, he believed that biodiversity was God's creation. This suggests that a formal trained forestry professional has two contradicting views of the biodiversity as being a result of natural evolution process and as God's creation, whereas such views are used depending on the context of the forester.

Table 7: Respondents' views on the origin of, status, importance and management of biodiversity in the South Nguru Mountain Forest Reserve

Response Item	Frequency (n=240)	Percentage
Respondents' views on the origin of biodiversity		
Created by God/gods	216	90.0
I don't know	24	10.0
Total	240	100
Respondent's awareness of the boundaries of the South Nguru Mountain Forests Reserve?		
Yes	210	87.5
No	30	12.5
Total	240	100
Respondents' views on the respect of the boundaries of the South Nguru Mountain Forests Reserve		
Yes	57	24.0
No	153	64.0
I don't know	30	12.0
Total	240	100
Indicators of the biodiversity status of South Nguru Mountain Forests Reserve (n = 240)		
There is increasingly agricultural activities and timbering	165	69.0
Increasing people settlements inside the forests reserve	45	19.0
Increased illegal hunting	61	24.0
There is no forest encroachment	64	26.0
I don't know	25	10.0
Respondents' views on the importance of biodiversity (n=240)		
Wild tree species provide timbers, fuel wood and poles	183	76.0
Tree habitation of wild animals	41	17.0
Conserves moisture and facilitates rainfall formation	231	96.0
Wild animals are a source of meat	29	12.0
Respondents' views on the management and use of biodiversity		
By avoiding excessive use to meet needs of the present and the future generations	235	98.0
It has to be used any how	5	2.0
Total	240	100

Arguing on the spiritual belief among indigenous people and conservation of biodiversity, Ylhäisi (2006) put it that spiritual reasons have played a significant role in the conservation of biodiversity, as they determine human-biodiversity interactions of a

particular ethnic group (Berkes 2008, Turbull 2007 and IIRR 1996b cited in Tanyanyiwa and Chikwanha, 2011 and Cobb, 2011), with less labour and more cost effective on conservation of biodiversity as compared to the biodiversity conservation methods (Kideghesho, 2009). Moreover, conservation of biodiversity and the degree of adoption of new innovations, such as biodiversity conservation methods, rest on the spiritual beliefs of a particular group of people about nature (IIRR, 1996a cited in Tanyanyiwa and Chikwanha, 2011).

Perceptions on biodiversity vary between indigenous people and scientists. While scientists conceive biodiversity as the management objects of goods and/or services outputs for their users/owners, indigenous people perceive biodiversity as the subject on which humans depend for utilitarian goods and services, social and spiritual self-identity and other social values through the diverse and changing biodiversity and human cultural relationships (Tanyanyiwa and Chikwanha, 2011). For example, Saj, Martha and Sicotte (2006) reported that in Boabeng-Fiema Monkey Sanctuary in Ghana, two species of monkeys, the white and black colobus (*Colobus vellerosus*) and the Campbell's monkey (*Cercopithecus campbelli lowei*) were considered as children of the gods who protect the villages, and therefore they were protected from being killed at any cost. Quoting Fargey (1991), Saj, Martha and Sicotte (2006) reported that a former Nkoranzahene (a paramount Chief of Nkoranza) who did not believe in the taboo attached to the monkeys, and regularly killed them around the village, was killed by angry villagers for killing god's children. In a related finding, Tanyanyiwa and Chikwanha (2011) also found that sacred groves have been perceived as being the habitation of spiritual spirits, who use those sacred groves/trees to reach people, and therefore, destruction of such sacred forests/groves or trees would detach them from their ancestors' spirits. This belief has been reported to have significantly contributed to the conservation of biodiversity.

According to Fargey (1991) cited in Saj, Martha and Sicotte (2006), the Boabeng-Fiema Monkey Sanctuary taboo was broken in the 1970s, as a result of the introduction of a new Christian sect, that was encouraging people to kill the monkeys, and people did that as a way of demonstrating their disregards to their old beliefs, and, as they never suffered any supernatural retribution, it was a sign of weakened deity resulting into decline of the monkey populations from hundreds to dozens (Saj, Martha and Sicotte, 2006). In addressing the problem, a combination of the indigenous taboos and government's rules and regulations for the protection of the Boabeng-Fiema Monkey Sanctuary was inevitable and it has resulted into promising results as the population of the monkey increased and the forest recovered (Saj, Martha and Sicotte, 2006). This implies that changes in the context within which the IKS is developed, enhanced and sustained, such as introduction of new religions, and unfamiliar government rules and regulations, have been significantly impairing the knowledge system.

It can therefore be argued that indigenous spiritual beliefs can be capitalized to further enhance conservation of biodiversity and achieve more, rather than relying on the use of unfamiliar rules and regulations only, a strategy that has resulted into conflict between governments on one side and the indigenous people on the other. For example, a study in Amazon Mountain Forests by Holt (2005) revealed that there have been conflicts between the indigenous people and other potential stakeholders interested in conservation of biodiversity, as a result of their differences on the best strategies for achieving the same. The author added that while indigenous people believe that biodiversity is a god given resource that has to be used, otherwise it will no longer be provided, other stakeholders, particularly the government rules and regulations, have constantly restricted human access to such resources, resulting into conflicts. In light of this view, Kweka (2004) in his study in the Usambara Mountains in Tanzania, reported that during the pre-colonial period

management of natural resources (biodiversity) was based on customary laws allowing people to use biodiversity such as entering into the forest reserve after performing certain rituals, while in the colonial and post-colonial era, the indigenous people were restricted from entering the forests: clear boundaries were demarcated to separate the forest reserves and farms. Such conflicts and different approaches and strategies between the indigenous people and pioneers of biodiversity conservation methods have resulted into accelerated destruction of natural resources: indigenous people intentionally destroyed these resources as their incursion against the imposed unpopular rules (Mbwambo, 2000; Mapara, 2009).

From the above findings three points are established by this study. First, spiritual connectedness between the indigenous people and biodiversity is a valuable social capital that determines management and use of specific species of both flora and fauna, resulting in their conservation. Secondly, the IKS is dynamic in response to changes in the context within which the knowledge system evolved, was enhanced and sustained. Thirdly, an integration of the IKS and biodiversity conservation methods would achieve more on conservation of biodiversity than each on their separation.

Results (Table 7) have shown that most of the respondents (87.5%) knew the boundary between the public land and the South Nguru Mountain Forests Reserve, while only 12.5% of the respondents said they did not know the boundary. The study also revealed that most of the respondents (64.0%) were of the opinion that encroachment in South Nguru Mountain Forest Reserve was increasing, while only 24.0% and 12.0% of the respondents said there were no encroachments or did not know respectively.

Results (Table 7) show that most than half of the respondents (69.0%) held that there was increasing encroachment inside the South Nguru Mountain Forest Reserve for agricultural activities, while 24.0% of the respondents mentioned increase in illegal hunting and 19.0%

of respondents claimed that there was increasing settlement inside the reserve, leading to biodiversity decline. Of all the respondents, 27.0% said that the status of biodiversity of the South Nguru Mountain Forest Reserve had remained the same over the past 20 years, and only 10.0% of the respondents said that they did not know. This researcher could observe newly opened farms; settlements, timbering and charcoal making inside the forests reserve (see Plate 1 and 2).



**Plate 1: Farming and settlement inside the South Nguru Mountain Forest Reserve
along Mandela village**



Plate 2: Timbering inside South Nguru Mountain Forest Reserve along Mandela village

A study by PEMA (2006) also disclosed that all of the respondents claimed that all people living in the villages adjacent to the South Nguru Mountain Forest Reserve depend on resources from the forest, with fuel wood from the reserve being a resource used by all people living in villages bordering the forest reserve, 50.0% collecting timber and poles and 31.0% obtaining medicinal plants from the forests. These are some of the resources that are collected on a daily basis from the forest reserves that include wood for tools and crafts, charcoal burning, hunting and collection of other forest edibles (PEMA, 2006). Similarly, Bracebridge (2006) found that there is increasing encroachment inside the South Nguru Forest Reserve for timber, settlements and farming inside the forest reserve, with hunting inside the reserve being higher than in other forests (Doggart and Loserian, 2006 cited in Bracebridge, 2006). Cultivation inside the South Nguru Forest Reserve has been an activity of many inhabitants, in search of fertile soil, cool temperatures and moist conditions that favour cultivation of cash crops such as cardamom, coco yams and cocoa,

just to name a few (DIIS, 2007). The authors further added that bylaws that otherwise would contribute to conservation of biodiversity are relaxed, and the forests are more likely open access for the majority of people in villages adjacent to the reserve. This implies that the encroachment that has been significantly contributing to biodiversity decline in the South Nguru Mountain Forest Reserve is widely known and reported (FBD, 2005; Bracebridge, 2006; PEMA, 2006; TFCG, 2007).

Arguing on the problem of encroachment, PEMA (2006) also found that the increasing encroachment of the South Nguru Mountain Forest reserve is a result of poor enforcement of unpopular biodiversity conservation methods, with signs of corruptions among government officials and forestry officials on the enforcement of the same. For example, Bracebridge (2006) reported without confirming that some people, who were farming inside the reserve, were allowed to do so by the forestry officers. The author also added that some farmers who were found residing inside the Mkindu forest reserve, claimed to have been permitted by the forest officers, though the claim could not be confirmed.

Results (Table 7) show that views on conservation of moisture and facilitation of rainfall formation were mentioned by most of the respondents (96.0%) as the advantages of biodiversity, whereas, 76.0% of the respondents mentioned timber, fuel wood and building poles. Of all the respondents, 17.0% said habitation of wild animals was the importance of biodiversity and only 12.0% of the respondents mentioned wild meat.

Results (Table 7) further show that most of the respondents (98.0%) believed that biodiversity was a God/god given resource, provided to support humans wellbeing, and therefore had to be used in a manner that would enable both the present and future generations to meet their needs and aspirations, while only 2.0% of the respondents said

that biodiversity was to be used anyhow, and the future generations will take care of themselves.

Based on the findings of this study, it is apparent that the indigenous people's practices that contributed to the biodiversity decline were not because of the dearth of knowledge on the significance of biodiversity, but rather due to the "push and pull factors" for their survival and/economic gains at the cost of conservation of the same. As a pull factor, economically better off households strive for more economic gains and as a push factor, poverty does compel economically poor households to deliberately abuse their IKS in order to make a living.

4.2.3 On farm tree retaining, trees normally retained and the reason(s) for retaining

Respondents views on tree retaining/not retaining and reason(s) for retaining/not retaining trees are shown in Table 8. Results show that most of the respondents (91.0%) retained wild tree species on their farmland(s) and only 9.0% of the respondents reported not retaining wild tree species on their farmland(s). Similar to these findings, a study by Mokuku and Mokuku (2004) also revealed that tree retaining is a common indigenous practice and the trees mostly retained are those perceived being having significant contributions to people's livelihood strategies and activities.

Results (Table 8) have shown that *Mkuyu* (*Ficus altissima*) was the wild tree species that was retained by more than half of the respondents (53.0%), while 44.0% of the respondents retained *Mvumo* (*Ficus inges*, *F.scassellatii*) and 23.0% of the respondents retained *Mlwati* (*Dombeya rotundifolia*) in their farmland(s). Results further revealed that 7.0 % of the respondents retained *Mtundwi* trees (*Ximenia americana*) and only 2.0% of

the respondents retained *Msungudi* (*Syzygium cordatum*). A study by Kweka, (2004) in East Usambara found that *Mkuyu* (*Ficus altissima*) is among several other wild tree species that have been retained for soil improvement and water conservation and shade, while *Mvumo* (*Ficus inges*, *F. scassellatii*) is believed to have water retention characteristics, a belief that favours its conservation.

Table 8: On-farm tree retaining and reasons for/not retaining

On-farm tree retaining	Frequency (n=240)	Percentage
Yes	218	91.0
No	22	9.0
Total	240	100
Trees species normally retained (n = 218)		
<i>Mkuyu</i> (<i>Ficus altissima</i>)	115	53.0
<i>Mvumo</i> (<i>Ficus inges</i> , <i>F. scassellatii</i>)	96	44.0
<i>Mlwati</i> (<i>Dombeya rotundifolia</i>)	50	23.0
<i>Mtundwi</i> (<i>Ximenia americana</i>)	16	7.0
<i>Msungudi</i> (<i>Syzygium cordatum</i>)	5	2.0
Reasons for on farm tree(s) retaining (n = 218)		
Improve soil fertility and conserve moisture	215	99.0
Provide timber and fuel wood	154	71.0
Herbs	13	6.0
Tree species normally not retained (n =131)		
<i>Mkalakala</i> (<i>Ozoroa insignis</i>)	31	23.7
<i>Mgunga</i> (<i>Acacia hockii</i> , <i>A. polyacantha</i>)	61	46.5
<i>Mlwati</i> (<i>Dombeya rotundifolia</i>)	19	14.5
<i>Mgude</i> (<i>Sterculia appendiculata</i>)	20	15.3
Total	131	100
Reasons of not retaining trees (n= 240)		
Compete with crops for light and nutrients	29	12.0
Have heavy shade	33	14.0
Thorn tree	49	20.0
Destroy land fertility	43	18.0
Consume a lot of water	105	44.0

Results (Table 8) show that while 23.0% of the respondents claimed that *Mhwati* (*D. rotundifolia*) was normally retained in farms, 14.0% of the respondents expressed that the tree species is not normally retained in farms. This suggests that tree species preference was varying among members of the same community based on their demographic and socio-economic characteristics. A study by Shresthra *et al.* (2010) also found that preference of tree species varied between elite and non-elite: based on scientific view of elite, and between economically and non-economically wellbeing households.

Of the respondents who retained wild tree species in their farmland(s) (Table 8), 99.0% were doing so to improve soil fertility, conserve soil moisture and water, while 71.0% of the respondents retained trees for timber and only 6.0% of the respondents did that to meet their fuel wood and herbs demands. The study further found that *Mgunga* (*Acacia hockii*, *A. polyacantha*) was mentioned by many (46.5%) of the respondents being a tree species not normally retained on farmland(s), while 24.0% of the respondents mentioned *Mkalakala* (*Ozoroa insignis*) as not normally retained in farms. Of the respondents, (15.0%) claimed that *Mgude* (*Sterculia appendiculata*) is not normally retained in farms, while 14.5% of the respondents said that *Mhwati* (*D. rotundifolia*) is not normally retained in farms.

The study (Table 8) revealed that majority of the respondents (44.0%) were normally not retaining tree species that are believed to consume a lot of water and/do not conserve moisture, while 20.0% of the respondents said that thorny tree species (such as *Mgunga*) are not normally retained and 18.0% of the respondents claimed that tree species that reduced soil fertility were not normally retained on farms. Of the respondents, 14.0% said that tree species that compete with crops for light are not normally retained on farms,

while 12.0% claimed that they normally did not retain trees which compete with crops for soil nutrients.

Through interviews and field observations, the study revealed that people were not retaining tree species in their farmlands that interfere with their livelihood activities and practices; among them thorny tree species were mostly not retained, a practice conceptualised by Tanyanyiwa and Chikwanha (2011) as “selective conservation”. Monela (1995) also found that several indigenous multipurpose trees were retained for fuel wood, building poles, local crafts and for traditional purposes, such as rituals. While a study by Kweka (2004) in East Usambara Mountain Forests found that, 90.0% of the respondents retained wild tree species for various purposes such as improvement of soil fertility and water conservation, firewood, medicine, timbers, fruits and building poles. Another study by Msuya and Kideghesho (2009) in West Usambara Mountains also revealed that 89.0% of the respondents were retaining and/ or domesticating wild tree species in their farmlands for the purpose of reducing their overexploitation or protecting threatened species, and this enhanced the conservation of 780 plants belonging to 46 species.

A study by Tanyanyiwa and Chikwanha (2011) in Marvisango, Mugabe area, Zimbabwe, disclosed that indigenous people conserved some beneficial wild tree species so as to prolong their existence for the products and/services they offer to the community. For example, the authors added that wild trees that are perceived of less significance, such as thorny trees are usually destroyed, while trees that are perceived as being habitats of ancestral spirits were strictly protected, as destroying them meant destroying the habitat of the ancestral spirits that guard and provide for their needs.

Similar to what Tanyanyiwa and Chikwanha (2011) referred to as “selective conservation”, a study in Nepal by Shreshra *et al.* (2010) also disclosed that indigenous silvicultural activities are utilities based, whereas trees whose values are known (such as, timber trees, fast growing and multipurpose trees and medicinal plants) are more likely to be retained at the expense of the less known or less valued trees, climbers and shrubs species (Archaya, 2003 and Baral and Katzensteiner, 2009 cited in Shrethra *et al.*, 2010). Frequent removal of thorny bushes, bushes and weed species is a very common practice in Nepal (Khadka and Schmidt-Vogt, 2008 cited in Shrethra *et al.*, 2010). While such selective conservation favours the survival of the well-known and valued tree species, it results into the decline of the biodiversity species of the less known and/or less valued species (Shrethra *et al.*, 2010). For example, Shreshra (2004) cited in Shrethra *et al.* (2010) reported that *Lobelia pyramidalis*, a rare medicinal tree species has been removed as a weed, and its conservation was a result of people being informed of the importance of the tree.

It is from these findings and literature, this study argues that on-farm tree retaining is a common indigenous practice amongst the Nguu ethnic group, with trees retained being those perceived as contributing to people’s livelihoods strategies and activities. However, such selective conservation can favour decline of the less known and/or valued tree species.

4.2.4 Sacred wild animals and reason(s) for their sacredness

Respondents’ views on the presence of sacred wild animals and plants and reason(s) for their sacredness are shown in Table 9. Results show that most of the respondents (75.0%) agreed on the presence of sacred wild animals in their community, while 23.0% of the respondents said there were no sacred wild animals and 2.0% of the respondents said they

did not know. It was revealed by the study that *Mbega* (*Colubus angelensis*) was mentioned by most of the respondents (84.0%) as being sacred and 18.0% of the respondents mentioned *Gwalangwa* (millipede) as being sacred (Table 9). Of the respondents, 10.0% claimed that *Kunguru* (*Corvus albus*, *C. albicollis*) was a sacred animal only 7.0% of the respondents mentioned *Dondoro* (*Cephalophus harveyi*) as a sacred wild animal.

Results (Table 9) have further shown that most (99.0%) of the respondents expressed that wild animal species that are neither destructive, harmless, nor consumable and those which contribute to people's livelihood strategies are normally considered sacred, and killing such animals has been perceived as a taboo, as such action goes against the god's reasons for creation and management and use of biodiversity. About 13.0% of the respondents said that they did not know why some wild animal species were perceived as sacred, though they believed killing such animals can lead to curse and/or death of an offender or a close relative, and only 4.0% of the respondents said that harmless animals, such as *Galangwa* (millipede), were sacred.

Table 9: Respondents' views on the presence of sacred wild fauna species

Presence of sacred wild fauna species(s)	Frequency (n = 240)	Percentage
Yes	179	75.0
No	56	23.0
I don't know	5	2.0
Total	240	100
Name of sacred wild fauna species (n = 179)		
<i>Mbega (Colubus angelensis)</i>	150	84.0
<i>Gwalangwa (millepede)</i>	27	18.0
<i>Dondoro (Cephalophus harveyi)</i>	10	7.0
<i>Kunguru (Corvus albus, C. albicollis)</i>	15	10.0
Reason(s) for sacredness (n = 179)		
Non-destructive and not consumable	177	99.0
Harmless	7	4.0
Killing can lead to curse and death	23	13.0

Mokuku and Mokuku (2004) contended that some animal species were perceived as being sacred as they have powers to cause certain awesome consequences for humans and are capable to communicate some messages to humans, once seen or encountered, suggesting the existence of complex interactions between physical and spiritual beings of indigenous people with other species. For example, an owl's call is believed to warn about or cause death in the family (Mokuku and Mokuku 2004; Kweka, 2004), while in the food web, it plays a significant role in rats' preying (Mokuku and Mokuku 2004). The authors also found that the pied crows (*C. albus*) are believed to bring good luck, such as one may get money, and therefore favour their conservation. Moreover, among Walegane ethnic group, the Ha tribe, perceive pied crows (*C. albus*) as totemic and sacred, whereas killing it might bring curse or bad luck to the family. Despite *Dondoro (C. harveyi)* being mentioned as a sacred animal, the study and literature show that duckers are some of the most hunted wild animals for bush meat, and can rarely be seen nowadays. Arguably, the animal was

mentioned as sacred either because they were illegally hunted inside the forests, a practice that has been restricted by the forest officers or as a way of trying to hide the facts on the ground.

In summing up the discussion on sacred animals and conservation of biodiversity, Mokuku and Mokuku (2004) put it that association of some organisms with fearsome consequences if destroyed and providence seen or encountered shrouds them with spiritual powers, sacredness and awe, creating a basis for their respect and therefore their conservation.

4.2.5 Presence of sacred wild flora species and reasons for their sacredness

The respondents' views on the presence of sacred wild flora species and reason(s) for their sacredness are shown in Table 10. Results show that most of the respondents (81.0%) agreed on the presence of sacred wild tree species, while only 19.0% of the respondents expressed their ignorance on the presence of sacred tree species in their village. This implies that most of the respondents were aware of the existence of sacred wild tree species in their village. The study further disclosed that *Mvumo* (*Ficus inges*, *F. scassellatii*) was mentioned by most of the respondents (63.6.0%) as a sacred tree species, while 32.0% of the respondents mentioned *Mkuyu* (*Ficus altissima*) and almost 10.0% of the respondents claimed that *Mdala* (*Euclea divinorum*) sacred. Of all the respondents, only 8.0% and 5.6% of the respondents mentioned any big tree/very old trees and *Mnyasa* (*Newtonia buchananii*) as sacred trees respectively.

Table 10: Respondents' views on the presence of sacred wild flora species and thereason(s) for their sacredness

Presence of wild flora sacred species	Frequency (n = 240)	Percentage
Yes	195	81.0
No	45	19.0
Total	240	100
Name of sacred flora species (n = 195)		
<i>Mvumo</i> (<i>Ficus inges</i> , <i>F. Scassellatii</i>)	124	63.6
<i>Mnyasa</i> (<i>Newtonia buchananii</i>)	11	5.6
<i>Mdala</i> (<i>Euclea divinorum</i>)	19	10.0
<i>Mkuyu</i> (<i>Ficus altissima</i>)	63	32.0
Any big tree	16	8.0
Reasons for sacred wild flora species (n = 195)		
Harbours evil spirits and used for traditional practices	118	60.5
Medicinal plants	14	7.2
Improve soil fertility and conserve water	126	64.6
Provide wild fruits	21	10.7
Can lead to curse, sickness and death	82	42.0

Results (Table 10) have further shown that majority (60.5%) of the respondents claimed that tree species that were sacred are believed to be a habitation of ancestral spirits and/or used for traditional ceremonies, while almost 65.0% of the respondents said that those trees that improved soil fertility and conserved moisture and 42.0% of respondents said that sacred trees were believed to cause curse, sickness and death to a person or a close relative if destroyed. Results have further shown that almost 11.0% of the respondents believed that all edible wild fruit trees were sacred and only 7.2.0% of the respondents claimed that medicinal trees were sacred.

The study also observed scattered wild tree species in public lands that are considered sacred, varying in size from very big and probably very old trees to small but very old trees. Moreover, through personal communication it was revealed that in case it is deemed

necessary to cut down such very big/very old trees, some rituals have to be performed as a way of pleasing ancestral spirits for so doing. For example, according to the Maasai ethnic group, trunk of the fallen sacred tree has to be covered by fresh leaves, as a way of pleasing ancestral spirits for cutting such a tree. For example, through stories which could not be confirmed, it was disclosed by the study that, in Pemba village, a sacred tree was once cut all-around its trunk but it did not fall, till it died of old age.

A similar observation was made by Tanyanyiwa and Chikwanha (2011) who found also that very big/very old wild trees were perceived among the Shona/Ndebele ethnic group as being a habitation of ancestral spirits and rainmaking, and are normally used for shade and traditional ceremonies, and therefore have been considered sacred and are protected from any malpractices that will threaten their survival. For example, the authors reported that tree species such as *Burkea Africana* and *Sclerorya* are perceived as sacred, whereas such tree species are not tempered with in any way such as burning or cutting, as it is believed that doing so will detach people from their ancestral spirits; ancestral spirits are believed to use such tree species to reach people.

A study carried out by Msuya and Kideghesho (2009) in West Usambara Mountain Forests found a total of 65 plants belonging to 27 species being perceived as sacred, of which 55 plants, from 22 species had medicinal values. Similarly, Tanyanyiwa and Chikwanha (2011) put it that trees with medicinal values in many cases have survived deforestation, among other mismanagement activities, even in communities in great need of fuel wood. For example, *Ficus sycomorus* L; *Ficus thorningii*, *E. abyssinica* and *Bombax rhodognaphalon* K. Schum tree species were believed as being sacred with medicinal value (Msuya and Kideghesho, 2009).

In extending the discussion on sacred tree species, a study by Tanyanyiwa and Chikwanha (2011) in Mugabe Masvingo area in Zimbabwe revealed that tree species such as *Ficus sycomorus* and *Gardenia Thunbergia* trees were believed to be favoured by rains, hence their mismanagement, in any way it was highly restricted by the custodians of IKS, and such tree species were believed to be associated with rainmaking, and therefore destroying them would disturb the rains expected to fall in the rain season. Similarly, Kweka (2004) also found that wild tree species that are believed to conserve water and bring rainfall are normally restricted from being cut through taboos attached to them. While Msuya and Kideghesho (2009) reported that *Ficus sycomorus* has been perceived being sacred because of its medicinal value, Tanyanyiwa and Chikwanha (2011) reported that the same tree species has been perceived among the Shona/Ndebele ethnic as being sacred because of its association with rainmaking, suggesting existence of different reasons for sacredness of a certain species among different ethnic groups.

Studies have further revealed that wild fruit tree species have been perceived as sacred and have been protected so they might continue to serve the communities; it has been restricted to shake off fruits from a tree or saying anything defamatory about the taste of certain wild fruits (Chiwandamira, 2000 cited in Tanyanyiwa and Chikwanha, 2011). This might be because any defamatory statement about a certain wild fruit would influence its management or abuse gods/ancestors spirits that are believed to be the providers of the biodiversity needed for people's livelihoods. Moreover, first fruits of each season of *marula* and *mazhanje* are considered sacred by the Shona ethnic group, and therefore, permission to harvest them must be sought from the chief, who believed in using the first fruits to appease the ancestral spirits (The Action Magazine, 1997 cited in Tanyanyiwa and Chikwanha, 2011). Fruit trees have been viewed as being part of the indigenous

people's cultural heritage, from which their IKS evolved, was enhanced and sustained (Mukwama, 2000 cited in Tanyanyiwa and Chikwanha, 2011).

Similar to the above findings and literature, an interview with the researcher's uncle: Thabit Madulu in Ulasa "B" village in Urambo District in Tabora in 2009, on why villagers were not replacing the old mango trees with those which produce large fruits that are increasingly being marketed, the uncle replied that as a result of increasing commercialization of the mango fruits, people are normally shaking them off the trees before they mature, hence their seeds cannot germinate, resulting into a decline of the biodiversity.

It is from the above findings and the literature that this study suggests that there is a close correlation among different indigenous ethnic groups that share similar or related ecological contexts, though with different perceptions and taboos attached to the same sacred tree species based on perceived contribution to people's livelihoods. Moreover, the presence of taboos for the use of different species and/or different products of the same tree species among the same members of the same communities based on their socio-economic characteristics or a different ethnic group signifies variations of people's perceptions of the contributions of the tree species to respective people's livelihood within the same community. Apparently, beliefs on sacred trees have significantly contributed to conservation of biodiversity.

4.2.6 The presence of, status and custodians of sacred groves/places

Results on the presence, custodians and status of sacred groves/places are shown in Table 11. Results have shown that most (93.3%) of the respondents appreciated the presence of sacred groves/place(s) in their communities, while 6.3% of the respondents said there were

no sacred groves/places in their community and only 0.4% of the respondents expressed their ignorance on the presence of sacred groves in their village. This implies that most of the respondents were appreciating the existence of sacred groves/places in their respective village. This study observed several sacred groves/places in all the villages, and the respondents who claimed that there were no sacred groves/places in their village might be have been influenced by other factors; the sacred groves/places were obvious, though were being less respected.

Table 11: Respondents' views on the presence, status of and custodians of the sacred groves and/places

Presence of sacred groves and/places in the village	Frequency (n = 240)	Percentage
Yes	224	93.3
No	15	6.2
I don't know	1	0.4
Total	240	100
Perceived custodian of sacred grove and /place (n = 224)		
<i>walukolo</i>	173	77.0
The village government	7	3.0
<i>walukolo</i> and village government	42	18.0
None	2	9.0
Size and density of the sacred groves as of the past 20 years (n = 224)		
Are of the same size(s)	59	26.3
Have decreased	98	43.7
Almost extinct	66	29.4
I don't know	1	0.4
Total	224	100

A similar argument was given by Tanyanyiwa and Chikwanha (2011) in their study observed that only 3.3% of the respondents were ignorant of the existence of the IKS in their area, being a result of personal discrimination, whereby indigenous issues are not regarded as being important. In a similar view, quoting Le Roux (1999), Zazu (2007) put it very clearly that indigenous people have not accepted the usefulness of their knowledge system, and a person or a community mostly relying on the knowledge system is considered inferior (Ocholla, 2007; Zazu, 2007).

Results (Table 11) show that most (77.2%) of the respondents said that sacred grove(s) were under the management of *walukolo* (indigenous leaders, elders in most cases), while 18.4% of the respondents said that sacred groves/places were managed by both *walukolo* and the village's government officials. Results further show that 3.1% claimed that sacred groves were managed by their village government and only 0.8% of the respondents said sacred groves/places are under the management of no one. According to PEMA (2006) conservation of sacred groves and/places have been an historical practice of the Nguu ethnic group, mostly under the custodian of heads of the clan (*mlukolo* in Nguu language, meaning a head of people sharing common norms, values and practices). Steiner *et al.* (2004) cited in Hens (2006), put it that despite sacred groves being biodiversity reservoirs, they were ignored by governments, conservation agencies and policies, so their survival rested on the hands on the indigenous people.

According to PEMA (2006) sacred groves/places have been devoted for worship, rituals, tribal ceremonies and cemeteries. It is worth noting that among the Nguu ethnic group, there are several clans, each identifying itself with their sacred places/groves, totemic species, their clan leaders, to mention just a few. Plate 3 shows one of the sacred groves, in public land.



Plate 3: A sacred grove in public land in Maskati village of the South Nguru Mountain Forest Reserve

Arguing on existence of indigenous leaders and gods amongst indigenous communities, Claridge (1964) cited in Saj, Martha and Sicotte (2006) put it very clearly that gods of the Gold Coast (Ghana) are local or individual, and their sphere of influence varies from the District, a single community, families or individual. The author further added that it has been perceived as foolish for someone to worship the local gods of another District who are too far away either to help or influence. This implies that there is spiritual connectedness amongst members of the same ethnic group, with different spheres of influence, ranging from individuals to community (ies) level(s).

In highlighting of the role of the indigenous elders (*lukolo*) a study by Kweka (2004) in East Usambara Mountain Forests also found that despite the abolishment of chiefdoms in

Tanzania after independence in 1961, there are still indigenous forms of leadership, whereas elders who are conversant with the IKS were responsible for leading and directing various indigenous activities in their society, such duties among others included setting of indigenous rules, customs and taboos and organization of rituals and punishing of offenders of their knowledge system, thereof determining humans-biodiversity interactions. In furtherance of this fact, a study in Ghana by Saj, Martha and Sicotte (2006), using the term the priest, unveiled that a priest was responsible for the enforcement of the taboos in the village.

Quoting Luoga *et al.* (2000), Kweka (2004) pointed out that experience from all over the country, has shown that burial sites are normally considered sacred places, and in most cases are kept under complete tree canopy and even dead wood is not collected from such areas. Through personal communications, it was revealed by this study that cutting trees in burial places would leave the ancestral spirits under direct sun, showing disrespect for the powers of the ancestral spirits which are the providers and protectors of the people. In his study, Mapara (2009) reported that the indigenous teaching among the Shona ethnic group was normally, through proverbs, normally starting with the words “Vakuru vedu vanoti”... or “Vakulu vedu vaiti” (“our elders used to say or “our elders said), whereas Vakuru implies either the dead or the elders who are knowledgeable/or were knowledgeable on IKS. This further shows that indigenous people believe on the existence of spiritual connectivity between human and their ancestral spirits, and going against elders’ teachings implied going against the will of ancestral spirits that might lead to bad omen.

Similar to what was reported by Kweka (2004) in Muinga and Ukindo peak in the Mlinga forest, this study also found that on top of *Mlima Mteke* in Mndela Village, which is a ritual place, there is believed to be a big and deep pond/dam that possesses spiritual

powers, and anyone climbing to the peak, except for ritual purposes, would drown in that dam, and will never be found. To date, such a belief is strongly held amongst people of the community.

Kweka (2004) concluded that the IKS prevents overutilization of the biodiversity, through restrictions on the use of certain species of plants, animals and places, showing the important role played by the knowledge system on decision making pertaining to the management and uses of biodiversity. In his study in Udzungwa, Mbwapbo (2000) found the so called Bokela, perceived by the locals as a “Mountain of God”, to whom sacrifices in times of droughts, diseases and famine have been offered by the indigenous people living around the place. Only the elders were allowed into the Bokela for prayers and offering sacrifices. The author further found that graves inside the Bokela were also considered sacred, and trees which are used for marking graves are not used for any other purposes. It is also believed that collection of products from this place is an invitation of evil spirits and may instigate calamities such as famine, floods or death. Grave forests in Ghana are protected as respect for the dead, as it is believed that the ancestral spirits live there, and entrance in those places is limited to certain members of the community such as the royal family members, village leaders and clan heads during burial purposes, resulting in conservation of biodiversity in such places (Ntiamou-Baidu, 1995 cited in Mbwapbo, 2000).

It was also reported by Mbwapbo (2000) that Bokela the “Mountain of God” was currently dormant with no sacrifice practices, and it is reported this was a result of increased population, westernization and immigration of other people who did not value and respect the IKS of the respective place, resulting into limited continuity of IKS.

Reporting on the status of the scared grove(s)/place(s) as of the past 20 years (Table 11), majority of the respondents (43.7%) claimed the size of scared groves had decreased and almost 29.4% of the respondents said that sacred groves were almost extinct. Of all the respondents, 26.3% said that size of sacred grove(s)/place(s) had remained the same, as of the past 20 years, and only 0.4% of the respondents said they did not know. Through FGDs and personal communications the study disclosed that some of the heads of clans (*lukolos*) were responsible for the destruction of their own clans' sacred grove(s) through encroachment for agricultural activities. It was further observed that some pieces of land which were previously restricted from farming, called *ng'alimwa* in Nguu language (meaning places that should not be farmed), have been converted to farmlands particularly in Maskati and Kwelikwiji villages, while in Pemba, encroachment was done by other members of the community. This study also revealed an ambiguous case involving a farmer and one of the *lukolo* on encroachment of the sacred grove by the former, whereas, bureaucratic legal systems have been favouring the farmer despite the support of the village system on the rights of *mlukolo* on the sacred grove. A similar conflict was also reported in Usambara Mountain forests by Ylhäisi (2006) who found that encroachment of sacred groves for agricultural purposes, fetching of fuel wood and valuable timber trees species led to a decrease in size and densities of most sacred groves and biodiversity decline at large. Jaryan *et al.* (2010) concluded that although sacred groves are not restricted to any particular place or community, they are well distributed across the globe and vary in size from few hectares to square kilometres, but unfortunately they are fast disappearing as a result of the influence of rapid socio-economic transformation and materialistic attitudes of the people that lead to the overutilization of the biodiversity.

According to Dash (2005) cited in Jaryan *et al.* (2010), sacred groves refer to patches of forests conserved through human's spiritual beliefs and faith. In furtherance of the

perception of the sacred groves, Ylhäisi (2006) refers to sacred forests/groves as those forests/groves that have been conserved by pre-colonial indigenous institutions and spiritual structures. The author added that sacred groves are believed to be inhabited by supernatural powers which influence the life of the people living in the area, and where ritual practices take place to strengthen the harmony between living people and supernatural powers, acting on behalf of the dead ancestors on one hand and the unity among the people themselves on the other hand. According to Ylhäisi (2006), sacred groves/places are believed by the *Batak* leaders in Palawan in Philippines, to be sources of gift of games given to the community by their ancestors, and their destruction has been prohibited to avoid destruction of the harmony of their livelihoods and the home of their ancestors.

In summing up the discussion on the presence of the *lukolo*, quoting Kajembe *et al.* (2010), Shemdoe (2003) pointed out that all over Tanzania there are indigenous leaders who are responsible for the formulation and enforcement of taboos, norms and rules which, among others, determine the interaction between humans and other biodiversity. This suggests that there exists custodians of the IKS amongst indigenous communities who are responsible for formulation of taboos, norms, leading their community in worship and ritual activities, just to name a few, but being given different names.

4.2.7 The Nguu ethnic groups and sacred groves and/or places

Results on different Nguu ethnic groups and their respective sacred groves/or places are presented in Table 12. This study revealed the existence of a total of 27 sacred groves/places with a total estimated area of 47.5 ha, managed mostly by 9 Nguu clans. The study (Table 12) further found out that the biggest sacred grove was 4.8 ha, while the smallest grove was 0.05 ha in size, with a mean size of sacred grove being 1.8 ha.

Table 12: The Nguu ethnic groups' sacred groves/places in the study area

Name of the village	Name of the sacred grove/place	Estimated size (Ha)	Custodian clan
Maskati	Mpeelee (Kwentingu)	4.0	Wanyagatwa
	Magole	2.0	Wanyagatwa
	Manyasa	1.6	Wanyagatwa
	Disalaza	0.8	Wanyagatwa
	Mazinde	0.8	Wanyagatwa
	Sub total	9.2	
	Pangai	1.2	Waganaza
Total	Gombero	0.05	Wafati
		10.45	
Mndela	Kochamazi	0.8	Wasongo
	Kwedimongo	1.2	Wasongo
	Mlima Mteke	2.0	Wasongo
	Total	4.0	
Pemba	Finta	4.0	Wasongo
	Nyanyiunga	1.8	Wasongo
	Mkunvuru	2.4	Wasongo
	Sub total	8.2	
	Kwevirango	4.4	Wanyasa
	Heviziwa	4.8	Wanyasa
	Mgoroka	2.0	Wanyasa
	Sub total	11.2	
	Khwarike	1.2	Waruwi
	Msente	0.4	Waluhanga
	Kwevilulu	0.8	Waluhanga
	Kikangazi	1.6	Waluhanga
	Sub total	2.8	
	Mheza	2.8	Kilangulu
	Rwinyi	1.2	Kilangulu
	Kimwege	2.4	Kilangulu
	Sub total	6.4	
	Vikinga	1.6	Wakwigina
	Gereza	1.6	Wakwigina
	Mapalamba	1.2	Wakwigina
	Sub total	4.4	
	Total	33.0	
Kwelikwiji	Luamba	0.05	Wanyagatwa
Grand Total		47.5	

Results (Table 12) show that in Maskati village there are 7 sacred groves with estimated sized of 10.45 ha, managed by three clans, Wanyagatwa (9.2 ha), Waganaza (1.2 ha) and

Gombero (0.05ha). Results (Table 12) show that Mndela village is dominated by a single clan, Wasongo, managing a total of 3 sacred groves, with a total of 4 ha. Results also show that in Pemba village there were a total of 16 sacred groves managed by six clans, Wasongo (8.2 ha), Wanyasa (11.2 ha,) and Kilangulu (6.4 ha). Others include Wakwigina (4.4 ha), Waluhanga (2.8 ha) and Waruwi (1.2 ha). Table 12 shows that in Kwelikwiji village, Mndela village is dominated by a single clan, having a single a sacred place, Luamba ritual site with an estimated size of 0.05 ha, that was under the custodian of Wanyagatwa. The study further disclosed that some of the clans were dominating more than one village, and therefore the indigenous territories were not conforming to government village demarcations.

The study further revealed that the Maasai have sacred groves/or places, and like the Nguu ethnic group, perceive biodiversity as being sacred, probably because of their forest-livestock relationships. Furthermore, traditionally, the Maasai do not hunt or consume wild meat and are less involved with forest clearance for agricultural purposes. It was further revealed by this study that the Maasai used to perform annual rituals, praying for health and wishes, though currently they are no longer practiced, as most of them prefer to sell their healthy cattle rather than to offer sacrifices for the ritual. This finding is supported by the study by Shemdoe (2003) in Lake Manyara National Park that revealed that the Maasai ethnic group had their indigenous leaders referred to as *laiguanan*. These were those acquainted with their clan culture, and mostly respected in terms of their decisions, rules and regulations on the management and use of biodiversity, among others.

Arguing on variations in sizes among different clans, a study by Ylhäisi (2006) reported on existence of great variation in size and density of sacred groves among different *lukolos* within and between villages, among different communities like the Zigua, Gweno and

Pare ethnic groups. Arguably, such variations in size and density of sacred groves, among other reasons, might be attributed to differences in the degree of social solidarity exercised by a particular clan and on the presence/absence of the responsible head of a clan (*mlukolo* in Nguu tribe) to manage the use of the clan's sacred grove(s)/place(s) (Ylhäisi, 2006). Similarly, Kweka (2004) and Msuya and Kideghesho (2009) observed that dominance of a certain ethnic group in a particular area determines their strengths in the emphasis of their indigenous knowledge for the conservation of biodiversity, and sacred grove(s) being part of it. Along a similar view, Ylhäisi (2006) found that participation of all members of a clan has been emphasized as it has been believed that absence of some members will make the ritual not function and may affect the well-beings of members of the clan, a belief that has been fostering social solidarity between members of the clan, thus significantly contributing to the management and use of sacred grove(s) and/or place(s).

As it was pointed out earlier in this study that the Nguu and Zigua ethnic groups are closely related in their culture, norms, values and language, a study by Ylhäisi (2006), revealed that for the Zigua, the first clan to settle in an area, established a new community (a clan), a *lukolo* (in both Zigua language and Nguu languages) responsible for the conservation of the sacred groves, ritual practices and enforcement of the IKS, among other duties. The *lukolo*, is mainly based on having a common ritual place, and not necessarily having blood relation (Oppen, 1992 cited in Ylhäisi, 2006). Similarly, Kideghesho (2009) in his study in Western Serengeti also found that the Ikoma, Kurya and Natta ethnic groups have been divided into several clans called Ebhehita, *lukolo* in Nguu language; each ethnic group being symbolized by a specific totemic/sacred tree and/ or animal species.

It is from the findings and literature this study argues that sustainability of sacred groves and/places that have been widely reported to comprise of high biodiversity values, mostly rests on the hands of the *walukolo*, in a context of increased external and internal pressure for their encroachment.

4.2.8 The status of teaching and learning indigenous knowledge system

Results on respondents' views on the teaching and learning of IKS are shown in Table 13. This study disclosed that most of the respondents (88%) claimed to have been taught IKS for the conservation of biodiversity, while only 12% of the respondents claimed that they had not been taught. Arguing on the indigenous teaching and learning of indigenous knowledge, Zweifel (1997) put it that the IKS has been formally passed on between family members, from elders to youth and the community at large, through teachings and practices.

Results (Table 13) have shown that most of the respondents who were taught IKS for the conservation of biodiversity, 77.5% were still passing on the knowledge system to their descendants, while 22.5% of the respondents said they did not pass on the knowledge system to their descendants. Using simple statistics of the teaching and learning status to date and of the past 20 years, results reveal that there is a decrease in passing on of the IKS by 11.5% and an increase by 10.5% of the people who are no longer passing on the knowledge to their descendants, indicating decline of the knowledge system and of the people knowledgeable on the same. In favour of these findings, a study by FBD (2005) also observed that the IKS that restricted access to the South Nguru Mountain Forests Reserve has been declining as a result of immigration.

Table 13: The status of learning and teaching of indigenous knowledge system

Response items	Frequency (240)	Percentage
Been taught on IKS for the management and use of biodiversity		
Yes	211	88.0
No	29	12.0
Total	240	100
Teaching of descendants the IKS for the management and use of biodiversity		
Yes	186	77.5
No	54	22.5
Total	240	100
Topics of IKS teaching on the management and use of wild animals (n = 186)		
No killing of non-destructive and non-consumable	133	71.5
No use of non-selective animal traps	30	16.1
No killing of female animals	2	1.0
Hunting for home consumption	2	1.0
Total	187	100
Example of indigenous knowledge teaching on wild plants (n = 186)		
No encroachment of sacred groves/natural forests	127	68.2
No use of wild fire and fire management techniques	64	34.4
No cutting of very big/very old trees	54	29.0
Rituals for rainfall formation and after harvests	9	4.8
Reason for not teaching IKS (n=54)		
The youth perceive IKS as an obstacle for their economic gains	30	55.5
IKS is perceived being outdated	8	15.0
Limited knowledge to pass on	47	87.0

Results (Table 13) have also shown that most of the respondents (71.5%) said that they were still teaching their descendants non-destructive and non-consumable wild animals were restricted from being hunted and 16.1% of the respondents claimed to be teaching their descendants in restriction to the use of non-selective animal traps. Results have further disclosed that only 1.0% of the respondents were teaching their descendants not to hunt female animals and hunting should be for subsistence use. Through personal

communications, it was revealed by this study that killing of a wild animal that does not interfere with people's livelihood strategies and those which are not consumable was perceived as a taboo; killing for no reason is going against the gods/ancestors reasons for creation. Apparently, the use of non-selective animal traps have been discouraged as they may catch tabooed and/or totemic species, leading to curses and/death to an offender(s) or their close relative(s), just to name a few.

This study further revealed that restrictions on hunting of female wild animals and hunting for subsistence uses was based on the idea that while female animals were mostly important for the continuity of their species population that was important to support people's livelihoods: it may happen that a pregnant animal gets killed, resulting to the death of unborn(s). Likewise, hunting for subsistence use has been emphasised by the indigenous people, as a way of avoiding excessive hunting for commercial purpose, threatening continuity of the supply of the wild meat. In favour of these findings, Kideghesho (2008) put it that indigenous conservation regulations such as hunting of adult and male animals and restriction of hunting wild animals during the breeding seasons have been common indigenous practices and have contributed to conservation of biodiversity, among indigenous communities.

On enquiring on the IKS teaching related to conservation of wild plant species, results have shown that majority of the respondents (68.2%) passed on of the knowledge system to their descendants on taboo for encroachment of sacred groves (the South Nguru Mountain Forests Reserve was previously perceived sacred) and 34.4% of the respondents claimed to be teaching their descendants on avoidance and control of wildfire. Of all the respondents, 29.0% said that they taught their descendants that very big/very old trees were the habitation of ancestral spirits and therefore sacred trees, whereas only 4.8% of

the respondents claimed to be passing on rituals performance for rain formation and for thanks giving after a good harvest. Arguing on the indigenous knowledge nexus wildfire, Kweka (2004) found that in a village where wildfire often occurred, people expressed their awareness on the existence of indigenous rules that prohibited the use of fire as a tool for hunting, while in a village with less wildfire occurrences, people expressed their ignorance on the existence of indigenous restrictions on the use of wildfire. This might be due to the fact that the IKS is normally evolved to address local problems resulting from human - biodiversity interactions.

It was further revealed by this study that it is believed by some people in Kwelikwiji village that the 1988 El Nino occurred in the country as a result of the rain rituals performed at the Luamba sacred place, after a long severe drought. Some respondents also explained that a *mlukolo* was commanded by ancestral spirits to return from Dar es Salaam immediately for the rain ritual performance. Unexpectedly, he added that he received all the money from the people who owed as him per ancestors' instructions, so he could immediately return home for the ritual. It is from this example, three points can be derived: firstly, there is a belief amongst indigenous people, that ancestral spirits communicate with people in various ways, such as night talks, dreams and signs; secondly, people believed on ancestral spirits power in helping them, and lastly, it expressed the degree of obedience of the people to their ancestors' spirits.

Results (Table 13) have further shown that most of the respondents (55.3%) were not passing on IKS for conservation of biodiversity to their descendants as a result of their limited knowledge, while 87.0% of the respondents said that they were no longer passing the knowledge system since the knowledge was currently perceived mostly by youth as an

obstacle for their economic well-being and almost 15.0 %of the respondents informed that they did not pass on the knowledge system as perceived by the youth being outdated.

The study further disclosed that the ritual for rainfall in Kwelikwiji village was lastly performed in 1988, implying that an indigenous person aged between 23 and 30 years has not witnessed a rainfall ritual practice or even be able to explain how the practice is performed. Similarly, Ylhäisi (2006), in their study in Usambara Mountains found that rituals and male initiation rites were lastly performed in the last 30 years; currently, many of the respected sacred sites have no ritual makers or even a person who knows how to perform them. This implies that there is a decline of the IKS for the management and use of biodiversity which was to be passed on to the youths, further accelerating the knowledge system decline.

According to Zweifel (1997), the IKS is less put into practice as a result of biodiversity decline, limiting the teaching and learning from one generation to another. Moreover, breakdown of indigenous social structures and networks, spearheaded by devaluation of the knowledge system have further limited the teaching and learning of the knowledge system (Zweifel, 1997). Citing Abromvitz (1994), Zweifel (1997) argues that, because parents spend more time on outside activities, transmission of the IKS to their descendants has become increasingly limited.

Based on these findings, this study argues that indigenous communities such as the Nguu ethnic group have had their indigenous knowledge for conservation of biodiversity, increasingly declining as a result of a decrease in passing it on to their youths.

4.3 Demographic and Socio-economic Characteristics of the Respondents and Compliance with the Indigenous Knowledge System

4.3.1 Respondents' views on the relationship between sex and compliance with the indigenous knowledge system

Results on the respondents' views on the relationship between sex and compliance with the IKS for conservation of biodiversity are shown in Table 14. Results show that most (62.0%) of the respondents claimed that compliance with the IKS for the management and use of biodiversity varies with sex of an individual, while only 38.0% of the respondents objected to the existence of the link between compliance with the IKS and sex of an individual. Of the respondents who argued for the link between compliance with the IKS and sex of an individual, 90.5% asserted that men were less compliance with the IKS's penalties, while 5.4% said that women were less compliance with the IKS, and only 4.0% claimed that women were mostly compliance with the indigenous penalties.

Table 14: The respondents' views on the relationship between sex and compliance with the indigenous knowledge system

Response item	Frequency (n =240)	Percentage
Existence of relationship between sexes compliance with the IKS		
Yes	148	62.0
No	92	38.0
Total	240	100
Reasons for the difference between sex on compliance with the IKS (n= 148)		
Men are less compliance with the IKS penalties	134	90.5
Women are mostly compliance with the IKS	6	4.1
Female are less compliance with the IKS	8	5.4
Total	148	100

Likewise most African indigenous societies, as with the Nguu ethnic group, regard man as the breadwinner for the family, although in actual fact it may not be the case. In such a belief the man is responsible for providing for his family, with a division of same duties at family and society levels. For example, a study by Mbwambo (2007) in Uluguru Mountains disclosed that women and children were mostly involved in the production of food crops, while their male counterparts were engaged in the production of cash crops, probably, because a man is perceived as the breadwinner of the family. In furtherance of the sex-based division of labour and management and use of biodiversity, Zweifel (1997) put it that there variations in priorities among men and women, resulting into the use of different species or different products of the same species, and sex-based division of labour among other factors; determining access to resources or interest in resource management (Joeke *et al.*, 1996 cited in Zweifel, 1997). Likewise, a study by Augustino (2006), in Urumwa forest observed that women were actively involved in domestication of plants at homesteads, while their male counterparts were mostly involved in harvesting

and decision-making on issues related to the protection of the forest reserves and its resources. The author further added that such sex-based division of labour and responsibilities were influenced by the socio-economic and cultural aspects of the community.

It is worth to reiterate that the South Nguru Mountain Forest Reserve has been perceived as sacred, and a permission to enter the forest had to be sought from *walukolo* (elders of the clan/the community), otherwise a bad omen would happen to the offender or his/her close relative(s). Similar findings were also reported by Mbwambo (2000) and Kweka (2004) that the Udzungwa and East Usambara natural forests were perceived as sacred, with some taboos favouring conservation of biodiversity in place. For example, while in East Usambara, Kweka (2004) found that the Mlinga Forest Reserve was perceived as sacred by the indigenous people, whereas ritual practices had to be performed for a safe entrance and exit from the forests; otherwise a safe return was uncertain. A study in Udzungwa Mountains forests by Mbwambo, (2000) also found that the Bokela Mountain forest was perceived as being the mountain of gods among people living adjacent to the forest, and only the elders were allowed into the Bokela Mountain forest for prayers and offering of sacrifices.

According to PEMA (2006), and DIIS (2007), encroachments of the South Nguru Mountain Forest Reserve have been mostly for the production of cash crops which include, but not limited to, cardamom, coco yams and cocoa. Other illegal activities inside the forest reserve included pit sawing, hunting and charcoal making, most of them being perceived as male activities. Arguing on sex-based division of labour, Mbwambo (2007) put it that in most cases men were responsible for heavy work including clearance of farmland/forests, slashing and burning. As it was reported in this study (in section 4.1.8 of

this chapter), for Nguu ethnic group, land is inherited mostly through the patrilineal system, putting most of land and of the sacred groves/places being under the custodian of men, which implies that decisions on the use or disposal, just to mention a few, rest mostly upon men.

The study by Kweka (2004) in East Usambara Mountain Forests also disclosed that in the patriarchal land tenure system, decision on either to plant or retain trees seemed to be dominated by men. Arguing on IKS and sex, Zweifel (1997) put it that, in most cases, women had significant experience in sustainable management and use of biodiversity; avoided overuse of the supporting ecosystem, and cared for and conserved a wide spectrum of biodiversity.

It is from both the findings and literature, this study argues that men were less complied with to the IKS compared to their female spouses: prior entry permission into sacred groves/forests, the South Nguru Mountain Forest Reserve is among them, has to be sought from *walukolo*. The study observed increased encroachment into the forest reserve mostly for production of cash crops, hunting, timber, mostly being informal male activities.

4.3.2 Respondents' views on the relationship between household level of income and compliance with the indigenous knowledge system

The respondents' views on the relationship between household's level of income and compliance with the IKS are shown in Table 15. Results have shown that most of the respondents (62.0%) claimed that compliance with the IKS varied with household's level of income, while 35.0% of the respondents said that there was no such a relationship and only 3.0% of the respondents said they did not know. Of the respondents who said there was a relationship between household level of income and compliance with the IKS,

85.1% expressed their view that in most cases, economically well-off households were non-compliance with indigenous restrictions and perceived the IKS as an obstacle: the IKS was founded on the subsistence livelihood. Moreover, the economically well off households were capable of meeting costs of encroaching sacred groves/places and/forests, such as offering a black goat/sheep, or paying government fines or bribes. However, the claim of bribery could not be confirmed.

Results (Table 15) have also shown that 9.4% of the respondents claimed that households with less economic wellbeing were the abusers of the IKS as they mostly encroached into sacred groves and/places and in natural reserve for their survival, and only 5.5% of the respondents said that better off households were more compliance with the IKS as they were mostly satisfied with their economic wellbeing.

Table 15: Respondents' views on the relationship between income and compliance with the indigenous knowledge system

Existence of relationship between household level of income and compliance with the IKS	Frequency (n = 240)	Percentage
Yes	148	62.0
No	85	35.0
I don't know	7	3.0
Total	240	100
Reasons for the relationship between Income and compliance with the IKS (n = 148)		
Economically well off household's aim for more economic gains	126	85.1
Those with less economic wellbeing disobey IKS to make a living	14	9.4
Economically well off households were satisfied with their status	8	5.5
Total	148	100

Through FGDs, this study further revealed that the term "renting of farmland(s)" inside the South Nguru Mountain Forest Reserve was mentioned by most of the respondents, implying that some economically better off households were virtually renting farmland

inside the South Nguru Mountain Forest Reserve, through “annual payment of fines” to either village government and/ or the Forest and Bee-keeping Division officers.

It is worth to note that in most cases indigenous people have been considered comparatively poor to other members of the community, a fact that may be associated with the subsistence livelihood strategies and practices that have enabled them to live in harmony with their supporting ecosystem. In linking indigenous livelihood strategies and activities and income, Mutta *et al.* (2009) and DasGupta (2011) argued that indigenous livelihood that have been perceived by market-oriented economy as being less profitable, have been helpful in attaining environmental sustainability, such as sustainable conservation of biodiversity. Citing Luoga (2000), Kweka (2004) reported that before the colonial era, consumption of natural resources among indigenous people was mainly for domestic uses, with elders guiding the society, whereas emergence of the trading class in a communal society was attributed to those traders increasingly seeking exploitation of biodiversity, irrespective of their politico-religious roles (Mukamuri *et al.*, 1999 cited in Mbwapbo, 2000). In light of this, Ylhäisi (2006) also added that introduction of cash export crops production had indirect ecological and social impacts, whereas social differentiation among indigenous communities which mostly relied on production for subsistence, has resulted into the breakdown of indigenous rules regulating land tenure, production and distribution on a sustainable basis. After the breakdown of the indigenous political leadership system, people began to compromise their indigenous conservation practices in favour of economic growth and social differentiation amongst indigenous people (Ylhäisi, 2006).

Arguing on the link between income and biodiversity, Boaten (1998) put it that the problem of biodiversity decline in most of the indigenous communities has been

spearheaded by the introduction of the market economy through cash crop farming, among others. For example, McNeely (1990) cited in Jaryan *et al.* (2010) found that the indigenous conservation practices such as worshipping certain tree species and felling of only dried trees, which once helped in conservation of biodiversity are slowly breaking up mainly because of commercialization and short-term economic benefits.

Poverty has been compelling indigenous people to change from traditional subsistence economy to commercial economy, leading to increased pressure on natural systems and altering social structures that generate, safeguard and enhance IKS, leading to decline of IKS and the ecosystems they used to conserve (Oviedo *et al.*, 2007). For the example, household level poverty compels people to knowingly destructing their ecology to make their living (Loibooki *et al.* 2002, Kideghesho *et al.*, 2005; Himmelfarb, 2006 and Kingazi *et al.*, (2008) cited in Kideghesho, 2009), thus, being less compliance with their IKS. For example, some people do sell animal species which are taboo to other people, to whom such animal species are not taboo (Kideghesho, 2009). Similarly, a study by FBD (2005) also reported that availability of markets for timber and poles has triggered big forest disturbance in the South Nguru Mountain Forest Reserve.

In summing up the discussion on the relationship between poverty and biodiversity decline, Chaudhary, Aryal and Bawa (2007) put it very clearly that poverty-led pace biodiversity decline, in scale, presents lower impact and is easily recoverable compared to non-poverty led biodiversity decline. The non-poverty led biodiversity decline is a result of commercial production, while poverty-led biodiversity decline is a result of people production for their survival. The author further elaborated that the poverty-led decline was being the compulsive, while the non-poverty biodiversity decline was a motivation-driven coerce.

This study therefore argues that income was both, a push and a pull factor to people's compliance with their IKS which determined human's interactions with ecosystem. As a pull factor, economically better-off households strive for more economic gains and as a push factor; poverty does compel economically poor households to deliberately abuse their IKS in order to make a living. Chaudhary, Aryal and Bawa (2007) put it that in order to address both poverty-driven and the non-poverty driven biodiversity decline, it was necessary to supporting the poor with alternative sources of livelihood, and to make the consumption pattern of the better off people judicious and sustainable.

In keeping with the Chaudhary, Aryal and Bawa view's, FBD (2005) recommended that poverty alleviation has to be an agenda in actions of conserving biodiversity hot spot areas, through supporting livelihood strategies that reduce human dependence on natural forests. However, contrary to this view, Korhonen (2009) argued that economic alternatives to indigenous people would not automatically contribute to conservation of biodiversity, as biodiversity has more than mere economic value amongst the indigenous people, but also spiritual, religious and magnificent value.

4.3.3 Respondents' views on the relationship between formal education and compliance with indigenous knowledge system

The respondents' views on the relationship between household's level of formal education and compliance with the IKS are shown in Table 16. Results have shown that half (50.0%) of the respondents indicated that compliance with IKS varied with the level of formal education of an individual, while 49.0% of the respondents claimed that there was no relationship between compliance with the IKS and level of formal education of an individual and only 1.0% of the respondents said they did not know. Results have further

shown that, of the respondents who indicated existence of the relationship between compliance with the IKS and the level of formal education, 63.3% said that in most cases, people with formal education perceived the IKS as outdated, while 28.3% of the respondents claimed that those with formal education are mostly compliance with IKS as they know the significance of biodiversity and only 8.3% of the respondents said that those with no/less formal education were mostly respectful and compliance with the IKS compared to those with formal education.

Table 16: The Relationship between formal education and compliance with the indigenous knowledge system

Existence of relationship between one's level of formal education and compliance with the IKS	Frequency (n = 240)	Percentage
Yes	120	50.0
No	117	49.0
I don't know	3	1.0
Total	240	100
Reasons for the relationship between formal education and compliance with the IKS (n = 120)		
The educated perceive the IKS being outdated	76	63.3
Those with no formal education rely mostly on the IKS	10	8.3
Those with higher level of formal education respect the IKS	34	28.3
Total	120	100

Mbwambo (2007) argued that, in most cases, rural areas of Tanzania were occupied by people with low level of formal education, as those with better formal education do normally migrate to urban areas looking for formal employment. In fact, education enhances people's ability and awareness of various aspects (URT, 2003 cited in

Mbwambo, 2007), such as conservation of biodiversity. Moreover, formal education influenced innovation-decision process, and adoption of innovations by an individual (Yaron, *et al.*, 1992 cited in Ruheza, Tryphone and Khamis., 2012), such biodiversity conservation methods. Arguably, the increase in adoption of new innovations as the level of formal education increase results into decline in compliance with the IKS.

In further examining the link between compliance with the IKS and the level of formal education, Zweifel (1997) put it that the IKS has been declining because the formal education system influenced the youth to perceive their IKS as primitive. The new generation is mostly exposed to the scientific education system at the expense of the IKS and anyone practicing the IKS is perceived as being outdated and primitive (Msuya, 2007). That is why people with good quantity and quality of IKS normally have the least scientific education (Cunningham, 1991 cited in Zazu, 2007). Greiner (1998) cited in Tanyanyiwa and Chikwanha (2011) also added that the scientific education system has been contributing to the decline of the IKS through harmonizing the world's culture, resulting into dilution of the indigenous cultural system which has been generating and safeguarding the former, resulting into incomplete knowledge base. For example, Sarfo-Mensah *et al.* (2007) in their study in Ghana and Parkin (1972); Githito (1988) cited in Mutta *et al.* (2009 and Mutta *et al.* (2009) in their studies in Kaya forests in Coast Region of Kenya, revealed that increased encroachments of sacred groves, one of several components of IKS, has been a result of introduction of formal education resulting into decline of IKS of the biodiversity richness of the groves.

According to Sthreshra *et al.* (2010) most of the indigenous knowledge on medicine has declined as a result of adoption of modern medicine, making the medicinal plants to be perceived as valueless by the newer generations. The authors further noted that species

preference varied between the elite and non-elite (based on the western view of elite), whereas plant species that were mostly preferred by the elites were mostly retained in community forests. In fact, the IKS that determined humans' interaction with biodiversity was not spared from the same trend of decline, as a result of adoption of modern innovations.

It can generally be argued that there has been a win-lose relationship between compliance with the IKS and of individual level of formal education. In light of this, a study by Msuya (2008) revealed on the existence of conflict of interest among sons and daughters of Sambaa and Zigua medicine men and women, on whether to abandon western education or become a traditional medicine man or the vice versa; whereas the IKS has been labelled as valueless, barbaric, pagan and primitive, spearheading its decline, while it has significantly contributed to conservation of biodiversity.

4.3.4 Respondents' views on the relationship between household farm size and compliance with the indigenous knowledge system

The respondents' views on the relationship between household's farm size and compliance with the IKS are shown in Table 17. Results show that most (70.0%) of the respondents claimed that compliance with IKS varied with household's farm size, while 29.0% of the respondents said that there was no relationship between the size of household's farmland and compliance with the IKS and only 1.0 % of the respondents expressed their ignorance on the relationship.

Of the respondents who claimed that there was a relationship between compliance with the IKS and household's farm size, 57.0% argued that households with large farmland are normally economically better off; they produce commercially, and have financial capabilities to deal with penalties for abuses of the IKS, while 34.0% said that households

with smaller farmland are mostly involved in encroachment into the South Nguru Mountain Forest Reserve and abuse of the IKS to expand their farmland and diversify sources of their income. Of the respondents, 5.0% claimed that generally, households with small farmland are normally poor, and agriculture is their major economic activities, therefore, they were perceived as concerned by the indigenous punishments, and 5.0% of the respondents claiming that and those with large farm sizes were satisfied with their farm sizes and higher economic status, and therefore were more compliance with the IKS.

Reporting on the influence of land tenure and compliance with the IKS, Holt (2005) put it that decrease in size of land ownership among indigenous people in Amazon compel indigenous people to develop new economic livelihood strategies such as commercial farming, livestock keeping, wage labour, resulting into decline of IKS. Oviedo et al. (2007); Anderson (2005) cited in Chamley *et al.* (2007) and Kideghesho (2008) further added that loss of access to indigenous land and resource uses reduce opportunities of indigenous people to practice their knowledge system attributing to the decline of such knowledge system and of the biodiversity it is used to manage.

Table 17: Respondents' views on the relationship between households' farm size and compliance with the indigenous knowledge system

Existence of relationship between households' farmland sizes and compliance with the IKS	Frequency (n = 240)	Percentage
Yes	169	70.0
No	69	29.0
I don't know	2	1.0
Total	240	100
Reasons for the relationship between farm size and compliance with the IKS (n = 169)		
Households with large farmland are satisfied with their farm size	6	4.0
Households with small farmland need to expand their farm size	57	34.0
Those with large farmland need more farmland	96	57.0
Those with small farmland are normally poor and afraid of IKS punishments	8	5.0
Total	169	100

It was further disclosed by this study that indigenous penalties/fines vary with the severity of the offence, varying from offering of a black sheep/goats to a cock that has to be slaughtered as a way of appeasing the ancestral spirits. Similarly, a study by Saj, Martha and Sicotte (2006) in Ghana added that breaking of a taboo requires ritual intervention and compensation so as to reduce the likelihood of supernatural punishment, such as sickness or sudden death. The authors further disclosed that an individual who violated a taboo had to pay a fine in various forms: cash, bottles of schnapps, sheep, cattle or goats (Ntiamoa-Baidu, 1995 cited in Saj, Martha and Sicotte, 2006), depending on the severity of the offense (Saj, Martha and Sicotte, 2006). Kweka (2004), in his study in East Usambara, also revealed that anyone found guilty of cutting a sacred tree species had to offer a male sheep or a white/black cock that had to be slaughtered to pacify the angered ancestral spirits. Saj, Martha and Sicotte (2006) asserted that compliance with the IKS not only depended on the degree of fear of the supernatural consequences as a result of violation of the knowledge, but also the severity of the punishment as a fine for such violation. For example, quoting Fargey (1991), Saj, Martha and Sicotte (2006) reported that a former

Nkoranzahene, who used to kill taboo monkeys believed to be children of the gods, had his head cut off by angry people, suggesting that severe punishment rather than payment of fines further refrained people from abusing the indigenous knowledge of their respective community.

Based on these findings and literature this study argues that, in most of indigenous societies worldwide, there are different indigenous fines for someone disobeying the IKS that vary between different societies as well as also on the severity of the offence. Moreover, economically better off households easily afford to pay such fines, making them less frightened of the IKS's penalties and fines.

4.3.5 Respondents' views on the relationship between age of an individual and compliance with the indigenous knowledge system

Compliance with the IKS varies with the age group of an individual as claimed by 89.0% of the respondents, while only 11.0% of the respondents denied the existence of relationship between the age group of an individual and compliance with the IKS (Table 18). Of the respondents who claimed that there was a link between age group and compliance the IKS argued that, contrary to the subsistence livelihood view of the IKS, generally, youths struggled for their economic achievements, and therefore they perceive the knowledge system as an obstacle, among others. In light of this finding, in their study in Usambara Mountains, Ylhäisi (2006) also revealed that views of most youth on life expectation have changed, making them consider the indigenous restrictions as being meaningless, with more and more young people being neither respectful of indigenous regulations nor accepting indigenous penalties. Kweka (2004) also found that most youths (72.2%) did not fear indigenous restrictions and refused ritual activities, as a result of westernization and new religions, which threaten future conservation of biodiversity.

Table 18: The respondents' views on the relationship between age of an individual and compliance with the indigenous knowledge system

Existence of relationship between age group and compliance with the IKS	Frequency (n = 240)	Percentage
Yes	214	89.0
No	26	11.0
Total	240	100
Reasons for the relationship between age group and IKS (n = 214)		
Youth are struggling for economic gains and perceive IKS as an obstacle	214	100
Total	214	100

In examining the link between age of an individual and compliance with the IKS, Tanyanyiwa and Chikwanha (2011) in Masvingo in Mugabe Area in Zimbabwe found that young people, amongst the Shona ethnic group did not appreciate the IKS, as the indigenous knowledge was perceived as old fashioned, and not well documented and its significance was not well conveyed to them, thus seeking for scientific explanations of the IKS. Likewise, Sibanda (1998) cited in Zazu (2007) also found that most youths in Binga area in Zimbabwe, believe that their community's IKS had little value as compared to the scientific knowledge system.

According to Nganje (2009), ritual component of taboo and totemic species which are some of the components of the IKS, have been fading out as youth were increasingly questioning on why they were not consuming certain species just because they were totems or taboo species. In a way, they are increasingly seeking scientific explanations for many things than before, whereas they tend to ignore those IKS ideas that cannot be scientifically explained (Tanyanyiwa and Chikwanha, 2011). Youths are less compliance with the IKS as a result of being less knowledgeable on the knowledge system at the



expense of the biodiversity conservation methods, and changes in life style from subsistence to commercial production, increasingly resulting in biodiversity decline.

4.3.6 Respondents' views on the relationship between years of residency and compliance with the indigenous knowledge system

Respondents' view on the relationships between years of residency and compliance with the IKS are shown in Table 19. It was disclosed by the study that most of the respondents (91.0%) agreed that compliance with the IKS varies with years of residency of an individual, while 8.0% of the respondents said that there was no such relationship and only 1.0% of the respondents did not know. Of the respondents who claimed existence of the relationship between compliance with the IKS and years of residency, 95.0% said that the longer one lives in an area the more he/she becomes more knowledgeable of the local knowledge system, as the knowledge is gained through human interactions with their support ecosystem interwoven with people's culture, while of 5.0% of the respondents said that immigrants from areas with quite different cultural contexts are less compliance with the IKS, resulting into, among others, decline of the specific IKS of the area.

In opening discussion on the relationship between years of residency and the quality and quantity of IKS, Tanyanyiwa and Chikwanha *et al.* (2011) put it that a good understanding of the natural resource base from which IKS is based, depends on the number of years one has lived and interacted with the supporting ecosystem or in a similar environment; as the knowledge is found amongst societies that have engaged in natural resources (such as biodiversity) use in a particular place over a long period of time (Berkes, 1999).

Table 19: Respondents' views on the relationship between years of residency and compliance with the indigenous knowledge system

Existence of relationship between one's years of residency and compliance with the IKS	Frequency (n = 240)	Percentage
Yes	219	91.0
No	19	8.0
I don't know	2	1.0
Total	240	100
Reasons for the influence of years of residency on IKS (n = 129)		
Immigrants from different IKS, are less compliance with the other people's IKS	11	5.0
Those who lived in the area for years are more knowledgeable and more compliance with the IKS	208	95.0
Total	219	100

In conceptualizing the term IKS, citing Dei (2002), Zazu (2007) argued that the indigenous knowledge is a body of knowledge that is associated with the long term interaction between humans and the supporting ecosystem of a given place, shaped by indigenous norms and social values. The knowledge was manifested through local practices, belief systems, myths and built from historical events (Hirji *et al.*, 2002 cited in Zazu, 2007). It is from this view; this study argues that the IKS one possesses depends on the years of interactions with the same or similar supporting ecosystem and socio-economic and political context.

Of the several examples that explain the relationship between the IKS and years of residency, Kweka (2004) disclosed that the 33.3% of the respondents, who expressed their ignorance on the ritual places in Potwe-ndondondo village in East Usambara, was a result having a large number of immigrants who did not practice ritual activities. Similarly, Mbwapbo (2000), found in his study in Udzungwa Mountain Forests that the Bokela which was perceived as the 'Mountain of God', was currently dormant with no more

sacrifice practices as a result of increased population, westernization and immigration of other people who did not value and respect the IKS of the place. This has limited the continuity of the knowledge system.

On the link between years of residency and adherence to the IKS, a study in Lake Chilwa in Zambia by Kalanda-Sabola *et al.* (2007) revealed that restricted fishing (sacred) sites were not observed by immigrants with different IKSs resulting into the decline of the indigenous rules, prompting indigenous people to do the same. Similarly, Holt (2005) and Sarfo-Mensah and Oduro (2007) also asserted that immigrants who had no respect for IKS have contributed to the breakdown of social structures and beliefs from which the knowledge system has evolved, enhanced and safeguarded, resulting into decline of both, the knowledge system and biodiversity that have been conserved over generations. Kajembe (1994) had also put it that in most cases deliberate or careless misuse of trees and shrubs seem to occur more frequently when one is outside one's territory. This suggests that once one is out of his/her indigenous territory one is less compliance with his/her indigenous knowledge that was determining his/her management and use of biodiversity. However, such level of compliance with the IKS depends on the degree of the enforcement of biodiversity conservation measures.

There seems to be a correlation between years of residency of an individual and their quantity and quality of IKS, as the knowledge is mostly passed on through human interactions with the supporting ecosystem and through practices and word of mouth. Through FDGs, the study also revealed that most of the immigrants and forestry officials lack the spiritual connectedness with the biodiversity that has been supporting the livelihoods of the indigenous people, making them more likely to go against it. According to Kweka (2004); Saj, Martha and Sicotte (2006) and Msuya and Kideghesho (2009) the

spiritual beliefs attached to biodiversity in a particular community, which lack amongst the immigrants, has significantly contributed to the conservation of biodiversity.

4.3.7 Respondents' views on the relationship between household labour and compliance with the indigenous knowledge system

Results on the respondent's views on the relationship between a household's man labour and compliance with the IKS are shown in Table 20. Results have shown that most (86.0%) of the respondents claimed that compliance with the IKS varied with the size of household labour, while only 14.0% of the respondents claimed that there was no relationship between the size of household labour and compliance with the IKS. Of the respondents who claimed the existence of relationship between the size of household labour and compliance with the IKS, 87.0% said that those with a large household labour are more likely to be less compliance with indigenous restrictions, while only 13.0% of the respondents said that households with least household labour are less compliance with the IKS as they are less productive, less economically better off, and mostly selling their labour to the better off households. Through personal communication, the study disclosed that in most cases households that have large family size accompanied with limited resources, are mostly those selling their labour for practices such as clearance inside the forest reserves, encroachment of sacred places, cutting of sacred trees and killing of sacred animals, to earn a living.

Table 20: The relationship between the size of household labour and compliance with the IKS

Existence of relationship between household's labour and compliance with the IKS	Frequency (n = 240)	Percentage
Yes	206	86.0
No	34	14.0
Total	240	100
Reasons for the link between household labour and compliance with the IKS (n = 206)		
Those that command a large household labour power need for more income	179	87.0
Those with less household labour power are less compliance with the IKS	27	13.0
Total	206	100

Based on these findings, two scenarios can be observed; firstly, for a household that can command enough labour mostly through hiring or using simple machines such chain saw, is normally economically better off households and is involved in commercial production. Secondly, households with adequate labour but with limited resources are expressly selling their labour to the commercial producers, to meet the demand for resources to make a living, noting that hiring of labour is too expensive to be invested into production of food crops that is relatively less profitable.

It is worth to reiterate that most people living in villages adjacent to the South Nguru Mountain Forest Reserve mostly depend on the labour intensive agricultural practices associated with labour intensive transportation of harvests to distant markets (PEMA, 2006), further increasing the household's labour demand. Citing Kajembe and Monela (2000), Kweka (2004) reported that indigenous people's exposure to new technology for converting logs to timber which mostly happened during the colonial and post-colonial periods has further aggravated the decline of natural forests, and of the biodiversity at

large. Moreover, relaxation of rules during post-independence period has resulted into forest reserves having open access for timber and agricultural activities (Mbwambo, 2000).

Thus technological advancement is a dangerous weapon for decimation of biodiversity, if misused. However, with the increasing population in villages adjacent to the South Nguru Mountain Forest Reserve, technological advancement that will integrate the IKS is of importance in addressing the problem of decreasing soil fertility, high labour cost, decreasing households' farm size, increasing household level of poverty, whereas, intensification and diversification of means of people's livelihood may be inevitable.

4.4 Effectiveness of the Indigenous Knowledge System/ Biodiversity Conservation

Methods on Conservation of Biodiversity and their Integration

The respondents' views on the significance of the IKS and biodiversity conservation methods in their separation on conservation of biodiversity are shown in Table 21. In light of the significance of the IKS on conservation of biodiversity, this study reveals that most of the respondents (97.0%) expressed their view that the IKS alone cannot effectively conserve biodiversity with only 3.0% of the respondents claimed that the knowledge system alone can effectively and sustainably conserve biodiversity.

Results (Table 21) have also shown that of the respondents who claimed that the IKS cannot sustainably conserve biodiversity, almost 91.6% said that lack of legitimacy and power of IKS to deal with offenders of the system have limited its effectiveness on conservation of biodiversity, while 10.4% of the respondents said labelling of the IKS as out-dated has been limiting its effectiveness, and almost 7.5% of the respondents said that, as not all areas are under the custodians of the IKS, its effectiveness in conservation of

biodiversity is thus limited. Results further revealed that almost 3.0% of the respondents said that the knowledge system can effectively and sustainably conserve biodiversity since the system is still respected by most people, while almost 2.0% of the respondents claimed that the knowledge system alone cannot sustainably conserve biodiversity, otherwise, poverty is dealt with; poverty has been compelling people to abuse their knowledge system just to make a living.

Arguing on the lack of legitimacy amongst the custodians of the IKS, Ylhäisi (2006) put it that regardless of the significance of the *walukolo* on the conservation of biodiversity through enforcing the IKS, their roles have increasingly been transformed into national legislation, government institutions and village administration, with most of the duties of the forestry officers being limited inside boundaries of the forests reserves, with exception of some exported plant species such as *Mninga* and *Mvule*. Through key-informant interview, it was disclosed that limited budget and staff was a reason behind the forestry officers being limited inside the boundary of the forestry reserve. In furtherance of the discussion on the exclusion of the indigenous people in the realm of biodiversity conservation, Ylhäisi (2006) further added that, despite the Tanzanian government being a signatory of the CBD of 1992 and the Forest Act of 2002 emphasizing active participation of the indigenous people, most forest officers still consider indigenous people as harmful to biodiversity, rather than potential partners in conservation of biodiversity.

Several studies reported that both the colonial and post-colonial government policies and regulations have been used to marginalize the IKS, triggering struggle for legitimacy between the knowledge systems (Mutta, *et al.*, 2009, Kideghesho, 2009 and Ossai, 2010). Literature further revealed that replacement of the IKS by government biodiversity conservation methods and has resulted in the decline of sacred forests (Mutta *et al.*, 2009),

while other sacred forests have disappeared (Githito, 1998 cited in Mutta *et al.*, 2009). It is worth noting that sacred groves and forests have been widely reported to have high biodiversity value compared to conventional conservation forests (Msuya, 1998; Mapara, 2009; Jaryan *et al.*, 2010). The significance of the IKS on conservation of biodiversity is therefore hampered by the lack of legitimacy and power, the knowledge being perceived as out-dated and being excluded from the realm of the practices, lack of integration of IKS with villages' environment and the problem of household poverty.

Table 21: Respondent's views on the effectiveness of the indigenous knowledge system/ biodiversity conservation methods on conservation of biodiversity

Effectiveness of the IKS alone, on conservation of biodiversity	Frequency (n = 240)	Percentage
Yes	7	3.0
No	233	97.0
Total	240	100
Reasons for the effectiveness status of IKS (n = 240)		
IKS has no legitimacy and legal power to deal with offenders	220	91.6
IKS is perceived as outdated	25	10.4
Not all areas are under IKS	18	7.5
People still respect IKS	7	2.9
Income poverty has to be dealt with	4	1.6
Effectiveness of biodiversity methods alone, on conservation of biodiversity		
Yes	6	2.5
No	234	97.5
Total	240	100
Reason for the effectiveness status of biodiversity conservation methods (n = 240)		
The government officials lack spiritual connectedness to biodiversity	65	27.0
The government has limited resources for meaningful conservation	134	56.0
Biodiversity conservation methods are less known	19	8.0
IKS is an ignored complementing partner	49	20.4

Results (Table 21) have shown that most of the respondents (97.5%) claimed that biodiversity conservation methods alone cannot effectively and sustainably conserve biodiversity, while only 2.5% of the respondents expressed that biodiversity conservation methods alone can effectively and sustainably conserve biodiversity. Results have further indicated that most of the respondents (50.2%) claimed that limited resources have hampered the effectiveness of the biodiversity conservation methods, while 24.3% of the

respondents mentioned lack of spiritual connectedness amongst forestry officers and other practitioners of biodiversity conservation to biodiversity they are obliged to conserve, which reduces their seriousness on conservation of the same. Of the respondents, 18.4% said that biodiversity conservation methods alone could not effectively conserve biodiversity in absence of a complementing partner, the IKS, while only 7.1% of the respondents said that biodiversity conservation methods could not effectively conserve biodiversity as they are less known to most people. Through a key-informant interview, it was reported that conservation initiatives of the forestry reserve were limited by shortage of fund and field forestry officers. For example, in the last financial year (2010-2011), the funds allocated was only 60.0% of the requested budget, with a shortage of seven field forestry officers needed for conservation of the South Nguru Mountains Forest Reserve as per the Mkingu Nature Reserve Forest strategic plan.

According to FBD (2005) and Kideghesho (2009) factors limiting the significance of biodiversity conservation methods on conservation of biodiversity include limited budgets and inadequate workforce which have limited the capacity of most governments in enforcement of the biodiversity conservation methods. Similarly, Sabuni (1998) cited in Mbwanbo (2000) and Burgess *et al.* (2007) also noted that insufficient funds limited effective conservation of biodiversity in the Eastern Arc Mountains Forests.

PEMA (2006) also found that poor enforcement of the little understood government rules and regulations for the conservation of biodiversity has been limiting their effectiveness. Arguably, limited resources have hampered the capacity of the government on effective enforcement of rules and regulations for the conservation of biodiversity. Moreover, through interviews, it was found that negligence of the spiritual aspects attached to

biodiversity amongst the government officials has also been limiting the effectiveness of the biodiversity conservation methods on the conservation of biodiversity.

In summing up the discussion of the effectiveness of the IKS and the biodiversity conservation methods in their separation, in conservation of biodiversity, Ylhäisi (2006) put it that bylaws, laws and the IKS, in their separation, have less influence in preventing people from using forest land, as most people prefer and follow the unwritten policies that enable them to survive, despite their being aware of the fact that by so doing they are destroying their most important partner in their survival (Mvungi, 1998 cited in Ylhäisi, 2006). In furtherance of this view, citing Guyer and Richard (1996), Korhonen (2009) argued that western idea of separating humans and nature is a strange idea in other culture, yet perceiving indigenous people as having lived in harmony with biodiversity is also not true. This suggests that both the IKS and biodiversity conservation methods are perceived as not being effective on conservation of biodiversity, and therefore the integration of these knowledge systems cannot be over emphasized.

4.5 Respondents' Experience on the Integration of Indigenous Knowledge System into Biodiversity Conservation Methods

Results on the respondents' views on the existence of biodiversity conservation methods and the integration of the IKS are shown in Table 22. Results have shown that most of the respondents (95.0%) expressed their awareness on the existence of biodiversity conservation methods (village environmental bylaws) in their respective villages, while 2.0% of the respondents claimed that there was no biodiversity conservation methods in their villages and 3.0% of the respondents said they did not know.

It was also disclosed in this study that despite the fact that most of the respondents expressed their awareness on the existence of biodiversity conservation methods in their

respective village, most of them, including members of the environmental committees, were ignorant of the contents of the same. The conservator of Mkingu Forest Reserve also put it that as a result of the short lifespan of the PEMA II project that facilitated formulation of the villages' environmental bylaws, there were less awareness creation forums for the local people on the contents of those bylaws, that is why most of the people were ignorant of the bylaws; the process of their formulation involved few members whom were believed to be representatives of their community. Sadly, the process of bylaws formulation did not consider different actors' interested in the management and use of biodiversity. Similarly, PEMA (2006) reported that most people were not familiar with the contents of the bylaws. However, through key-informant interview, it was reported that the bylaws were under review, so as to capture views, perceptions and strategies for the conservation of the natural forest reserve. Unfortunately, the Ministry of Natural Resources and Tourism approved only 21.0% of the proposed budget requested for the review process and for awareness creation.

Table 22: Respondents' experience on the integration of indigenous knowledge into biodiversity conservation methods

Existence of village e bylaws for the management and use of biodiversity	Frequency (n = 240)	Percentage
Yes	227	95.0
No	5	2.0
I don't know	8	3.0
Total	240	100
Facilitator for the formulation of the bylaw (n = 227)		
PEMA and the village government	32	13.0
The village government	165	69.0
The forest department	27	11.0
Total	227	100
Integration of the IKS into the bylaws		
Yes	57	24.0
No	183	76.0
Total	240	100
Reasons for the exclusion of the IKS into the bylaw (n = 183)		
I don't know	148	81.0
The knowledge lacks official recognition	22	12.0
The idea of integrating the knowledge was not introduced by the facilitators	13	7.0
Total	183	100

Table 22 also reveals that most (73.0%) of the respondents mentioned that the village environment bylaws were formulated by their respective village governments with 15.0% of the respondents claiming that they were formulated in collaboration between the Participatory Environment Management (PEMA) and 12.0% of the respondents said that the bylaws were formulated by the Forest and Beekeeping Division (FBD). In fact, the process of bylaws formulation was facilitated by PEMA II project, under the implementation of TFCG and CARE. Such great variations of opinion as to who facilitated the formulation of those environmental bylaws among respondents might be due to the minimum level of participation of the local people.

It was also disclosed in this study that though most of the respondents viewed the process of facilitation of the formulation of the biodiversity conservation methods in their respective villages as being participatory, such participation was questionable, as the

process overlooked the custodians of the IKS (in this case the *walukolo*) and other institutions interested in conservation of biodiversity, such as religious institutions. Most disappointing is the fact that in all of the four villages in the study, none of the villages' environmental bylaws neither mentioned *walukolo* nor sacred groves/places, and all contexts of those bylaws were concerned with the conservation of biodiversity inside the South Nguru Mountain Forest Reserve. Moreover, all of the bylaws in the four villages of the study were similar on most issues, and one can argue that the same format and contents of the bylaw was used in facilitation process to all villages, with addition or exclusion of some issues. This view was also shared by the conservator, who argued that the project was working within a time limit; it was more likely that, the first village bylaw formulated was replicated in other villages/used as guidelines for the formulation of same in other villages, regardless of their socio-economic and other disparities.

URT (2009) also argued that despite most of villages having environmental bylaws, lack of wide participation of the local people in the process of their formulation has resulted into limited awareness and lack of ownership of the same by the local communities. According to Kweka (2004) citing Gibson *et al.* (1999), most of biodiversity conservation methods have been failing as a result of having been developed without a meaningful participation of primary beneficiaries. The author added that active participation of primary beneficiaries could do much better on conservation of biodiversity such participation would address the problem of limited government staff for the enforcement of the rules and regulations, increase indigenous people's sense of ownership of the biodiversity to be conserved, enhance changes of peoples' attitude towards conservation and the forestry staff and increase mutual trust between forestry staff and the indigenous people. On Joint Forest Management (JFM), Mbwapbo (2000) asserted that success of the Joint Forest Management, rests on the respect of the rights of the indigenous communities

as joint managers, and that is a fundamental policy principle to enhance integration strategies (Metcalf, 1995 cited in Mbwambo, 2000). Similarly, according to Woodcock (2002) and Wily (2002) cited in Vihemäki (2009), participatory approaches too often see local people just as “beneficiaries” and not as actual decision makers over forest management. The authors further added that shifting the responsibility and powers over conservation to the local level is often not cheap and simple, as it might contradict with the conservation objectives. The problem of reconciling conservation of forests and the needs of local people has not been solved, particularly in areas of high biodiversity value (Platteau *et al.*, 2002 cited in Vihemäki, 2009).

It was further disclosed by this study (Table 22) that most (76.0%) of the respondents said that the IKS is not integrated into biodiversity conservation methods (the village environmental bylaws) and only 24.0% of the respondents claimed that the IKS is integrated into the biodiversity conservation methods. Results further show that most of the respondents (81.0%) expressed their ignorance of the reason(s) for the exclusion of the IKS in their village environmental bylaws, while 12.0% of the respondents said that the IKS was not integrated into their village environmental bylaws because the government does not recognise the knowledge system, and 7.0% of the respondents said that the idea of integrating the IKS was not introduced during the process of formulation of the bylaw, that is why it was not integrated into the biodiversity conservation methods of the respective villages. On enquiring from the Conservator on why IKS was not integrated into the biodiversity conservation methods, the conservator said that facilitators overlooked both the CBD of 1992 and the Tanzania Forest Act of 2002 that emphasises on the wide use and application of indigenous people and their knowledge system, while ensuring mutual sharing of the benefits among actors.

Arguing on the relationship between government policies and IKS, Kideghesho, (2008) asserted that despite global recognition of IKS, in many countries such recognition in conservation policies is very minimal. This implies that signing global conventions such as Convention on Biological Diversity (CBD) is meaningless unless such conventions are reflected in respective government policies at several levels of their implementation.

Several studies revealed that lack of government rules and regulations that could otherwise be used to enforce and enhance IKS has significantly eased encroachment of sacred groves/forests, indigenous rules and taboos (Fargey, 1991; Falconers, 1992; Ellis, 2000; Ntiamoa-Baidu, 1995 cited in Safo-Mensah *et al.*, 2007; Kideghesho, 2008; Mutta, 2009). Moreover, imposition of unfavourable policies and practices has been threatening the viability and implementation of indigenous and scientific knowledge systems into diverse environments has been a major one among others, undermining the integration of these knowledge systems (Charney *et al.*, 2007), an integration that has been emphasized as a strategy in addressing an overwhelming problem of decline of biodiversity.

Contrary to the Tanzania Forest Act of 2002 that emphasized the active participation of potential stakeholders, such as indigenous people, with great concern, Mattee (2007) put it very clearly that policies in Tanzania are formulated through a centralized system for public interest resulting into failure of such policies. The author further argued that such policies formulation processes have been ignoring power relationship and roles among potential stakeholders making them being almost irrelevant. A similar view was also put forward by Vihemäki (2005) who found that some of the Forestry and Beekeeping Division(FBD) officials perceived the concept of participatory conservation as an imposed Western idea, a view that might further be perpetuating the existence of power struggles between the national and regional level actors and individuals.

Tension created by binary divide between scientific knowledge system and IKS clearly persists despite many well-intentioned efforts to reduce or eliminate such divide (Briggs, 2005). For example, power imbalance between indigenous people and scientists has been significantly contributing to the failure of integrating IKS into biodiversity conservation methods (Chapekie, 1995; Lukey, 1995; Stevenson, 1997 cited in McGregor, 2004; McGregor, 2004; Chernley *et al.*, 2007; Nadasdy, 1999 cited in Cobb, 2011). Moreover, such power imbalance has been fostering rejection of IKS, its transformation and its integration into biodiversity conservation methods (Ellis, 2000).

Contrary to the findings of this study, a study by Ylhäisi (2006) found that in Simbomu and Vuchama Ngofi villages of Mwanga District, village by-laws were supporting protected indigenous forests, whilst the caretakers of the indigenous forests (*walukolo*, in the case of this study) are officially recognised and continue to protect their forests using their IKS. In cases where a caretaker of a certain sacred grove got converted into either Christianity or Islam, the management of the sacred groves would become the responsibility of the respective village government. Moreover, village governments have been responsible for all cases on destruction of the protected indigenous forests instead of the care takers of these forests, who in most cases are elders and unable to meet the costs and all other bureaucracy associated with dealing with the offenders (Ylhäisi, 2006). The author further reported that in such by-laws, afforestation of sacred groves using indigenous tree species was agreed in close collaboration with the village governments and the custodians of those sacred groves.

Citing the Simbomu and Vuchama Ngofi examples of the integration of the IKS and biodiversity conservation methods, Idd (2002) cited in Ylhäisi (2006) argued that that was a very important strategy and a good example to the whole of Tanzania, and it has been

reported to have resulted into recovery and improvement of the sacred groves in Simbomu village.

4.6 Reviving the Indigenous Knowledge System for the Conservation of Biodiversity

Respondents' views on what should be done to revitalize the IKS are shown in Table 23. Half of the respondents (83.0%) suggested that the youths be formally taught on the significance of the IKS for conservation of biodiversity to ensure sustainability of the knowledge system, while almost 44.0% of the respondents proposed official recognition of, and capacity building for, the custodians of the knowledge system. Of the respondents, 12.5 % said that integration of IKS into village bylaws will enhance and sustain a wide use and application of the knowledge system, while 24.2% of the respondents expressed their ignorance of what should be done to revive the knowledge system. A study by Kweka (2004) in Potwe-ndodondo and Mwembeni-magoroto, sadly disclosed that almost 42.0% of the respondents expressed their ignorance of what should be done to revive positive IKS, but 28.0% of the respondents recommended the integration of the IKS into biodiversity conservation methods as a strategy to revive the IKS.

Table 23: Suggestions for reviving of the indigenous knowledge system

Reason	Frequency (n = 240)	Percentage
There should be more teaching on the significance of IKS	199	83.0
Official recognition and capacity building of IKS	105	44.0
Integration of IKS into village bylaws	30	12.5
I don't know	58	24.2

Results (Table 23) show that despite the fact that all villages in the study area had environmental by-laws that claimed to have been formulated in a participatory way; neither the name nor the roles of the *walukolo* were mentioned in those by laws. Arguing on the lack of official recognition of IKS, Kideghesho (2009) put it very clearly that despite the global recognition of the IKS in conservation of biodiversity, there is minimal official recognition of this knowledge system in conservation policies. This implies that despite the government being a signatory of the CBD of 1992 which emphasized the integration of the knowledge system; it is rarely implemented at the grassroots levels. According to Tanyanyiwa and Chikwanha (2011), legitimacy and credibility of the IKS rests on its utilization in research and management plans in the eyes of both, indigenous people and outside scientists, increasing cultural pride and motivation in solving local problems with indigenous people's inventiveness and resources. Furthermore, equal valuation and mutual participation of both the indigenous people and the so called "scientists" is inevitable to favour enhancement and sustainability of IKS.

According to Bisong and Andrew- Essien, (2010), valuation of the IKS as a valid mode of learning, research and sustainable development among many academics and development practitioners has been, to date, a problem, with most of development teaching, learning and development initiatives relying heavily on formal scientific methods, at the expense of the IKS, thus most of the youths remain ignorant of the indigenous knowledge and perceive it as being valueless, which increases biodiversity decline. Cobb (2011) suggests creation of public awareness so as to change people's attitudes and perceptions on the significance of the IKS, as the knowledge has been badly labelled; a community or a person mostly relying on such a knowledge system is seen as supposedly inferior to those who practice the opposite (Ocholla, 2007; Zazu, 2007), and therefore limiting its wide use, application and its integration into other forms of knowledge systems.

The survival and the significance of the IKS on conservation of biodiversity, therefore rests on the promotion of the indigenous teaching and learning practices and official recognition and capacity building of the custodians of the knowledge system, among others. It is envisaged that such proposed initiatives will favour not only its wide use and application but also its integration into other knowledge systems, such as biodiversity conservation methods.

4.7 Demographic and Socio-economic Factors Limiting Integration of the Indigenous Knowledge system into Biodiversity Conservation Methods

Section 2.1.2 of this study mentioned that factors that undermined the wide use and application of the IKS for conservation of biodiversity were also limiting its integration into other knowledge systems such as biodiversity conservation methods. The influence of demographic and socio-economic factors on the wide use and application of the IKS is described using the dummy multiple regression models developed in Section 3.2.1 of Chapter Three. Definitions and descriptive statistics of the demographic and socio-economic factors used for the dummy multiple regressions are shown in Table 24.

Table 24: Variable definitions

Variables	Description	Mean	SD
Dependent variable			
Integration of IKS	- Wide use and application of the IKS		
Independent variables			
Age	- Number of years that a person has lived	59.64	1.44
Sex	- Male or female		
Years of residency	- Number of years someone has lived in an area	54.54	1.68
Level of education	- Numbers of years in school	2.21	0.79
Household income	- an average household annual income in Tshs	274 250	9.6
Household labour	- Number of working people in a household	3.64	2.02
Household's Farm size	- A total household's farmland measures in acres	6.73	6.25

A dummy multiple regression model was used to establish the relationship between the dependent and a set of independent variables, by explaining a proportion of the variance in a dependent variable at a significance level and to predict the influence of each of the independent variables to the dependent variable through comparing beta weight of the independent variable. A two-tailed t-test at 0.05 percentage level of significance was used to accept or reject the tested hypothesis, in this case, H_0 is rejected only when $P < 0.05$. To assess the goodness of fit of the regression model, a coefficient of determination (R^2) was applied, whereas, the higher the R^2 the more powerful the model is. However, the information collected through FGD and field observations were used to complement the quantitative data and in interpretation of the results based on the IKS of knowing and doing. The dummy multiple regression results on the influence of the socio-economic and

political factors on the wide use and application of the IKS and its integration into biodiversity conservation methods are shown in Table 25.

Results have shown that only age group of the respondents and years of residency had a significant relationship with the wide use and application of the IKS for conservation of biodiversity. Of the factors that influence the dependent variable, years of residency had a higher contribution to the model ($\beta = 0.608$) while age group of the respondents had ($\beta = - 0.459$) (Table 25). In fact, a negative β value of the age group of the respondents on the wide use and application of the IKS implies that there is decrease in pass on of the knowledge system from the elders to the youths, as it was disclosed in Section 4.2.8 of the study. It worth noting that the elders were responsible to pass on the IKS to youths through practices, as the knowledge is a belief-practice, they seem not to practice it as they youths were considering the IKS as being an out-dated and an obstacle for their economic prosperity, whereas the knowledge emphasis on subsistence use of the natural resources and respect to the ancestral spirits. It is worth to reiterate that the IKS is a knowledge-belief-practice, normally passed on from elders (*walukolo*) to the youths through taboo, norms, rituals practices, poems and storytelling.

Using interviews and FGDs the study also revealed that most youth were perceiving the knowledge system as being an obstacle for their economic gains, as it emphasizes on subsistence livelihoods and the knowledge being perceived as an out-dated form of knowledge system at expenses of the biodiversity conservation methods that are guided by scientific principles. A study by Mbwambo (2007) also noted that farmers' were most driven by the survival motives rather than profit maximization: apparently, the subsistence ideology was perceived as an economic obstacle by most of youths.

Results further show that there was no significant relationship between most of the independent variables on the wide use and application of the IKS for the conservation of biodiversity ($F = 7.0$ percentage) with a weak model on the relationship between the independent and the independent variables ($R^2 = 17.4 \%$). This might be due the fact that the low degree of variations among the respondents on their level of education, farm sizes and income (most being categorized as poor) might be contributing to the insignificance relationship between the dependent and the independent variables, and to the weak multiple regression model.

Table 25: A dummy multiple regression results to represent the relationship between the wide use and application of IKS and demographic and socio-economic factors

Independent Variables	B	Std error	Coefficient	t	95 %	Conf. Interval
constant	1.634	0.428		3.814	0.000	2.478
Age group	- 0.459	0.052	- 0.268	-4.546	0.000	- 0.015
Sex	- 0.071	0.114	- 0.071	- 1.181	0.239	0.090
Years of residency	0.608	0.005	0.040	6.086	0.000	0.40
Level of Education	- 0.090	0.068	0.039	- 1.396	0.164	0.039
Household income	0.109	0.001	0.067	1.496	0.136	0.002
Household labour	- 0.041	0.028	-0.980	- 0.608	0.544	0.039
Farm size	0.043	0.009	0.065	0.642	0.521	0.023

df: 8 significance at $< 5 \%$; $F = 7.0$ $R^2 = 17.4 \%$

4.8 Ways to Facilitate Integration of Indigenous Knowledge System into

Biodiversity Conservation Methods

Respondents' views of what should be done to facilitate integration of the IKS into biodiversity conservation methods are shown in Table 26. In exploring the respondents' view on what should be done to facilitate integration of the IKS into biodiversity conservation methods, most of the respondents (83.3%) pointed out that identification, official recognition, motivation and active participation of the *walukolo* in conservation of

biodiversity initiatives were the cornerstones necessary for the integration of the knowledge systems, while 14.0% of the respondents said that income poverty had to be dealt with, as it has been compelling people to abuse their IKS knowingly, just to make a living.

Results (Table 26) also shows that 11.2% of the respondents said that there was a need of a policy(ies) which necessitate(s) the integration of the IKS into biodiversity conservation methods, while 7.0% of the respondents said that documentation and training on the significance of the IKS mostly to youth, would facilitate a wide use and application of the knowledge system, and of its integration into other knowledge systems, and 8.3% of the respondents expressed their ignorance on what should be done to facilitate integration of these knowledge systems.

Table 26: Respondents views on ways to facilitate the integration of indigenous knowledge system into biodiversity conservation methods

Ways for facilitating the integration of IKS	Frequency (n = 240)	Percentage
- Custodian of IKS (<i>walukolo</i>) has to be identified, motivated and actively involved	200	83.3
- There should be policy(ies) in place that insist on integration of IKS	27	11.2
- Documentation and trainings on IKS is highly needed	17	7.0
- I don't Know	20	8.3
- Household level poor is a challenge for the wide use and application of IKS	34	14.0

Results from a key-informant interview have shown that active participation of indigenous people is a slow process, that should include negotiations, renegotiations and formulation of collective approaches, strategies and activities that determine the management and use

of biodiversity in which all potential actors are actively involved, based on their ways of knowing and doing. Others include continuous awareness creation to actors on the significance and mutual benefits for the conservation of biodiversity and continuous reviews of such bylaws whenever necessary. These would create a sense of ownership of the biodiversity to be conserved, and therefore minimize conflicts among actors. In this sense, a long term strategy with sustainability of resources for the process is of paramount importance. Arguing on active participation of potential actors, URT (2009) noted that lack of benefit sharing guidelines between potential actors and the bureaucratic process of signing joint forest agreements were limiting the active and meaningful implementation of the Tanzania Forest Act of 2002, which emphasised on active participation of potential actors and on the sharing of benefits of such participation.

Cited in Mbwambo (2000), Metcalfe (1995) argued that recognition of the rights of the indigenous people is a fundamental policy strategy that would enhance integration of the knowledge system, whereas recognition and legitimization of the indigenous initiatives would lead to successful conservation practices, such as of biodiversity. It is argued that recognition and legitimization of the custodians of and the IKS will trigger a wide use and application of the knowledge system, particularly on the enforcement of the indigenous restrictions.

Several studies also argue that household poverty does compel people to knowingly abuse their IKS which would, otherwise, contribute to conservation of biodiversity (Oviedo *et al.*, 2007; Kideghesho, 2008; Nganje, 2009). For example, some people sold animals that were taboo to other people to whom such animals were not tabooed, just to earn a living (Kideghesho, 2009). Through interviews, the study also disclosed that the black and white colubus monkey (*C. angelensis*) and *Mvule* (*M. excelsa*) were perceived as sacred. The

former being a non-crops ridding species, it was regarded as innocent, and the latter species was perceived as a habitat for evil spirits. Currently they are increasingly being killed and harvested, respectively for commercial purposes.

Arguing for the importance of training on the significance of the IKS for conservation of biodiversity, Msuya (2007) and Shresha *et al.* (2008) asserted that documentation of the IKS will facilitate its wide use, application and its integration into other forms of knowledge systems. Similarly, Ellis (2000) and Kalanda-Sabola *et al.* (2007) added that lack of documentation of the IKS have contributed to the decline of the knowledge system, as elders were dying without passing on the knowledge system to their descendants. With respect to the creation of public awareness on the significance of the IKS, Cobb (2011) argued that creation of public awareness is the cornerstone for its integration into other knowledge systems so as to change people's negative attitude on their knowledge system, which has been negatively labelled as primitive, barbaric, archaic and superstitious (Reid *et al.*, 2004 cited in Kalanda-Sabola *et al.*, 2007; Ocholla, 2007; Zazu, 2007).

Incidentally, in this study, 7.0% of the respondents proposed documentation and training on the significance of the IKS, as a strategy to facilitate its integration into biodiversity conservation methods. This is in favour of Berkes *et al.* (2003) cited in Cobb (2011) who argued that documentation of the IKS using signs and codes used in formal education system is not effective in the IKS, as the knowledge is easily understood orally. Moreover, Rahman (2000) added that the amount of the IKS expressed in numbers and words is just a fraction of the knowledge system, and such documentation will further lead to its decline (Gupta, 1994 cited in Zazu, 2007).

This study therefore conclude that promotion rather than documentation of the IKS relevant to the conservation of biodiversity, using its own ways of knowing, teaching and learning, will ensure not only its wide use and application but also its integration into other knowledge systems. Moreover, official recognition, motivation and active participation of the *walukolo*, coupled with strategies aimed at addressing household level poverty, are of significant importance in favouring the anticipated wide use, application and its integration into other knowledge systems. It is worth noting that several authors argued that factors that have been limiting the wide use and application of the IKS have also been limiting its integration into other knowledge systems (Egneus *et al.*, 2000 cited in Knutsson, 2006; Charnley, Fischer and Jones, 2007; Ocholla, 2007; Darr, Pretzsch and Dresden, 2009; Ossai, 2010; Cobb, 2011).

4.9 Summary of the Chapter

This sub-section presents a summary of the findings of this study. Using the South Nguru Mountain Forest Reserve, Morogoro, Tanzania, this study aimed at exploring the socio-economic and political factors limiting integration of the IKS into biodiversity conservation methods. Specifically, the study aimed at answering the following research questions: - (i) What is existing IKS for biodiversity conservation in the South Nguru Mountain Forest Reserve?; (ii) What is the significance of IKS on biodiversity conservation in South Nguru Mountain Forest Reserve?; (iii) How do the indigenous people's demographic and socio-economic characteristics limit the integration of the IKS into biodiversity conservation methods?. Based on the above research questions, the summary of the findings of the study are presented hereunder:-

i. Indigenous knowledge system favouring conservation of biodiversity in the South Nguru Mountain Forest Reserve

Using interviews, FGDs, field observations and the review of the literature, this study disclosed the existence of indigenous social network and structure that included the people, the land and their ancestral spirits, with the ancestral spirits believed to have power to influence the lives of the people, a belief which contributed to the existence of several sacred groves and places amongst different clans of the Nguu ethnic group. The study also revealed that most of the indigenous people believed that all the living and the non-living things were God/or god's creation and deserve upmost respect, so they had to be used in a reciprocal relationship among themselves, whereas restrictions in forms of taboo, sacredness, totemic, just to list a few, were attached to certain species of both plants and animals perceived to be supporting people's livelihood, to ensure continuity of their products and services; what can be termed selective or utilitarian conservation. Apparently, the indigenous system was less active and is declining.

ii. The Significance of the indigenous knowledge system on conservation of biodiversity

This study revealed that a wealth of IKS possessed by the people of the South Nguru Mountain Forest Reserve cannot sustainably conserve biodiversity of the forest reserve, regardless of its significant contribution to the same. The significance of the knowledge system among others is limited by the lack of legitimacy and power to deal with offenders, as such a role has been taken off from *wahukolo*; the knowledge has been badly labelled limiting its wide application and the knowledge system being just limited to some areas with a large landscape. The study further disclosed that the biodiversity conservation methods alone could not sustainably conserve biodiversity in the South Nguru Mountain Forest Reserve due to limited staff, resources and lack of spiritual connectedness among

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forest officials on the biodiversity they are obliged to conserve. So to say, the integration of these knowledge systems was highly recommended.

iii. Demographic and Socio-economic factors limiting integration of the IKS into biodiversity conservation methods

In Section 2.1.2 of the study, it was described that demographic and socio-economic factors limiting the wide use and application of the IKS were also limiting its integration into biodiversity conservation methods. The study compliance with IKS among members of communities varied with sex, age and years of residency of an individual. The study also observed that compliance with the IKS varied with household income, farmland size and household labour.

Contrary to the Convention on Biological Diversity (CBD) of 1992, of which the Tanzanian government is a signatory, and the Tanzania Forest Act 2002, both being emphasizing reciprocal and mutual participation of indigenous people and their knowledge system on conservation of biodiversity, as their integration would achieve more than neither in their separation, their integration has yet to happen in realm of practices in conservation of biodiversity in the South Nguru Mountain Forest Reserve; resulting not only to decline of the IKS but also its lack of integration into biodiversity conservation methods.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the findings of this study the following conclusions are drawn. First, in the South Nguru Mountain Forest Reserve, local people possessed a wealth of the IKS that favoured selective conservation of biodiversity. The knowledge system was interwoven with the local people's indigenous social structure and politics, whereas, the social structure links humans, the land in which ancestors were buried and the ancestral spirits, with the latter being believed to affect the lives of the living. The knowledge system included, among other things, sacred groves, which are globally known for their biodiversity richness, sacred species of both flora and fauna and selective conservation of wild species of flora and fauna, perceived to positively contribute to people's livelihood.

Second. Guided by the Wiesmann's Actor-oriented model and Roba's Socio-Economic and Ecological Model (SEEM) and the conceptual framework, of which, all theories on examination of the socio-economic and political factors determining potential actors' interaction with their supporting ecosystem is a pre-requisite for successful interventions, this study provides that, for the integration of IKS into other knowledge systems to be realised, there should be no elevation of one knowledge over others, and each of the knowledge systems be understood based on its own ways of knowing and doing. So to say, based on the Cobb's steps to integrating IKS into ICT (Section 2.4), this study argues that promotion, valuing, stewardship and co-management and discourse of the knowledge systems, particularly, the IKS and its own ways of knowing and doing, is a cornerstone for such integration to be realised.

Third, despite Tanzania being a signatory of the 1992 Rio De Janeiro Convention on Biological Diversity (CBD) and the Tanzania Forest Act of 2002 on active participation of indigenous people and mutual sharing of the benefits of biodiversity conservation. in the South Nguru Mountain Forest Reserve such initiatives are as good as fine and fence, advocated by the pro-nature conservatisms ideology, whereas, local people and their IKS are perceived as threat rather than important partners in conservation initiatives. Apparently, the IKS and the biodiversity conservation methods are in a parallel and a win-lose relationship rather than a win-win relationship (pro-both: people and biodiversity ideology), while the indigenous knowledge is increasingly being replaced by biodiversity conservation methods.

Last but not least, wide use and application of the IKS in the South Nguru Mountain Forest Reserve has been limited by demographic and socio-economic characteristics of the local communities, lack of official recognition of the system, valuation, promotion and capacity building of the indigenous social structures from which the knowledge system evolved, got enhanced and sustained over years. Moreover, lack of reciprocal relationships between pioneers of biodiversity conservation methods and the indigenous people in their socio-economic and political contexts in which the indigenous social structure existed, have been limiting the wide use and application of the IKS, and of its integration into biodiversity conservation methods.

5.2 Recommendations

In light of the conclusions drawn, this study considers the following recommendations critical for the integration of the IKS into the biodiversity conservation methods in the South Nguru Mountain Forest Reserve. It is thus recommended that:

- i. Implementation of international conventions and adherence to such commitments, formulation of policies, strategies and approaches for the conservation of biodiversity at local contexts, such as CBD, require critical analysis of the local context within which such policies, bylaws, Acts and so forth, are to be implemented. A 'one fit all' approach has already resulted into failure of several initiatives.
- ii. For the integration of the IKS into other knowledge systems to be realized, a mutual and active participation of all potential actors, with each of the knowledge systems being understood and equally accepted based on their own ways of knowing and doing are inevitable. In so doing, unnecessary conflicts of interest will be significantly reduced.
- iii. The Government and non-governmental organizations, official recognition, motivation, capacity building and promotion of the indigenous social structures from which the IKS relevant for conservation of biodiversity evolved, is enhanced and sustained are collectively vital for successful conservation of biodiversity. The IKS should be used based on its own ways of knowing, taught and learned to facilitate its wide use, application, sustainability and its integration into other knowledge systems.

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APPENDICES

Appendix 1: Interview questions with the indigenous people

Interviewer's introduction

I am a Ph.D student in the Development Studies Institute of the Sokoine University of Agriculture in Morogoro. I do not represent the government or any political party. I am studying about the indigenous knowledge system, with focus on the factors limiting its integration into biodiversity conservation methods in the South Nguru Mountain Forest Reserve, Tanzania. I would like to discuss these issues with you and all the information obtained will be treated confidentially. It is also worth to note that answers to these questions are an important input toward development of collective and comprehensive strategies of addressing the problem of biodiversity declination and enhance and sustain the indigenous knowledge system, thus, improving people's livelihood capacity sustainably.

Section I: Household Information

1.1 Background information of the respondent

Date of interview	Village	Ward
Name of enumerator	Household code	Ethnicity of the respondent
Age of the respondent (years)	Sex of the respondent 1. Male () 2. Female ()	Residence duration (years)
Education level 1. Non-formal education () 2. Primary (up to Standard 4) () 3. Primary (up to Standard 7) () 4. Secondary school () 5. Post-secondary school (). 6. Others (specify).....	Major source of income 1.....	An estimate monthly income in Tshs.....

1.2. Household composition

Name	Age (Years)	Sex	Relationship	Education	Occupation
1		1= male	1=Husband	1=None	1=Child
2		2=Female	2=Wife	2=Std IV	2= Student
3			3= Child	3=Std VII	3=Farmer
4			4=Other relatives	4=Secondary	4=C/servant
5			5=None relatives	5= Higher Ed.	5=Non -farm
6					
7					
8					
9					
10					
11					
Total Resident HH Members					

2. How many people in your household are able to work?.....

3. Is your household labour adequate for your household labour demand?

01) YES () 02) NO ()

4. If you answered NO in the above question, how do you address the problem of labour shortage? Please, rank them.

1.

2.

3.

5. Who owns farmland(s) in your household?

1) A husband () 2) A wife () 3) Both () 4) Others

specify.....

6. What is the total size of your farmland(s) in the village?.....acres.

7. Do you own other farmland(s) in other village(s)

01) YES () 02) NO ()

8. If you answered YES in the above question, what is the total farmland(s) size and the distance from the villageacres,.....Km

9. Is the size of your farmland(s) adequate for your household needs?

01) YES () 02) NO ()

10. If you answered NO in the above question, what do you do to address the problem of small farmland?

(1) Rent () (2) Buy () (3) Clearance of forest () (4) Other (specify).....

Section II: The indigenous knowledge system for conservation of biodiversity

11. If you look around your environment today, would you say it is the same as the one your ancestors left 20 years ago in terms of the number and abundance of the wild species of plants and animals? 01) YES () 02) NO ()

12. Please, give reason(s) for the above answer.

1.

2.

3.

13. How important are plants, animals and the forests to you and your community?

1) Very important () 2) Important () 3) Not important ()

14. Please, give reason(s) for the above answer.

1.

2.

3.

15. What is the origin of plants, animals and forests in your community?

1) Created by God () 2) Through evolution () 3) Created by the gods ()

4) I don't know () 5. Other (specify).....

16. Based on your belief, how are you supposed to manage and use the wild species of plants and animals?

- 01) With consideration of the present generation only ()
- 02) For the present and future generations ()
- 03) Any how ()
- 04) I do not know ()

17. Please, give reason(s) for the above answer.

1.
2.
3.

18. Do you retain plant species in your farmland?

- 01) YES () 02) NO ()

19. If you answered YES in the question 18 above, what plant species do you normally retain in farmland?

Sn	Tree normally retained	Reason(s)
1		
2		
3		
4		
5		

20. What plant species are normally not retained in farmlands?

Sn	Tree normally not retained	Reason(s)
1		
2		
3		
4		
5		

21. In your community is/are there any natural forest(s) that is/are managed using the indigenous knowledge system?

01) YES () 02) NO ()

22. If you answered YES in the above question, what is/are the purpose(s) for their conservation?

1)

2)

3)

4)

23. If you answered YES in the question 21 above, what is/are the status of their conservation?

01) Intact () 02) Somehow decreasing ()

03) Almost extinct () 04) I do not know ()

24. Is/are there wild species of animals that are restricted by the indigenous knowledge system from being killed?

01) YES () 02) NO ()

25. If you answered Yes in the above question, what is/are the animal(s)?

Sn	Wild animal(s) restricted from being killed	Reason(s) if known
1		
2		
3		
4		
5		

26. Is/are there wild species of plants that is/are restricted by the indigenous knowledge system from being cut?

01) YES () 02) NO ()

27. If you answered Yes in the above question, what is/are the species?

Sn	Wild plants restricted from being cut	Reason(s) if known
1		
2		
3		
4		
5		

28. What is the status of the indigenous knowledge system for management and use of wild species of plants, in terms of their sustainability?

01) Declining () 02) Still effective ()

29. If the indigenous knowledge system is declining, please give examples

Sn	The Indigenous knowledge system	Reason(s) if any
1		
2		
3		
4		
5		

30. What is the status of the indigenous knowledge system for management and use of wild species of animals, in terms of its sustainability?

01) Declining () 02) Still effective ()

31. If the indigenous knowledge system is declining, please give examples

sn	The Indigenous knowledge systems	Reason(s) if any
1		
2		
3		
4		
5		

32. Were you taught by your ancestors on the indigenous knowledge system for the management and use of wild species of plants and animals?

01) YES () 02) NO ()

33. If you answered YES in the above question, do you teach your descendants on the indigenous knowledge system for the management and use of wild species of plants and animals?

01) YES () 02) NO ()

34. If you answered YES in the above question, what indigenous skill(s) do you normally teach them?

sn	Indigenous knowledge system normally taught for the management and use of wild species of plants and animals	Sex		Name of wild spp of plant/animal intended
		Boys	Girls	
1				
2				
3				
4				
5				

35. If you answered NO in question 33 above, why do you not teach your descendants on the indigenous knowledge system for the management and use of wild species of plants and animals?

1.
2.
3.

Section III: Socio-economic Characteristics of the respondents and their compliance with the Indigenous Knowledge System

36. Based on your view, do males and females obey the indigenous knowledge system for the management and use of wild species of plants and/animals the same way?

01) YES () 02) NO ()

37. Please, give reason(s) for the above answer.

(1).....

(2).....

(3).....

38. Do people with different levels of household income obey the indigenous knowledge system for management and uses of wild species of plants and animals similarly?

01) YES () 02) NO ()

39. Please, give reason(s) for the above answer.

1.....

2.....

3.....

40. Is there a link between compliance with the indigenous knowledge system and the level of education of an individual?

01) YES () 02) NO ()

41. Please, give reason(s) for the above answer.

1.....

2.

3.

42. Does compliance with the indigenous knowledge system for management and use of wild species of plants and animals vary with the household's farmland size?

01) YES () 02) NO ()

43. Please, give reason(s) for the above answer.

1.
2.
3.

44. Is there a link between the age of an individual and their compliance with the indigenous knowledge system for management and use of wild species of plants and animals?

01) YES () 02) NO ()

45. Please, give reason(s) for the above answer.

1.
2.
3.

46. Does compliance with the indigenous knowledge systems for the management and use of wild species of plants and animals vary with years of residency of an individual?

01) YES () 02) NO ()

47. Please, give reason(s) for the above answer.

1.
2.
3.

48. What should be done to revive the indigenous knowledge system for the management and use of wild species of plants and animals? Please, rank them

1.
2.
3.

Section IV: Integration of the indigenous Knowledge System into Biodiversity conservation methods for the management and use of wild species of plants and animals

49. Do you know the boundaries of the South Nguru Mountain Forests?

01) YES () 02) NO ()

50. If you answered YES in the question above, are they respected?

01) YES () 02) NO ()

51. Please give reason(s) for the above answer.

1.
2.
3.

52. Are you aware of the government rule(s) and regulation (s) governing the management and use of the South Nguru Mountain Forests?

01) YES () 02) NO ()

53. If you answered YES in the above question, what are the rules and regulations?

1.
2.
3.

54. Does the government and/or NGOs insist (s) on the wide use and application of the indigenous knowledge system for the management and use of wild species of plants and animals?

01) YES () 02) NO ()

55. If you answered YES in the above question, please provide example (s)

1.
2.
3.

56. Does your village have by-laws governing the management and use of wild species of plants, animals and natural forests?

01) YES () 02) NO ()

57. If you answered YES in the above question, who facilitated their formulation?

.....

58. If you answered Yes in question 56 above, is the indigenous knowledge system integrated into the by-laws for management and use of wild species of plants and animals?

01) YES () 02) NO ()

59. If you answered YES in the above question, please give examples of the indigenous knowledge system integrated in the bylaws?

1.
2.
3.

60. If you answered NO in the above question, do you know of why the indigenous knowledge system was not integrated into the village environmental by-laws?

01) YES () 02) NO ()

61. Please, give reason(s) for the above answer.

1.
2.
3.

62. Do you think government rules and regulations alone can sustainably conserve biodiversity in the South Nguru Mountain Forests?

01) YES () 02) NO ()

63. Please, give reason(s) for the above answer

- 1.....
2.
3.

64. Do you think the indigenous knowledge system alone can sustainably conserve biodiversity in the South Nguru Mountain Forests?

01) YES () 02) NO ()

65. Please, give reason(s) for the above answer.

- 1.....
2.
3.

66. Have you ever witnessed an integration of the indigenous knowledge system and the biodiversity conservation methods for the management and use of wild species of plants and animals?

01) YES () 02) NO ()

67. If you answered YES in the above question, please give example(s),

- 1.....
2.
3.

68. If you answered NO in the question 66 above, why was the indigenous knowledge system not integrated into the village environmental by-laws for the management and use of wild species of plants and animals?

- 1.....
2.
3.

69. Based on your own view, what should be done to facilitate the integration of the indigenous knowledge system into the biodiversity conservation methods for management and use of wild species of plants and animals in the South Nguru Mountain Forests?

- 1.....
2.
3.

THANK YOU FOR YOUR COOPERATION

Appendix 2: Field observation schedule

Field observation was used to observe of all issues related to the indigenous knowledge system for the management and use of biodiversity, demographic and socio-economic factors related to its wide use, application and integration into the biodiversity conservation methods.

Appendix 3: Questions for the focus group discussions

Facilitator's introduction

I am a Ph.D student in the Development Studies Institute of the Sokoine University of Agriculture in Morogoro. I do not represent the government or any political party. I am studying about the indigenous knowledge system, with focus on the factors limiting its integration into biodiversity conservation methods in the South Nguru Mountain Forest Reserve, Tanzania. I would like to discuss these issues with you and all the information obtained will be treated confidentially. It is also worth to note that answers to these questions are an important input toward development of collective and comprehensive strategies of addressing the problem of biodiversity declination and enhance and sustain the indigenous knowledge system, thus, improving people's livelihood capacity sustainably.

Selection of the participants in the Focus Group Discussions was based on their understanding of and perceptions on the indigenous knowledge system and biodiversity conservation methods. The discussions were be guided but not limited to the following questions: -

1. What is the originality of the wild species of plants and animals at man exposure?
2. What is the abundance and the number of wild species of plants and animals as of the past 20 years?
3. Does your community have the indigenous knowledge system governing the management and use of wild species of plants and animals?
4. Based on the indigenous knowledge system, how is one supposed to use and manage the wild species of plants and animals?
5. Was the process of formulating the village environmental by-laws participatory?

6. Why was the indigenous knowledge system for the management and use of biodiversity not integrated into the village environmental by-law?
7. IS the indigenous knowledge system, alone, able to conserve biodiversity sustainably?
8. Are the biodiversity conservation methods, alone, able to conserve biodiversity sustainably?
9. What should be done to revive the indigenous knowledge system on the management and use biodiversity conservation?
10. What should be done to facilitate the integration of the indigenous knowledge system into biodiversity conservation methods?

Appendix 4: Questions for the key-informant interview

Interviewer's introduction

I am a Ph.D student in the Development Studies Institute of the Sokoine University of Agriculture in Morogoro. I do not represent the government or any political party. I am studying about the indigenous knowledge system, with focus on the factors limiting its integration into biodiversity conservation methods in the South Nguru Mountain Forest Reserve, Tanzania. I would like to discuss these issues with you and all the information obtained will be treated confidentially. It is also worth to note that answers to these questions are an important input toward development of collective and comprehensive strategies of addressing the problem of biodiversity declination and enhance and sustain the indigenous knowledge system, thus, improving people's livelihood capacity sustainably.

The interview based on the understanding and perceptions of, and the significances of the indigenous knowledge system and biodiversity conservation methods on conservation of biodiversity and on the implementation of the Rio de Janeiro 1992 Convention on Biological Diversity (CBD) and the Tanzania Forest Act of 2002. The discussion were guided by, but not limited to the following questions: -

Section I: Government capacity on conservation of the South Nguru Mountain

Forest Reserve

1. How many field forestry officers are positioned in villages bordering the South Nguru Mountain Forests?.....
2. What are their academic qualification(s)
.....
.....
.....
3. What is the adequate number of the field forest officers for a meaningful conservation of biodiversity in the South Nguru Mountain Forests?.....
4. What was the total budget requested for effective conservation of the Mkingu Natural Forests for the last financial year.....?:
5. What was the annual budget allocated in the last financial years(Tshs).

Section II: The indigenous knowledge system, conservation of biodiversity and its integration into biodiversity conservation methods

6. Based on your profession, what is the originality of the biodiversity at man's exposure?
7. Based on your own belief, what is the originality of the biodiversity at man's exposure?
8. If the views on the originality of biodiversity in question 6 and 7 above contradict, how do you manage to accommodate such contradiction?

9. Are you aware of the existence of the indigenous knowledge system favouring conservation of biodiversity in the South Nguru Mountain Forests?
10. Article 8(j) of the Convention of Biological Diversity (CBD) of 1992 and the Tanzania Forest Act of 2002, emphasis on the promotion, wide use, application and the integration of the indigenous knowledge system and a reciprocal relationship between actors, how have you been ensuring achievement of such commitments? Please, provide examples?
11. What need be done to facilitate the integration of the indigenous knowledge system into the biodiversity conservation methods?
12. Comment on the process of the formulation of the environmental bylaws in villages bordering the South Nguru Mountains Forests, what is it participatory?
13. Why was the indigenous knowledge system not integrated into the villages' environmental bylaws for the conservation of biodiversity?
14. How does your office support and motivate the Village Environmental Committees that is entitled for the enforcement of the bylaws in their respective village?



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