TRENDS IN THE USE AND APPLICATION OF INDIGENOUS KNOWLEDGE: IMPLICATIONS ON NATURAL RESOURCE MANAGEMENT AMONG NANDI PEOPLE OF, KENYA

PACIFICA CHEPKOSGEI MINING

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DECLARATION

Declaration by the Candidate

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Mining Pacifica Chepkosgei

Siganature:_____ Date: _____

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Declaration by Supervisors

This thesis has been submitted for examination with our approval as university supervisors.

Signature: _____ Date: _____

Dr. Grace J. Cheserek

University of Eldoret

Signature: _____ Date: _____

Dr. Reginalda N. Wanyonyi

University of Eldoret

DEDICATION

To the Custodians of Indigenous Knowledge of the Nandi people.

ABSTRACT

Indigenous Knowledge (IK) has been widely reported by researchers and natural resource managers as a valuable contributor to natural resource management (NRM) and biodiversity conservation. The influences of modernity throughout Africa and the developing world have seriously contributed to the negation of traditional indigenous knowledge in ongoing efforts to ensure sustainable management of natural resources. This study sought to investigate the changing trends in use and application of IK in NRM; establish environmental implications of changes in use and application of indigenous natural resource management; and determine interrelationships between the Nandi indigenous natural resource strategies and modern natural resource strategies. The study adopted a case study design. The target population were all officers in charge of environmental management in the county, traditional specialists and household heads. A total of 385 household heads, 13 traditional specialist and 10 Nandi County natural resource management officers were selected through systematic, snowball and purposive sampling methods respectively. Quantitative data was collected using questionnaires while qualitative data was collected through key informant interviews and focus group discussions. Quantitative data was subjected to both descriptive and inferential analysis. Descriptive data were analyzed using frequencies, percentages, and means. For inferential statistics, chi square was computed to test relationships between study variables while qualitative data was analyzed thematically. The study established significant changes in the use and application of IK in NRM- specifically in Land use, water resources, forest cover and wildlife management. Modern approaches in NRM had taken precedence over traditional ecological knowledge as a result of this trend; Nandi County had experienced significant negative environmental effects ranging from shrinking of water bodies and vegetation cover to extinction of key endemic species particularly in Nandi forest. The study established that IK and modern NRM should be complimentary rather than contradictory. These findings suggest the need to encourage community-based NRM at grass root levels, and incorporation of rural participatory NRM strategies to ensure sustainable environmental management in the County. This will enhance the integration of indigenous knowledge in modern natural resource management strategies.

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LIST OF ABBREVIATIONS

IK	Indigenous knowledge
TK	Traditional Knowledge
NR	Natural Resource
NRM	Natural Resource Management
IUCN	International Union for Conservation of Nature and Natural Resources
WCED	World Conference on Economic Development
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environmental Programme
GOK	Government of Kenya
KSS	Kenya Soil Survey
SPSS	Statistical Package for Social Scientists
NEMA	National Environmental Management Authority
FGD	Focused Group Discussion
NGO	Non-Governmental Organization
MS	Microsoft

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CHAPTER ONE

INTRODUCTION

1.0 Overview

The chapter presents key issues that lay the foundation to the study. These include: the background to the study, statement of research problem, the aim and objectives, research questions, justification, scope and limitations of the study.

1.1 Background to the Study

Globally, there is increasing acknowledgement of the relevance of indigenous knowledge as an invaluable and underused knowledge reservoir, which presents developing countries particularly Africa, with a powerful asset in environmental conservation (Mapara, 2009; Mawere, 2011; Shoko, 2012). The Rio Declaration, the Convention on Biological Diversity, the documents coming out of the World Summit on Sustainable Development, and a whole host of other international instruments and forums have emphasized the current (and future) relevance of IK. Institutions such as the World Intellectual Property Organization, the International Labor Organization (especially Convention 169), the Food and Agricultural Organization, the World Health Organization, UNESCO, UNEP, UNDP, the UN Commission on Human Rights, and a number of other international organizations have similarly given it importance (Odote, 2010).

The Convention on Biological Diversity (CBD) was the first to develop measures for use and protection of Traditional Knowledge related to the conservation of and sustainable use of biodiversity (United Nations Education Scientific and Cultural

Organization, 2010). The Agreement on Trade Related Intellectual Property Rights (TRIPS) inserted Article 27.3 (b) which allows member states of World Trade Organization (World Trade Organization) to use sui-generis system. This permits countries to come up with specialized and appropriate forms of protection regimes, which can use local legislation to protect IK. The World Intellectual Property Organization (WIPO) is working with organizations and indigenous and local communities in different nations to address the policy/ legal issues on traditional knowledge protection through the Intergovernmental Committee on Intellectual Property, Genetic Resources, Traditional Knowledge and Folklore. The African Regional Intellectual Property Organization (ARIPO) and Organization Africaine de la Propriete Intellectualle (OAPI), Traditional Knowledge and Traditional Cultural Expressions (TCE) aim at providing a legal framework to protect them and it is formalized into a protocol for protection of Traditional Knowledge (Finneti, 2011). African states therefore have enough ground to come up with policies and legal frameworks.

The World Conference on Science, organized by UNESCO and the International Council for Science (ICSU), in its Declaration on Science and the Use of Scientific Knowledge, explicitly recognized the importance of Indigenous Knowledge and the need to respect and encourage its use for various forms of human endeavor (United Nations Education Scientific and Cultural Organization, 2010). The UN Declaration on Indigenous Peoples endorsed by the UN Human Rights Council in June 2006 recognized the contribution of indigenous knowledge to sustainable development and proper management of the environment (United Nations Environmental Programme, 2008). It is particularly instructive that the United Nations Committee on Trade and Development (UNCTAD), which essentially deals with international economic

relations, has also given Indigenous Knowledge considerable attention (World Trade Organization, 2002).

After Rio de Janeiro conference, Kenya embarked on translating Agenda 21 into national development agenda (Odote, 2010). The National Environmental Management Action Plan (NEAP) was developed with a view to enhancing integration of environmental concerns into national planning and development process. The enactment of the Environmental Management and Coordination Act (EMCA) 1999 provides an appropriate legal framework for the management of the environment in Kenya. Policies emanating from EMCA include involvement of local communities and civil society in the planning and management of environmental resources (Government of Kenya, 2004). The important role played by indigenous knowledge in natural resource management, has thus been recognized.

The most commonly accepted role of Indigenous Knowledge (IK) in the "traditional" or primary sectors of the economy such as agriculture and pastoralism, forestry, fisheries, water, and products made from natural resources such as crafts, furniture, and housing has been noted (Ossai, 2010). Given the fact that a majority of the world's population remain dependent on these sectors for their survival and livelihoods, and for various aspects of shelter, the contribution that IK makes towards sustaining billions of people is quite clear. However, the role of Indigenous Knowledge in the secondary and tertiary sectors of the economy too is becoming clearer (Finneti, 2011). A whole range of industrial products are dependent on or use Indigenous Knowledge in various ways.

Health care is dependent on Indigenous Knowledge, or on combinations of Indigenous Knowledge and modern knowledge. According to the World Health Organization

(WHO), the majority of the world's population is dependent on varying degrees on medicinal plants through traditional health care systems. The World Health Organization estimates that 25 per cent of modern medicines are made from plants that were first used traditionally (World Health Organization, 2001). Services like food distribution, education, climate forecasting and warning, and community care also continue to be performed through institutions using traditional means, and in some cases even modern institutions of government or corporate sector are discovering the value of this.

From time immemorial, natural resources conservation and management in Africa has been deeply rooted in local communities, which apply and use indigenous knowledge to monitor climate and other natural systems and establish early warning indicators for their own benefit and future generations (Mwaura, 2008; Shoko, 2012). Indigenous knowledge is therefore an essential element in the development process and the livelihoods of many local communities. South Africa gets R29 billion per year from trade in Traditional Medicine (Monder, Ntuli, Diedericks & Mavundia, 2007). The San tribe of South Africa sold the right of ownership of the Hoodia Plant to a British Company for about US$ 20 million. The devils claw plant in Namibia which is used as an analgesic and anti-inflammatory drug earns Namibia US$ 2 million annually (Wekunda, 2012).

In the traditional African worldview, environmental resources (land, water, animals and plants) are not just production factors with economic significance but also have their place within the sanctity of nature (Mawere, 2011; Mapara, 2009). Certain places have a special spiritual significance and are used as locations for rituals and sacrifices, for example, sacred grooves, shrines, mountains and rivers. These locations are often

patches of high biodiversity which are well conserved and protected by the community. For the traditional people of Northern Ghana, gods, spirits, shrines, ritual crops and animals, food items and cash crops are all inter-related (Sarfo- Mensa & Odura, 2010). African indigenous knowledge systems are often elaborate and adapted to local culture and environmental conditions tuned to the needs of people and quality and quantity of available resources (Akindele, 2010).

There is need for sustainability in how to manage the environment. This need is yearned for in the midst of a growing destruction of non-renewable resources and the ceaseless degradation of the African environment. IK has a vital role, for traditional peoples and communities have used a wide range of their own indicators and methods to get an idea of sustainability. Water flows, the presence/absence or appearance/disappearance of certain species, the behavior of domestic or wild animals, and other kinds of changes in their surroundings are used in myriad sophisticated ways to learn about ecological changes that may be detrimental or beneficial (Mawere, 2011).

For many years, communities in Kenya have used Indigenous Knowledge (IK) as a part of their very cultural and social identities, well-being, sustainable development and intellectual and cultural vitality. Article 8(j) of the Convention on Biological Diversity (CBD) to which Kenya is party obliges members to respect, preserve and protect Indigenous Knowledge of local communities (Manek, 2001). In addition, Article 69(10) (c) of the Kenyan Constitution requires the State to respect the environment by protecting and enhancing Indigenous People in, and indigenous knowledge of, biodiversity and Genetic Resources of the communities of Kenya (Odote, 2012). For most of the 42 communities or tribes in Kenya (the Nandi Community included), IK is

inseparable from their ways of life and their environment, natural resources, cultural values, spiritual beliefs and customary legal systems.

However, despite the prevalent application and use of indigenous knowledge by local communities, it is arguable that it has not been fully harnessed to fit into the current scientific framework for environmental conservation and natural resource management in Africa. As a result, there is a general lack of information and understanding of the need to integrate or mainstream indigenous knowledge into scientific knowledge systems for sustainable development in the continent (Nganje, 2009; Kajembe, Mbwambo, Mwokalolo, Kimara & Njana, 2010). To ensure integration requires a blend of approaches and methods from science and technology and from indigenous knowledge (Stevenson, 2005; Fitzgerald & Stronza, 2009; Das Gupta, 2011).

1.2 Statement of the Problem

Indigenous knowledge provides valuable insights on how numerous communities have interacted with their changing local environment including its biodiversity (Mapara, 2009; Tasara & Maposa, 2012). Huntingford (2006) notes that Indigenous Knowledge has been used by the Nandi community from time immemorial to live in harmony with its environment. The community had powerful structures that exercised authority to ensure compliance with the observance of the rules of natural resource conservation in the course of making a living. The indigenous knowledge systems were particularly evident in agricultural production, food preservation and storage and natural resource conservation.

The older generation which is the traditional custodian of indigenous knowledge is dying off without leaving a written record of knowledge within the Nandi community. Due to rapid environmental, socio-economic and political changes occurring in this community indigenous knowledge is in danger of being totally replaced by new knowledge.

Indigenous knowledge systems among the Nandi are at risk of becoming extinct because of rapidly changing natural environments and fast paced economic, political and cultural changes. Practices vanish, as they become inappropriate for new challenges or because they adapt too slowly. However, many practices disappear only because of the invasion of foreign technologies that promise short term gains or solutions to problems without being capable of sustaining them. Additionally, modern knowledge is increasingly gaining a lot of popularity and replacing the use of IK among the Nandi in natural resource management. This study therefore sought to find out changes which have occurred in the use and application of Indigenous Knowledge in natural resource management in Nandi. The study also sought to establish the implications these changes have had on natural resource management in Nandi County.

1.3 Objectives of the study

1.3.1 Main objective of the study

The main objective of the study was to establish the implications of the trends in the use and applications of Indigenous Knowledge to natural resource management by the Nandi people, of Nandi County in the Rift Valley of Kenya.

1.3.2 Specific objectives of the study

The specific objectives of this study were:

i. To investigate the trends in the use and application of Indigenous Knowledge in natural resource management among the Nandi.
ii. To establish environmental impacts of changes in use and application of Indigenous Knowledge in natural resource management in Nandi County.
iii. To determine the interrelationships between the Nandi indigenous natural resource management strategies and modern natural resource management strategies.

1.3.3 Research Questions

The following research questions guided the study.

i. What changes have occurred in the use and application of indigenous knowledge in natural resource management among the Nandi over time?
ii. What are the environmental impacts of change in use and application of indigenous knowledge in the study area?
iii. Is there any relationship between the Nandi indigenous natural resource management strategies and modern natural resource management strategies?

1.4 Justification and Significance of the Study

Indigenous knowledge provides valuable insights on how numerous communities have interacted with their changing local environment including its biodiversity (Mapara,

2009; Das Gupta, 2011). Indigenous knowledge systems in Africa have not been systematically recorded and are therefore not readily accessible to policy makers, researchers and development agents although several writers have provided detailed overviews of indigenous knowledge systems in agricultural development, pastoral management, and agro-forestry (Mapara, 2009).

There is very limited data from literature review in the indigenous communities of Kenya that has been documented specifically on indigenous knowledge in environmental conservation (Ipara, 2004; Mackenzi, 2004). This situation is of great concern (Chigwenya & Manatsa, 2007). Although this is arguable, Tasara and Maposa (2012) supports the argument by noting that both Nigeria and India have gone far by documenting their unique species into published glossaries despite limited resources. This study aims to fill this gap by investigating the Nandi community.

Mawere (2011) highlights the value of indigenous knowledge (IK) and the need for documentation to be increased in line with globalisation. Indigenous knowledge is not yet fully utilized in the development process (Houde, 2007). Conventional approaches imply that development processes always require technology transfer from locations that are perceived as more advanced (Rist & Dahdoulo-Guebas, 2006; Houde, 2007). This has often led to overlooking the potential in local experiences and practices in development scene. Utilizing IK helps to increase the sustainability of development efforts because the IK integration process provides for mutual learning and adaptation, which in turn contributes to the empowerment of local communities (Charnley, Fisher & Jones, 2007; Amman, 2007).

By enquiring into the changing trends in use and application of IK among the Nandi community, it is hoped the findings of the study will raise level of awareness of the local people on the need to preserve their local knowledge and transmit to it to future generations. The results will also be useful to environmentalists and conservationists; Non Governmental Organizations (NGOs) and development agencies involved with development of communities, agriculture, water and forests sectors in Nandi County.

The findings of this study will generate information on how the Nandi community has interacted with their local environment. This will be useful to researchers, environmental conservationists and development planners to understand more fully the dynamics of local ecosystems. Furthermore, the output of this study will also inform policy makers on the need of policy interventions to integrate indigenous knowledge and scientific knowledge and the need to involve indigenous people for sustainable management of natural resources. Finally, the results of this study will be of benefit to scholars, researchers and the students interested in Indigenous Knowledge as it provides them with information in further studies in the same area or elsewhere.

1.5 Scope and limitations of the study

The study is limited to a sample size of 385 respondents, due to available resources and time allocated for the study. The sample drawn was representative of the entire Nandi community population. The research was based on three natural resources namely land, water and forest.

Notwithstanding, the successful execution of the study, a number of limitations encountered in the process need to be acknowledged. First, some households

approached refused to be talk because of cultural inhibitions. In one case, the respondents were unwilling to explain some of the plants and tree species used found in sacred places. In such cases such important information was not captured. Secondly, the terrain across Nandi County was extremely rough consequently leading to more time spent in data collection. Lastly, most of the respondents could only respond in the indigenous language a limitation that was countered through extensive training of the research assistants who luckily were from the communities selected and could understand the language.

1.6 Operational Definition of Terms

Natural Resource refers to naturally occurring materials such as land, water, forests, flora and fauna that can be useful to humans.

Modern Knowledge refers to concepts, ideas, values imparted in the minds of the people by extension officers who are trained in scientific natural resource management.

Indigenous Knowledge is a systematic body of knowledge, skills and technology embedded in traditional institutions, cultural beliefs and practices that are used to utilize and manage natural resources in a specific community.

Natural Resource Management refers to use of natural resources such as land, water , plants and animals with a particular focus on how use affects the quality of life for both present and future generations.

Trends refer to changes which occur in society's information base as a result of internal creativity and experimentation as well as contact with external systems over time.

Community refers to a group of people, who claim a historical continuity and cultural affinity with society endemic to their original territory that developed prior to exposure to the larger connected civilization associated with the Western culture.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter synthesizes relevant literature appertaining to the study as per the set objectives. The concept of indigenous knowledge (IK) and sustainable development, policy related to IK and natural resource management, use and application of IK, impact of modernization on natural resource management and IK, integration of IK and modern knowledge are examined. Furthermore, information on significant theories and conceptual framework upon which this study is based is presented.

2.2 The Concept of Indigenous Knowledge

A variety of terms have been used to describe this form of unique knowledge. The terms include local knowledge, traditional knowledge, indigenous knowledge, indigenous technical knowledge, traditional knowledge, rural knowledge, traditional ecological knowledge. These terms have however similar meanings and can be used interchangeably. The various available terms, create problems of having one common meaning that can be used across indigenous communities hence each community has its own knowledge system. For the purpose of this study indigenous knowledge is used.

Mawere (2011) and Mapara (2009), define indigenous knowledge as a set of knowledge systems that embrace cultural, social, traditional, scientific, legal, and philosophical and governance systems of a particular community. The system consists of skills and knowledge used to guide the way of life (Berkes & Berkes 2009). Odora-

Hoppers (2002) however denote that indigenous knowledge is inclusive of climatic knowledge, management techniques, and technology in agriculture, forest, and resource exploitation. The knowledge is shared by people of the same ethnic group and of the same language; therefore it is exclusive to specific localities (Berkes & Berkes, 2009). However, the knowledge can sometimes be unique to specific individuals of the community such as traditional leaders, herbalists and expert food gatherers. Mapara (2009) defines IK as a body of knowledge, of the indigenous people of particular geographical area that they have survived on for a very long time. Altieri (2000) defines IK as knowledge forms that have originated locally and naturally and have failed to die despite the racial and colonial onslaughts that they have suffered at the hands of Western imperialism and arrogance. It is also seen to contrast with knowledge generated within the international system of universities, research institutions and private firms (Ammann, 2007).

Despite the several meanings, the central theme in all these definitions is that indigenous knowledge consists of a set of knowledge and technologies created to ensure that positive relations exist among people, and between people and the natural environment. For the purposes of this study, indigenous knowledge is the combination of different knowledge, skills and technology embedded in traditional institutions, cultural beliefs and practices that are used to manage natural resources in a specific community.

According to Reid, , Berks, Wilbanks & Capistrano (2006), Indigenous knowledge systems are holistic in nature as they embrace complex relationships that exist between the physical, human and spiritual worlds. They suggest that people perceive the world as a single interwoven unit where people are viewed as equal to nature. As such this

study seeks to find out how this perception is used in natural resource management. Sarfo-Mensa and Oduro (2010) and Reid *et al*., (2006) envisage that indigenous knowledge is imbedded in social, cultural, traditional institutions and cultural practices, rites, taboos, myths, folklore, songs, dances, and dreams. It is these traditional beliefs and practices that are used to control and manage socioeconomic activities in the community.

Indigenous knowledge is as dynamic as cultural, economic and ecological environments are. Kolawole (2004) elaborates that indigenous knowledge systems change as they are continually produced and reproduced by internal creativity and through contact with external systems. Indigenous knowledge systems are therefore cumulative due to addition of new knowledge into the already existing body of knowledge (Behera & Nath, 2005). The point is that indigenous knowledge systems are therefore contemporary since they are continually revised and up-dated to deal with contemporary environmental and economic issues (Naidoo, 2007).

Indigenous knowledge systems are stable systems of knowledge because despite the transformation they undergo, their original worth and meaning are maintained through to the new paradigm (Du Toit, 2005). The values, the know-how and technologies are resilient and transmitted from one generation to another. Indigenous knowledge is traditionally stored in social memory and is rarely in any form of documentation (Reid *et al*., 2006). Sarfo-Mensa and Oduro (2010) state that, elders, traditional leaders and traditional healers, play an insurmountable role as keepers and transmitters of indigenous knowledge systems. Elders, traditional leaders and traditional healers are therefore cornerstones for the continuity and perpetuation of indigenous knowledge systems across generations.

Indigenous knowledge systems are stored in traditional and cultural practices, beliefs, taboos, myths, legends, folklore and in cultural dances (Ipara, 2004). Nyong, Adesina, & Osman (2007) observe that the knowledge is also kept in traditional equipment, tools and in artifacts owned by indigenous communities. The main reason for transferring indigenous knowledge to younger generations is to equip them with survival skills. Transmission is traditionally by oral means, that is, through the word of mouth (Mapara, 2009). Indigenous knowledge systems are communicated through folklore, stories, rituals, dances, taboos and myths which are imbued with cultural and ecological knowledge and codes of behavior (Reid *et al*., 2006; Enaji, *Nfamu, Ajor, Ben, Bassey & William,* 2012). The young people observe experience and participate in community activities and therefore acquire indigenous knowledge.

The modes of storage and transmission have been criticized as insufficient and unreliable because indigenous knowledge systems are vulnerable to loss when custodians die or due to other external pressures. In Africa, the death of an old man is equated to a burnt library (Kalawole, 2004). This highlights the great loss of indigenous knowledge systems due to lack of documentation that might have negative implications on resource use and management. This study explores the use and application of IK in natural resource management among the Nandi people with the aim of documenting it for future generations.

Indigenous Knowledge reflects the dignity and identity of the local community. IK of a community can share itself with modern Knowledge Systems with a background of more complex culture. According to Das Gupta (2011), modern knowledge has many things to learn from IK; especially in the face of global changing environmental and

socioeconomic conditions it is essentially the root of sustainable natural resource management.

2.2.1 Indigenous Knowledge and Sustainable Development

Indigenous knowledge (IK) has been recognised in recent decades as making an important contribution to natural resource management systems particularly in the developing world (Kobina & Kofi, 2009; Wekunda, 2012). Central to this has been the assertion that IK is dynamic, that it evolves over time within a particular culture and as a result, local communities possess the capacity to adapt to change (Makenzi, 2004). Possessing such knowledge and capacity to adapt and apply it in the face of changing environmental and socio-economic conditions is essentially the root of sustainable natural resource management (Mwaura, 2008). The immense significance of indigenous knowledge in environmental conservation by local communities is well documented (International Union Conservation of Nature, 1991). Works in this area include studies in the transmission of traditional knowledge (Mawere, 2011) and application of indigenous knowledge to development (United Nations Educational Scientific Cultural Organization, 2010).

Indigenous environmental knowledge gained international recognition through such documents as the World Conservation Strategy (International Union for Conservation of Nature, 1991) and Our Common Future (World Conference on Environment and Development, 1987). Both documents emphasised the need to use directly the environmental expertise of local people in managing natural resources. They stressed that sustainable management of natural resources could be achieved by developing a science based on the priorities of local people and creating a technological base that

blends both traditional and modern approaches to solving problems. The Brundtland Commission Report defined sustainable development as that development which meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). The concept was more in the context of the impact of the development process on environment and vice versa, the concept of sustainable development should be considered in its wider framework for evaluating the development process and also for evolving suitable development for the future" (Bohenksy & Maru, 2011). With this view, governments were therefore encouraged to develop policies that would integrate both IK and modern knowledge, in the context of natural resource management.

The United Nations Conference on Environment and Development (UNCED), commonly known as the Earth Summit held in 1992 in Rio de Jenairo, Brazil produced agreements on the basic principles for sustainability and established specific requirements for ensuring a more secure sustainable future (Anaya, 1996). The principles are enshrined in the Rio Declaration and the requirements in Agenda 21, a comprehensive and a far reaching program of action for ensuring sustainability (www.un.org/esa/dsd/agenda 21). Critical to the successful implementation of agenda 21 is the recognition of the contribution of indigenous people and their knowledge in the quest for a sustainable future (United Nations Environmental Programme, 2008).

Rapid developmental activities performed by the market economy of Modern World in the era of Globalization consequently face various problems as pointed out by the United Nations Development Program (UNDP) report: Challenges of global warming, rapid loss of bio-diversity, crisis-prone financial market, growing international

inequality, emergence of new-drug resistant disease strains and genetic engineering (Das Gupta, 2011), thus creating an urge for sustainable development.

2.2.2 Environmental Management and Policy in Kenya

Prior to the onset of colonialism (pre-1895), natural resources (i.e, land, forests, water and wildlife) were managed by indigenous communities. They had their own rules and systems for controlling access to and utilization of natural resources (Elkins, 2005). Many of these systems comprised of sacred groves, religious taboos and cultural practices as a form of protection. Others were, however, utilitarian, motivated by a need to ensure a sustainable supply of resources. Natural resource management was closely regulated; bringing new land into cultivation was the result of community consultation and consensus (Okoth- Ogendo, 2007). Management fell under a clearly defined structure of authority, leaders, clans, and family heads. These systems combined to promote sustained use of natural resources among the Nandi people.

The management of natural resources in Kenya officially begun when Kenya was declared a British protectorate in 1895 (Odote, 2010). It moved through a series of stages, colonial and post colonial, each reflecting, economic and political realities of the time. The objective of natural resource management in the colonial period was to protect natural resources from destructive indigenous land use practices, to prevent European settlers from obtaining private ownership and generate revenue for the colonial government (Thuo, 2010). Post–colonial objectives were catchment protection, industrial forestry development and protection from encroachment by local communities.

Since independence, Kenya has continued to demonstrate her commitment to environmental management through various initiatives, among them the National Development Plan of 1974 and the National Environment Action Plan of 1994 (Odhiambo & Nyangito, 2002). Further, there have been a number of sectoral policies on environment in fields such as Agriculture, Livestock, Water, Energy, Food, Land, Wildlife, Forest, Industry, Trade, Arid Lands, Disaster Management and the Draft Sessional Paper No. 6 of 1999 on Environment and Development (Kamau, 2011). The Environmental Management and Coordination Act of 1999 provides for the integration of environmental concerns in national policies, plans, programmes and projects, legal and institutional framework. It proposes a strategy for achieving sustainable development in line with Kenya's quest to meet the Millennium Development Goals (MDGs) in particular goal no. 7 (that is) ensure environmental sustainability. Additionally Vision 2030 envisages an economic growth that will rely on exploitation of natural resources hence the need for effective natural resource management strategies that will ensure sustainability.

Various Laws and policies related to natural resource management exist in Kenya, among them are: The Forests Act No.7, 2005 makes provision for the establishment, development and sustainable management, including conservation and rational utilization of forest resources for the socio-economic development of the country (Government of Kenya, 2005). The Sessional Paper No. 1 of 2007 on forest policy outlines among other objectives the participation of private sector, communities and stakeholders in forest management to conserve water catchment areas, create employment, reduce poverty and ensure the sustainability of the forest sector (Government of Kenya, 2007).

Sessional Paper No. 3 of 2009 on Land policy provides a platform for addressing current issues such as access to land, land use planning, restitution of historical injustices, environmental degradation, conflicts, unplanned settlements, outdated legal framework, institutional framework and information management (Njuguna & Baya, 2012). The land Act No. 3 of 2012 Chapter 5, provides for equitable, efficient and sustainable management of land resources (Government of Kenya, 2012). The Agriculture Act of 2012 Cap 318 provides for soil and Water conservation and prevention of the destruction of vegetation. This Act provides for rules to prohibit, regulate, and control clearing of land for cultivation and grazing of livestock thus complementing the forest Act (Government of Kenya, 2012). Enforcement of the Act has been the biggest problem especially on protection of river banks that have been cultivated resulting in soil and heavy silt load on rivers.

The Water Act No. 8 of 2002 provides for catchment protection and protection of wells, and springs that occurs in the forest and further support community involvement in management of these catchments (Government of Kenya, 2002). The policy recognizes the fact the increased human activities in catchment areas is a threat to water availability. The Wildlife (Conservation and Management) Act, Cap 376 provides for the protection of endangered Flora and Fauna. As provided for in the Act, the process of gazettement and de- gazettement of protected areas under the Kenya Wildlife Service (KWS) jurisdiction requires parliamentary approval (Government of Kenya, 2006).

The Kenyan Constitution 2010 makes environmental protection an obligation of the government and the citizens. Proper conservation and utilization of the environment and natural resources is encouraged through Articles; 42; 60(1), 69 (1 and 2), which obligates the State and every person to protect and conserve the environment to ensure

ecological sustainable development and use of natural resources (Odote, 2008; Government of Kenya, 2010).

2.2.3 Use and Application of Indigenous Knowledge Systems in Natural Resource Management

The development of IK systems has been a matter for survival to the people who generated these systems. Such systems are cumulative, representing generations of experience, careful observations and trial and error experiments (Armitage & Johnson, 2006; Mercer *et al*., 2009). Indigenous knowledge systems in traditional Africa have been used by communities to protect natural resources from unsustainable exploitation thereby averting disasters that may have occurred from such exploitation (Kamara, 2004).

A study by United Nation Environmental Programme (2008) found that many communities in Africa such as Kenya, South Africa, Swaziland and Tanzania used a variety of innovative, effective, and in some cases unique indigenous knowledge approaches to environmental conservation. Some of the approaches, such as shifting cultivation, mixed cropping intercropping and transhumance were common practices. However, many of the approaches were peculiar to the local environments and cultures and could not easily be replicated elsewhere. For example, the cultivation technique known as *Ngoro* could only have evolved in an environment like the *Matengo* Highlands in southern Tanzania where unusually heavy rain pounded on the landscape destroying crops planted on hillsides. The *Matengo* people, believed to have lived in the steep slopes of *Matengo* Highlands since the Iron Age, built the system to protect their

farmlands against erosion and to trap the rapid run-off to improve the moisture of the soil, as well as to conserve soil fertility by composting (Mwaura, 2008).

Throughout India and Africa, traditional farmers have known the insecticidal properties of the neem tree for centuries. In Niger and Mali, farmers have long observed the immunity of its leaves to desert locust attack (Widgren, 2010). Although not as powerful as synthetic pesticides, the neem extract contains 20 active ingredients, which makes it difficult for any insect pest to develop a resistance to them all (Charnley, *et al*., 2007). A study by Diana (2007), on indigenous knowledge in agriculture in Uganda, found that farmers employed various indigenous practices most of which were cross cutting among the crops grown. For instance, farmers take advantage of the early rains which also reduce the incidences of pest and disease leading to high yields. When farmers burn grass or trash in their farms, they prefer to plant or sow green vegetables and millet in it. The ash is assumed to be a source of nutrients and also burning is believed to kill crop pests.

Land management under indigenous knowledge involves a number of farming technologies that have repercussions across the wide spectrum of conservation. These include such practices as slash-and-burn, shifting cultivation, use of grass strips, intercropping, selective cultivation, and a number of other technologies and practices that seek to optimize food production under varying environmental conditions. In addition, many of the communities combine cultivation with livestock rearing (Kamara, 2004).

A study in Kenya on the application and use of traditional knowledge in environmental conservation and natural disaster management cited examples of areas where such

knowledge is still prevalent and harnessed (Mwaura, 2008). Regarding land-use conservation, shifting cultivation was a traditional practice in which land was never over-used or repeatedly cultivated season after season and year after year. Land was left to rest and covered again with plants and leaves to enable it to accumulate vegetable manure. Mixed crop cultivation practices enable leguminous crops to restore nitrogen in the soil for other food plants. Knowledge of when to expect long or short rainy seasons enabled the farmers to plan appropriately which crop was suited for a particular season. Indigenous knowledge terminologies of types of soil and their reaction to water enabled the people to use each type of soil appropriately by planting the correct crops.

Given the changes that have taken place in the environment as a result of global warming and the resulting unpredictability of weather conditions which has a become a major concern today, integrating IK and modern scientific knowledge would help in finding solutions to these problems. Similar application and use of indigenous knowledge is the use of grass strips in Swaziland, which is a common traditional land management system. Pieces of land, one to one-and-a-half metres wide, with traditional vegetation are left between fields to control soil erosion (Edje, 2004). These examples underscore the importance of harnessing indigenous knowledge not only as a precious national resource but also as a vital element in environmental conservation (Kamara, 2004).

Intimately tied to the use of indigenous knowledge in land management practices was the conservation of forests. Using indigenous knowledge know-how as well as rules, prohibitions and taboos, all the communities practiced forest conservation. In most communities in Kenya, most of the farming was done on the edges of forests, leaving the thick forests untouched (Mwaura, 2008). This helped protect indigenous plants in

the thick forests, which take long to mature. It also prevented land degradation. There were also tree and plant species that were considered sacred, or as totems, or were associated with some bad omens. For those reasons they were protected. For instance, *Ficus thonningii,* known locally in Western Kenya as *pocho,* is considered sacred by many Kenyan communities including the *Embu, Kikuyu, Kipsigis, Luhyia, Luo, Maasai* and *Meru*. The tree is not supposed to be cut down or its wood used for fuel (Mwaura, 2008; Kamara, 2004). In Swaziland trees such as bhubhubhu (*Crotalaria capensis*) and gcolokhulu (*Rapanea melanonphloeos*) are protected from being used as sources of building materials (Mwaura, 2008). In almost all the communities, there were also plants and trees that were associated with shrines and water sources that were therefore protected.

In many African communities, there were restraints on the customary right of access to forests, thus checking the indiscriminate use of forest resources. There were also taboos and restrictions on gathering of plants, which limited to some degree the harvesting of plant resources. Some taboos prevented women and young people from cutting down certain trees. Menstruating women, for example, were prohibited from collecting medicinal plants; since it was believed that if they did so, the act would reduce the healing power of the plants. These taboos ensured the conservation of many species (United Nations Education, Scientific and Cultural Organization, 2010; Bohensky & Maru, 2011).

In many communities, big trees were not cut for domestic purposes; only small shrubs, reeds, and grass, which regenerate quickly, were used, for example, for building houses. Among the communities in the Lake Victoria basin, aquatic plants such as papyrus

reeds and water reeds commonly used in making basketry, sleeping mats, fish cages and for thatching roofs were harvested sustainably (Mwaura, 2008).

Animals, fish, birds and insects played major roles in the lives of the communities for example; pigeons were considered as clan symbols by some *Banyala* clans in Western Kenya and were never hunted for food (Ipara 2004). Swaziland, which is well endowed with flora and fauna, has developed various indigenous methods for protecting biodiversity as local communities have long recognized the value of biodiversity (Edeji, 2004). The *Swazis* have long-standing cultural practices and folklore that help in preserving biodiversity. These include appropriate agricultural practices, widespread existence of tribal or family totems and respect for traditional taboos.

Local farmers in sub-Saharan Africa have been known to conserve carbon (C) in soils through the use of zero tilling practices in cultivation, mulching and other soil management techniques (Widgren, 2010). Natural mulches moderate soil temperatures and extremes, suppress diseases and harmful pests and conserve soil moisture. Before the advent of chemical fertilizers, local farmers largely depended on organic farming, which also is capable of reducing Green House Gas (GHG) emissions. It is widely recognized that forests play an important role in the global carbon cycle by sequestering and storing carbon (Fifanou, Ousmane, Gaunthier, & Brice, 2011).

Local farmers are known to have practiced the fallow system of cultivation, which encouraged the development of forests. It may be argued that with the growth in population, lengths of fallow have been reduced to the extent that the practice no longer exists in certain areas. However, the importance of forests has been recognized by traditional institutions to the extent that communal forest reserves were very common in

traditional societies. Besides the fact that these well managed forests provided food and timber resources to the community, they also served as carbon sinks. It is recognition of the role of forests in climate change that has influenced participants of the Kyoto Protocol to allow countries to include carbon sequestered in forests in a country's emission requirements.

Agro forestry is another practice that has been very effective in carbon sequestration. It is a rational land-use planning system that tries to find some balance in the raising of food crops and forests (Bohensky & Maru, 2011). A practice similar to this has been described in south western part of Nigeria to raise shade tolerant crops such as *Dioscorea spp* and cocoyam in essentially a permanent forest setting (Faleyimu *et al*, 2011). In addition to the fact that agro forestry techniques can be perfected to cope with the new conditions that are anticipated under a drier condition and a higher population density, they lead to an increase in the amount of organic matter in the soil thereby improving agricultural productivity and reducing the pressure exerted on forests. Local farmers in sub-Saharan Africa have developed several adaptation measures that have enabled them to reduce vulnerability to climate variability and extremes (Mayatsi, 2011).

One important step in reducing the vulnerability of a climatic hazard is the development of an early warning system for the prediction or forecast of the event (Ajibade & Shokemi, 2003). There is a wealth of local knowledge based on predicting weather and climate. Studies by various scholars (Mayatsi, 2011; Mapara, 2009) of weather knowledge in various parts of the sub-Saharan Africa reveal the wealth of knowledge that farmers possess. These farmers have developed intricate systems of gathering, prediction, interpretation and decision-making in relation to weather. These systems of

climate forecasts have been very helpful to the farmers in managing their vulnerability to a very great extent. Farmers are known to make decisions on cropping patterns based on local predictions of climate and decisions on planting dates based on complex cultural models of weather.

Generations of indigenous farmers have developed diverse, complex and locally adapted agricultural systems that are managed via traditional institutions and techniques. They ensure food security while conserving the diversity of wild and domesticated plants. Climate change may have detrimental impacts on these agricultural systems. Argumedo and Yun (2010) highlight the importance of maintaining diverse traditional crop varieties and access to seeds in case studies in China, Bolivia and Kenya, while Andean farmers maintain a high number of potato varieties and Karen rice farmers in Thailand employ seed exchange and social networks. In Zimbabwe, farmers encouraged diversity in crop varieties in order to 'better guarantee a harvest regardless of seasonal variability (short dry season or long wet season) and to ensure variety in taste and quality' (Shava, O'Donghue, Kransky & Zazu, 2009).

Diversifying farming techniques and technologies is also a key characteristic of resilience among indigenous peoples and local communities. Swidden agriculture enables hundreds of plant species and varieties to be sustained, with both food and medicinal plants cropped together in a single field. Plants are harvested at staggered intervals, with annuals available on a regular basis and perennials becoming available in subsequent years. Recent research confirms the contribution of swidden agriculture not only to the preservation of species diversity, but also to soil and water conservation, and climate-change mitigation (Mwaura, 2008).

Historically, governments have criticized swidden farmers (who are often members of ethnic minorities) as a driving force for deforestation and degradation of water resources (Widgren, 2010). Many have been forced to abandon swidden agriculture due to government restrictions, pressures to re-settle and sedentarize, and encouragement to switch to cash crops. These imposed changes have rendered farmers more vulnerable to climate change impacts (Nyong *et al*., 2007), and replaced swidden agriculture with unsustainable land-use practices, such as extensive, long-term cultivation of annual crops, monoculture tree plantations such as oil palm, and livestock grazing.

2.3. Impact of Modernization on Natural Resource Management/ Sustainable Development

Rapid decline in biological diversity species, ecosystems, and genetic diversity is one of the critical challenges of the 21st century (Odote, 2008). This is because indigenous knowledge systems are rapidly eroding worldwide. The resulting breakdown of these informal, self-imposed restrictions on natural resource use is threatening species and habitats that were once afforded protection by traditions (Anoliefo *et al*., 2003; Lingard *et al*., 2003). The disregard for these traditional checks and balances especially among modern communities has adversely affected their enforcement. The abandonment of traditional cultural practices is doing harm that goes beyond the abrogation of traditional cultural practices to serious threat to natural environmental structures (Anoliefo *et al*., 2003). The erosion of tradition is characteristic of developing countries, where there is increased exploitation of the natural resources. This is threatening approximately one third of species worldwide (Mercer *et al*., 2012).

Notwithstanding the role of indigenous knowledge in natural resource management, other factors such as public policies and change in land tenure, creation of protected areas (Kohler, 2008; Adams & Hutton, 2010), payment for ecosystems services (Rival, 2011), can influence decision-making process of ecosystem and resources management with socio-ecological consequences. These can be either reversible or not, and will be reflected in land use and cover changes and impacting natural resource conservation over time (Adams & Hutton, 2010).

In the past, crop yields in agricultural systems depended on internal resources, recycling of organic matter, built-in biological control mechanisms and rainfall patterns. Agricultural yields were modest, but stable. Production was safeguarded by growing more than one crop or variety in space and time in a field as insurance against pest outbreaks or severe weather. Inputs of nitrogen were gained by rotating major field crops with legumes. In turn, rotations suppressed insects, weeds and diseases by effectively breaking the life cycles of these pests. In this type of farming systems the link between agriculture and ecology was strong and signs of environmental degradation were seldom evident (Adams & Hutton, 2010).

But as agricultural modernization progressed, the ecology-farming linkage was often broken as ecological principles were ignored. Several scholars agree that modern agriculture confronts an environmental crisis (Altieri, 2004; Berker & Berker, 2009). Evidence has accumulated showing that whereas the present capital- and technology-intensive farming systems have been extremely productive and competitive; they also bring a variety of economic, environmental and social problems (Adams & Hutton, 2010). Evidence also shows that the very nature of the agricultural structure and prevailing policies have led to this environmental crisis by favouring large farm size,

specialized production, crop monocultures and mechanization (Altieri, 2004. Furthermore, evidence indicates, however, that excessive reliance on monoculture farming and agro industrial inputs, such as capital-intensive technology, pesticides, and chemical fertilizers, has negatively impacted the environment and rural society (Rival, 2011). Despite awareness of the impacts of modern technologies on the environment, current advances in biotechnology deemed to provide solutions to myriad problems in agricultural production may in the long run cause more environmental harm (Rival, 2011).

2.4 Integration of Indigenous Knowledge and Scientific Knowledge in Natural Resource Management

Natural resource management is the heart of sustainable development (Das Gupta, 2011). Emphasis on the integration of the indigenous and the scientific knowledge systems for sustainable management and use of natural resources stems from the fact that the two knowledge systems complement each other in their strengths and weaknesses, and their combination may achieve what neither would achieve alone (Stevenson, 2005; Nganje, 2009; Kajembe *et al*., 2010; Das Gupta, 2011). Although a lot of emphasis has been put on integration of the two knowledge systems for natural resource management very little has been done towards achieving meaningful integration (Zazu, 2007).

Integration of indigenous knowledge is seen in other disciplines like medicine (Aikenhead & Ogawa, 2007; Hens, 2006; Msuya, 2007; Das Gupta, 2011). This can be attributed to other factors underpinning the integration of these knowledge systems for conservation of the natural resources. Likewise, it is arguable that the social, economic

and political situations in most African countries may limit the wide use and, integration of IK with the scientific knowledge system (Kideghsho, 2008; Mercer et al., 2009).

Knowledge integration has not been easy to define because of tensions that arise due to various uses and interpretations by various scholars (Wohling, 2009). However it is commonly defined as the process of synthesizing multiple knowledge systems into a common system and the process of incorporating new information into a body of existing knowledge. This requires determining how the new information and the existing knowledge interact, how existing knowledge should be modified to accommodate the new information and how the new information should be modified in light of the existing knowledge (Houde 2007).

Nevertheless, interest in integrating indigenous, local, or traditional knowledge and science is steadily growing along several lines of argument (Rist & Dahdouh-Guebas, 2006; Houde, 2007). One is that these forms of knowledge are essential for maintaining global cultural diversity and the biological diversity with which it is intricately connected (Maffi, 2001; Maffi & Woodley, 2010), and will only be appropriately valued and protected through integration that brings benefits to both scientists and local people interested in maintaining that diversity (Edwards & Heinrich, 2006). A second argument is that these types of knowledge contribute invaluable information for science and natural resource management; they often fill gaps in understanding that which science cannot (Nyong *et al*., 2007; Warren, 1995).

A third argument is that recognition of traditional knowledge in natural resource management has importance beyond scientific or broader societal merit: it is tantamount

to social justice, sovereignty, autonomy, and identity of indigenous peoples (Nelson, 2005; Aikenhead & Ogawa, 2007). These different motivations for integrating knowledge are neither mutually exclusive nor entirely harmonious.

Management of natural resources cannot afford to be the subject of a single body of knowledge such as the Western science, but it has to take into consideration the plurality of knowledge systems. Application of scientific research and local knowledge contributes both to the equity, opportunity, security and empowerment of local communities, as well as to the sustainability of the natural resources (Mawere, 2010). Indigenous knowledge helps in scenario analysis, data collection, management planning, designing of the adaptive strategies to learn and get feedback, and institutional support to put policies in to practice (Brosius, 2006). Science, on the other hand, provides new technologies, or helps in improvement to the existing ones. It also provides tools for networking, storing, visualizing, and analyzing information, as well as projecting long-term trends so that efficient solutions to complex problems can be obtained (Gagnon & Berteaux, 2009).

Indigenous knowledge systems have been found to contribute to sustainability in diverse fields such as biodiversity conservation and maintenance of ecosystems services, sustainable water management, genetic resource conservation and management of natural resources. Indigenous knowledge has also been found useful for ecosystem restoration and often has ingredients of adaptive management. Modern science is more acceptable to the indigenous communities if it is integrated with what they already know (Maffie, 2009). Scientific weather forecasts, for instance, may be more credible to the communities if ways are found to integrate them with indigenous knowledge that they have relied on for generations to predict and cope with droughts, floods, and other

natural hazards. A good example is the Nganyi people of Western Kenya who rely on traditional weather specialists. The peasant farmers listen to weather forecasts on radio by the meteorological department but still prefer to rely on their own traditional knowledge of when to start planting.

Over thousands of years societies have developed a diversity of local water harvesting and management regimes that still continue to survive, for example, in South Asia, Africa, and other parts of the world (Ossai, 2010). Such systems are often integrated with natural resource management strategies (Wekunda, 2012; Fifanou *et al*., 2011).Another theme for knowledge integration is resilience , the ability of a social-ecological system to withstand disturbance without changing structure, function, feedbacks, and identity, and to remain flexible in response to changing environmental and social contexts (Houde, 2007). It further holds that management of complexity and uncertainty in social-ecological systems can benefit when different types of knowledge systems are combined (Folke *et al*., 2005; Nadasdy, 2007), however argue that despite criticisms that the resilience basis for knowledge integration, may entrench unequal power relations (Nadasdy, 2007), it merits consideration for the because of its emphasizes on new ways to address longstanding as well as emerging complex social-ecological challenges.

Similarly other scholars like (Mapara, 2009; Nganye, 2009) reported that Modern problems cannot be solved with singular, science-centered solutions but with a blend of indigenous knowledge systems. Although these observations have been made, it remains ignored in much natural resource management policy (Moran, 2009).

Knowledge integration has been a challenge, due to tensions caused by unclear objectives of integration processes. Areas of concern such as scientific research, natural resource management, conservation, development, and advocacy for indigenous rights have all been legitimate drivers of efforts to integrate knowledge. Wohling (2009) alludes that, knowledge integration has merely become a fashionable trend in natural resource management.

2.4.1 Comparisons between Indigenous Knowledge and Science and Benefits and Challenges of Using and Integrating Indigenous Knowledge

Various scholars (Moller, Berkes, Lyver, & Kislalioglu, 2004; Davis & Ruddle, 2010) agree that, understanding of similarities and differences between IK and scientific knowledge, and the benefits and challenges of integrating these different knowledge systems, is a prerequisite to knowledge integration. Berkes, *et al.* (2006) report that IK is used to manage natural resources through practices that are similar to Western adaptive management systems, and these indigenous practices are founded on important social mechanisms. Pierotti and Wildcat (2000) argue that IK has close relationship with Western science disciplines like community ecology, and is inherently interdisciplinary. However, some scholars such as (Pierotti and Wildcat (2000) and Berkes and Berkes, (2009) have argued that, compared with science, IK is place and space -based, focusing on spatial relationships in nature.

Some authors have identified differences between IK and science. Fernandez-Gimenez (2000) distinguishes Mongolian pastoralists' perceptions from science, indicating that science is better equipped to detect a causal link between land use change and threats to pastoralists' livelihoods. Aikenhead and Ogawa (2007) underscore the value of local

knowledge to science assessments, as a source of detailed information about local ecosystem services in areas where little formal knowledge exists. Conversely, they also acknowledge several shortcomings of indigenous knowledge, such as its inability to evolve quickly enough to accommodate change in social-ecological systems, and its tendency to lack relevance outside local context.

Differences between IK and science are evident for example Davis and Ruddle (2010) report that indigenous knowledge is essentially scientific because it is gathered through methods that are empirical, experimental, and systematic, whereas scientific knowledge , by contrast, may be seen as narrow and naïve in the way it considers and defines questions. Berkes *et al*. (2006) and Nyong *et al*., (2007) stress the importance of wisdom and "showing respect" as distinctive features of traditional ecological knowledge. Maffie (2009) acknowledges the tendency of IK holders to reject what they view as Western philosophy's obsession with truth, belief, and worldview. . However, he further argues that much of the perceived differences between science and indigenous knowledge systems arise from treating scientific knowledge or IK as a singular entity when in fact both have multiple forms and dimensions.

Davis *et al*., (2013) argue that IK and Western science are complementary or parallel rather than fundamentally incommensurable. They further report that differences between them can be resolved through an integrated approach by blending Indigenous knowledge with conventional knowledge.

2.5. Theoretical and Conceptual Framework of the Study

The theoretical and conceptual frameworks of the study are presented in separate sections hereunder.

2.5.1 Theoretical Framework

The study was guided by three theories namely cultural ecology, experiential learning, and time-space distanciation. Details of each of these theories are described in the following sections.

2.5.1.1 Cultural Ecology Theory

The cultural ecological theory also referred to as the human adaptation theory is attributed to the works of Julian Steward. This theory postulates that people respond and adapt to changes in the environment and society through cultural adaptation. Cultural change generates new cultures that assist humans to adapt themselves to this change (Steward, 1955).

The proponents of this theory argue that the society and its surrounding are composed of four interrelated components namely: people, culture, technology, and the physical environment in which, humans live (Duncan, 1964; Catton, 1987). They further state that these four elements are in constant interaction, and a change in one affects the other. They, however, contend that because humans occupy a central place in the society-land-environment triad, their relations and interactions with other organisms, the land they inhabit and the wider environment have a long history, much of which is intertwined in the diversity of cultures. They maintain that through the diversity of indigenous natural resource management systems embodied in the local people's cultures, humans are able to conquer, modify and reconstruct the physical environment to suit their changing needs.

In addition, they assert that through the evolution of varied institutions and channels of communication, knowledge, skills and technologies about environmental resources and how they would be conserved and sustainably utilised are inter-generational. This way a sense of ownership and belonging is instilled in community members to the extent that their changing needs, resource values as well as attitudes and perceptions about natural resources reflect the socio-economic and ecological changes in the environment (York *et al*., 2003a).

The human ecology theoretical approach is relevant to this study and guided the investigation into the changing trends in use and application of IK in natural resource management among the Nandi, thus shading light on methods of natural resource conservation (land, forests, and water) with an aim of documenting this valuable knowledge for future generations. Furthermore the theory guided the study in tracking changes which have gradually occurred (from colonial period to the present time) in use and application of IK and helped identify the resulting effects of those changes on natural resource management.

Steward's concept of cultural ecology has proved to be a powerful and effective strategy for human ecological research, offering new understanding of how traditional societies are effectively adapted to their environments, its successes have been achieved primarily in studying small-scale, primitive societies, however, especially those where a stable relationship has been established between a static population and an unchanging environment.

The concept has been much less applicable to complex modern societies where the actions of large human populations are producing rapid environmental change with

consequent need for re-adaptation of the cultural core. As conceived by Steward, the cultural ecology model lacks any systematic conceptualization of the environment or of the ways in which human activities impinge on it. Thus, its emphasis is almost exclusively on the human side of the human-environment equation, focusing on the adaptation of culture to nature while ignoring environmental change in response to human intervention. This fundamental weakness of the concept of cultural ecology is revealed in the work of Marvin Harris (1966), an American anthropologist who incorporated this approach into studies referred to it as techno-environmental determinism. Operating under the assumption that the technological means of adaptation to the environment is the prime mover of cultural evolution, Harris asserts that the forms taken by all other aspects of culture are determined by the relationship between technology and the environment.

To address the weaknesses of the cultural ecology theory, the study adapted the experiential learning approach so as to finding out the impacts of human activities on environmental resources and furthermore in establishing interrelationships between IK natural resource management strategies and modern natural resource management strategies with an aim of suggesting policy and strategic options for integrating IK into mainstream environmental management strategies for sustainable development.

2.5.1.2 Experiential Learning Theory

Kolb (1984) provides major insights into experiential learning which he describes as "the process whereby knowledge is created through the transformation of experience". Kolb proposed that experiential learning follows a cyclical process – from experience to reflection to conceptualisation to application, with this cycle being continuously

repeated. Experiential learning is based on the notion that ideas are not fixed or unchangeable elements of thought but are formed and re-formed through experience. It is also a continuous process, often represented as cyclical, and being based on experience, implies that we all bring to learning situations our own ideas and beliefs at different levels of elaboration. Indigenous knowledge is not static; it undergoes transformation through interaction with other knowledge systems.

This theory provides insights into indigenous natural resource management practices among the Nandi. It also helps in identification of changes which have occurred in use and application of indigenous knowledge among the Nandi people during the pre-colonial (Before 1895), colonial (1895 to 1963) and post colonial (1963 to date) periods. Therefore helps to understand how indigenous people adapt to change by understanding their environment. The theory provides insights on how indigenous knowledge can be integrated with mainstream natural resource management strategies.

2.5.1.3 Time-Space Distanciation Theory

According to Giddens (1984), social relations of pre- modern societies predominately are largely confined to a face to face interaction in a given locale. However, the advent of modernity undermines social interactions by fostering relations between absent others, internationally distant from any given situation of face to face interaction. It disembeds or lifts out social relations from local contexts of interaction and rearranges them across indefinite spans of time- space. According to Giddens (1984) changes often reflect or cause disruptions so that people's actions and their social systems become detached from the particular condition of ecosystems, in essence, people's perception of a relationship to elements in the ecosystem change. This can lead to over exploitation of

resources and contribute to erosion of indigenous knowledge. This theory is useful in identifying the changes which have occurred over time in the use and application of indigenous ecological knowledge among the Nandi and their effects on the natural resources.

2.5.2 Conceptual Framework of the Study

The study is conceptualized on the theoretical premise that man tries to adapt to the environment which he lives and derives his livelihood, he improves his knowledge skills and strategies to harness natural resources in a sustainable way. In the conceptual framework, shown in Fig 1, Indigenous Knowledge is represented as emergent from man's daily interactions with the environment, observations and experiments (social, historical, cultural and bio-physical). These interactions greatly shape and model the decisions made by people regarding exploitation of natural resources. That change may occur as a result of influence of factors from outside the ecosystem. As changes occur in time and space, indigenous knowledge also changes to adapt with the changing times. As IK becomes lifted from local context, it becomes less experiential and more factual influenced more by factors outside the ecosystem. This has repercussions (impacts) on the local ecosystem. Reflexivity enables local people to apply IK in new context thereby leading to sustainable use of natural resources in the community and hence environmental conservation

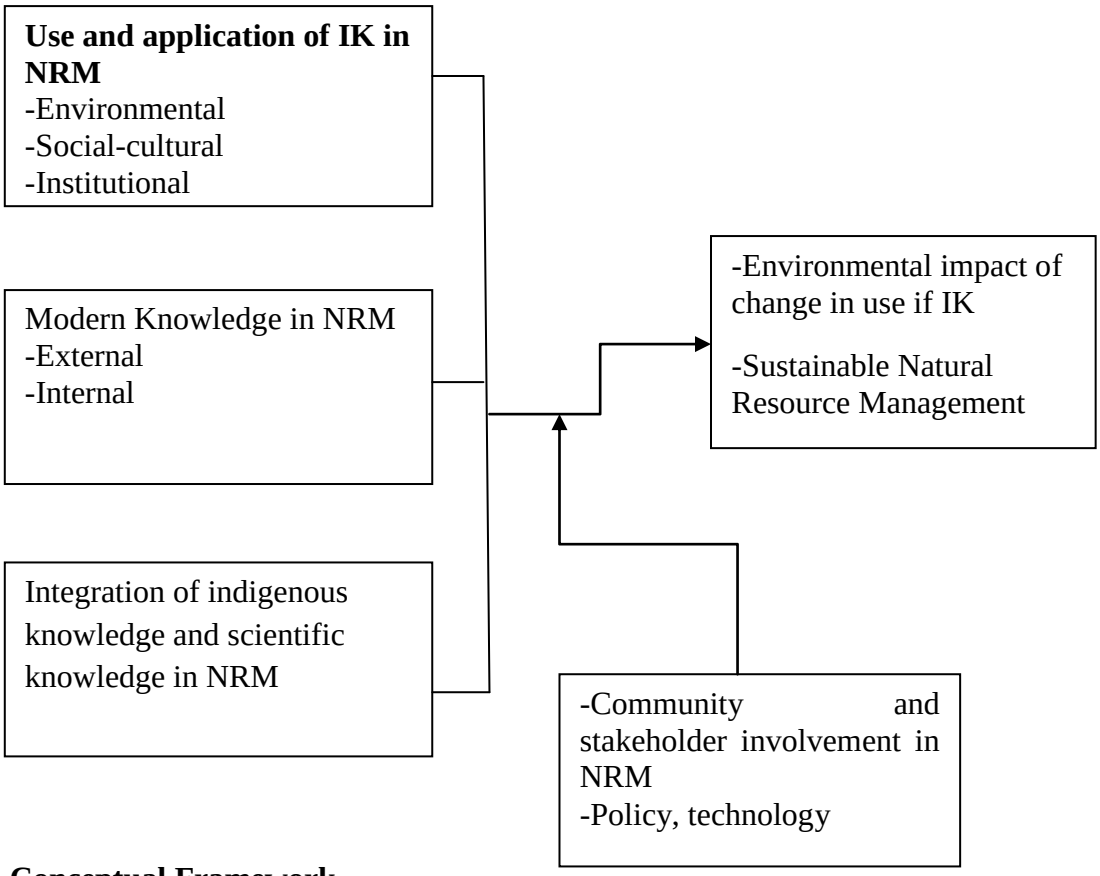


Figure 2.1: Conceptual Framework

Source: Author, 2013

2.6 Chapter summary

The first section of the chapter explored the concept of indigenous knowledge highlighting the various meanings and how communities over time have used these knowledge systems to live in harmony with the environment. It is clear from literature that local and international agencies recognize the contribution of indigenous knowledge for sustainable development and to this end various policies have been put in place to encourage and promote integration of IK into mainstream natural resource management strategies. To achieve meaningful integration of IK and modern

knowledge systems there is need for more involvement of local communities in policy formulation and implementation.

The second section presented a theoretical and conceptual framework which shows how mans interaction with environment is shaped by socio-cultural, institutional and interactions with the eternal environment. The frame work acknowledges that these factors shape how man interacts with its environment.

The next chapter presents the research approach, methodology and methods used in data collection. Data analysis and presentation techniques as well as ethical considerations are discussed.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter gives a detailed background of the Nandi Community, the research design employed in the study, the study area and procedures and methods used in this study. Further, this chapter describes the structure of the study indicating how data was collected, the study population, the instruments used to collect the data and the procedures and methods of data analysis. The ethical considerations made during the data collection exercise are also presented in the chapter.

3.2 Background of the Nandi community in Pre-colonial and Colonial Period

This section gives background information about the Nandi Community, with regard to the homestead, land divisions and local authorities, population distribution and social, economic, and, political organization and also describes age sets.

3.2.1 The Nandi Homestead

A Nandi homestead consisted of a living hut (*kot*) for the family, a hut for the boys'*sikiroinet*, a cattle- fold and a granary. The hut *kot*, was a circular building some 20 feet in diameter, with mud- plastered walls about four feet high, a thatched roof with a slope of about 35 degrees supported by a centre post '*toloita'*. There were two entrances, the front or *kurket ap serem*' opening into the peoples part of the hut (called

koiimaut) while the back door *or kurket ap injor*', led into the rear half of the hut, *injorut*, where calves and goats slept; partitioned with a door way separates the two halves of the hut, and a ceiling of poles laid across the top of the walls forms a loft, *tapot*, where goods were stored (Huntingford, 2006).

Adjoining the hut, and often right up against it, was the cattle-fold*, peut'*, a circular enclosure made of poles and branches where the cattle were kept at night. A few yards from the hut was a smaller one *sikiroinet*, the centre-post of which was often not more than six feet high. Here slept small boys and unmarried men as well as their sweet hearts who had been circumcised. The homestead was completed with a granary, *choket*', a small hut raised from the ground on posts where the crops were stored (Hemsted, 1923).

3.2.2 Land Division and Local Authorities

Although there was no grouping of homesteads into villages, their arrangement was not without organization, for the Nandi was divided into large areas called *emet'*, which was sub-divided into small units called *pororiet*. A varying, number of homesteads formed *koret'*; (plur. *Korotinwek*) the basic political unit. A *kore*t contained as few as 20 homesteads or as many as 100 homesteads. The size of the *koret* was determined by topography and local population. Each koret had a name often derived from a natural feature or from the names of trees, animals, and birds. As a political unit each *koret* had its council, called *kokwet* (Hollis, 1909).

The largest territorial divisions were called *emet'* (plur. *Emotinwek),* which means 'country, land' or county. It had no political function. This was used to distinguish the

different parts of Nandi country during the colonial period. During the colonial period there were six *emotinwek*: 1. Aldai, in the south-west. The soil of Aldai, though rocky, is fertile, and the inhabitants grew corn which they sold (*alde*) to people of other parts of Nandi, whence the name. 2. Chesumei, in the west, is largely forest, and the name is derived from sume', hairs', i.e forest- covered country'. 3. Soiin, in the south-east. This *emet'* included both the flat country at the foot of the escarpment and the hilly area to the south-east bordering on the Tindiret forest where the Dorobo live. The name is derived from soi', grazing ground', and, in, 'that': 'that grazing ground'. 4. Emgwen, in the centre. Fom *em'*, in', and *kwen'*, centre. 5. Mosop, in the east. This is a dialect word, used to describe the forest- Kosirai and Kachepsir forests. 6. Wareng, in the north. This name denotes uninhabited country where grass can be burnt with restriction, and therefore was probably applied to this part before the Nandi settled there in the nineteenth century (Huntingford, 2006).

In these two divisions, the *koret*' and the *emet'*, is fitted a third, the *pororiet* (plur. *Pororosiek*) a Nandi word which denoted a group of people who formed a fighting unit, all such people having equal status as warriors of the same age set (regiment). Later on, the term was extended to cover the land on which the members of the regiment lived; and as the tribe expanded, these regimental areas ceased to be limited by *emet* divisions and become spread over the country, some having more than one branch. The original settlement in Nandi at the beginning of the seventeenth century resulted in the establishment of fifteen *pororosiek* in southern Nandi between the river mokong-sirua and the escarpment , in the *emotinuek* of *Aldai, Chesumei, and Soiin: Aladai; Kakipoch, Kapianga, Kapsile, Kaptumoiis, Kapingot, Kapkiptalam, Kapsiondoi, Pasieny: Chesume; Kimgoror, Kakimno, Murk ap tuk, Cheptol: Soiin; Kapchepkendi, Kamelilo,Tuken* (Hemsted, 1923).

In the course of time, as stock and population increased, some of the *pororosiek* expanded to the north of the Mokong- Sirwa River, as far as the Cheplingwich and Rongit rivers, and each *pororiet* that took part in the movement acquired its own portion of newly occupied territory, leaving some of its members in the old home. Further expansion took the Nandi right up to the Murkusi River, which was regarded as the boundary between them and the Maasai. In the eighteen century a new *pororiet* named Koileke of Maasai origin, appeared and become part of Mosop. Before the Nandi war of 1905-6, Parsieny became amalgamed with Tepingot. The last expansion was made in the nineteenth century by Tepingot and Kaptumoiis into Wareng. In 1906 Kapchepkendi and Kamelilo were moved by the colonial government from Soiin to Wareng (Huntinford, 2006).

After the Nandi War of 1905-6, the newly constituted Reserve was divided into twenty-five locations for administrative purposes. These locations were known as *Korotinwek,* followed as far as the distribution of the *pororosiek*. Location 26 was added later in order to segregate the Talai *orkoiik*. Later still, the number of locations was reduced from twenty six to nine, with the object of amalgamating the *porosiek* and thereby lessening their military influence; the Talai location remained unchanged (Matson, 2009).

The Nandi territorial system is therefore as follows:

Non-political or *Emet,* embracing Political divisions: (1) *KORET* with its *Kokwet* (2) *PORORIET*, with its council (1&2 Native system). (3) LOCATION, with its headman and official court (European addition) (Huntingford, 2006).

3.2.3. Population Distribution and Social Organization

The Nandi clans (*oret*, plur. *Ortinwek*) are exogamous, totemic, and partrilineal. Clansmen do not claim descent from any particular human founder, but they do claim to be brothers of their clan animal or totem, and through the totem there exists a mystical brotherhood between all members of the clan. Marriage between a man and woman of the same clan is thus considered incestuous and forbidden. The names of Nandi clans are *Moi* (with three totems); *kipoiis, Kipkenda, Toiyo, Kipasiso* (two totems each); the rest, with one totem each being *Kipkoiiting, Kipeken, Kipamwi, Kipkokos, Talai, Kipsirkoi, Sokom, Kiptoppke, Kipaa, Kamwaike, Tungo*, and *Kapchemuri*. Nandi clans were dispersed in the *koret'*. The only localized was the section of the *Talai* set aside for them in 1919 by colonial administration at their request to reduce friction between them and the rest of the tribe. Each clan had a sacred animal (totem). In the past, the killing of a sacred animal by a clan's man was strictly forbidden, and any breach of this was severely dealt with, the offender was put to death or driven out his clan and his cattle confiscated (Huntingford, 2006).

According to the Nandi, the male sex was divided into boys, warriors and elders, the female sex into girls and women. The first stage was continued till circumcision, which may be performed between the ages of ten and twenty. All boys circumcised at the same time are said to belong to the same age set.

3.2.4 Economic Organization

The Nandi were originally a community of hunters who later took to agriculture, and grew large quantities of eleusine grain and millet. Other products included beans,

pumpkins, sweet potatoes, and tobacco, and small quantities of maize and bananas. They kept livestock; cattle, goats and sheep.

3.2.5 Political Organization

The political organization of the Nandi people in the pre-colonial period which consisted of land councils, and age set system is described in separate sections below.

3.2.5.1 The Land (*Koret*) Council

The fundamental principle of a political system is the need for preserving the tribe. People cannot live without close association, and without their tribe existence in the past would have been impossible, for man had too many enemies in both the seen and unseen worlds. The first step towards this is to feel a pride in belonging to a tribe. The general attitude of the Nandi is that all other people are nothing (Hollis, 1909). The Nandi considered himself the equal of any man, and superior to all who are not Nandi. The Nandi had no chiefs. The central feature of the Nandi was the group which they called *tiliet'* that is, relationship system. The *tiliet* was linked to the clan, which thus helped maintain tribal solidarity.

The basic political unit was the *Koret,* and the council which handled its affairs was called the *Kokwet* (plur. *Kokwotinwek*), 'the parish council'. This was the most important of the Nandi councils, because all men of the *Koret* could attend it to discuss public affairs. The meeting place of the *kokwet* was under a shady tree, preferably under the shade of one of the five species of a fig tree which grew in Nandi: *teldet, simotwet, choruet, mokoiywet* and *nyarpotwet*. The fig tree was considered magical and sometimes regarded as sacred (Hollis, 1909). Each *kokwet* had an elder or spokesman,

poiyot ap kokwet, 'the elder of the council'. The *poiyot ap kokwet* reached this position by recognition that he is a man whose knowledge and advice are sound, whose character is such that he can carry the *kokwet* with him, and whose wealth is enough to enable him to perform social duties which fall to his lot as a public man. The *poiyot ap kokwet* is listened to and obeyed. The principle subjects discussed at the *kokwet* are cattle disputes, compensation cases, offences against the individual, crimes against the tribe, steps to combat calamities like drought, locusts, and cattle diseases, and other matters.

The *porororiet* council: the *korotinwek* with their *kokwet* councils form the larger group called *pororiet*. The *pororiet* council decided on matters which affect all the *korotinwek* within it- war, circumcision, and planting. This council was in contact with the *orkoiyot*. The *kiruoket ap pororiet* (council of the *pororiet*) consisted of the *poiisiek ap kokwet* of the *pororiet* area, over whom presided two active old men called *kiiruoki*', 'the councillors', the senior being the '*kiruoindet ne oo'*, the junior, '*kiruokindent ne mining'*. Attached to this council were two special representatives for the '*orkoiyot*' called '*maotik*'. The *pororiet* was an independent unit, able to go to war or to raid on its own, or else to seek co-operation with other *pororosiek* when necessary (Matson, 2009).

The *Orgoiyot:* The *orkoiyot* as an institution or participation in certain public affairs by a man, whose influence was based on his magical powers, may date back to the middle of the nineteen century. The chief *orkoiyot* was not executive authority, he was a ritual expert, or religious head; his real functions were confined to magic and religion. The *orkoiyot* may also be described as an intermediary. He had the authority to sanction war, circumcision, and planting. The *orkoiyot* also practised all the different kinds of divination and was also a witch and could put spells on people in order to injure them (Huntingford, 2006).

3.2.5.2 Age-Sets

Every male in the tribe belonged from birth to one of the seven age sets, *Ipinda.*. These sets were closely connected with circumcision, and their functions were both military and political, and in addition they had considerable effect on behaviour and relations between people in the *tiliet.* The sets worked in a recurring cycle, and the names appear again and again. The length of interval was determined by the flowering of a bush which marks the beginning of the period during which the boys were circumcised, and the end of the warriors' period of power was calculated from this. As the bush flowers at intervals of about seven or eight years, alternate flowering were taken to fix the circumcision (15 years interval). The age sets succeeded one another in the following order: *maina, nyongi, kimyike, kaplelach, kipkoiimet, sawe, juma*. Each set is sub-divided into four permanent associating groups called *mat*, which means fire', and the term is derived from 'the fire that roars in the seclusion huts (*menjet*) of those who are being circumcised , and those who share such a hut are of the same *mat*'. These four groups are: (1) *chonginiot*- ostrich feathers, (2) *kipalkonyot*- 'we dig out eyes', (1 &2 senior group) (3) *Tetekatindet'* those who are greeted' *tete*'', (4) *Kiptoiyot,* the bullcalves (3&4 junior group). All four groups, with the same names, occur in each age-set (Sutton, 1978).

3.3 Study Area

The location, size, administrative boundaries, physiographic and natural conditions and the socio-economic profile of the study area are presented in separate sections hereunder.

3.3.1 Location, Size and Administrative Boundaries

The Nandi community inhabits Nandi County and is also scattered in the neighbouring counties of Uasin Gishu and Trans Nzoia. Nandi County is one of the counties in the former Rift Valley Province and is situated on the Western part of the province. The County lies within latitudes 0 and 0 34 north and latitudes 34 44 and 35 25 east. It borders four counties; to the South Kericho County; to the South West Kisumu County; to the West Kakamega County and to the East Uasin- Gishu County (Figure 3.1). The County has nine Administrative Divisions namely; *Kipkaren, Kabiyet, Kosirai, Kapsabet, Kilibwoni, Aldai, Kaptumo, Nandi Hills* and *Tinderet*. The County occupies a total area of 2,899 Km^2 with *Kapsabet* occupying the largest area (482 Sq. Km.) and *Kosirai* the smallest (18 Km^2) (Table 3.1).

The County is politically divided into four constituencies namely; *Aldai, Mosop, Tinderet* and *Emgwen. Aldai* Constituency comprises *Kaptumo* and *Aldai* Divisions. *Mosop* Constituency comprises *Kabiyet, Kipkaren* and *Kosirai* Divisions. *Tinderet* Constituency comprises *Tinderet, Nandi Hills* and *Kilibwoni* Divisions while *Emgwen* Constituency comprises *Kapsabet* Division.

The county has three local authorities namely *Kapsabet* Municipal council, *Nandi* Municipal County Council and *Nandi Hills* Urban Council, and with 98 wards. The county has a total population of 833,134 (Kenya National Bureau of Statistics, 2009).

Table 3.1: Administrative Sub-County and Area (Km2)

Sub-County	Division	Area in sq. km	No. of locations
Nandi Central	Kapsabet	496.1	
	Kilibwon	163.7	23
	Kosirai	44.7	
Nandi South	Kaptumo	137.7	16
	Aldai	387.7	
Nandi North	Kosirai	150.8	23
	Kabiyet	286.2	
	Kipkaren	300.5	
Nandi East	Nandi Hills	427.2	22
	Ol'lessos	109.9	
Tinderet	Tinderet	379.7	15
Total	**11**	**2,884.4**	**99**

Source: (KNBS, 2009) Kenya population and Housing Census

Table 3.2: Nandi County Political Units

No	Constituency	Sub-County/s	No of Wards
1	Emgwen	Nandi Central	4
2	Mosop	Nandi North	7
3	Chesumei	Nandi Central	5
4	Aldai	Nandi South	6
5	Nandi Hills	Nandi East	4
6	Tinderet	Tinderet	4
TOTAL			30

Source: (NCIDP, 2013) Nandi County Integrated Development Plan

Table 3.3: Administrative Units, Population Size and Density

Division	Area/ km^2	Population	Density	Number of sub-locations
Aldai	385.3	96,220	272	38
Kabiyet	268	43,367	177	18
Kapsabet	493.7	125,115	276	24
Kaptumo	137.4	26,782	213	14
Kilibwoni	273.1	62,692	249	52
Kapkaren	315.5	52,753	182	28
Kosirai	195	35,383	197	24
Nandi Hills	390.3	77,514	204	46
Tinderet	41.7	58,925	155	39
Total	**2,873**	**578,751**	**218**	**283**

Source: (NCIDP, 2013) Nandi County Integrated Development Plan

3.3.2 Physiographic and Natural Conditions

Physiologically, the county is divided into five distinct features. These are the rolling hills to the west, the Kapsabet plateau, the highlands, and the foothills of Tindiret in the south east and the Kingwal swamp in the Baraton/Chepterit area and the dissected Nyando escarpment at the southern border (Nandi County Integrated Development Plan, 2013)

The altitude of the county ranges from 1300m to 2,500m above sea level. It is hilly and is underlain by outcrops of basement, which are distinct to the north giving way to thick layers of soil covered anthills to the south. This topography is favourable to the growth of natural forests, which serve as watersheds for major rivers and the numerous streams that form a good drainage pattern in the rest of the district. The major rivers are Kipkaren, Olare, Onyonkie, and Kimondi Kingwal, Mekong and Yala.

Nandi County has a cool and a moderately wet climate. On average the county receives between 1,200mm and 2,000mm of rainfall per annum. The mean temperatures of 18^0C and 22^0C are recorded during rainy seasons while average temperatures of 23^0C during the months of December and January. The coolest temperatures are experienced during the cold spell of July and august. The highest temperatures averaging 26^0C are recorded only to the southwest area in the neighbourhood of Nyando escarpment lying 1,300 metres above sea level.

The county has seven agro-ecological zones namely: LH1 – lower humid highland; LH2-low sub-humid highland; LH3- lower semi-humid highland; UH-upper highland; UM1-upper humid highland; UM2- upper sub-humid midlands; UM3-upper midland (Government of Kenya, 2005).

3.3.3 Geology and Soils

The county is hilly and underlain by an outcrop of basement rock systems, distinct in the north. The soils are generally deep with organic matter content of mollic and humic nistols and humic acrisolis, mainly in the cultivated areas. At the hills, the soils are rich in organic matter while those at the escarpments and the sloppy areas have soils of humic materials of moderate to high fertility. The soils in most of the county are deep, well drained and very suitable for cultivation. The soils are relatively rich in organic matter and hence have moderate to high fertility (Nandi County Integrated Development Plan, 2013). Due to the adequate and reliable rainfall, the county has the potential to produce a surplus of diverse agricultural crops, including tree crops, horticultural crops, and pyrethrum, cereals and fruit trees.

3.3.4 Socio-economic profile

Agriculture plays a major role in the development of commerce, trade and services. The industrial sector mainly consists of agro-based industries such as tea and milk processing and saw- milling. The bulk of the formal employment labour force is in the public sector and the tea estates. Diverse crops such as tree crops, horticulture, pyrethrum, coffee, Irish potatoes, sweet potatoes, beans, vegetables and cereals (maize, millet, and sorghum) are cultivated. The chief cash crops in the southern part of the district are coffee, tea and sugarcane. The county is dominated with farmers keeping pure breed dairy cattle and high grade crosses with tea as the main cash crop. Malnourishment stands at 24.9% among children under 5 years of age. Absolute poverty is at 64.2% and food poverty level at 55.4%, with 47.5% of the residents having access to safe and clean water (Government of Kenya, 2005).

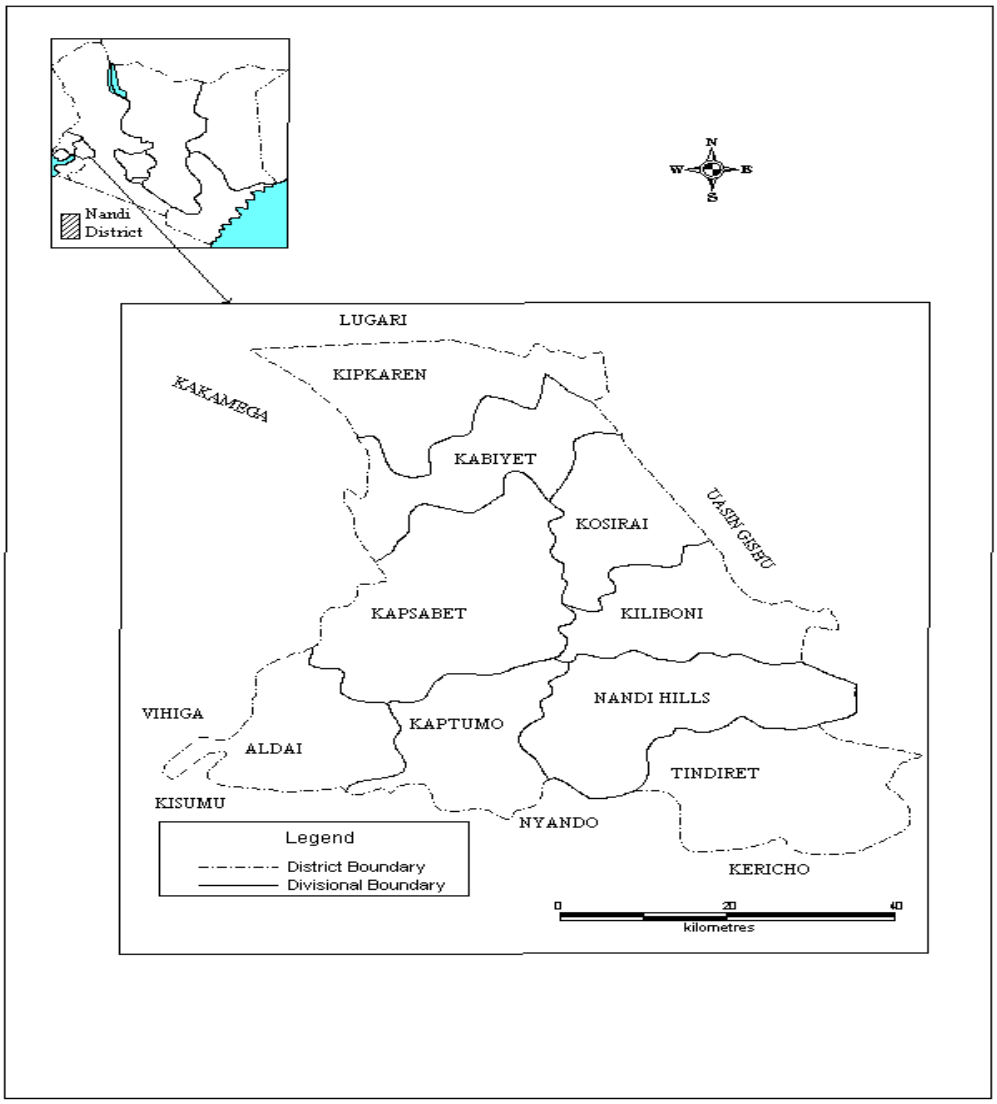


Figure 3.1: Map of Nandi County

Source: (NCIDP, 2013) Nandi County Integrated Development Plan

3.4 Research Design

This study adopted a case study design. Thomas (2011) indicates that case studies are analysis of persons, events, decisions, periods, policies, institutions or other systems that are studied holistically by one or more methods. Case studies can be based on a mix of quantitative and qualitative evidence. This is also supported and well formulated in (Lamnek, 2005). The case is a research approach, situated between concrete data taking

technique and methodological paradigms. It allows the researcher to explore individuals or organizations, simple through complex interventions, relationships, communities, or programs (Yin, 2009) and supports the deconstruction and the subsequent reconstruction of various phenomena. Particularly for this study, case study design was helpful in highlighting key components of the Nandi people's culture which was important in understanding aspects of the past.

In this study, 385 respondents were involved in the research in order for data to be collected and analysis to be made. The data collected from the sample were used as a representative of the entire Nandi community population. The use of focus group discussion technique helped bring a small group of a carefully selected sample to engage in a guided discussion about the use and application of indigenous knowledge in natural resource management.

3.5 Target Population

This study targeted households in three divisions within Nandi County namely Kapsabet, Kipkaren, and Nandi Hills. According to 2009 population census, Kapsabet division had a population of 125,115, Kipkaren division 52,753 while Nandi Hills had a population of 77,514 (Kenya National Bureau of Statistics, 2009). It also targeted officials from the National Environment Management Authority (NEMA), Ministry of Agriculture, Ministry of Water, Ministry of Forestry and national museums in the County.

3.6 Sampling Techniques and Sample Size

This study employed both probability (systematic and simple random sampling) and non-probability (purposive and snowball) methods. Purposive sampling is a strategy in which particular settings, persons, or events are selected deliberately in order to provide important information that can't be gotten as well from other choices. Individuals selected are deemed 'experts' in aspects of what is going on in their own community by virtue of living there and/or socializing with a particular group of people (Nachmais & Nachmais, 2008).

Purposive sampling was used to select key respondents for the interviews. The target was people who had knowledge on major changes which have occurred over different periods of time in use and application of IK. Among those targeted were the following policy makers in the County overseeing management of natural resources; from Ministry of Agriculture, Livestock and Fisheries who provided information on land use activities and policies on agricultural land use issues; officials from Ministry of Environment, Water and Natural resources who gave information on the situation of water sources in the county and policies relating to management of water resources,; from department of Forestry and NEMA who provided information about forests and the environment respectively. A total of ten (10) key informants were selected for this study.

Snowball sampling involves building up a sample of a special population by asking an initial set of informants to supply names of other potential sample (Cresswell, 2009). This technique is often designed to identify people with knowledge, skills or characteristics that are needed as part of a consultative process (Robert & Larry, 2010).

It was used to select traditional specialists with specific indigenous knowledge in natural recourse management and also used to recruit individuals for focus group discussion. The researcher, through key informants identified traditional specialists with knowledge in traditional medicine, rain prediction and religious leaders (those who performed various rituals in the community). The study sampled a total of thirteen (13) traditional specialists.

Simple random sampling is considered as a method of drawing a representative sample from a given population where all possible samples from the population n have the same probability of being selected from the population N (Kerlinger, 1973). This method was picked by the researcher since it was practical and bias free. It was used to select the divisions and location. For systematic sampling, first a list of all locations in the divisions was made and simple random sampling technique was used to select a location in each of the three divisions where respondents for the study were drawn. Secondly a list of all households was compiled and numbered, this constituted the sampling frame. Each eighth (8^{th}) household was then selected and the head of each household selected as a respondent. In total 385 respondents were selected using this method.

Fisher (1991) suggested that if the target population is more than 10,000 then the following formula can be used:

$n= z^2 (pq)/d^2$,

Where

n= the desired sample size (when the population is more than 10,000)

z= the standard normal deviate at the required confidence level

p= the proportion in the target population estimated to have characteristics being measured (255,382) ***384.16***

q= 1-p

d= the level of statistical significance set

The sample size for this study was therefore 385 respondents.

Samples from three divisions were then drawn proportionately using Mugeda and Mugeda (1999) formula as outlined below:

Xi = (Ni/N) * 385

Where:-

Ni- is approximate population size for the i^{th} division of the Nandi County.

N – Is the approximate total population size for the 3 divisions of the Nandi County.

Xi- Is the sample size to be picked in the i^{th} division of Nandi County.

384 = the total sample size to be used in the study.

I – represents the divisions of the county.

Therefore samples drawn from the divisions were as follows;

Kapsabet with a total population of 125,115 (24,941 households), a sample of 188 respondents was drawn; Kipkaren, with a total population of 52,753 (10481 households), a sample of 79 respondents was drawn; Nandi Hills with a total population of 58,925 (15,522 households), a sample of 118 respondents was drawn.

3.6.1 Criteria for selecting respondents

Generally, the research participants were required to meet certain criteria aimed to ensure that they were sufficiently familiar with their respective communities. The

criteria used was that they had to be 18years and above and be conversant with the daily community life and local language.

3.7 Data Collection

Both primary and secondary data were collected for this study. A hallmark of the case study design is the use of multiple data sources, a strategy which also enhances data credibility (Nachmais & Nachmais, 2008; Yin, 2009). Data sources for this study included documents, use of key informant interviews, focus group discussions, direct observations, and photography. To facilitate a holistic understanding of changing trends in use and application of indigenous knowledge in management of natural resources, a questionnaire was used to collect quantitative data.

3.7.1 Secondary Data

Secondary data was collected from both published and unpublished sources. Secondary sources of information reviewed include reports, books, journals, research and policy papers and other relevant printed materials from libraries at Moi University, University of Eldoret, Eldoret Library, and at the National Museum Archives at Koitalel Samoei Museum. Data was also compiled from relevant records collected from Ministry of Agriculture, Ministry of Lands, Forest department, Ministry of water, and County Council of Nandi.

3.7.2 Primary Data

The collection of primary data progressed in stages. During the preliminary stages, key informant interviews, focus group discussions, and direct observations were used to

collect data that was used to identify the study population and the specific issues that needed to be investigated further. The information obtained from the preliminary findings was then used to refine the research instruments for the main questionnaire survey and the key informant interview guide. After the survey, the information obtained from these methods was used to enrich and clarify the findings of the quantitative and qualitative research.

3.7.2.1 Key Informant Interviews

A large proportion of information used in the study was obtained from interviews held with 23 key informants purposively selected from various sectors within the study area based on specific informative characteristics they possessed. Out of these, 3 respondents were drawn from Department of Agriculture, 2 from Department of Water, 3 from forest department, 2 from NEMA, 1 drawn from each location sampled for the study and 13 traditional specialists (rain makers, herbalists, and traditional religious leaders). The number of respondents interviewed from each Department was based on the information needed and the availability and willingness of the people to provide the information by virtue of their knowledge and experience (De Vaus, 2002; Robert & Larry, 2010). A key informant interview guide (Appendix 2) was developed and used to guide these interviews. The information obtained from the interviews helped to validate or clarify any of the information generated by the final questionnaire for the field survey that may not have been clear to the researcher.

Key informant interviews were conducted first because they provided a mechanism of: (a) identifying the target populations and the issues that needed to be investigated further; (b) gathering information where cultural barriers would have made the survey

or focus group research difficult. For instance, key informant interviews with community leaders who knew their community well, and the skills to work with mainstream culture provided the information needed and hence refined data collection efforts; (c) clarifying the findings of the quantitative research; (d) collecting supplementary information about respondent's personal characteristics and environment, which was of great value in interpreting results; and, (e) mobilizing the respondents for the focus group discussions. All the interviews were audio- recorded. This was supplemented with note taking to take care of items which could not be audio-recorded such as physical setting.

3.7.2.2 Focus Group Discussions

Focus group discussions (FGDs) were utilised to enhance the quality of data collected and to capture important information that would otherwise not have been unearthed using the quantitative methods of data collection. The use of FGDs helped in creating an environment in which the respondents stimulated a richer response as well as valuable thoughts. They were also instrumental in challenging the thinking of the respondents and illuminating conflicting opinions. FGDs were used with groups of male and female community members and these discussions generated information which was used later in constructing the questionnaire for field survey and corroborating the information provided in the questionnaire by the respondents.

In total, three (3) focus group discussions were constituted for this study, using only one meeting with each of the focus groups. The group size varied with the smallest group having eight participants and the largest having a total of 14 participants; in Kipkarren 8 members, Kapsabet 14 members; and Nandi Hills 10 members. The FGD sessions

lasted for two hours. Participants were recruited by word of mouth (Greenbaum, 2000), through the use of key informants (Nachmais et al., 2008). As much as possible, neutral locations were identified and used to avoid either negative or positive associations with a particular site or building (Greenbaum, 2000). Focus group meetings were held in a variety of places, for example, *Ndalat* primary school, *Nandi* Hills museum and *Kapsisiywa* dispensary.

In this study, both homogenous and heterogeneous focus groups with respect to gender were used. To gain insights on issues relating specifically to either male or female, homogenous groups were constituted. This was necessary to avoid a situation where either gender is unable to express themselves freely in the presence of members of the other gender. As observed by Greenbaum (2000), participants need to feel comfortable with each other. Meeting with others whom they think as possessing similar characteristics or level of understanding about a given topic, will be more appealing than meeting with those perceived to be different (Greenbaum, 2000). On the other hand, where the objective was to gain an understanding of issues relating to both genders in general, a heterogeneous group comprising both male and female participants was used. These variations helped to avoid a few members dominating the discussion (Yin, 2009).

During the meeting, the researcher, who was the main facilitator, provided a clear explanation of the purpose of the group, helped the participants to feel at ease, and facilitated interaction between group members. The discussions were guided by a predesigned interview schedule (Appendix 3) consisting of open-ended questions. These enabled the investigator to promote debate, probe for details, and challenge the participants in order to draw out people's differences, generate a diverse range of

meanings on the topic under discussion and generally direct the discussions. The facilitator ensured that everyone participated and all participants got a chance to speak. To avoid favouring particular participants, the facilitator avoided showing too much approval (Thomas, 2011), and giving personal opinions so as not to influence participants towards any particular position or opinion.

Research participants

Interviews with research participants lasted for one hour to one and half hours. The focus group discussion lasted for approximately two hours.

The research participants were labelled as follows:

i. Traditional specialists were labelled as TRS 1...13

ii. Key informants in government departments related to management of natural resources in Nandi County were labelled as: Department of Agriculture DA 1...3: Department of Forest DF 1..3 : Department of Water DW 1...2: Department of Environment DE 1...2

iii. Focus group discussions were labelled as follows: Nandi Hills FG 1-1...:10 Kapsabet FG 2-1....13:Kipkaren FG 3-1....8

Table 3.4: General characteristics of respondents

Study site	Characteristics	Number of participants
Nandi Hills	**Gender**	
	Male	18
	Female	3
	Age:	
	Adult	
	Status in community	
	Community elders	3
	Traditional specialist	6
	Community member	7
	Government officer	5
Kapsabet	**Gender**	
	Male	17
	Female	7
	Age:	
	Adult	
	Status in community:	
	Community elder	4
	Traditional specialist	6
	Community member	10
	Government officer	4
Kipkaren	**Gender**	
	Male	8
	Female	1
	Age;	
	Adult	
	Status in community	
	Community leader	2
	Community member	6
	Government officer	1

Source: Field Data (2013)

3.7.2.3 Direct Observation, Photography and Aerial Map Interpretation

Further data was collected through direct observations. During the exploratory stages of the research, this method was used to get direct evidence of the use and application of indigenous knowledge in the area and to cross check and validate the information and focus group discussions. The specific objectives for observation activity were determined beforehand and a list of things to pay attention to was prepared and kept on hand for quick reference (Appendix 4). However, the investigator also looked out for unexpected scenario's which could suggest new directions for the research.

Information collected through observation was useful in formulating the questions to be included in the questionnaire. Observations during visits to the farms, rivers, forests, shrines, salt licks, enabled the researcher to get first hand information on observable phenomena such as land use activities, vegetation, trees, animals, river volumes, activities along river banks and forests. During these observational sessions, the investigator was able to observe objectively the surroundings, take photographs of relevant scenes and happenings, clarify and validate information already collected, and also record new information. Aerial map interpretation was used to complement direct observation and photography

Freedman (2008), states that observable indicators are useful for evaluation of physical conditions of a community. The information collected through observation was useful in gaining an understanding of the physical, social, cultural and economic contexts in which indigenous knowledge is used.

3.7.2.4 Use of Questionnaire

A questionnaire is a highly structured data collection technique where each respondent is asked the same set of questions. A semi structured questionnaire was administered to 385 randomly selected respondents in the study area. The questionnaire was preferred as the main tool of data collection in this study because through the use of open ended and closed ended questions, the investigator was able to collect both quantitative and qualitative data (Robert & Larry, 2010). Furthermore, questionnaires provide a very efficient way of collecting information from potentially large number of people. Additionally questionnaires are easier to administer, analyse and economical in terms of time and money.

However, questionnaires responses are limited and the respondent is compelled to answer questions according to the researchers' choices (Nachmais & Nachmais, 2008). To mitigate this shortcoming, other methods of data collection that give the respondent opportunity to express their own views were used. A structured questionnaire (Appendix 1) was administered to respondents to elicit data and information on demographic characteristics of the respondents, use and application of indigenous knowledge in natural resource management at household and community level, effects of change in use of Indigenous Knowledge on natural resource management, and to establish the link between the Nandi indigenous natural resource management and modern natural resource management strategies.

3.7.2. 5 Questionnaire Design and Administration

The questionnaire was structured according to objectives of the study. The questionnaire had four main parts (Appendix 1). Part A solicited information about respondent's socio-economic background such as gender, marital status, and level of education, occupation, size of land and period of residence. Part B solicited information relating to the changing trends in use and application of Indigenous Knowledge in natural resource management in relation to various aspects of; a) land use b) forest resources c) water resources. In Part C the participants were asked to respond to questions relating to impacts of changes in use and application of Indigenous Knowledge on key natural resources examined in the study that is, land, water and forests. Part D participants responded to questions relating to areas of interrelationships between IK and modern scientific knowledge in the management of land, water and forest resources.

The questionnaire was administered by the researcher with the help of four research assistants. The research assistants were drawn from the local community and could speak the local language fluently. The research assistants had all attained a minimum of O'level education, two were pursuing undergraduate courses in different fields of study and two had worked as research assistants for a Non Governmental Organizations dealing with Malaria control in the community.

3.8 Validity and Reliability of Research Instruments

This study established content and face validity to assess the accuracy, meaningfulness, appeal and appearance of the instruments for data collection. Validity of an instrument

is the success of a scale in measuring what it sets out to measure so that the differences in individual scores can be taken as representing true differences on the characteristics under study (Freedman, 2008); while content validity refers to the subjective agreement among professionals that a scale logically appears to reflect accuracy in what it purports to measure (Kothari, 2004). To determine content validity of the instrument items, the researcher's supervisors assisted in ensuring that the instruments were in relation to the set objectives and content area under study. Their suggestions and comments were used as a basis to modify the research items and make them adaptable to the study. Basing on the feedback from the experts, the wording of the instruments were modified, some were excluded while others were modified as deemed fit. A combination of data collection techniques (interviews, participant observation, focus group discussion and questionnaire survey) provided an opportunity to assess the validity of information gathered by examining data relating to same theme from different techniques used (data triangulation).

Data collected from the pilot study were used to compute the reliability of the instruments' items. Cronbach's coefficient alpha method was used to determine internal consistency of the items. This method is appropriate owing to the fact that it requires only one administration of the test (Cresswell, 2009). It is also appropriate where items have got choices (Robert & Larry, 2010). In this study, the items were considered reliable since they yielded a reliability coefficient of 0.70 and above. This figure is usually considered desirable for consistency levels (Freedman, 2008). Some key respondents were also asked for their judgements about what were and not representative views, through focused interviews.

3.9 Data Analysis

Analysis of qualitative data involved organising, categorising and identifying key themes emerging from data collected. Both discourse and inductive approaches to data analysis were applied to generate a wider and more comprehensive description of the emerging indigenous knowledge on natural resource management among the Nandi. In order to draw as diverse themes as possible from the qualitative data collected as possible, the researcher enlisted the help of 3 other colleagues who are natural resource management champions and together they all worked in identification of themes and subsequent thematic analysis

Quantitative data was managed through Statistical Package for Social Sciences (SPSS) computer programme version 20.0. The first part of the quantitative analysis was majorly descriptive involving representing data through counts and percentages. Representation of the descriptive analysis was through graphs and tables. The second part of the analysis employed inferential analysis where key variables were analysed in order to establish whether or not they were independent from each other. This was helpful in making comparisons between the indigenous natural resource management and modern natural resource management related activities. Chi-square test for independence was mainly used.

3.10 Ethical Considerations

Alreck and Settle (2004) assert that the purpose of research ethics is to protect the welfare of the research participant. The following ethical concerns, as suggested by

Christian (2005) were therefore put into consideration before and during the entire study period:

a). **Informed consent**: Under informed consent the following was put into consideration:

i. **Disclosure**: The research participants were informed in details the nature and purpose of the study, the procedures to be used, their roles in the study and the expected impacts to the participant and/ or the community.

ii. **Understanding**: To ascertain whether the research participants understood what was explained to them, they were given an opportunity to ask questions and to raise any unclear issues.

iii. **Voluntariness**: The research participants were required to participate in the study on voluntary basis, that is, without physical or psychological coercion or promises of benefits unlikely to result from participation.

iv. **Competence**: The study targeted research participants who were mainly competent enough to give consent.

v. **Consent**: The potential research participants were required to authorize their participation in the study orally.

b). **Privacy and confidentiality**: Confidentiality was maintained primarily to safeguard the research participants from unwanted exposure. Christian (2005) notes that the single most likely source of harm in social science inquiry is the disclosure of private

knowledge considered damaging by research participants. Thus, efforts were made to, not only protect information from unauthorized observation but also to ensure the confidentiality and anonymity of the research participants. The researcher also established whether the participants preferred to be named in the written report of the research or given a pseudonym.

c). **Security**: Here, the primary concern of the researcher was to safeguard the interests and safety of the research participants. This was accomplished by carefully considering foreseeable risks, stresses, and discomforts, and continuous monitoring the study as it proceeded.

3.11 Chapter Summary

The first section explored the background of the Nandi people during the pre-colonial period, highlighting their social, economic and political organization. This research employed a combination of quantitative and qualitative approaches. This approach was aimed at getting a detailed understanding of the Nandi people and to appropriately address the research objectives. Thus the use of qualitative methods which included focus group discussion, interviews, and observation allowed for an in-depth exploration of IK among the Nandi people. The use of quantitative methods, in particular, questionnaires, allowed for information from a larger sample of the population to be collected. Both qualitative and quantitative methods were used to complimentary way, to confirm findings which increased validity and reliability of results.

The next Chapter present the results and associated discussions based on the research objectives.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter outlines the results obtained from data analysis. The presentation and discussion of the results is in line with the objectives of the study.

4.2 Demographic Characteristics

There were a total of 408 respondents who participated in this study; 385 household heads, 10 government officials in environment related ministries in the County and 13 traditional specialists. The researcher established the demographic characteristics of these respondents.

4.2.1. Gender

Majority (77.7%, n=299) of the respondents in this study were male whereas only 23% (n=86) of the respondents were female.

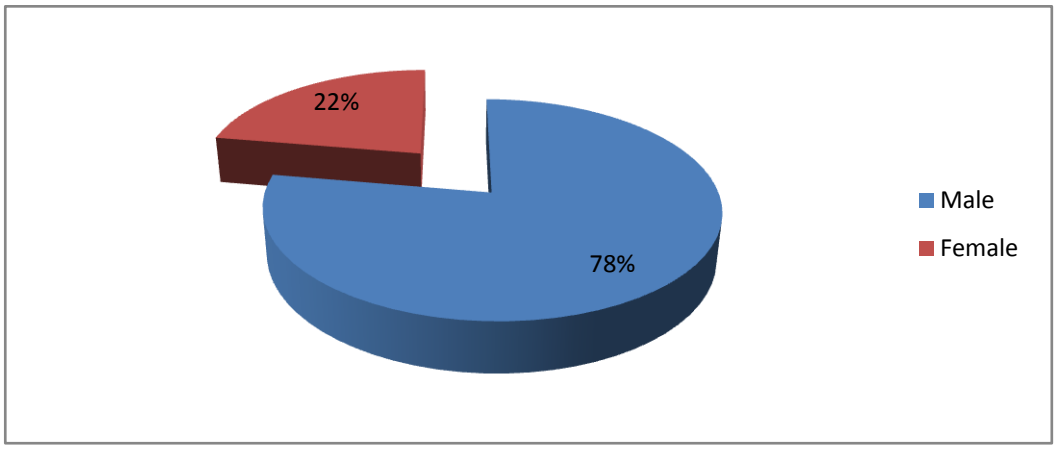


Fig 4.1: Proportion of household heads respondents by gender

Source: Field data (2013)

4.2.2 Education Level

The results showed that 85.2% of all the respondents in this study had formal education. Out of all those who reported to have formal education, most 57.9 %(n=223) had attained primary level education. Those who had attained A-Level/O-Level education were 16.4% (n=63) whereas 9.9% (n=38) had attained undergraduate education. Only 1% (n=4) had attained masters' level education. This information is presented in Table 4.1.

Table 4.1: Proportion of Household Heads Respondents by Education Level

Level of Education	Frequency	Percentage
No formal education	57	14.8%
Primary	223	57.9%
A-Level/O-Level	63	16.4%
Undergraduate	38	9.9%
Masters	4	1.0%
Total	**385**	**100%**

Source: Field data (2013)

Table 4.2 Cross tabulations of education level and gender of respondents

Education level	Gender		Chi-square
	Male	Female	
Never attended	54.8%	45.2%	
Primary school	63.8%	36.2%	
Secondary school	72.2%	27.8%	**10.203** df=4 **P=0.037**
Tertiary	75.4%	24.6%	
University	52.6%	47.4%	
Total	66.3%	33.7%	

Source: Field data (2013)

The above Chi-square results (P=0.037) indicate the independence between gender and education. These results implied that the level of education attained did not depend on what gender the respondent was.

4.2.3 Occupation

The study established the occupation of household heads in order to assess the extent to which families dependent on natural resources for livelihoods. A majority of the respondents (51.9%; n=200) were small scale subsistence farmers while 27.8% (n=107) were large scale farmers. Those who were earning a salary from formal employment were 8.3% (n=32) while 11.9% (n=46) were in other business. Report from focus group discussion revealed that self employed individuals were majorly engaged in agricultural related business activities such as selling livestock, middlemen, mechanic engaged in repairing farm machinery. Those in formal employment were mainly primary school teachers who also supplemented their income by engaging in farm activities. A summary of these results is illustrated in Figure 4.2

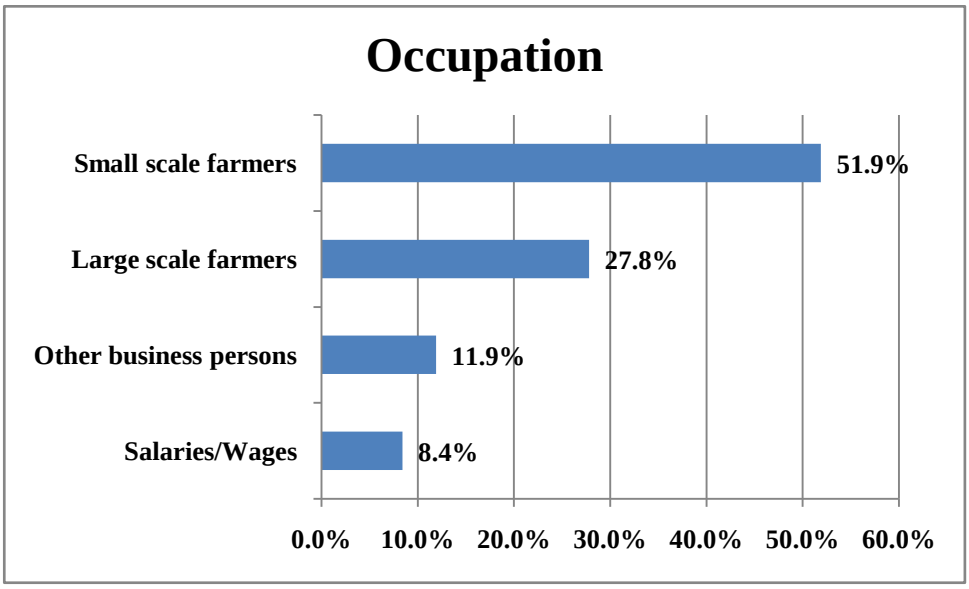


Figure 4.2: Proportion of household heads respondents by occupation

Source: Field data (2013)

Table 4.3: Cross Tabulation of Occupation and Gender

Occupation	Gender		Chi-square
	Male	Female	
Unemployed	62.0%	38.0%	
Self employed	69.5%	30.5%	**2.503** df=3
Formal/salaried	72.0%	28.0%	**P=0.475**
Farmer	62.9%	37.1%	
Total	65.8%	34.2%	

Source: Field data (2013)

The Chi-square result (P=0.475) indicate the dependence between gender and occupation. These result implied that the occupation status of the person could be linked

to the gender of the person. The results also showed that most salaried persons in the study were likely to be male.

4.2.4 Age of household heads

Age is an important factor in establishing use and application of indigenous knowledge in any community. Results indicate that 29.4% (n=113) were aged between 21-24 years. Additionally 28.3% (n=109) were aged 41-50 years. Furthermore 19.1% (n=79) were aged 51-60. While 23.2% (n=89) were 60 years and above. A summary of age cohorts is shown in Table 4.4.

Table 4.4: Age groups of the household heads

Age group	Frequency	Percent
21-40	113	29.4%
41-50	109	28.3%
51-60	74	19.1%
>60	89	23.2%

Source: Field data (2013)

Table 4. 5: Cross Tabulation of Age and Gender

Age	Gender		Chi-square
	Male	Female	
21-40	51.4%	48.6%	
41-50	66.7%	33.3%	**18.097** df= 3
51-60	76.1%	23.9%	**P<0.05**
>60	76.7%	23.3%	
Total	66.3%	33.7%	

Source: Field data (2013)

4.2.5 Residence of respondents

Residential status of the respondents was examined from two angles; the type of residence and period of residence. It is clear from the study that majority 84.6% (n= 326) were residence of their various divisions by birth and a minority 15.4% (n=59) were immigrations from other places. Majority 62.6% (n=241), of respondents had lived in the study are for more than 20 years. Those who have lived for 11-20 years were 15.7% (n=60), while those who have lived in the study are for ten years and below were 22.7% (n=84). A breakdown of these results is illustrated in Table 4.6.

Table 4.6: Residence of respondents

Residence		
Residence by	**Frequency**	**Percent**
Birth	326	84.6
Immigrant	59	15.4
Total	**385**	**100**
Period of residence	**Frequency**	**Percent**
Less than a year	7	1.9
1 to 5 years	25	6.4
6 to 10 years	52	14.4
11 to 20 years	60	15.7
More than 20 years	241	62.6
Total	**385**	**100**

Source: Field data (2013)

4.2.6 Environmental Officials

The study sampled ten (10) officials from institutions charged with the responsibility of natural resource protection. These officials were key in informing the research on

existing policies on natural resources. Out of the 10 officials, 7 were male and 3 were female.

4.2.7 Traditional Specialists

The study sampled thirteen traditional specialists from the Nandi community. These were individuals who were knowledgeable about traditional natural resource management strategies that have been instituted over the years by the Nandi community. Out of the 13 traditional specialists sampled, 10 were male.

Plate 4.1: Researcher with Nandi traditional specialists in the field

Source: Author, 2013

4.3 Trends in the Use and Application of IK in Natural Resource Management

Majority of the respondents (92% n=351) reported that the Nandi community traditionally participated in natural resource conservation. Specifically, the respondents

mentioned land, wildlife, forest and water as the natural resources most conserved in the past. Figure 4.3 gives a summary of these results.

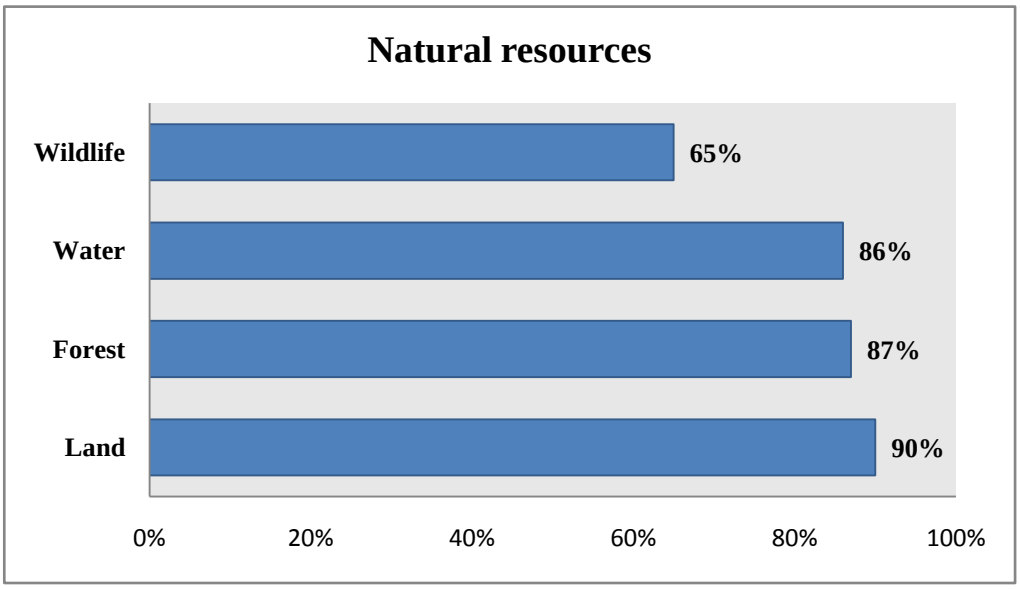


Figure 4:3 Natural resources that were traditionally conserved

Source: Field data (2013)

Some of the elderly traditional resource person (TRS 6) stated the following:

"This generation has tremendously changed, in the past; we used to regard our resources as sacred. Land for forests and water bodies were never tampered with. We used forests for religious purposes; prayer and offerings...you could not destroy such resources. Destruction was traditionally condemned. Today, you just see young people carelessly destroying the environment" (Personal Communication, TRS6).

*"We had cultural beliefs and taboos which guided us on how to live and care for our natural resources" (*Personal Communication, FG 1-3,)

"Children learned our way of life through stories and songs narrated to them by grandparents" (Personal Communication, FG 2-8)

4.3.1 Indigenous Knowledge and Land Use Systems

The study sought to establish the various land uses that have been in existence in Nandi region during three main phases: pre-colonial (Before 1895); colonial (1895-1963); and post colonial (1963 to date), and how indigenous knowledge influenced these land uses. Views on land uses were sought from the respondents and the study established that indigenous knowledge played a significant role in land uses during the pre-colonial and colonial times.

4.3.1.1 Reasons for land conservation

Various reasons were given by respondents for land conservation among the Nandi in the pre-colonial period. Majority 87.1% indicated that land was conserved for grazing, 84.1% reported that land was conserved for food, while 80% indicated conservation of land for settlement and 63.6% indicated prestige and wealth. A summary of these results is given in Fig. 4.4.

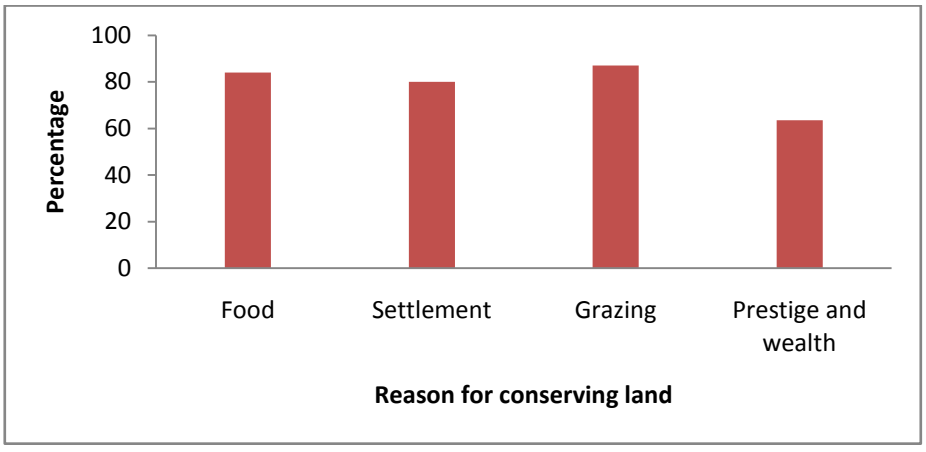


Figure 4.4: Reasons for conserving land

Source: Field data (2013)

A proportion of 70.6%(n=272) majorly comprised of respondents aged over 40 indicated that the main land uses during these periods were hunting, gathering, livestock keeping, mixed cropping and indigenous agro forestry practices.

"We kept large herds of cattle, sheep and goats... which were our source of food...milk and meat and also our source of wealth" (Personal Communication, FG 1-5)

"Our young men hunted wild animals such as antelopes, hare, gazelles, which supplemented our diet. We had organized hunting parties with leaders who were skilled and knew the hideout and movement of wild animals...used bows, arrows and traps. Women and children collected wild fruits and nuts" (Personal Communication, TRS 10)

"We planted a few crops...millet and sorghum...also had variety of vegetable like isochot, chepkerta, pumpin, mityiek...mostly grew wild" (Personal Communication, FG 1-9

"We didn't plant crops in one place for many years... we cultivated one place then moved to a new place after two or three years" (Personal Communication, FG3-6

4.3.1.2 Timing of land use activities

Representative quote from (FG2-3)

"Land was only cultivated for 3-4 years and then a new area for cultivation was identified this ensured that the soil was not over exploited" (Personal Communication, FG2-3)

4.3.1.3 Soil erosion control

Representative quote from (FG2-7)

"Slopes and hilly areas were only cultivated for one year. In such areas trenches were dug round the field and in some instances ridges were built by piling logs and branches of trees across the field to control soil erosion" (Personal Communication, FG2-7.

4.3.1.4 Agro forestry with 'friendlier' species of tree

Responses from the participants indicated that land in Nandi community was assigned a number of uses which did not in any way degrade the natural ecosystem. A middle-aged respondent (FG 3-1) added that:

"Traditionally, agro forestry was also performed where crops were grown in the wilderness with natural vegetation using traditional artefacts which could not destroy the environment. The only difference between traditional and modern agro forestry is that the latter practice has introduced invasive plant species which destroy our indigenous crops" (Personal Communication, FG 3-1.

4.3.1.5 Colonial period

"New methods of farming that we different from ours were introduced... white settlers come with new seeds of maize which were white in colour...introduced new breeds of cattle such as Ashire, Redpoll, Frisians" (Personal Communication, FG2-5

"Europeans come with ploughs and tractors which were used to cultivate large pieces of land ... these tools were more powerful than our simple tools" (Personal Communication, FG 1-2

"Our main agricultural activity currently is keeping livestock and cultivating crops...we grow maize, and beans for subsistence... tea is our major cash crop...it gives us more money" (Personal Communication, FG1-7

4.3.1.6 Post colonial period

Respondents reported the main land use during post colonial period has been crop production, mixed cropping, mono cropping, agro forestry and animal husbandry.

Respondents were asked to rank their farm use activities in order of their current main uses. Majority (71.8%) of respondents ranked crop production as number 1; 67.5% ranked livestock rearing number 2; 70 % ranked agro-forestry ranked number 3 while 68.5% ranked forestation ranked number 4. Figure 4.5 shows the percentage for the ranks of the various activities the respondents practice on their farm.

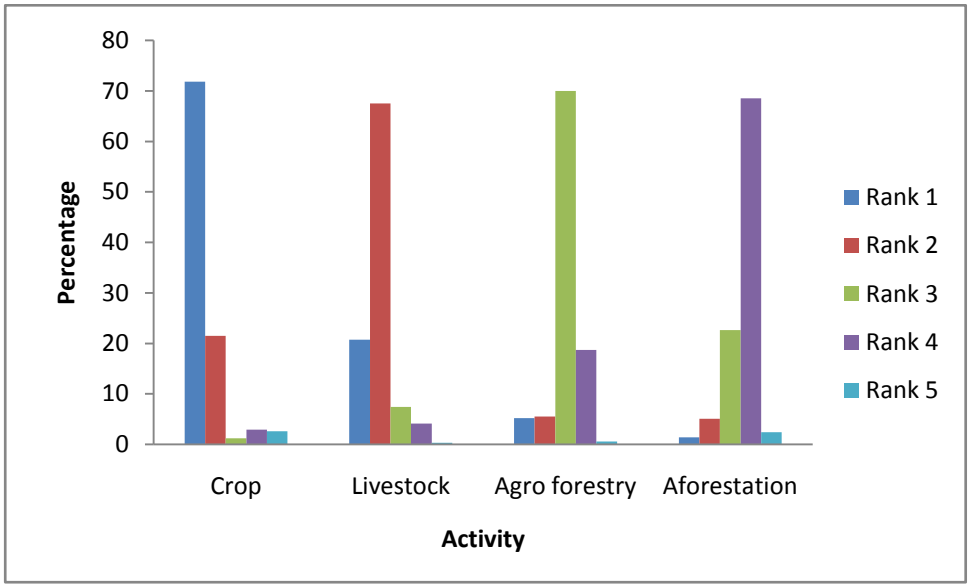


Figure 4.5: Rankings of respondents farm activities

Source: Field data (2013)

A respondent (TRS 7) mentioned during the focus discussions that:

Traditionally, mixed cropping was done on a background of indigenous knowledge...that some crops were better suited for intercropping with others and this helped in conserving the natural ecosystems. Today, what informs intercropping is done with the aim of economic gain and not natural resource conservation and management (Personal Communication, TRS 7.

Plate 4.2 illustrates modern practices of mixed cropping in Nandi where natural resource (river) degradation abounds.

Plate 4.2: Modern mixed crop growing in Nandi

Source: Author, 2013

4.3.2 Indigenous Knowledge attached to the Conservation of Forests among the Nandi

Before highlighting the indigenous knowledge attached to forest conservation, the study established key reasons why forests were conserved in the past. This information was

sought from the three categories of respondents. There were 66.6% (n=256) respondents who indicated that the key traditional reason attached to conservation of forests in Nandi was preservation of cultural sites, 61.4% (n=236) indicated religious attributes as a key reason while 47.2% (n=182) indicated shelter for wildlife as a key reason. Those who indicated the key reason as provision of fuel wood were 49.6% (n=191); medicinal reasons 97.8% (n=377); rainfall attraction 98.3% (378); protection of water catchment areas 98.0% (n=377) and provision of construction materials, 84% (n=323). Figure 4.6 presents this information.

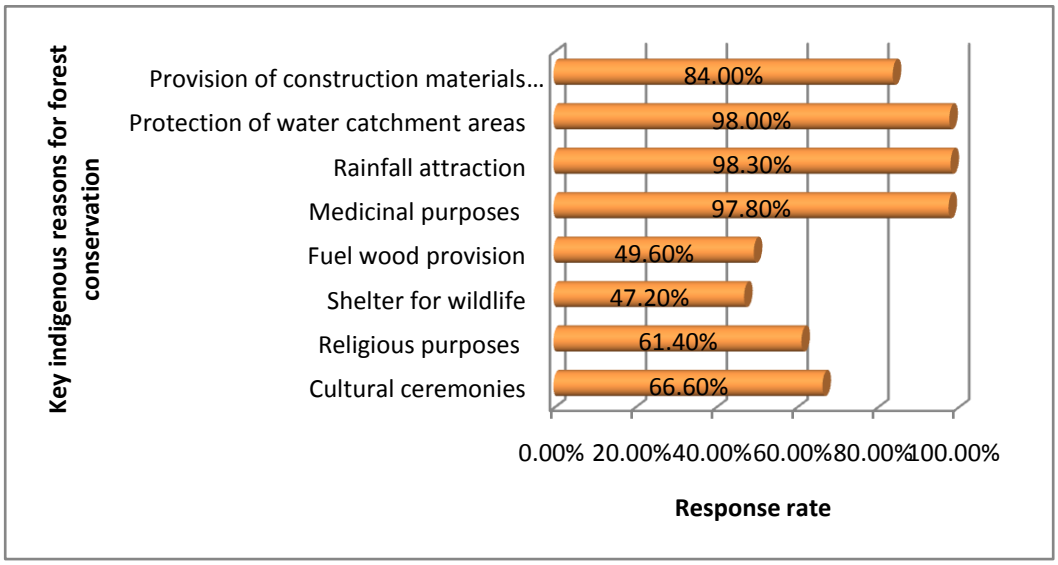


Figure.4.6: Indigenous reasons for forest conservation

Source: Field data, 2013

4.3.2.1 Categorisation of forests in the past

Results reveal that majority (87.2%) of respondents reported that forest were categorised as hunting grounds. Another 81.3% indicated that forests were categorised as ritual sites, while 57.4% indicated that they were categorised as graveyards. 14.6% indicated other forms of categorisation (Figure 4.7).

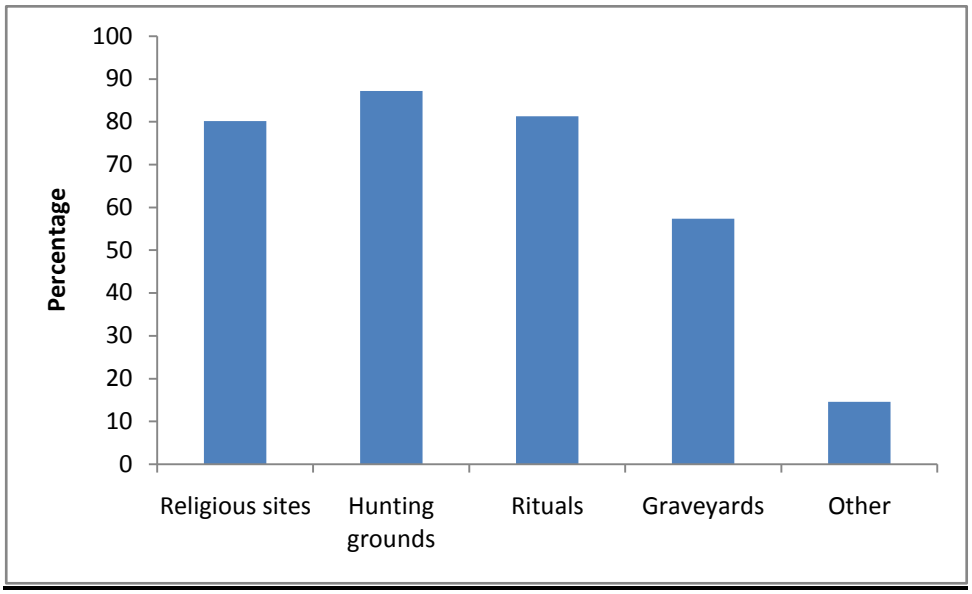


Figure 4.7: Categorization of forests in pre-colonial period

Source: Field data (2013)

4.3.3 Indigenous reasons attached to the Conservation of Trees and other Plant Species among the Nandi

This study sought to establish the indigenous reasons behind the conservation of specific tree species and other plant species. Information collected from focus group discussions on this attribute was cleaned and presented in Table 4.7.

Table 4.7: Indigenous reasons for conservation of tree/plant species among the Nandi

Tree/Plant Species	Indigenous Reason for conservation
Simatwet (Fig)	• Sacred tree • Herbal medicine • Sacrifices offered under the tree
Emdit (olive/ olea chrysophylla)	• Medicinal value • Making symbolic sticks for elders • Preserving milk • Providing shade for elders discussing community issues
Tendwet (prunus africanium)	• Medicinal value • Making women ceremonial sticks
Lamaiywet (ximenia Americana)	• Water catchment preservation • Fruits are edible
Kagarweet (erithrina toonentosa)	• Had healing properties • Its seeds were used to make decorative beads for the women
Sosiot (palm) Arecaceae	• Considered sacred and used for religious purposes • Used for construction of initiates huts • Used to clean guards for storing milk • Used to make brooms
Kipkoskoit(angelica genuflexa)	• Used to make arrow extensions • Used for making beer drinking straws since it is hollow inside
Tumeiyot (Khat) Catha edulis	• The leaves of the tree were chewed for pleasure

Source: Field data, 2013

They also indicated that the penetration of Christianity in the community has tremendously sidelined the use and application of indigenous knowledge in resource conservation. One of the traditional specialists (TRS11) observed as follows:

"...we now worship in church and as a result of Christianity, very few families among the Nandi practice traditional initiation rites...with the introduction of modern medicines, herbal medicines have lost popularity and hence the indiscriminate cutting of trees in the natural forests" Personal Communication, TRS 11.

These sentiments allude to the fact that the use and application of indigenous knowledge in resource conservation has been changing over time. These changes have significantly impacted negatively on resource conservation in Nandi. Plate 4.3 shows a natural tropical forest in the study area, which is still used for cultural rituals and ceremonies by the local people.

Plate 4.3: Natural forest in the study area

Source: Author, 2013

4.3.3.1 Factors contributing to forest depletion during colonial and post colonial periods

Results in Table 4.8 reveal that various factors have contributed to the shrinking of forest cover in Nandi County. 86.8% (n=308) indicated forests have been cleared for settlements, while 85.4% (n=303) indicated forest have been depleted due to population growth. Furthermore, 82.8% (n=293) indicated that forests have been cleared for fuel wood provision, 72.4% (n=257) indicated that forest have been cleared for urbanization while 62.5 (n=222) reported laxity in law enforcement as a factor contributing to forest depletion.

Table 4.8: factors contributing to forest depletion in Nandi County

Factor	Frequency	Percentage
Population growth	303	85.4
Human settlement	308	86.8
Fuel wood	293	82.8
Laxity in law enforcement	222	62.5
Urbanization	257	72.4

Source: Field data. 2013

"Prime land was alienated by Colonial government to settle white settler farmers as a result most forests were cleared for agricultural activities and the remaining parts of forests become private property of white settlers and the colonial government" (Personal Communication, DF 1)

"Africans were displaced from their lands and the colonial forest department claimed the land without considering the rights of local inhabitants and imposed strict regulation on use of forest products by forest adjacent communities. African communities resisted these regulations and hence encroachment and misuse of forest resources" (Personal Communication, DF 2)

4.3.3.2 Post colonial period

The study established that most of the policies operational during post colonial period were inherited from the colonial administration as allude to by key informants from the forest department in Nandi County.

"Forest policy is a legacy from colonial administration...it does not recognize traditional systems, local knowledge and traditional rights. This has made it difficult to enforce the forest act, due to resentment of government officers by local people" (Personal Communication, DF 3)

4.3.4 Indigenous knowledge for Wild life Conservation among the Nandi

Before highlighting the indigenous knowledge attached to wildlife conservation, the study established key reasons why wildlife was conserved in the past. From Figure 4.8 majority of the respondents (98.5%, n=379) indicated that provision of food was the main reason wildlife was conserved. Other reasons identified were aesthetic purposes at 27.0% (n=103), totem provision at 24.6% (n=95), hides and skins at 52.1% (n=201) and religious purposes at 52.8% (n=203).

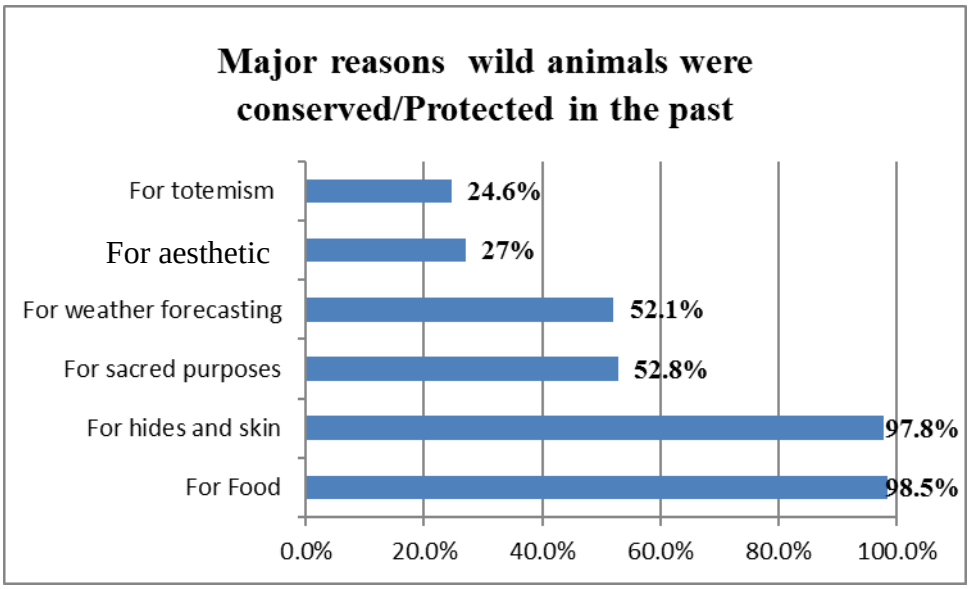


Figure 4.8: Major reasons for wildlife conservation

Source: Field data, 2013

A significant proportion (97.8% n=375) of the household heads' respondents indicated that the Nandi community lived in harmony with wild animals and that wild animals were not killed haphazardly. These respondents indicated that in order to protect animals, each clan had a sacred animal (totem) and the clan protected the animal. The killing of sacred animals was forbidden and any breach of this was dealt with severely. From focus group discussions, it was reported that the offender was either put to death or driven out of his/her clan and his cattle confiscated.

Traditional specialists indicated during the focus group discussions that if for any reason the community members wanted to kill a lion for its skin, the *talai* clan elders would be approached and asked for permission to kill the animal.

The traditional specialists emphasized that this helped in wildlife conservation. Some of the traditional specialist retorted as follows:

"...many of our wild animals have been killed because this generation no longer observes indigenous customs attached to exploitation of natural resources...they (the current generation) are mainly driven by greed...!" (Personal Communication, TRS11)

"*Our wildlife is our cultural heritage, yet through over hunting, timber harvesting, bush fires, use of toxic chemicals...a large number of animals, reptiles, and birds species have been lost"* (Personal Communication, TRS 4)

"Our tradition of totemism is not idol worship...it was intended to moderate and save our wildlife" (Personal Communication, TRS 10)

"...we cannot throw away our totemism just like that because it has been one of the major traditional conservation tools which have helped to conserve many wildlife species" (Personal Communication, FG 1-8)

The traditional specialists indicated that the hyena for instance, was highly protected and feared among the Nandi since it was considered a living mausoleum of the dead. Table 4.9 provides a list of clans in the Nandi community and the animals that were considered totems for each clan.

Table 4.9: Clans and their totems in Nandi community

Clan	Totem
Kipasio	Sun and mole
Kipaa	Snake and Columbus monkey
Tungo	Hyena
Kamwaike	Partridge
Kiptopke	Monkey
Moi	Crested crane and buffalo
Sokom	Hawk
Kipsirgoi	Warthog
Toiyoi	Solider ant and rain
Talai	Lion
Kipkokos	Lizard
Kipkenda	Bee and frog
Kipamwi	Duiker (hunters)
Kipkoitiim	Elephant and chameleon
Chemur	Wild cat

Source: Field data, 2013

Traditional specialists indicated that there were beliefs attached to killing of wild animals in Nandi community. One traditional specialist narrated a story as follows:

"...a woman once killed a frog and later gave birth to a baby with frog like features (short and rough skinned)...when a person killed an animal, he/she had to ask the animal for forgiveness...! This is unlike today where young people just kill wild animals with impunity...!" (Personal Communication, TRS 6)

"Wildlife conservation dates to colonial period when law controlling hunting was first enacted ...colonial law regulated hunting , hunting methods and trade in wildlife with some endangered species being fully protected... unfortunately these relations were not strictly enforced...white settlers hunted game for pleasure and as trophies...this greatly contributed to depletion of wildlife in the county" (Personal Communication, DE 1)

"Poor cultivation methods, deforestation, charcoal burning, overgrazing are the main factors causing severe wildlife habitat degradation" (Personal Communication, DE2

4.3.5 Indigenous knowledge attached to the conservation of water resources among the Nandi

Results in Table 4.10 indicate the Nandi people conserved water for varied reasons. Majority (97.8% n=354) of the respondents indicated that water was conserved for domestic use. About 87.3% (n=316) reported that it was conserved for cultural practices, 74% (n=268) indicated salt licks for animals, while 76% (n=275) reported religious rituals.

Table 4.10: Reasons for conserving water resources in the study area

Reason for conserving water source	Freq	Response (%)
Domestic use	354	97.8
Salt licks for animals	268	74.0
Cultural practices	316	87.3
Religious rituals	275	76.0

Source: Field data 2013

Respondents indicated in various, events and activities that traditionally were carried out in water sources. A large proportion of 87.5% (n=357) were of the opinion that water resources were traditionally used for initiation ceremonies; 84.0% (n=348) indicated that a lot of water sources were used as sacred places while 68.9% (n=281) were of the opinion that significant water sources provided clay that was used in smearing houses and pottery work. Those who were of the opinion that water sources were used in cleansing ceremonies were 78.9% (n=322) as illustrated in Table 4.11.

Table 4.11: Traditional practices associated with water sources

Traditional water use	Frequency	Percentage Response
Initiation ceremonies	357	87.5
Sacred places	348	84.0
Clay for houses &pottery	281	68.9
Cleansing ceremonies	322	78.9

Source: Field data, 2013

4.3.5.1 Regulation of water at watering points through allocation of 'user time'

There were certain regulations that ensured that such watering points were not misused. The elders there regulated the use of this points, different villages were allocated particular days they could use this point, so as to ensure that there was no congestion and to protect the resource from misuse.

4.3.5.2 Paying attention to changing seasons especially during dry seasons

Specialists' responses indicated that indigenous knowledge was key in the use of water resources. The participants indicated that water was used sustainably by paying attention to changing seasons. They indicated that more attention was paid to the use of water during dry seasons since this resource was scarce during such seasons. One of the traditional specialists (TRS 4) indicated during the focus discussions as follows:

"...we could not allow any careless use of water resources especially during dry seasons... this was meant to ensure that water was available for everyone during that

season. There were clear signs of dry seasons like disappearance of crested cranes birds and falling of leaves of some trees..." (Personal Communication, TRS 4)

Plate 4:4 Researcher with women respondents at a traditional spring (*kunguut*)

Source: Author, 2013

4.3.5.3 Labelling rivers as sacred places

The respondents during focus group discussions indicated that rivers were regarded as sacred places, and many religious rituals were held in rivers. The respondents explained that this was due to the belief that ancestral sprits resided in rivers. They also mentioned that cleansing ceremonies and special prayers were also held in rivers. The traditional

specialists explained during the focus group discussions that whenever there was a prolonged drought, there was a ritual that was performed by women asking god for rain. *"Talai clan was questioned on delay of rainfall, as it was believed that the Talai could stop rain. In case of prolonged drought a ritual was performed by women to ask God for rain. Women would gather together, proceed to the river singing songs imploring God to give them rain. They carried with them cooking sticks and pots and at the river women chanted prayers and threw the cooking sticks and pots to the river as a sign of offering to the rain god. Upon returning home it was believed that rain would fall immediately and indeed this happened*" (Personal Communication, FG2).

4.3.5.4 Changing use of water resources

The respondents who were drawn from household heads indicated that there has been tremendous change in the use and application of indigenous knowledge in conservation of water resources among the Nandi. One of the respondents (FG3-5) stated as follows: *"Things have really changed...this generation (young) has thrown away our treasure (indigenous knowledge) that was significant in water conservation. Today water flows wastefully...pipes are burst, a lot of water is wasted in irrigation, in factories...many uses. What pains me is that the use of this water is careless!*" (Personal Communication, FG3-5).

Another elderly respondent retorted:

"...at this rate, I wonder if this (pointing to his grandchild) will ever have sufficient water. They (this generation) should ask us how we used to conserve water resources..." (Personal Communication, FG 3-6)

The traditional specialists indicated during the focus discussions that indigenous knowledge on birds has changed tremendously over time. One of the traditional specialists (TRS 7) indicated as follows:

"...in the past, we knew when we were about to experience drought or when there was an impending danger just by observing the behaviour of different bird species...today trouble strikes and people are not aware...they have neglected traditional knowledge on environmental resources..." (Personal Communication, TRS 7)

4.3.6 Indigenous Knowledge and Land Tenure Systems

One of the elderly household head indicated that:

"The tenure system in Nandi was on a community basis hence each community had its own area of occupation. There were areas that were shared by the entire community and hence a communal grazing land. The entire community could also benefit from the entitlements over those common areas like the salt licks for their animals and water points too." (Personal Communication, TRS 7)

Majority of the respondents (88.82%; n=361) indicated that communal land tenure system was an effective tool in enhancing natural resource conservation in Nandi. Respondents indicated that this is because communal land tenure system had a system of controls and checks that ensured that each member of the community acted responsibly towards the protection of natural resources.

The study sought to find out the reasons for preference of communal tenure over other land ownership systems. Although 72.6% participants indicated that the main reason underpinning communal land ownership was to ensure effective natural resource

conservation, the participants comprising household heads and traditional specialists had varied responses on which resources this ownership system intended to conserve.

A greater proportion of 72.6% (n=289) of respondents were of the opinion that communal land ownership helped in facilitating conservation of land resource, 50.5% (n=201) biodiversity, 25.1% (n=100) wild animals, and 49.7% (n=198) forests. This information is presented in Figure 4.9.

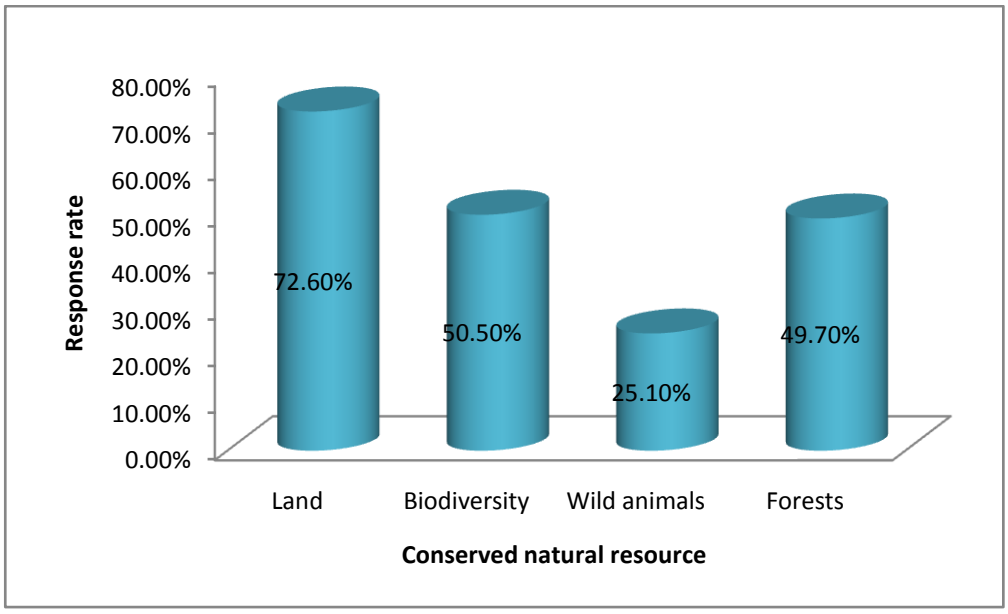


Figure 4.9: Reasons for the predominant communal land ownership system

Source: Field data, 2013

4.3.7 Changes in Land Tenure in Nandi

The study established that there had been remarkable changes in land tenure systems since the colonial period. Majority of the respondents (97% n=377) reported that there had been changes in the recent years in land tenure, land ownership and land use

activities. About (88.95%) reported that changes brought about individualization of land ownership, 73.2% reported sub-division of land, 59.21% indicated that it enhanced inequality, 56.55% reported change in land use, while 43.21% indicated loss of equal access to land. Figure 4.10 illustrates the changes in the various periods.

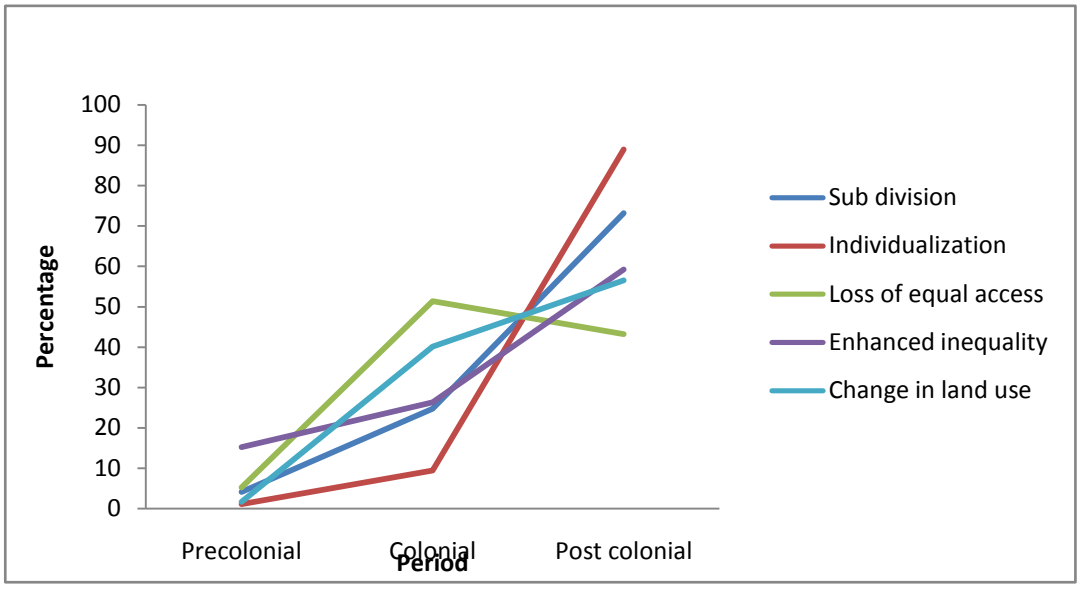


Figure 4:10 Changes in land tenure systems

Source: Field data, 2013

4.4 Environmental Impacts of Changes in Use and Application of Indigenous Knowledge

Analysis of responses given by respondents revealed that gradual changes in use and management of natural resources from pre-colonial period through colonial period to the present date have had profound impacts on natural resources such as land, forests, wildlife and water sources in Nandi County.

4.4.1 Environmental Implications of changing Land Tenure Systems in Nandi

The study sought to find out the implications of the changes in land tenure from communal land tenure among the Nandi to environmental resources. The implications cited by the respondents varied in magnitude. Those who indicated that changes in land uses over time led to land and water pollution were 75.7% (n=308). Those who indicated that the changes had led to forest depletion were 78.6% (n=320), extinction of certain species of flora and fauna were 51.8% (n=211) while those who attributed the drying up of rivers and wetlands to changes in land tenure were 83.5% (n=340). This is illustrated in Figure 4.11.

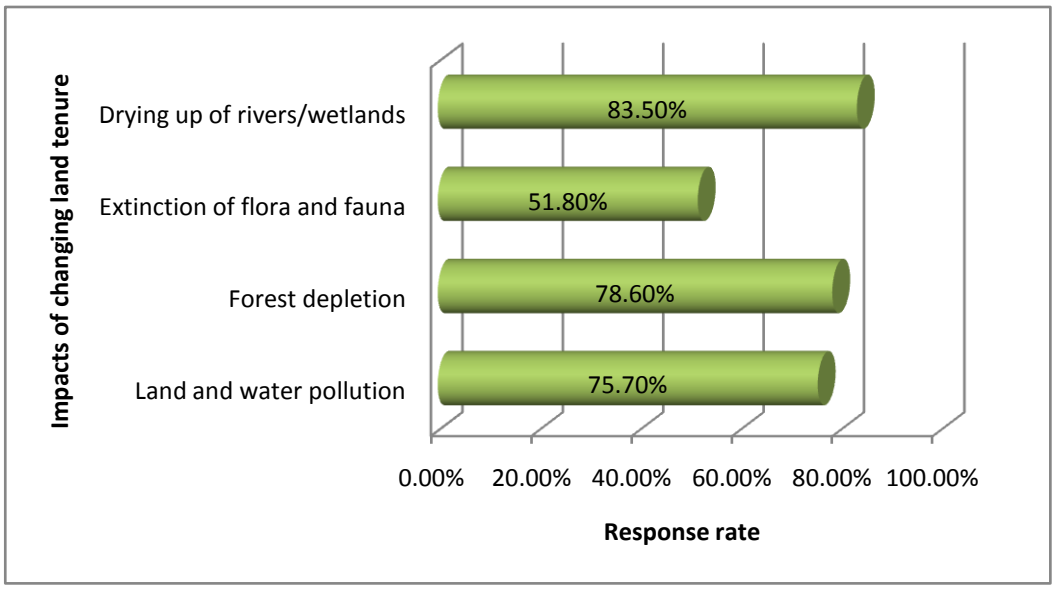


Figure 4.11: Environmental implications of changing land tenure in Nandi

Source: Field data, 2013

4.4.2 Environmental implications on land use

Responses on environmental impacts are due to changes in use and application of indigenous knowledge showed variations in the opinions given as shown in Table 4.12. In relation to land use, results showed the following changes and effects have occurred:

On **land cultivation**: About 79.4% (n= 273) of the respondents indicated loss of soil fertility, 72.4% (n=249) reported that it destroys and inhibits growth of certain plants, while 39.4% (n= 134) indicated soil erosion and 33.8% (n=115) reported compacting of the soil.

On **crop types and systems,** 83.4% (n=287) of the respondents reported increase in pests and crop diseases, 82.6% (n=284) indicated neglect of traditional food crops, 77.9% (n=284) reported change of soil structure and pH, while 77.3% (n=266) mentioned food insecurity. **Harvesting and Storage** of crops: On harvesting of crops 84.3 % reported soil compaction as a result of use of machinery. On storage of crops 82% (n=282) indicated aflatoxins due to poor storage. **Number and type of livestock**: Majority 84.9% (n=292) reported keeping of few high yielding animals, 80.5% (n=277) indicated intensive use of land (zero grazing), 66.9% (n=230) indicated specialization, 64.8% (n=223) reported spread of livestock diseases, while 64% (n= 220) indicated soil erosion as a result of overstocking.

Table 4:12: changes in land use and environmental effects

Land Use: Change	Effects	Frequency	Response(%)
Land cultivation	Loss of fertility	273	79.4
	Destroys and inhabits growth of certain plants	249	72.4
	Soil erosion	134	39.4
	Hard (compacting of the soil)	115	33.8
Crop types and systems	Pest and crop diseases	287	83.4
	Neglect of traditional food crops	284	82.6
	Change in structure and pH	268	77.9
	Food insecurity because of cash crop farming	266	77.3
Harvesting of crops	Compacting of soil	290	84.3
	Aflotoxins due to poor storage	282	82
	Use of pesticides which harmful to human beings	252	73.3
Number and type of livestock	Keeping fewer high yielding animals	292	84.9
	Intensive use of land (zero grazing)	277	80.5
	Specialization	230	66.9
	Spread of livestock diseases	223	64.8
	Soil erosion as a results of overstocking	220	64.0

Source: Field data, 2013

It was also evident in the focus group discussion that in the past the soils in the study area were fertile as alluded to by one member, that:

"In the past we grew our crops without the use of any fertilizers or manure, the soil was very fertile, nowadays if we do not use fertilizers, we get poor harvests" (Personal Communication, FG 1-3)

4.4.2.1 Land use change in post-colonial period

Given that land cover/use changes are dynamic in nature and that they have to be monitored at regular intervals for sound environment management, the researcher narrowed down to post-colonial period and used remote sensing data to get a view of the changes during the years 1985 and 2014(see landset image in Appendix 6). The table below gives a summary of these data.

Table 4.13: Land cover/use change between January 1985 and January 2014

Between January 1985 and January 2014		Magnitude of change	Biggest contributor to the change
Land Cover	Forests	Reduced by 66.3%	Expansion of agricultural land (20.7%)
	Swamp/Marshland	Reduced by 34%	Expansion of agricultural land (43.5%)
Land Use	Tea plantation	Increased by 70.1%	Depletion of forests (6.5%)
	Agricultural farms	Increased by 57.3%	Expanding into swamps/marshlands (20.7%)
	Building and construction	Reduced by 16%	Expansion of agricultural land (61.9%)

Source: Landset data, 2014

4.4.3 Environmental Implications of change in use and application of Indigenous Knowledge on forests in Nandi

In terms of forest management, 100% of the respondents indicated that new species of trees and plants have been introduced. When asked to state their views on the effects of

introduction of new species respondents gave varied answers (Table 4.13). A total of 85.7% (n=294) of the respondents reported that this brought about high demand in forest products, while 83% (n=284) indicated loss of medicinal plants, further 81.6% (n=279) mentioned drying of catchment areas, 81.3% (n=278) reported destruction of catchment areas and 67% (n=229) indicated reduction of rainfall.

When asked about effects of changes in hunting methods, majority 87.5% (n=229) of respondents reported a reduction of animals and birds in the forest, while 85.7 % (n=294) mentioned extinction of some birds and animals. Asked further to state their views on effects of change in methods of firewood collection and charcoal burning, 85.7 % (n=294) indicated that destruction of forests had occurred, 81.3 % (n=279) reported destruction of water catchment areas, while 83.4% (n=286) indicated extinction of some plant and bird species in the forest.

Views of respondents also varied on effects of clearing of forests. About 86 % (n=294) of the respondents reported that destruction of water catchment areas had occurred, 84.8% (n=291) indicated soil erosion, while 81.6 % mentioned a reduction of rainfall, furthermore 79.9% (n=274) indicated reduction/ extinction of some medicinal plants found in the forest, 79% (n=271) reported destruction of wildlife, additionally 76.1% of the respondents indicated destruction of habitat.

Response to effects brought about by settlement in forest reveals that 89.5 % (n=307) indicated deforestation, with 84.5% (n=290) reporting destruction of habitat while 76.1 % (n=261) indicated soil erosion. Table 4.14 gives a summary of the reported changes and its supposed effects on the environment whereas Plate 4.5 illustrates the changing natural forest cover over time in Nandi.

Table 4.14: Changes in forest use and environmental effects

Change: Forests	Effect	Frequency	Response (%)
New species Introduced	High demand for timber	294	85.7
	Loss of medicinal plants	284	83
	Drying up of water catchment	279	81.6
	Destruction of water catchment area	278	81.3
	Reduction of rainfall	229	67
Hunting methods	Reduction of animal and bird	300	87.5
	Extinction of birds and animals	294	85.7
Firewood collection/ charcoal burning	Destruction of forest	294	85.7
	Extinction of some plant species	286	83.4
	Destruction of water catchment area	279	81.3
Clearing of forest	Destruction of water catchment area	294	85.7
	Soil erosion	291	84.8
	Reduced rain	280	81.6
	Reduction/ extinction of some medicinal plants	274	79.9
	Destruction of wildlife	271	79
	Destruction of habitat	261	76.1
	Land slides	247	72
Settlement in forest	Deforestation	307	89.5
	Destruction of habitat	290	84.5
	Soil erosion	261	76.1

Source: Field data, 2013

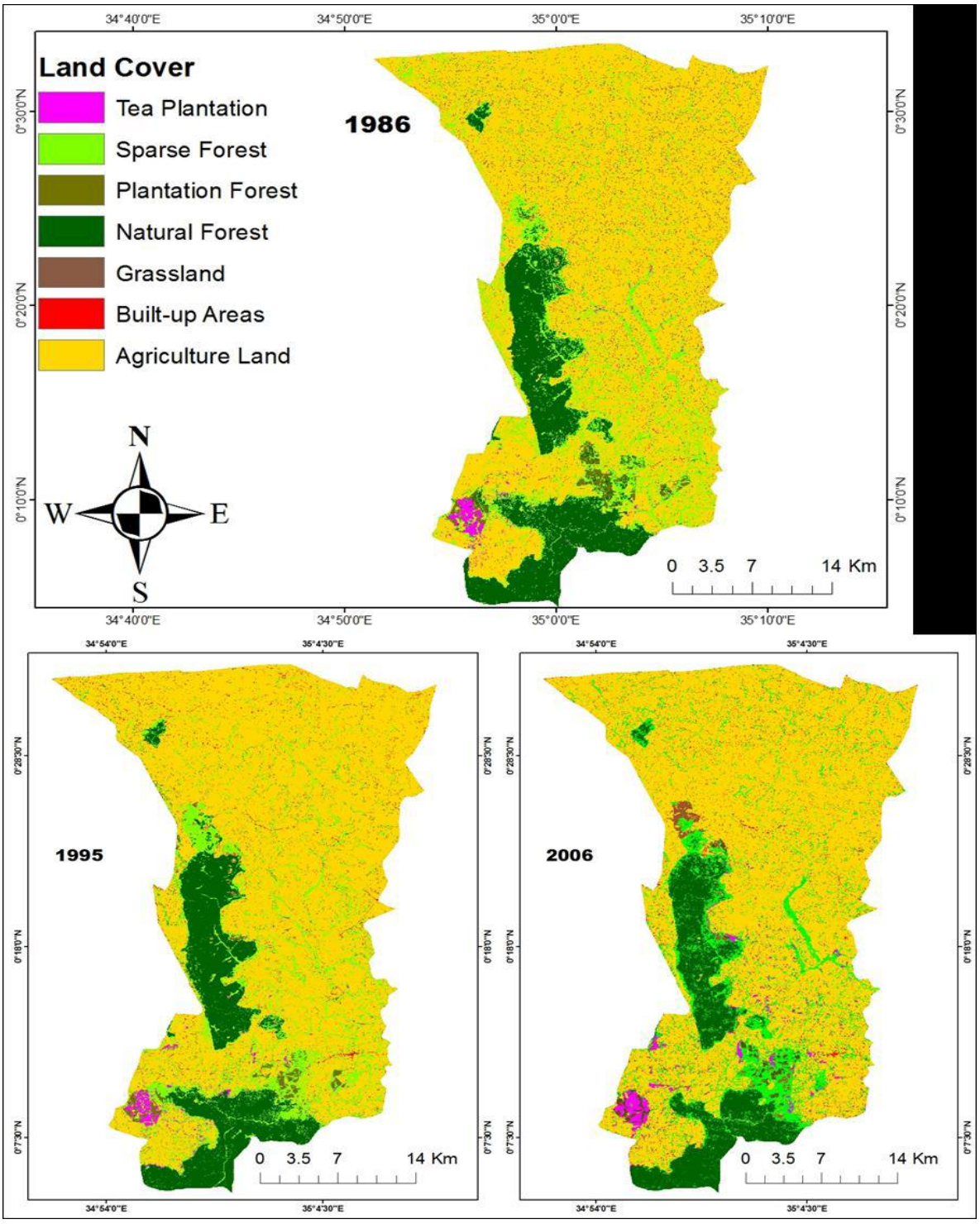


Plate 4.5: Changing natural forest cover in Nandi

Source: Landset Image, 2014

They observed that, conversely, changes in rain patterns in Nandi had also been experienced. The respondents observed that in the past the rain and weather patterns

were very predictable and consistent. This consistent weather flow chart is presented in Table 4.15.

Table 4.15: Previous consistent weather patterns in Nandi region

Local season name	Characteristic of the season	Month of the year
Ngatiato	Spring of plants	January
Kitamo	Dry, planting of millet	February
Iwotkut	Start of long rains	March
Waki	Rainy	April
Ngei	Rainy	May
Robtui	Heavy rain	June
Buret	Misty/cold	July
Epeso	Declining rains, harvesting millet	August
Kipsunde netai	Little rain	September
Kipsunde neboaeng	Little rain	October
Muigul netai	Little rain	November
Mulgul nebo aeng	Little rain	December

Source: Field data, 2013

These respondents further observed that today, these weather patterns have drastically changed and that it is practically impossible to predict weather in the region. One of the traditional specialists (TRS 9) reported as follows:

"…this generation has messed us up….previously, it was possible to predict weather conditions by using traditional knowledge…they brought in this wazungus (whites) way of life in Nandi and now it is difficult to know when to plant or harvest…we should go

back to traditional ways of conserving our environment…" (Personal Communication, TRS 9)

The traditional specialists further observed that the Nandi had weather forecasting specialists who were relied upon to give information about weather patterns and to advice on planting and harvesting seasons. One of the traditional specialists (TRS12) reported as follows:

"The traditional specialist, seer (maotiyot) woke up very early in the morning before dawn at around 5 am, observed the stars in the morning facing east and was able to predict if there was going to be drought or rainfall...as simple as that, and what he says would come to pass...perhaps because we lived in harmony with nature..." (Personal Communication, TRS12)

A traditional specialist (TRS 8) gave insights into how natural resources would be used to predict weather conditions as follows:

The appearance of many butterflies would indicate an impending drought and migration of birds, particularly the appearance of cheptalamik (sparrows) migratory birds indicated the onset of rains. Traditional specialists were able to "predict rain or drought by observing intestines of the animals. Generally, the Nandi lived in harmony with nature and nature provided them with answers to their needs. But today, we cannot use these things (plants and animals) since they have been destroyed..."! (Personal Communication, TRS 8)

The traditional specialists indicated during the focus discussions that indigenous knowledge on birds has changed tremendously over time. One of the traditional specialists (TRS 2) indicated as follows:

"...in the past, we knew when we were about to experience drought or when there was an impending danger just by observing the behavior of different bird species...today trouble strikes and people are not aware...they have neglected traditional knowledge on environmental resources..." (Personal Communication, TRS 2)

4.4.4 Changes in the Use of Water sources and subsequent effects on environment

Broad changing areas identified from the results in relation to water resources conservation were, irrigation, drainage, cultivation and brick making. As a result of such broad changes, most of the respondents feel that the environment has been greatly affected leading to soil infertility, drying up of water resources, pollution of water resources and general change in ecosystem amongst other changes. Table 4.16 illustrates these results as follows:

On the effects of irrigation, 77.9 % (n=268) of the respondents indicated soil infertility, 77.6 % (n=267) reported drying of rivers, additionally, 76.2 % (n=262) indicated soil erosion, while 73.5% (n=253) reported siltation of rivers and destruction of soil structure. On drainage majority 82.5 % (n=285) of respondents reported drying up of rivers, 79.4 % (n=273) reported soil infertility, 78.8% (n=271) indicated destruction of soil structure, while 73.5% (n=253) mentioned soil erosion.

Views of respondents on effects of land cultivation showed that 83.7 (288) reported pollution of water sources, 81.7% (n=281) indicated destruction of water catchment areas, 76.7 (n=264) reported changes in ecosystem, 74.4% (n=256) indicated drying up of streams.

A total of 81.1% (n=279) of the respondents reported destruction of water catchment areas, 80.2% (n=276) indicated pollution of rivers, while 79.9% (n=274) mentioned drying up of streams.

Table 4.16: Changes in water resource use and effects on environment

Change: Water resources	Effects on the environment	Frequency	%
Irrigation	Soil erosion	262	76.2
	Siltation of rivers	253	73.5
	Drying up of water resources	267	77.6
	Soil infertility	268	77.9
	Destruction of soil structure	253	73.5
Drainage	Drying up of water sources	285	82.8
	Soil erosion	253	73.5
	Soil infertility	273	79.4
	Destruction of soil structure	271	78.8
Cultivation	Destruction of water catchment areas	281	81.7
	Pollution of water sources	288	83.7
	Changes in ecosystem	264	76.7
	Drying up streams	256	74.4
Brick Making	Pollution of water sources	276	80.2
	Changes in ecosystem	279	81.1
	Drying up of streams	274	79.9

Source: Field data, 2013

Qualitatively, the respondents in focus group discussion drawn from household heads indicated that there have been tremendous changes in the use and application of indigenous knowledge in conservation of water resources among the Nandi.

Generally, the results showed that there was much less concern about the conservation of water resources as evidenced from the quotation below:

"Young people are now clearing and cultivating our wetlands, something that was not allowed in the past… we only utilized wetlands for grazing animals in times of drought. What pains me is that this generation does what they want in order to make money!" (Personal Communication, FG 2-13)

Water source have notably been polluted by farming activities upstream.

"Clearing of vegetation along river banks has ruined our water sources… runoff rain water from farms are washed down to our rivers and therefore polluting our water sources" (Personal Communication, TRS 9)

The changes have led to loss of precipitation as a result reducing rainfall levels thus a significant reduction in the quantities of water available for the individuals

"A lot of water from rivers is now diverted for irrigation and this has led to some rivers and springs drying up … notably water volumes in rivers have significantly reduced, this has made us walk long distance to fetch water for domestic use and for our livestock…those who can afford sink wells" (Personal Communication, FG 1-8)

4.5 Interrelationship between Nandi Indigenous Natural Resource Management Strategies and Modern Natural Resource Management strategies

The interrelationships between Nandi indigenous natural resource management strategies and modern (western) natural resource management strategies were analyzed thematically in three main themes; similarities, differences and linkages.

A greater proportion of the respondents (97.5%; n=376) indicated that indigenous knowledge in Nandi in natural resource management has for long been used to manage complex natural resource management systems through practices that bear many

similarities to modern natural resource management strategies and that many of these traditional practices on natural resource management are founded on important social mechanisms. One of the elderly household respondents indicated that:

"...I do not understand why this generation does not want to utilize our knowledge (indigenous) in natural resource management...after all, what they now call modern ways of managing natural resources is just traditional knowledge..."

"Indigenous knowledge and modern scientific knowledge need not be thought of as opposites; rather complimentary...it is important that we look for areas of agreement rather than disagreement" (Personal Communication, DA 1-2)

4.5.1 Differences in indigenous knowledge and modern natural resource management practices

Respondents also acknowledged differences between IK in NRM and modern NRM strategies. They indicated that modern NRM strategies are better equipped to detect a causal link between land use change and threats to livelihoods of community members.

One of the traditional specialists (TRS3) recognized the value of local indigenous knowledge in NRM to modern NRM assessments as a source of fine-grained, detailed information about local ecosystem services in areas where little formal knowledge exists. This respondent indicated the sentiments as follows:

"...the way out is to go back to indigenous knowledge in natural resource management. The knowledge that our fore fathers nurtured in natural resource management cannot

be compared to modern natural resource management strategies since it's more comprehensive and detailed..." (Personal Communication, TRS3)

Plate 4.6: Researcher and respondents in a focus group discussion

Source: Author, 2013

However, the respondents, during the focus group discussions, acknowledged bottlenecks in the use and application of indigenous knowledge in natural resource management. They articulated a major shortcoming of indigenous knowledge as its inability to evolve quickly enough to accommodate change in social-ecological systems, and its tendency to lack relevance outside local context.

From the sentiments of the respondents, tensions between IK in NRM and modern NRM strategies are evident. 70% of the officials who were sampled in charge of environmental management in Nandi County concurred with one major component of the tensions that exist between indigenous knowledge and modern natural resource management. They suggested that modern knowledge is essentially scientific because it

is gathered through methods that are empirical, experimental, and systematic, whereas indigenous knowledge in NRM may be seen as narrow and naïve in the way it considers and defines questions. They stressed the importance of wisdom and "showing respect" as distinctive features of traditional ecological knowledge that has long ensured protection and management of natural resources among the Nandi.

They were quick to indicate that most natives in Nandi, particularly the elderly displayed the tendency to reject what they view as western philosophy's obsession with truth, belief, and worldview in natural resource management. They indicated that what mattered most to indigenous Nandi, is how one lives, not what one believes. They also acknowledged that much of the perceived incompatibility between modern NRM strategies and other knowledge systems arose from treating modern NRM strategies or IK as a singular entity when, in fact, both have multiple forms and dimensions.

The respondents indicated the main differences between IK and modern NRM strategies were to include the fact that modern NRM is scientific and diachronic (that is, it tends to collect short-term environmental data over large areas), whereas IK is synchronic (that is, it tends to collect environmental information over long periods of time), modern NRM strategies focus on averages while IK focuses on extremes; modern NRM strategies collect quantitative environmental information while IK collects qualitative environmental information; and modern NRM strategies are objective while IK is subjective.

The respondents agreed that IK and modern NRM strategies are complementary or parallel rather than fundamentally incommensurable. Differences between them, they suggested, can be resolved through collective natural resource management approaches.

Table 4.17 presents the interrelationship between modern NRM strategies and IK as cited by respondents.

Table 4.17: Interrelationships between modern NRM strategies and IK

Theme	Significance	Key Lessons
Similarities and differences between Nandi IK and modern NRM strategies.	An understanding of similarities and differences between IK and modern NRM, and the benefits and challenges of integrating these different knowledge systems, is a prerequisite to knowledge integration.	- IK and modern NRM strategies are complementary or parallel rather than fundamentally incommensurable. - Differences between IK and modern NRM strategies can be resolved through collaborative approaches and by finding common ground. - Some IK practices similar to modern NRM strategies but the IK tend to be based on social mechanisms. - Modern NRM strategies are better equipped to detect causal links and to evolve quickly enough to accommodate new information. - Tensions between IK and modern NRM strategies persist: some IK holders reject modern science.

Source: Field data, 2013

4.5.1.1 Differences in indigenous knowledge and modern natural resource management

All the respondents were asked to indicate whether differences between IK and MNRM practices as regards the three natural resources existed and the extent the use and

applicability of the methods had changed. Chi square was then used in investigating if the change mentioned between the indigenous and modern methods on each category was significantly different. Across board all the P-values generated were less than 0.05 ($P<0.05$). These results implied that the participants felt that the differences between the indigenous and modern methods are significant.

4.5.1.2 Land Use Practices

On crop cultivation, a total of 80.99% (n=277) of the respondents reported that ox ploughs were used in the past, while 83.92% (n=287) reported that currently the ox plough is still in use. 79.82 % (n=273) indicated that rotational cultivation was practiced in the past while 81.58% (n=279) reported that the practice is currently practiced. 79.82% (n=273) indicated that planting was by broadcast method while 76.61% (n=262) is currently practiced. 73.68% (n=223) reported that seed selection was done in the past while 65.20 % (n=252) indicated that seed selection is practiced currently.

On soil fertility, 85% (n=294) of the respondents reported that animal manure was used in the past to improve soil fertility, while 89.77% (n=307) indicated that the use of animal manure is practiced. 69.88% (n=239) mentioned intercropping while 76.02% (n=260) indicated that the same practice is currently in use. 52.05 %(n=178) reported that traditionally fallowing was practiced while 61.99% (n=212) indicated that the same practice is currently used, 74.56% (n=255) reported that shift cultivation was practiced in the past while 74.27% (n=254) indicated that the same practice is still in use.

On soil control, 73.02% (n=249) reported that in the past cover crops were used, none of the respondents were aware of the same practice currently. 72.43% (n=247) indicated

that grass trash was used in the past. 62.76% (n=214) mentioned that in the past ridges were built to control soil erosion, while 76.83% (n=262) reported that the same practice was in use. Majority 85.04 % (n=290) and another 78.30% (n=267) indicated that terraces and contour planting respectively were currently used.

On harvesting and storage, 81.23% (n=277) of the respondents indicated that communal labour was used during harvesting while 85.34% (n=291) indicated that the practice was still in use. 74.49% (n=254) reported that in the past manual labour was employed while 40. 66% (n=135) mentioned that the same practice is still in use. About 34.94% (n=116) reported that currently harvesters are also used in harvesting.

On food preservation, a total of 76.54% (n=261) of respondents mentioned that culturing was used in the past, while 82.99% (n=283) indicated that the same practice is currently used. 69.79% (n=238) mentioned that salting (use of magadi) was used in the past, while 74.49% (254) indicated that same practice is currently in use. 77.42% (n=264) reported that smoking was used in the past, while 76.25% (n=260) indicated that the practice was in use. 73.61 % (n=251) reported that drying in the sun was used in the past, while 72.73% (n=248) indicated that the same method was in use.

On pest and weed control, 84.07% (n=285) of the respondents indicated that ash was used to control pests in the past, while none were aware of the practice then. 58.41% (n=198) reported that insecticides were used then. None of the respondents were aware of use of insecticides in the past. 71.68% (n=243) mentioned the use of traditional herbs in the past while 87.61% (n=297) indicated the current use of traditional herbs. 66.96% (n=227) indicated use of rotational cropping in the past, while 69.35% (n=235) reported that the same practice is currently used. On weed control 60.47% (n=205) reported the

use of cover crops in the past while 67.26% (n=228) indicated that the same practice is currently practiced. 66.37% (n=225) indicated that weeding was used in the past, while 75.22% (n=255) reported the use of cover crops.

On livestock rearing, a total of 77.88% (n=264) of the respondents indicated that in the past livestock rearing was free range, while 79.06% (n=268) reported that the same was practiced. 73.45% reported that in the past saltlicks were used to improve the health of livestock, while 76.70% (n=260) indicated that the same practice was in use. 76.99% (n=261) reported that rotational grazing was done in the past, while 86.14% (n=292) indicated that the same was being practiced.

On disease control, 61.95% (n=210) of the respondents reported that sick animals were quarantined, while 74.93% (n=254) indicated that the same was still done. 72.57% (n=246) reported that rotational grazing was practiced to avoid disease, while 79.06% indicated that it was still done. 82.89% (n=281) indicated that traditional herbs were used to treat live stock, while 76.40% (n=259) noted that modern medicine was in use. 83.48% (n=283) reported that traditional herbalists were specialist in treating livestock, while 89.1% (302) indicated that veterinary officers were in charge of animal health. On administration of regulation on land use, a total of 89.1% (n=302) reported that it was done by elders, while 93.20% (n=315) noted that currently it is done government officers.

Table 4.18 represents the differences between indigenous strategies and modern strategies as indicated by the respondents in the study.

Table 4.18: Differences between indigenous land use strategies and modern strategies

Land use practice	Method	Traditional	Modern	Chi-square
Crop cultivation	Use of Ox plough	277 (81)	287 (84)	0.3147
	Rotation cultivation	252 (73.7)	279 (81.6)	0.0132
	Broadcasting of seed	273 (79.8)	262 (76.6)	0.3082
	Seed selection	223 (73.7)	252 (65.2)	0.0161
Soil fertility	Use of manure	294 (86)	307 (89.8)	0.279
	Inter cropping	239 (69.9)	260 (76.)	0.0707
	Fallowing	178 (52.1)	212 (62)	**0.0086**
	Shift cultivation	255 (74.6)	254 (74.3)	0.9302
Soil erosion control	Ridges	214 (62.8)	290 (85)	**0.000**
	Cover crops	249 (73)	262 (76.8)	0.2528
	Grass trash	247 (72.4)	267 (78.3)	0.0768
Harvesting and storage	Manual	254 (74.5)	135 (40.7)	**0.000**
	Communal labour	277 (81.2)	291 (85.3)	0.1537
	Harvesters	-	116 (34.9)	-
Food preservation	Culturing	261 (76.5)	283 (83)	**0.0371**
	Salting	238 (69.8)	254 (74.5)	0.1734
	Smoking	264 (77.4)	260 (76.3)	0.7179
	Drying	251 (73.6)	248 (72.7)	0.7962
Control of pests,weeds	Use of ash	285 (84.1)	-	-
	Insecticides	198 (58.4)	297 (87.6)	**0.0122**
	Traditional herbs	243 (71.7)	235 (69.3)	0.5049
	Rotation cultivation	227 (67)	-	-
	Weeding	225 (66.4)	255 (75.2)	**0.0122**
Livestock rearing	Cover crops	205 (60.5)	228 (67.3)	0.0681
	Free range	264 (77.9)	268 (79.1)	0.713
Grazing/feeding	Salt licks	249 (73.5)	260 (76.7)	0.3351
	Rotational grazing	261 (77)	292 (86.1)	**0.0026**
Disease control	Quarantine/ curfews	210 (62)	254 (75)	**0.0003**
	Curling	216 (63.7)	254 (75)	**0.00017**
	Rotation grazing	246 (73)	268 (79.1)	0.0516

	Traditional herbs	281 (82.9)	259 (76.4)	**0.0391**
	Traditional specialist	283 (83.5)	-	-
	Vet	-	302 (89.1)	-
	Elders	302 (89.1)	-	-
Administration regulation	Govt land officers	-	315 (93.2)	-

Source: Field data, 2013

Comparative analysis of the past and the modern land use practices showed possible differences between the two time periods. These variables were shown to be independent of each other. On soil fertility, fallowing (p=0.0086) as a practice was shown to be used more currently compared to the past. On soil erosion, ridges (p=0.000) were being used more presently compared to the past. On harvesting using manual methods (p=0.000), the practice was shown to be more rampant compared to what is currently happening. In relation to food preservation, culturing (p=0.00371) is commonly used presently compared to the past. In relation to controlling of weeds and pests, Insecticide use (p=0.012) was shown to be used more presently compared to the past. On animal grazing, rotational grazing (p=0.0026) was shown to be currently commonly used compared to the past. With regards to controlling diseases, quarantine/curfew (p=0.0003) and curling (0.00017) are methods currently used. Use of traditional herbs (0.0391) was shown to be used more in the past compared to the present

4.5.1.3 Water Sources

On water collection, 84.87% (n= 286) of the respondents reported that in the past clay pots were used to collect and store water for domestic use in the past, while 82.25%

(n=278) reported that currently water is stored in tanks. On administration of regulation of water sources 86.39% (n=292) noted that that in the past it was done by elders while 90.83% (n=307) reported that currently it is done by government officers.

Table 4.19: Regulation of water sources among the Nandi

Water resources:	Method	Traditional	Modern	χ
Rivers, streams, wetland and aspects of Water collection/ harvesting	Community regulation	292 (86.39)		0.000
	Govt laws		307 (90.83)	
	Dams	195 (57.69)	286 (84.87)	
	Use of clay pots	286 (84.87)		
	storage tanks		278 (82.25)	

Source: Field data, 2013

The chi-square test results (230.702 df=1 =0.005) between usage of dams in the past and present showed that there were differences between the two periods. The results also showed that usage of dams for collection and harvesting is more rampant presently

4.5.1.4 Forests

On trees and plants, 73.96% (n=250) of the respondents reported that in the past taboo and community laws regulated use of trees and plants, while 93.20% (n=315) noted that government laws are currently used. These results are presented in Table 4.20 below.

Table 4.20: Regulation of forest resources use among the Nandi

Forests	Method	Traditional	Modern	χ
Trees/ plants	Community laws	250 (73.96)	-	
	Govt laws		315 (93.20)	
	Taboos (regulations)	258 (76.33)		

Source: Field data, 2013

On wildlife conservation 89.64% (n=303) reported that traditionally, wildlife resource use was restricted through totem system and community regulations such as taboos, while 74.56% (n=252) indicated that currently government laws are in place to regulate exploitation of wildlife resources. These results are presented in Table 4.21 below.

Table 4.21: Regulation of wildlife resource use among the Nandi

Wildlife	Method	Traditional	Modern	χ
Conservation and policy	Totem system	303 (89.64)		
	Govt laws		291 (86.09)	
	Anti poaching laws		252 (74.56)	

Source: Field data, 2013

4.6 Chapter summary

This chapter has provided a detailed analysis of trends in use of IK among the Nandi people in the pre-colonial period, colonial period and post colonial period. Results reveal that IK was predominately used during the pre-colonial and part of colonial period. Changes in use of IK emerged during the colonial the colonial period,

necessitating readjustment on how people interacted with their environment. Results further reveal that changes had repercussions on natural resource use strategies among the Nandi people. The study also found out that there is a close relationship between Nandi Indigenous knowledge and modern knowledge which can be integrated for sustainable management of natural resource. The next chapter presents a detailed discussion of the study findings.

DISCUSSION

4.7 Introduction

This section provides a review of the results presented in chapter four, in an attempt to provide an understanding of what has been learned on the use of indigenous knowledge among the Nandi people and their implications for natural resource management strategies and sustainable development.

4.7.1 Socio-Demographic factors influencing use of indigenous knowledge

In the present study, the analysis of use and application of indigenous knowledge was based on socio-economic factors such as gender, age, education level, occupation and period of residence. It was imperative to establish gender of respondents to assess the responses presented basing on this attribute given that women interact with the natural resources more than males (Wekunda, 2012). The study established that the use and application of indigenous knowledge in management of natural resources differed between men and women among the Nandi. The women were more knowledgeable in names and uses of plants, processing and preservation of food item than men. On the

other hand, men had more knowledge in land use management and animal husbandry. This specialized knowledge was reflected in the fact that women were consulted in cases of treatment of various ailments, while the men make the choices pertaining to the selection of appropriate fields for specific crops. The disparity in the proportion of male and female respondents can be attributed to the fact that in Nandi community, the male speak on behalf of their families on matters that directly involve their families. Those females who were captured in this study as household heads were either single or widowed. These findings confirm prior research that found that indigenous knowledge systems are by their very nature gendered (Chapin,*et al*., 2009; Altieri, 2004).

Education is an important issue in development of livelihood strategies as it determines which livelihood activities a household is involved in. In the study, 85.2% of the respondents had at least received formal education. Education is an enabling factor that influences households in the study area on how they use and manage resource for their livelihood. Similar arguments were put forward by Mitinje,*et al*., (2007), that education is key to improved opportunities for development and accessibility to information. Moreover other studies have shown that the more educated an individual is, the less the desire to over exploit natural resources. This is because more educated individuals tend to have higher income earnings and are more likely to be buyers than exploiters of natural resources (Shackleton, *et al*., 2002).

Age is an important determinant of the local people's knowledge about a resource and is therefore viewed as one of the main factors that determines variations in the acquisition and utilization of knowledge on natural resource management. Different age groups attach different values to different natural resources and more so reasons to use and apply indigenous knowledge in natural resource management. Due to the nature of the

study, 70.6% of the respondents were age 40 years and above. They were more knowledgeable about indigenous and modern natural resource management strategies and the roles of local communities in conserving particular resources for socio-cultural, economic and ecological reasons. The younger generations who were below 40 years old were more knowledgeable in modern issues of natural resource management. However, their knowledge about indigenous knowledge was limited compared to the older generation. This limited scope of knowledge was attributed to western education values and ethics, influence of Christianity, and exposure to other cultures such as the Luhya who are their immediate neighbours. Similar findings are documented by Ipara (2004); Mackenzie, (2004) and Faleyimu, *et al*., (2011). Similarly, since a respondent's age is more often associated with the length of residence, it is believed that the older generations who have resided in an area for long have a wealth of knowledge and wisdom that is of importance in conservation of natural resources (Faleyimu, *et al*., 2011; Mitinje, *et al*., 2007).

People who live in a certain area for a longer period of time accumulate experience on use and management of natural resources. Thus, more resources are demanded from their environment and more land is required to meet the demands of the growing population. In the present study majority (60.1%) of the respondents had lived in the study area for more than 20 years and 84.6% were residents by birth. It is logical to argue that those who have stayed longer than 20 years have profound knowledge in use and management of natural resource and the changes that have occurred over time. Implicit this observation is the view that these residents are likely to be at the forefront in advocating for the integration of relics of indigenous knowledge in contemporary approaches to natural resource management within Nandi County. Similar observations were reported by Kajembe, *et al*., (2010) and Caoulibaly, *et al*., (2009) which show that

people who have stayed longer in an area are likely to provide relatively reliable historical data.

4.7.2 Trends in the use and Application of Indigenous Knowledge

An analysis of the responses to questionnaire survey given by all the respondents reveal that the Nandi conserved natural resources and most important resources conserved were land, water and forests. Varied reasons for conserving the resources were mentioned by the respondents which included; food, settlement, grazing, and wealth and prestige. Respondents in the focus group discussions indicated that the Nandi community valued natural resources as wealth which was created by God and hence sacred. They indicated that such natural resources were to be conserved and used sustainably for posterity. These observations corroborate with those of Mapara (2009), and Jaryan et al. (2010). The traditional specialists and respondents in FGDs indicated that a variety of traditional management tools were used in natural resource conservation in Nandi. They named them as: cultural practices, traditional ecological knowledge, folk media, taboos and beliefs, and traditional institutions. These findings are in tandem with those of Ipara (2004) who observed the same practices among the Isukha community of western Kenya.

4.7.2.1 Land use and tenure

It emerged from FGDs that the indigenous land tenure among the Nandi was communal. Access to land was based on membership of a land holding community by birth. Right to natural resources such as land, plants, animals and water was often communal. The communal tenure enjoyed strong proprietary and security rights to biotic resources.

Natural resources were held as a common property. This implied common exploitation and management of resources with respect to hunting, collection of firewood, harvesting of fruits, nuts, leaves and even farming or grazing of livestock. It also related to group interest and control of resources; with each group composed of extended family, a lineage or a village defined by common descent or common residence. The control of land was vested in council of elders who hold them in trust for all members of the community. Land was allocated to individual indigenous household for farming where land had no conflicting rights. Land was passed from generation to generation with customary rules of succession. Communal land tenure focused more on ecology and conservation.

Reforms in the customary tenure in Kenya began during British colonial rule. However, respondents reported that gradual changes in rights to communal land resulted to: loss of equal access rights, individualization/ privatization of land, sub division, enhanced inequality in land ownership by all sexes and change in land use activities (Fig.4.10).

Colonial white settlers erroneously perceived any tract of land left fallow as no man's land and annexed it. It is commonly noted that the swynerton plan (Okoth-Ogendo & Oluoch- Kosura, 1995; Okoth –Ogendo, 2007) sought to bring about the intensification of agricultural production in high potential areas through individualization of land rights. This has continued to inform policy on land tenure reform in post colonial Kenya. Based on the foregoing observations, there is empirical evidence suggesting that generally changes in land tenure system occurred during the colonial period and post colonial period (Chege & Ngugi, 2001; Wily & Mbaya 2001).

4.7.2.2 Land use in pre-colonial period

As indicated earlier in chapter three, the Nandi community were originally hunter gatherer community and later took to agriculture. They mainly grew elusine grain and millet, and practiced pastoralism where they kept large herd of cattle, sheep and goats. Information gathered from questionnaire administered to house hold heads, revealed that 70.6 % (272) of the respondents indicated that the Nandi predominantly practiced sedentary cattle herding, hunting and gathering, mixed cropping and agro-forestry. These sentiments were supported by traditional specialists and respondents in focus group discussions. They all alluded that these practices were carried out with the aim of conserving the environment.

I. Hunting and Gathering

Land necessitated hunting and gathering since in it grew forests. Respondents in FGDs reported that hunting practices adopted by the Nandi people had in-built conservation oriented mechanisms that enabled the community to control and regulate the hunting activities of most hunters to that extent that any destructive elements in their hunting techniques and tools were either minimized through enforcing rules and regulations, outright condemned or prohibited. Small animals were hunted for food such as *boinet* (antelope), bushbuck, *toiret* (wild pig), *kipkesito* (Warthog), gazelles and rabbits were hunted for food. Apes were hunted for their skin which was used to make clothing and hats for the elders for example Columbus monkey (*koroiyet*) and bush baby (*Tisyet*) were hunted for their beautiful skins. Apart from skin, monkeys were generally killed for destroying crops (not for food). Hunting was done using various methods most common being traps, clubs, bows and arrows and the dog acted as a hunter's

companion. Forests were zoned and so were hunting grounds thus no other activities were allowed to be carried out. Each clan had their hunting grounds, and hunting was a seasonal activity regulated by elders. This was meant to guard against over hunting.

The hunters were special people in the community who had a wealth of knowledge about hunting and wild animal behaviour. Hunting was done by men; women were not allowed to do so. Rules and regulations such as hunting of adult male animals and restriction of hunting wild animals during breeding contributed to conservation of wildlife. This finding concurs with findings by Kideghesho (2008). Hunting parties had leaders called *Kimelelelit*. Rituals were conducted before hunters went out to hunt. The hunting leader was an experienced and skilled hunter who was well versed with animal movement patterns and was able to track movement of animals and their hideouts. Hunting was well coordinated and rules were observed by all; whoever struck the animal first was considered as the owner (number 1) of the animal and in sharing meat he was given the head, hind leg and skin. The one who startled the animal (number 2) was given the front limb. The owner of the dog took the other hind limb (number 3): The support hunter *Roperindet* (*Kipkwechot*) took the back (*sukulumto*) (number 4): Support hunter *Roperindet* (*Sororochik*) took two ribs and the rest of the hunting party shared the intestines. These finding concur with those of Murombedzi (2003) and Kideghesho (2008) who reported that because of technological limitations, indigenous hunter gatherers did not adversely affect the populations especially of big game in pre-colonial period.

Supplementary to hunting was fruit gathering. Collection of variety of fruits from the forest and bushes was done by women and children. To supplement their diet wild mushrooms, bird eggs, grasshoppers, termites were collected. Fruits and spices were

important for food and herbal medicine. Based on the observation it can be inferred that indigenous knowledge in pre- colonial period was engendered. These findings corroborate those by Dhlamini and Bhekezache (2014) who observe that before colonial intervention rural societies forms of livelihoods were ecologically balanced, resource sustainable and which produced the necessary for food security.

II. Shifting cultivation

Shifting cultivation characterized agricultural practices owing to land tenure practices and use of simple farm tools such as *ikoret* (hoe*) and marut* (panga/slasher*).* The main food crops during this period were finger millet, sorghum, sweet potatoes (borrowed from neighbouring Luhyia community) and red and yellow maize. Cultivation also included a variety of wild vegetables such as *isagiat* (spider weed), *isochot*', *Mityinek* (sunnhemp), *ikopchot* (cowpeas), *Nderemiat* (during famine), *chebololet* (pumpkin) and *Mburochet*. All this was made possible because of their indigenous knowledge. Shifting cultivation among the Nandi was practiced mainly to avoid weeds in previous cultivated land, another reason was to get ash which was only possible in a place where grass had bound up a lot of soil lumps. Each family had a *shamba* next to its home stead, the head of household was charged with responsibility of identifying land for cultivation and organising labour. Clear land was often chosen for cultivation; bushes and grass were slashed and burnt, then dug using simple tools after which it was left for some time to allow the soil to dry before the soil was mixed with the ashes. This practice improved soil fertility and helped eliminate pests and diseases in the soil. The period of cultivation was limited to few years often not more than four years. The shifting of fields was sometimes accompanied by the relocation of villages. Rights of possession or user rights were not upheld after fields were abandoned. Sizes of cultivated land depended

on the family ability to have it cultivated. These observations concur with those documented by Ramish (2005) and Widgren (2010).

111. Cattle keeping

As noted earlier, the Nandi were also pastoralist, they kept large herds of cattle, goats and sheep. Cattle were a source of wealth and were used to pay dowry. Due to socio-cultural attachments of the Nandi people to cattle, it necessitated accumulation of large herds of cattle. To acquire cattle, raiding neighbouring communities was encouraged. Every family had a cattle shed, often close to the home. Grazing lands were communal and all cattle belonging to the village were grazed collectively by young men. Grazing was rotational; elders identified grazing fields which had lash grasses, watering points, and salt licks. Grass lands were regulated by elders; over grazing was not allowed. This practice ensured that the environment was protected and used sustainably. These findings concur with findings documented by Austin (2008).

1V. Agro-forestry

Information gathered from FGDs revealed that agro-forestry was practiced among the Nandi people through selective cutting, intercropping, and protection of woodlands. The Nandi people had cultural beliefs that did not allow indiscriminate cutting of trees. Only dry trees and shrubs were cut for firewood, selected trees were cut for building materials and this was only done with permission from elders. Sacred trees were not touched at all. In case of land needed for cultivation, patches of land without much vegetation were selected leaving areas with trees; this practice allowed intercropping of tree and crops and also conservation of trees. Certain woodlands were protected; these were mainly

those with medicinal plants and trees. Only specialists with medicinal knowledge were allowed to collect products from the woodland, which helped in conservation of trees and biodiversity. Thus, traditional religious beliefs, common property resource tenure and farm forestry contributed to conservation of trees. These observations concur with those documented by Fifanou et al., (2011).

4.7.2.3 Colonial and post colonial period

The coming of white settlers in Kenya coupled with subsequent land tenure systems brought change in land use system among the Nandi people. Notable change was the annexation of Nandi land for white settlers and the creation of African reserves, which meant that the local people had to readjust their land use practices. Consequently, new methods of farming were introduced in Nandi, the white settlers established large scale farms, where they cultivated new crops such as maize, tea, coffee, and tobacco (Okoth-Ogendo & Oluoch-Kosura, 1995; Odhiambo & Nyangito, 2002). They also introduced new breeds of livestock. Among those introduced were breeds of cattle such as Redpoll, Jersey, Friesian, Ayrshire and Sahiwal and exotic breeds of sheep. Initially, the Nandi were not allowed to keep these breeds but with policy changes introduced by the Swynerton plan of 1954, Africans were then allowed (Okoth-Ogendo, 2007). It also emerged that modern tools of farming were introduced during the colonial period, notable were ploughs, mowers, tractors, tillers, and shellers. New technology was also introduced during this period such as the use of chemical fertilizers, pesticides and herbicides. These findings agree with those by Syagga, (2006),Musyoka, (2006) and Thuo, (2010)

Information gathered from questionnaire survey and in depth focus group discussions and observation showed that the main agricultural activities carried out by majority of respondents are crop production, livestock keeping, and agro forestry. Respondents ranked crop production (number 1) as the main land use activity practice in the study area, followed by livestock rearing (number 2), agro-forestry (number 3), forestation (number 4). Further information from FGDs reveal that changes have gradually occurred over different periods, starting from the onset of colonial period through to post independence period with subsequent land policy changes and environmental changes causing people to adjust their land use activities accordingly. The study established that much as mixed cropping is practiced among the Nandi, currently the predominant crop has been tea. Respondents indicated that tea as a crop consumes a sufficiently large amount of nutrients from the soil and hence compromises the growth of other crops.

4.7.2.4 Forest Conservation

Cultural practices evolved and utilized by the Nandi people to conserve forests were a product of the complex interrelationships and associations between human, the environment and diverse natural resources. Consequently, there were varied underlying reasons for forest conservation practices and included protection of water catchment, medicinal purposes, rainfall attraction, religious purposes, and shelter for wildlife, cultural ceremonies and fuel wood collection. This finding is in tandem with findings of studies by Faleyimu, *et al*., (2011) who observed that forests are important to African people in terms of both tangible and non-tangible products derived from. Other benefits include provision of valuable source of income, household tools and some therapeutic medicine (Faleyimu, *et al*., 2011; Faleyimu & Akinyemi, 2010).

Household head respondents during the focus discussions indicated that the Nandi people categorized forests according to their uses and that there were certain forests that only special people in the community were allowed access. Hence, the forests were categorized as religious and ritual sites. These sites could only be accessed by religious specialists when performing certain rituals. Children and activities such as grazing of animals were not allowed in these sites and there were rules and regulations to ensure that this was followed. Within the forests there were shrines where rituals were conducted in honour of ancestral spirits and Supreme Being *Cheptalel/ Chepongolo/ Assiis.* Each clan had a sacred place (appendix 5). Rituals were conducted annually after a harvest at the *Kapkoros* (shrine), where an altar (*mabwaita*) was build with poles and vines from *koros* sacred tree, upon which a white he-goat was sacrificed. After every sacrifice, elders sprinkled a concoction of milk and animal urine, *suguteke*, on the people to bless and heal them from various illnesses.

The forest was valuable to the Nandi as an economic resource. They cultivated millet, sorghum, and elusine on plots cleared from the forest. Through shifting cultivation, the Nandi changed over time sections of the forest into open glade which they periodically grazed livestock and clumps of bush (*sondiit*), which formed breeding grounds for wild animals, such as rabbits, squirrels, and antelope. This makes such sites important for hunting. These areas were also important as sources of wood fuel, food and herbs. In dense portions of the forest (*timmto*), the Nandi hunted big game and honey (*kuumyat*). Honey was used for medicinal value and used to make a sweet drink called *kipketinik.* The dense forest also served as a food reserve during periods of drought. Its resources supplemented the meagre food supplies available to the people during such hard times. The Nandi people hunted wild animals and collected honey, gathered plants and fruits,

dug root tubers such as yams and arrow roots in such places. They also turned to the forest for pasture when the grasslands dried out.

Traditional specialists reported that the Nandi feared the dead and would simply abandon corpses in forest and vacate their homesteads for fear of being haunted by spirits. Since dead bodies were not buried in graves in the past, Nandi believed that the wild animals and in particular hyenas would eat the bodies. This was the key reason why some forests were designated as grave yards and no one was allowed to destroy them.

The traditional specialists further reported that the Nandi believed that there were some species of both plants and animals within sacred forests which were strictly protected. These respondents indicated that in some cases, touching such species was forbidden; examples of such trees include the olive tree (*Emdiit*) and Fig tree (*simatweet).* These practices encouraged conservation and management of forests and other natural resources in Nandi. Similar findings have been documented by Mitinje, *et al*., (2007) and (Faleyimu, *et al*., 2011), who observed that the landscape , hills, pools, imposing trees, forests, caves and streams are of great significance, they tend to represent hidden forces on which man draws his survival and therefore associated with invisible entities and thus become objects of veneration.

Respondents' opinions during the focus group discussions indicated that generally, the Nandi community conserved trees and plants that had medicinal value, sacred value and those that protected valuable resources like water catchment areas (Table 4.7). Further information gathered from focus group discussions revealed that that these trees were still valued by the Nandi community although the significance attached to them had

declined. Consequently, the respondents attributed this to modern approaches to natural resource conservation which disregard traditional knowledge of resource protection. These observations corroborate with those of Adams (2003) and Tanyanyiwa and Chiwanha (2011).

Results from FGDs and key informants reveal that the Nandi experienced gradual changes in management of forest from the colonial period which were carried on to the post colonial period. Colonial officials and settlers understood forests as places separate from societies, places to be conserved for recreational and monetary purpose. According to them, forests had to be beaconed, protected and subjected to specifically controlled use. A key informant noted that colonial policies were coercive and therefore resisted by the Nandi people. Respondents also observed that forests were cleared by the white settler for settlement and agricultural activities. Subsequently, more forest land was annexed after independence to create more settlements and farmlands for the increasing Kenyan population. These observations concur with those of Thuo (2010) and Mutta, *et al*., (2009).

4.7.2.5 Totems

The Nandi people conserved wildlife for varied reasons which include provision of: totems, food, aesthetic values, clothing and religious purposes. A significant proportion (375; 97.8%) of the household heads' respondents indicated that the Nandi community lived in harmony with wild animals and that wild animals were not killed haphazardly. These respondents indicated that in order to protect animals, each clan had a sacred animal (totem) and the clan protected the animal. The killing of sacred animals was forbidden and any breach of this was dealt with severely. They reported in focus

discussions that the offender was either put to death or driven out of his/her clan and his cattle confiscated. Traditional specialists indicated during the focus discussions that if for any reason the community members wanted to kill a lion for its skin, the *talai* clan elders would be approached and asked for permission to kill the animal. The culture of totemism was therefore used by the Nandi people to conserve wildlife. Today, totemism is still practiced but regulations are not strictly observed as in the past. These findings corroborate with those documented by Darr, *et al*., (2009) and Kideghesho (2008).

4.7.2.6 Water resource

The participants in the study identified swamps, rivers and streams within the Nandi community as the main water sources. As regards conservation of water resources in the indigenous Nandi community, an overwhelming majority (97.8%) indicated that they conserved water sources for domestic purposes (water for drinking, cleaning, watering livestock, ceremonies, medicine and rituals). Specific water points (*ngeny*) were conserved to provide salt licks for the community's livestock. Since the Nandi community were cattle keepers salt licks (*ngeny*) were extremely important for them.

There were certain regulations that ensured that such watering points were not misused; the elders there regulated the use of these points. Different villages were allocated particular days when they could use this point to ensure that there was no congestion and misuse of the resource. The Nandi people also liked decorating themselves, their houses and making clay pots for cooking, storing water, brewing beer and storing grains. In this respect, there were special rivers that were protected for provision of colourful clay (*ngariet*), used by young initiates to decorate themselves during their period of seclusion. The women also got the clay for decorating their houses from these

rivers. Based on these uses, the community developed and maintained strategies and techniques to utilize manage and conserve water and watersheds. This finding agrees with that of Cheserek's (2005) in a study carried out among the Marakwet people of Kenya.

A significant proportion of the household respondents (84%; n=348) indicated that as a result of the profound sacred status that the many rivers, pools and water sources held among the Nandi community, there existed a range of taboos surrounding their access and utilization. It emerged focus group discussions that such taboos include; children, lactating mothers and donkeys not allowed to come to water points; not washing in or near the river or stream; cutting of trees not allowed. These taboos assisted the community to protect and manage their water sources. The respondents further indicated that pools, rivers and expanses of water were held with a mixture of awe, fear and reverence and that great care was taken to avoid disturbing or angering the water spirits. This, in the opinion of respondents significantly assisted in the protection of water resources. The Nandi practiced water rituals were they called upon the rain-god to give them rain in times of drought or when the onset of rains delayed. This ritual was performed by women, who offered sacrifices in the form of their cooking pots, cooking sticks and flour. These findings are in tandem with studies done by Cheserek, (2005) and Chemhuru and Masaka, (2010).

4.8 Environmental implications of changes in use of indigenous knowledge

An analysis of responses given by respondents revealed that gradual changes in use and application of indigenous knowledge in management of natural resources over time

have had profound impacts on natural resources such as land, forests, and wildlife and water sources in Nandi County.

4.8.1 Land use

Results in Figure 4.10 indicate that changes in land tenure from communal to private ownership in Nandi have had profound impact on the natural resources. Consequently, it has led to drying up of water resources (river, streams and wetlands), forest depletion, and land and water pollution. This situation has been accelerated due to the disregard to indigenous knowledge that guarded against inappropriate land tenure systems that would degrade the natural environment. For this reason, the majority of those interviewed posited that the Nandi indigenous knowledge had checks and balances that guarded against misuse of natural resources. Hence, they were of the opinion that aspects of Nandi indigenous knowledge should be integrated with modern knowledge for sustainable management of natural resources. These findings concur with those of Chege and Ngugi (2001), Wily and Mabaya (2001), Chapin, *et al*. (2009) and Coulibably, *et al*. (2009).

Similarly, land use systems have gone through tremendous changes with resultant effects on the environment. As indicated in Table 4.12, it is evident that with individualization of land ownership, more land was put into agricultural production with introduction of new technology. Most of those interviewed concurred that the introduction of new methods of land cultivation led to more intensification of land hence resulting in loss of soil fertility, destruction and loss of biodiversity, soil compaction due to use of heavy machinery and soil erosion. These findings are in tandem with those of Ogoth- Ogendo (2007) and Githu, *et al*. (2009).

Information gathered from questionnaires administered to household heads and key informants reveal that new types of crops and farming methods have gradually been introduced, respondents reported that cash crops and in particular tea was now the major crop cultivated in the study area. Majority of the respondents agreed that the introduction of new crops and systems of farming had led to increase in pests and crop diseases which were not common in the past. Further, they noted that concentration on cash crop farming had led to neglect of traditional food crops and hence food insecurity. It was also revealed in focus group discussions that demand for more land for agricultural production had led to encroachment on forest land and wetlands. These results corroborate with those by Odote (2010) and Mitinje, *et al*. (2007).

Respondents indicated that change in methods of harvesting crops (the use of machinery) had led to soil compacting and that changes in methods of storage had resulted in use of pesticides which they said was harmful to their health. They also noted that food poisoning due to poor storage facilities has been experienced in the study area. Results from respondents further revealed that the type and number of livestock kept had also changed resulting into introduction of high yielding animals, and that there was intensive use of land as result of introduction of zero grazing methods. It was also noted that there has been rise in animal diseases which were mainly attributed to introduction of exotic breeds which were introduced during the colonial period by the white settlers. Results further reveal that during the colonial period due to changes in land tenure there was overstocking as a result of the colonial government annexing land from the Africans and pushing them to reserves which led to overcrowding and hence soil erosion and land degradation. As noted earlier in chapter three, the Nandi were pastoralist who valued keeping large herds of cattle as a source of wealth and social prestige, this new land arrangement therefore had great repercussions on the land

carrying capacity. This concurs with findings by Okoth – Ogendo (2007) and Odote (2010).

Respondents observed that modern methods of farming such as ploughing, mowing, use of chemicals, and machinery which were introduced during the colonial period resulted in more land being put under crop production. Besides, respondents indicated that the replacement of traditional farming tools with modern farm tools such as tractors, combine harvesters, tillers, brought more land under cultivation at the expense of protection of natural environmental resources. These findings concurs with findings of a study carried out in Nigeria by Eneji, *et al*. (2009) where he acknowledged that changes in land use policy in Nigeria have taken control of land and other natural resource management from the hands of the local authorities, thus giving the state control and authority of caring, protecting and managing resources located within such lands hence resulting in changes in the traditional methods of management to modern management systems.

4.8.2 Forest use

Results in Table 4.7 indicated that notable changes in forest cover and use have taken place in the study area, among the changes indicated include introduction of new species of trees, clearing of forests, settlement, firewood and charcoal burning and hunting. Consequently, it was revealed that these changes had brought about negative impacts such as: high demand for timber; reduction of animals, birds and extinction of some species; soil erosion and landslides loss of medicinal plants as a result of destruction of the natural forests; destruction and drying up of water catchment areas; and reduction of rainfall.

It emerged from focus group discussions that the rapid urbanization and population growth in Kapsabet and Nandi hills urban centres, have become the major driving force for the high demand of timber for construction and charcoal for urban poor households. Consequently, this has led to illegal logging and charcoal burning. Key informants from the department of forest revealed that Biodiversity loss can occur during selective logging as well, as individual species may be intolerant to loss of a particular tree type or to the presence of logging operations. The Nandi relied on herbal medicine during the pre colonial and colonial period for treatment of various ailments. Respondents in focus group discussions eluded that as a result of introduction of exotic trees some of the medicinal plants that were found in indigenous forests had disappeared. Some of the plants mentioned include nettle plant *siwoot, cheptenteret,* and *cheroriet* (melothia sp.).

It was revealed during focus group discussions that exotic tree such as Cyprus, pines and Eucalyptus which supplies timber for local markets had been introduced to the forest areas. A key informant from department of environment reported that the Eucalyptus tree species have higher net evaporation rates than indigenous tree species and extract more ground water, hence cause water loss. These finding concur with those documented by Le Maitre, *et al*. (2002), and Pejchar and Mooney (2009).

A key informant averred that clearing of forests had led to evapotranspiration resulting in less rainfall and drier conditions over broad areas surrounding forest land. The respondents further alluded that due to changes in forest cover water levels in rivers have reduced and that some rivers, swamps, and springs have dried up in the study area.

It was further revealed that clearing of forests for settlement and agricultural activities had lead to destruction of wild animals and bird habitats. From the FGDs it was noted

that elephants, rhinos, buffalos and tigers once lived in forests in the study area. Birds noted to be extinct or have become rear in the area include; the hornbill, partride, crested crane, owl, parakeet, and stork. A key informant from Department of forest averred that forests contain particularly rich soil that has received organic material over extended periods of time. When a forest is destroyed, the soil is exposed to the sun, which causes it to lose nutrients. During heavy rains, the dry soil is washed away due to lack of root structures in the ground. Once topsoil is lost in an area, it can be very difficult to re-establish forest or use the land for other productive purposes. That Loss of forests had resulted in increased flooding and erosion of sediment into rivers, disrupting river ecosystems and landslides. They further alluded that government laws on protection of forests were weak and hence the locals had taken advantage to encroach natural forests. Similar observations are documented by Stevenson (2005) and Tanyanyiwa and Chikwanha (2011).

Plate 4.5 indicates that Nandi forest zone has undergone a series of conversions from natural forest to sparse forest and later to agricultural farm lands. Respondents indicated that Agricultural activities in Nandi had continually posed a major threat to the existence of the natural forests. The elderly household respondents indicated that this was majorly attributed to the fact that indigenous knowledge on the use of forest resources had been neglected.

4.8.3 Weather prediction

The traditional specialists reported that plants, insects and birds were used to predict weather. They indicated that the flowering of particular plants (*tembeiywet*) and *chepnyatia*t would indicate the onset of rains. The respondents indicated that such plants

were protected from misuse due to this important function. They also reported that the appearance of many termites would indicate the onset of the rainy season. All respondents were of the opinion that it was not possible currently to predict weather conditions using natural indicator due the changes that have occurred in the ecosystem. Similar observations have been documented about the Shona of Zimbabwe (Tasara & Maposa, 2012). Further these findings corroborate those by Shoko (2012)) who pointed out that knowledge of birds by rural communities serves an important purpose of enhancing benefits from birds on environmental awareness issues

4.8.4 Water use

Broad changing areas identified from the results in relation to water resources conservation were, irrigation, drainage, cultivation and brick making. As a result of such broad changes, most of the respondents feel that the environment has been greatly affected leading to soil infertility, drying up of water resources, pollution of water resources and general change in ecosystem amongst other changes.

A key informant from department of agriculture reported that the wetlands are characterized by fertile soils, which are suitable for agriculture. Crops such as yams, sugarcane, maize and sweet potatoes do well in wetlands. Thus, results in over cultivation, due to desire for high yields, hence high rate of depletion. Consequently respondents in FGDs observed that since drainage of wetlands in Nandi is mainly digging channels, it has lowered the water table in the area and has led to the drying up of wells and streams and has resulted in serious water shortage for people and animals. It was also noted that animals in the wetland have been displaced by destruction of the wetlands, among the animals mentioned are hippopotamus, snakes and *Sitatunga.*

Information gathered from questionnaire survey, FGDs and key informants revealed that brick making is a serious threat to wetlands in the study area. It was observed that brick making leave behind big holes, which greatly disrupt the wetland ecosystem and hinders movement and communication. Respondents further noted that brick making involved clearing of vegetation around the wetland, so as to provide fuel with which to make them. It was observed that such fires destroy soil fertility of the wetland. Information gathered through Observation show that brick making is a common practice in Kingwal and Kimondi wetlands. Documented examples of similar cases include; effects of farming practices on wetlands in Kisii in Kenya (Mironga, 2005); impacts of dam construction on the floodplain of Congone and Benue Rivers in Cameroon (Schoite, *et al*., 2000).

Further, 67.6% (n=344) of respondents observed that current neglect in the application of indigenous knowledge in natural resource management had contributed to shrinking and drying up of many water resources and wetlands in Nandi. Such water resources that had shrunk include King'wal wetland and Kimondi River. Traditional specialists observed during the focus group discussions that in the past, wetlands were protected and only used as grazing lands during periods of drought but that this had changed.

These respondents also reported that clay from rivers that was used to decorate the houses is no longer available to the community, since it is now in private land. The traditional specialists further revealed that many springs (*kunguut*) in Nandi had disappeared as a result of clearing of forests and cultivation activities which had been done in total disregard of indigenous knowledge. They observed that, conversely, changes in rain patterns in Nandi had also been experienced. The respondents observed that in the past the rain and weather patterns were very predictable and consistent.

4.9. Interrelations between Indigenous Knowledge and Modern Natural Resource Management Strategies

Information gathered from questionnaires administered to household heads coupled with key informant interviews and FGDs reveal that indigenous knowledge in natural resource management has for long been used by the Nandi people to manage complex natural resource management systems through practices that bear many similarities and differences to modern natural resource management strategies and that many of these traditional practices on natural resource management are founded on important social mechanisms.

4.9.1 Similarities

A study by Buthelezi and Albert (2010) found that there are many links between indigenous knowledge and modern knowledge in terms of land evaluation ranging from determination of land use to management issues which are critical components of sustainable agriculture.

These respondents specifically indicated that indigenous knowledge on natural resource management converges on modern natural resource management disciplines like community ecology, emphasizing connectedness and relatedness between human and non-human components of ecological systems, and as the basis for indigenous concepts of nature, religion, and ethics, and that IK is inherently interdisciplinary. Similar observations have been made by Pieroti and Wildcat (2000) and Berkes and Berkes (2009).

As indicated in Table 4.18 some indigenous methods of crop cultivation such as the use of manure, intercropping, soil erosion control and food preservation are still practiced today and have a close relationship with modern methods of crop production. Focused group discussions confirm the results of the questionnaire survey, although it emerged that the traditional methods were very simple and crude as compared with the modern methods. It was also revealed by a key informant from the Ministry of agriculture that modern methods of agricultural production borrow a lot from indigenous knowledge. Other scholars (Salick, *et al*., 1997; Amman, 2007) observed that indigenous knowledge provides scientific insight into crop domestication, breeding, crop rotation and management.

The Nandi people had well developed processing techniques such as soaking, germination and fermentation, which were used to preserve food. These methods have been found to reduce significantly the levels of phytates and tannins by exogenous and endogenous enzymes formed during processing (Nuha, *et al.* 2010). A number of studies confirmed the importance of fermentation as a simple technique for improving both the nutritional and functional properties of traditional staple food grains and animal products (Belton & Taylor, 2004; Motarjemi, 2002). This confirms that indigenous knowledge of the Nandi people is similar with modern scientific knowledge. Indigenous fermented milk products have been evaluated by a number of Sudanese scholars. The processing of roob and mish, using spices like black cumin, fenugreek, garlic and other known spices; the spices were proved to have significant effect as preservative (El-Zubeir *et al*., 2005).

4.9.2 Differences

Respondents in FGDs and key informants concurred that indigenous knowledge has some differences with modern knowledge. They reported that indigenous knowledge is an integral part of culture and often tends to have a large social context. They mentioned that some traditional knowledge may include elements, such as the religious dimensions which do not make sense to science. For example, some non-living parts of the environment (including rivers and mountains), as well as all the living beings have spirit. Science has no tools to study the spiritual dimensions of the environment.

All the respondents were asked to indicate whether differences between IK and MNRM practices as regards the three natural resources existed and the extent the use and applicability of the methods had changed. Chi square was then used in investigating if the change mentioned between the indigenous and modern methods on each category was significantly different. Across board (Table 4:18) all the P-values generated were less than 0.05 ($P<0.05$). These results implied that the participants felt that the differences between the indigenous and modern methods are significant. In relation to land use significant differences were found in crop cultivation: use of ox plough $p=0.314$; broadcasting of seeds $p= 0.3082$; intercropping $p=0.007$; shifting cultivation $p=0.9302$; cover crops $p=0.2528$; grass trash $p=0.0768$; communal labour $p=0.1537$; control of pests $p= 0.5049$: livestock rearing: free range $p=0.7130$; saltlicks $p=0.3351$. These differences can be attributed to the fact that modern scientific methods of agricultural production are technology intensive, while indigenous methods were simple and based on trial and error. Moller et al., (1962) argued that traditional knowledge and western science are two parallel modes of acquiring knowledge.

Results further reveal that traces of most practices in the past are still practiced currently by the Nandi people. In relation to land use, agriculture was the main activity carried out by the Nandi community; these activities were informed by Indigenous knowledge. In the past, the Nandi cultivated crops such as sorghum, millet, maize, sweet potatoes and a variety of vegetables. Cultivation of crops was mainly for subsistence. Land that was clear was selected for cultivation this ensured that that forest and natural ecosystem was less interfered with. The methods used in crop cultivation include the use of ox plough, rotation cultivation, broadcasting of seeds and seed selection.

Some authors acknowledge differences between IK and science. In her case study of Mongolian pastoralists, Fernandez-Gimenez (2000) distinguishes pastoralists' perceptions from science, noting that science is better equipped to detect a causal link between land use change and threats to pastoralists' livelihoods. Fabricius *et al*. (2006) recognize the value of local knowledge to science assessments, as a source of fine-grained, detailed information about local ecosystem services in areas where little formal knowledge exists. They also articulate several shortcomings of local knowledge, such as its inability to evolve quickly enough to accommodate change in social-ecological systems, and its tendency to lack relevance outside local context. FGDs, revealed differences between IK and modern methods of crop production: the Nandi planted crops by broadcasting seeds while modern methods of planting involve, planting in rows using machinery. Differences were also noted in intercropping; in the past, sorghum and millet was the main crops planted, currently there many varies of crops that have been developed through modern science. Field observation revealed that maize and beans are the main crops most farmers intercrop, although intercropping lowers crop yields hence the practice is on the decline. In the past, the Nandi people used ash and herbal plants to control pest and crop diseases, this practice has been over

taken by modern technological methods which involve the use of chemical pesticides. Labour in the past was communal; it was a social event that brought together members of the community to help one another, currently farm labour is highly commercial and has its social meaning.

Notable difference were also observed in the management of livestock, in the past the Nandi had natural watering points with salt licks, currently due to land tenure changes and conversion of wetlands for crop production, such resources are extinct, farmers rely on modern processed salts to feed their livestock. An additionally communal free range cattle keeping is no longer possible and nonexistent in Nandi County. Although no significant differences were found between modern and indigenous methods of livestock disease control, it emerged from FGDs that, in the past treatment of animal disease was done by traditional specialist with vast knowledge in management of animal diseases, currently the practice has been over taken by use of modern treatment administered by trained veterinary doctors. Based on these observations, it can be argued that advances in modern scientific methods of management of natural resource have significantly contributed to the sideling and in some cases complete neglect of indigenous knowledge which may be attributed to an upsurge of current resistant crop diseases and general environmental degradation experienced in Nandi County.

Results in Table 4.18 reveal that there was no significant difference in indigenous methods and modern methods of crop production in relation to crop rotation (P=0.0132), seed selection (P=0.0161), fallowing (p=0.0086), ridges (0.0000), weeding (P=0.122), rotation grazing (0.0026) of live stock, quarantine of animals (0.0003), curling (0.0003) and use of traditional herbs (0.0391). FDGs and key informant information reveal that the Nandi practiced a type of crop rotation where by millet and

sorghum and sweet potatoes were cultivated on a rotational basis. Sorghum and millet would be planted on the same piece of land for about two years after which it would be replaced by planting sweet potatoes for one or two years, then left fallow for animals to graze on. Fallowing involved cultivating a piece of land for only three to four years after which it was abandoned for awhile and later re-cultivated. The respondents indicated that this method discouraged the growth of weeds, allowed the soil to regain its fertility and prevented emergence and spread crop of diseases. They also reported that on hilly or sloppy areas cultivation was only done for one year. The reason given was that soils in these eras were prone to erosion and that over cultivating these areas could lead to soil degradation. Further investigation revealed that to prevent soil erosion, ridges were constructed on hilly and sloppy areas. Construction of ridges was done by young men who used branches of trees or piles of stones or dug trenches around and the cultivated field to prevent runoff water during rainy season. Weeding of crops was done manually by plucking (*keputpek*) undesired plants growing amongst cultivated crops. Special farm tools such as *ikoret* (a simple farm implement made of wood), that did not degrade the environment were used. Seed selection was a technology that has been practice by the Nandi since time immemorial, best seeds from the previous harvest were selected by seed specialists, after which they were preserved by drying by the fire place (*tabut*) in readiness for use in the next planting season. These findings concur with other scholars Widgren (2010) and Ofor (2011).

It was revealed during focus group discussion that culturing was away of preserving milk, it was a long process which needed a lot of patience and this was mainly done by women. First, the guard was prepared by applying crushed charcoal from special plants called *itet* such as *tendwet (prunus africanium),* and wattle tree. Secondly, milk was stored in a guard for about three to four days for the fermentation process to kickoff

after which water from the milk was extracted. The water could be used to feed children during periods of famine. The next step was to add fresh milk into fermenting milk and left for another two days and same process repeated for about a week. The fermented milk could then be stored for about one year.

Other methods of food preservation among the Nandi people included fermentation, salting, smoking and sun drying. Fermentation of millet and sorghum was also done for brewing beer and for porridge which was used by adults and children. Special porridge was prepared for lactating mothers and initiates after circumcision. This process is a practice that is still practiced among the Nandi especially the older generation and has a lot of similarities with the modern methods of culturing milk.

Salting and smoking were used to preserve meat. Meat from slain animals sheep, goats, cows, and wild game was first cut in long pieces, salted, and dried for about a week to give a product called "*teliyat*". Another method was to hang the long strips of meat across poles above the fire place to dry. This process ensured that the meat did not rot and could be stored for several months. Salting and smoking also improved the quality of the meat. Currently this is not a common practice in the study area, but it can be equated with the modern method of preserving food by salting and drying. Sun drying-dehydration- was a common method for drying grains among the Nandi community. After the harvest cereals such as maize, millet and sorghum were dried in the sun for several days depending on the weather conditions prevailing at the time of harvest. When the cereals were dry there were stored in well ventilated granaries or stored in traditional underground store or pits (can be of different shape and size) to increase their shelf life. Another method was drying cereals by the fire place; selected seeds were suspended on a pole above the fireplace. This process was mainly done for seeds

selected for the next planting season. The smoke helped preserve the seed and prevent seed from pest attacks.

4.9.3 Water

Respondents' responses to relationship between traditional methods of water resources management that are still practiced in the modern times revealed significant differences. In terms of water collection methods, the use of clay pots to collect and store water a practice of the past is no longer used today. It was revealed that majority (see Table 4.19) 82.25%) of respondents store their water in plastic or metal tanks. It emerged from focus group discussions that most households collected their water using plastic containers and stored water in plastic tank or metallic tanks or concrete water tanks, which could hold large volumes of water. It was also revealed that clay pots were used only for storing drinking water. Because clay pots filter and cool water they were considered more hygienic than plastic tanks.

Concerning regulations on use of water resources, remarkable differences between traditional and modern methods were observed. In the past, community regulations were enforced by elders, while in the modern times regulations are government laws enforced by government officers.

Construction of dams is an old age technology among communities that practice pastoralism. Chi square test in Table 4.19 indicates a strong relationship (0.0000 df=2) between modern and traditional practice of harvesting water using dams ($P \leq 0.05$). Focus group discussion revealed that dams were mainly constructed along river banks. Water from the main river was diverted and small dams' built by piling stones to

prevent water from flowing back to the river were constructed. These dams were mainly built for watering their livestock. Similar dams were also created in springs by removing mud around a spring were clean water could collect. These were for women to collect water for domestic use. Springs were highly protected; animals and small children were not allowed in those areas. This was aimed at avoiding contamination of water and also to avoid degradation of water catchment areas. These results concur with those by Cheserek (2005).

4.9.4 Forests and Wildlife Conservation

Responses to questionnaire survey showed no interrelationship between traditional and modern methods of forest and wildlife conservation. In the past, community laws regulated use and extraction of forest products; currently government laws regulate the use of forest products. From focused group discussion it was reported that the Nandi had systems of checks and balances on how forest resources were used. There were taboos that were passed down from generation to generation that forbade indiscriminate cutting of trees. Notably some trees like *kagarweet* (erthrina toonentosa) and s*imatwet (*fig tree) were held sacred hence nobody was supposed to even touch them. This practice which was held by the Nandi helped conserve certain species of trees. As noted earlier in this chapter, forests were classified those with some demarcated for performance of rituals, here no tree or plant would be removed, this ensured the preservation of biodiversity. Women were only allowed to collect dry trees from forest areas that grazing of livestock was allowed. To access building materials, permission had to be sought from elders, who identified which type of trees could be cut for building materials.

As indicated earlier, wildlife was important for the Nandi community. Totem system ensured that wild animals were protected; this system contrast with modern methods of wildlife conservation, which is predominantly done through government laws that protect certain endangered species and anti poaching laws. Focus group discussion revealed that each clan (Table 4.9) associated itself with a certain animal; it was the duty and responsibility of each clan members to protect their animal. This system helped conservation of wildlife. A key informant from the forest department noted that the government law and regulations have not done much to protect wildlife since the local be people are not involved and do not feel a sense of responsibility towards the wildlife.

A traditional specialist observed that *"this generation has no respect for wildlife, you see people killing innocent animals for the merely eating their crops"*.

Another one added "*in the past when a wild animal visited your shamba you did not chase or kill it, what we did was to allow it to eat to its fill and let it go".*

There are many studies in Africa which suggest that incorporating cultural norms and taboos into conservation programs may provide incentives to communities to conserve natural resources. For instance, in Madagascar, Lingardet, *et al*. (2003), Schachenmann (2006), Tengo, *et al*. (2007), Jones, *et al.* (2008) and Rabearivony, *et al*. (2008) reported the relevance of taboos and cultural laws in the continued existence of forest biodiversity. Also in Ghana, studies have shown how clans protect their natural resources through the use of taboos (Abayie- Boaten, 1998; Saj, *et al*., 2006; Sarfo-Mensah & Oduro, 2007; Kobina & Kofi, 2009; Nganje, 2009). Similar cases were also recorded in Nigeria (Bassey & Kanung, 1996b; Anoliefo, *et al.,* 2003; Obasohan, 2008;

Akindele, 2010). East Africa also has a good record of effectiveness of taboo and social norms in wild life conservation (Kweka, 2004; Kideghesho, 2008; Kassilly & Tsingalia, 2009). There are also records of efficacious use of traditional norms and taboos in wildlife conservation in other parts of the World (Berkes, *et al*., 2000; Colding & Folke, 2001; Moller, *et al.,* 2004). These were based on the fact that these practices control human behaviours (Saj, *et al.*, 2006; Kobina & Kofi, 2009).

4.10 Chapter summary

This chapter has provided a detailed discussion of the study findings and understanding of indigenous knowledge of the Nandi people from the pre-colonial, colonial and post colonial period. The chapter has also brought about the similarities and difference between IK and modern knowledge in the management of natural resources.

The next chapter presents a detailed summary of the research, conclusions and recommendations.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary and conclusions of the findings of this study. The chapter also presents the recommendations derived from the findings of this study as well as recommendations for further research.

5.2 Summary

This study aimed at investigating trends in the use and application of indigenous knowledge and its implications to natural resource management in Nandi community of Nandi County. The study adopted a case study design approach. The target population comprised of households of Nandi community members, personnel of Ministry of Agriculture, Livestock and Fisheries, Ministry of Environment, Water, and Natural Resources and the National Museums in Nandi County.

This study employed three main sampling techniques in order to arrive at the sample. Purposive sampling was used to select key respondents for the interviews. The researcher, through key informants identified traditional specialists with knowledge in traditional medicine, rain prediction and religious leaders (those who performed various rituals in the community). Snow ball sampling technique was then employed in selecting other traditional specialists. The study sampled a total of thirteen (13) traditional specialists. Systematic sampling technique was used to select households where the respondents to the questionnaire survey were drawn from. The research with

the help of research assistants and the village elders drew a list of all households in the study area (sampling frame), from the list every eighth house household was selected and the head of each household selected as a respondent. In total, 385 respondents were selected using this method. To get a sample for each location, proportionate sampling was then used. A sample of 118 respondents was drawn from Nandi Hills, 188 respondents from Kapsabet and 79 respondents from Ndalat. A list of all locations in the divisions was made and simple random sampling technique was used to select one location in each division where respondents for the study were drawn from.

A list of all households was compiled and numbered; this constituted the sampling frame for the study. Data was collected by use of key informant interview schedules, focus group discussion guides, direct observation, photography and questionnaire. Findings were analyzed thematically. A chi square test was computed to establish the relationship between respondents' demographic characteristics (gender, educational level, occupation, age) and their level of indigenous knowledge in natural resource management. Findings were presented in form of tables, graphs and charts.

The study established a significant change in the use and application of IK in natural resource management. Modern natural resource management approaches in natural resource management had taken precedence over traditional ecological knowledge. As a result of this trend, Nandi County had experienced significant negative environmental implications that ranged from shrinking of water bodies and vegetation cover as well as extinction of key endemic species particularly in Nandi forest. The study established that IK and modern NRM strategies are complementary or parallel rather than fundamentally incommensurable. The study recommended that the relevant authorities charged with the responsibility of natural resource management should encourage

community-based natural resources management study alternatives as to the most exploited species of flora and fauna to reduce the selection pressure on a small number of species currently under heavy exploitation in Nandi and, incorporate rural participatory natural resource management in their environmental management plans. This will enhance the integration of traditional ecological knowledge in scientific natural resource management paradigms.

5.3 Conclusions

The management of natural resource to meet people's requirements has been practised for many generations. The direct dependence on natural resources by rural communities created a direct and clear relationship between nature and the people within their localities. Such relationships made communities understand characteristics and interactions among the living and non-living, hence the creation of indigenous knowledge. Based on the research objectives the study makes the following conclusions:

Use and application of indigenous knowledge (IK) in Nandi has changed significantly during the three phases of pre-colonial, colonial and post-colonial periods. The changes have been significant in the use and application of indigenous knowledge in the conservation of water resources, land use and land tenure and use and protection of forests and wild animals. Land tenure among the Nandi people in the pre-colonial period was communal, based on clan ownership. This type of tenure ensured equal access of land resources to all members of the community. Change in land tenure began with the establishment of colonial rule in Kenya in1895, which saw the introduction of private own and government ownership of land. Prior to colonisation, the Nandi

management of natural resources was by use traditional tool such as cultural practices, traditional ecological knowledge, folk media, taboos and beliefs. Establishment of colonial rule in Kenya led to the introduction of modern scientific knowledge in natural resource management, which has gradually replaced indigenous approaches in management of NRM in Nandi.

Significant environmental impacts have been observable in Nandi majorly due to the neglect of use and application of indigenous knowledge in natural resource conservation strategies and management. Significant effects have been observed in form of extinction of specific species of plants and animals, destruction of water catchment areas, reduced rainfall, shrinking of rivers and drying up of wetlands as well as reduction in vegetation cover, forest depletion and encroachment, soil erosion, and landslides.

The study established that IK and modern NRM strategies are complementary or parallel rather than fundamentally incommensurable. Differences between them can be resolved through collective natural resource management approaches. The main differences between IK and modern NRM strategies are that; modern NRM is scientific and diachronic, that is, it tends to collect short-term environmental data over large areas, whereas IK is synchronic, that is, it tends to collect environmental information over long periods of time; modern NRM strategies focus on averages while IK focuses on extremes; modern NRM strategies collect quantitative environmental information while IK collects qualitative environmental information; and modern NRM strategies are objective while IK is subjective.

5.4 Recommendations

In order to conserve indigenous knowledge of the Nandi people there is need to create awareness among the local people on the need to preserve it for future generations. With the advent of modernization and globalization, IK has been rendered almost irrelevant with new knowledge taking precedence. Awareness creation can be achieved through promotion of cultural events within the community to show case cultural aspects of the community, such as rites of passage, folk media, rituals, proverbs, taboos and songs with the aim of imparting knowledge. An annual cultural event could be organized at the county level through the ministry of culture, were people from different parts of the county are encouraged to participate.

There is need for documentation of Nandi people indigenous knowledge in natural resource management so that it can be easily retrieved and analyzed. Written, audio and video recording of the community's knowledge on the utilization of natural resources in the community's own language should be done. After recording IK, the study recommends a creation of a community knowledge center where all information about the Nandi culture and in particular natural resources management is stored and can be made available for those who wish to use the knowledge. Some of indigenous knowledge could be patent by the community.

Traditional specialist / leaders are the formal custodians of indigenous knowledge of the Nandi community which are historically entrusted to them. The existence of traditional leadership in the development process of IK is therefore significant. An agreed mechanism involving traditional leaders on IK activities should be established to ensure that researchers gain access to IK and local community on a sound and sustainable basis.

Additionally, conventional indicators and methods for assessment and monitoring environmental degradation should be reconciled with those used by local communities. This should involve establishing an inventory of plant, trees, birds and animal species that occur in local landscapes. Local communities should be trained in terms of collecting sample specimens to be kept in a community herbarium. With such an inventory and specimens in place, it would be possible for taxonomists to conduct proper classifications, thereby, providing important baseline information for monitoring the status of plant species in the local landscapes. The plant samples could be used to create local herbaria to support the training of local community members as well as schools, in order to promote the spirit of environmental conservation.

Findings of the study have shown that IK enhances the conservation, management and use of natural resources such as land, water, forests, wildlife, and plants. Therefore, there is need to integrate relevant existing IK systems with sustainable natural resource management strategies. There should be efforts at establishing formal mechanisms into the education system, by training teachers to embed IK innovation in their school activities. Such programmes should organize workshops to train primary, secondary and tertiary level teachers and also to encourage students search for and document innovations from the community. Traditional leaders could be involved in the development and facilitation of such programmes.

There is need to create real and meaningful partnerships among local communities and other key stakeholders. Such arrangements should be based on dialogue, consultation, participatory decision-making, and principle of benefit sharing. True partnership arrangements require that all partners are treated equally. Likewise, such institutional arrangements require that formal relationships between those involved are well built and

a framework for sharing responsibilities in conservation is well structured. The expectations and commitments of all partners should be agreed on beforehand, and benefits and losses shared equally. Such partnerships should also aim at integrating local communities and relics of indigenous natural resource management.

5.5 Further Research

Further research may be conducted focusing on traditional institutions of natural resource management and what can be borrowed by the current structures to ensure that laws and policies on natural resource management are accepted and executed at all levels of governance. Additionally research should be done on how to integrate best practices from IK into mainstream natural management strategies to ensure sustainability.

REFERENCES

Abayie-Boaten, A. (1998). Traditional conservation practices: Ghana's example. In: DS Amlalo, LD Atsiatorme, C Fiati (Eds.*). Biodiversity Conservation: Traditional Knowledge and Modern Concepts.* Paper presented at the Third UNESCOMAB Regional Seminar on Biosphere Reserves for Biodiversity Conservation and Sustainable Development in Francophone Africa (BRAAF). *Research Review*, 14(1) pp. 42-51.

Adams, W. (2003). Nature and the Colonial Mind In Adams W. and Mulligan, M. (eds.) *Decolonizing Nature: Strategies for Conservation in a Post-colonial Era*. London: Earthscan. Pp 16-50.

Adams, W. M & Hutton, J. (2010). People, Parks and Poverty: Political Ecology and Biodiversity Conservation. In: Maffi, L., and E. Woodley (Ed.), *Biocultural diversity conservation: A global sourcebook*. London: Earthscan. Pp147-183.

Aikenhead, G. S., & Ogawa. M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education 2,* 539-620.

Ajibade, L.T., & Shokemi, O.O. (2003). Indigenous approaches to weather forecasting in Asa LGA. Kwara State, Nigeria. *Indilinga Afr J Indigenous Knowl Syst*, 2, 37-44

Akindele, S.O. (2010). *Forest Restoration through Traditional Institutions in Nigeria:Challenges and Prospects*.
http://www.cfc2010.org/papers/session13/Akindele- 13. (Retrieved August 27, 2011).

Alreck, P.L, & Settle, R.B. (2004). *The survey research handbook* (3rd ed.). Boston: McGraw Hill/Irwin

Altieri, M.A. (2000). *Agroecology: Principles and strategies for designing sustainable farming systems*. University, of California, Berkley.

www.cnr.berkeley.edu/~agroeco3/principles_and_strategies.html. (Retrieved, 1 september, 2012)

Altieri, M.A. (2004). Linking ecologists and traditional farmers in the search for sustainable agriculture. *Frontiers in Ecology and Environment 2* (1), 35-42

Ammann, K. (2007). Reconciling Traditional Knowledge with Modern Agriculture: A Guide for Building Bridges. In A Krattiger, RT Mahoney, L Nelsen, et al. (eds). *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices* MIHR: Oxford and PIPRA: Davis.

Anaya, J. (1996). Indigenous people in international law. Oxford: Oxford University press.

Anoliefo, G.O., Isikhuemhen, O.S. & Ochije, N.R. (2003). Environmental implications of the erosion of cultural taboo practices in Awka-South Local Government Area of Anambra State, Nigeria: 1. Forests,trees, and water resource preservation. *Journal of Agricultural and Environmental Ethics,* 16, 281-296,

Argumedo, A., & Yun, L., (2010). *The Ayullu System of the Otato Park, Cusco, Peru.* United Nations University Institute of Advanced Studies. IPSI.

Armitage, D. R. & Johnson, D. (2006). Can resilience be reconciled with globalization and the increasingly complex conditions of resource degradation in Asian coastal regions? *Ecology and Society 11*(1), 2. .

Austin, G.(2008). Resources, Techniques and Strategies South of Sahara: Revising the tractors Endowment perspective on African Economic Development, 1500-2000; *Economic History Review, 61* (13)

Bassett, T. J., & Crummey, D. 2003. Contested images, contested realities: Environment and society in African savannas. In African savannas: Global narratives and local knowledge of environmental change, ed. T. J. Bassett and D. Crummey. Oxford: Oxford University Press

Bassey, A.E., & Kanung, R. (1996b). The history and cultural background of Busipeople. In: E Obot, J Barker (Eds.): *Essential Partnership- the Forest and*

the People. Paper presented at the Workshop on Rain Forest of South -Eastern Nigeria and South Western Cameroon, Nigeria

Baxter, P, & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. The qualitative Report, *13*(4)Banjo, A.D., Otufale, G.A., Abatan, O.L., & Banjo, E.A. (2006). Taboo as a means of plant and animal conservation in South-Western Nigeria: A case study of Ogbe River and its Basin. *World Applied Sc,* 1, 39-43.

Behera, D.K., & Nath, N. (2005). Resource conservation and utilization through knowledge in a tribal community of Orissa, India. Indillinga; *African Journal of Indigenous Knowledge; A Cross- pollination and Critique, 4* (1), 210-227

Belton, P. S. & Taylor, J. R. N. (2004). Sorghum and millets: protein sources for Africa. *Trends in Food Science & Technology* 15, 94-98.

Berkes, F., Reid, W. V., Wilbanks, T. J., & Capistrano, D. (2006). Bridging scales and knowledge systems. In W. V. Reid, F. Berkes, T. J. Wilbanks, and D. Capistrano, (ed.), Bridging *scales and knowledge systems: concepts and applications in ecosystem assessment* (pp. 315-331). Washington, D.C: Island Press

Berkes, F., & M. K. Berkes. 2009. Ecological complexity, fuzzy logic, and holism in indigenous knowledge. *Futures* 41(1):6-12.

Berkes, F., Colding, J., & Folke, C. (2000). "Rediscovery of Traditional Ecological Knowledge as Adaptive Management". Ecological Applications 10 (5): 1251–1262.

Bohensky, E. L., & Y. Maru. (2011). Indigenous knowledge, science, and resilience: what have we learned from a decade of international literature on "integration"? *Ecology and Society 16*(4), 6

Brosius, J. P. (2006). What counts as local knowledge in global environmental assessments andconventions? In W. V. Reid, F. Berkes, T. J. Wilbanks, and D. Capistrano, (ed.). *Bridging scales and knowledge systems: concepts and applications in ecosystem assessment* (pp. 129-144). Washington, D: Island Press,

Buthelezi, N., Jeffrey, H., & Albert,M. (2010). The use of scientific and indigenous knowledge inagricultural land evaluation and soil fertility in two villages in Kwazulu-Natal, South Africa. 19th World Congress of Soil Science, Soil Solutions for A changing World. Brisbane, Australia

Catton, W. R. (1987). The Worlds most Polymorhic Species. *Bioscience 37*(6), 413-419

Change Mitigation and Adaptation Strategies in the African Sahel. *Programme, Mitig Adapt Strat Glob Change. 12*,787-797

Chapin F.S., Kofinas G.P., & Folke C., (2009). *Principles of ecosystem stewardship: resilience based management in a changing world.* Springer, New York, U.S.A. pp 29-53.

Charnley, S. Fischer, P. A. & Jones, T. E. (2007). Integrating traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest. *Forest ecology and management* 246, 14 – 28.

Chege, W. & Paul, E. N. Ngugi (2001) *The Effects of Existing Land Tenure Systems on Land Use in Kenya Today* International Conference on Spatial Information for Sustainable Development Nairobi, Kenya. (1): 17-29

Chemhuru & Masaka, D. (2010). Taboos as sources of Shona people's environmental ethics. *Journal of Sustainable Development in Africa, 12*(7), 121-133

Cheserek, G. (2005). *Indigenous Knowledge in Water and Watershed Management: 'Marakwet'Conservation Strategies and Techniques*. Summer School. Topics of integrated Water Shed, Water Management- proceedings. FWU, (3): 25-33

Chigwenya A., & Mantsa, D. (2007). The history of natural resource management in Zimbabwe: A chronicle of how sustainable resource management an elusive concept. *Journal of Sustainable Development in Africa, 9*(2): 102-115.

Christian, C.G. (2005). Ethics and Politics in qualitative research. In N.K. Denzin, and Y.S. Linciln,(eds.). *The sage handbook of Qualitative Research* (3rd ed.). London: Sage Publication

Colding, J. & Folke, C. (2001). Social taboos: "Invisible" systems of local resource management and biological conservation. *Ecol Appl,* 11, 584-600.

Coulibaly-Lingani, P., Tigabu, M., Slvadogo, P., Oden, P. & Ouadba, J. (2009). Determinants of access to forest products in Southern Burkina Faso. *Forest Policy and Economics, 11*, 516-524

Cresswell, J. (2009). *Research design: Qualitative and Quantitative and Mixed methods Approaches.* London. Sage Publications.

Darr, B. Pretzsch, J. & Dresden, T. (2009). Traditional forest perception and its relevance for forest conservation among the Tiriki in Kenya. Traditional forest-related and sustainable management in Africa. *IUFRO world service 23,*113 – 130

Das Gupta, D. (2011). Indigenous Knowledge. *Antrocom Online Journal of Anthropology 7*(1), 57 – 64.

Davies, J., R. Hill, F. J. Walsh, M. Sandford, D. Smyth, & M. C. Holmes. 2013. Innovation in management plans for community conserved areas: experiences from Australian indigenous protected areas. *Ecology and Society 18* (2): 14.

Davis, A., & Ruddle, K. (2010). Constructing confidence: rational scepticism and systematic enquiry in local ecological knowledge research. *Ecological Applications 20*(3), 880-894

Davis, M. (2006). Bridging the gap or crossing a bridge? Indigenous knowledge and the language of law and policy. Pages 145-163 in W. V. Reid, F. Berkes, T. J. Wilbanks, and D. Capistrano, editors. *Bridging scales and knowledge systems: concepts and applications in ecosystem assessment.* Washington, D.C: Island Press

De Vaus, D.A (2002). *Survey in social research* (5th ed.). London: Routledge publishers.

Dhlamini, N., & Bhekezathe, N., (2014). Globalization and Ndebele indigenous knowledge systems in agriculture: Challenges and opportunities. *Journal of Pan- African Studies, 6*(10)

Diana, A. (2007). Indigenous knowledge in agriculture, A case study of the challenges in sharing knowledge of past generations in a globalized context in Uganda.

World Library and Information Congress : 73rd IFLA General conference and council 19-23 August 2007.

Du Toit, C. (2005). Indilinga; The environmental integrity of African indigenous knowledge: probing the roots of African rationality. *African Journal of Indigenous Knowledge; A cross pollination critique, 4* (1)

Duncan, O. D. (1964). From Social System to Ecosystem. *Sociological Inquiry, 31*, 40-149

Edeji, O. T. (2004). Indigenous knowledge systems: Its role in household foods security. Paper presented at a conference on *Embracing Information Communication Technology in the Development of Indigenous Knowledge Systems* in Swaziland. Esibayeni Lodge, Matsapha.

Eneji, C. V. O., Gubo, Q., Okpiliya, F. I., Aniah, E. J., Eni, D. D.,& Afanghideh, D. (2009). Problems of Public Participation on Biodiversity Conservation: the Nigerian Scenario. *Journal of Impact Assessment and Project Appraisal, Manchester UK, 27*(4), 301-307

Eneji CVO ,Ntamu GU, Ben CB, Bassey TE, Williams JJ (2012). Ethical Basis of African traditional religion and socio-cultural practice in Cross River State, Nigeria. *Journal of research in peace, gender and development*, *2*(2):034-042. Garret L (2007). Attitudes and values of sacred groves, Southwestern

Edwards, S. E., & Heinrich, M. (2006). Redressing cultural erosion and ecological decline in a far North Queensland aboriginal community (Australia): The Aurukun ethnobiology database project. *Environment Development and Sustainability* 8,569-583. Njuguna, H .K., & Baya, M. M. (2012). Land reforms in Kenya: An institution of surveyors of Kenya (ISK) iniative, Nairobi, Kenya

Elkins C. (2005). *Imperial reckoning: The untold story of Britain Gulag in Kenya*. London: Pimlico.

El-Zubeir, I. E. M. Abdalla, W. M. & El Owni, O. A. O. (2005). Chemical composition of fermented milk (roob and mish) in Sudan. *Food Control* 16, (7), 633–637. Eneji, C. V. O., Ntamu, G. U., Ajor, J. O., Ben, C. B., Bassey, J. E. & Williams, J. J. (2012). Ethical basis of African traditional religion and sociocultural

practices in natural resources conservation and management in cross river state, Nigeria. *Journal of Research in Peace, Gender and Development*, 2(2), 34-43.

Fabricius, C., R. Scholes, & G. Cundill. (2006). Mobilizing knowledge for integrated ecosystem assessments. In W. V. Reid, F. Berkes, T. J. Wilbanks, and D. Capistrano, (eds.), *Bridging scales and knowledge systems: concepts and applications in ecosystem assessment* (pp. 165-182). Washington, D.C: Island Press

Faleyimu, O.I., Ijeomah, H.M., & Oso, A.O. (2011). Medicinal Utilization of roots of forest plants in Lare local government area of Kaduna State, Nigeria. *Journal of Agriculture and Social Research (JASR)11*, 2.

Faleyimu,O.I & Akinyemi, O. (2010). Herbal approaches to the treatment erectle dysfunction in Kiduna State , Nigeria. *Egyptian Journal of Biology*. 12: 103-107

Fernandez-Gimenez, M. E. (2000). The role of Mongolian nomadic pastoralists' ecological knowledge in rangeland management. *Ecological Applications 10*, 1318–1326.

Fifaanou, V. G., Ousmane, C., Gauthier, B., & Brice, S. (2011). Traditional Agro forestry Systems and Biodiversity Conservation in Benin West Africa. *Academic Journal. 82* (1), 1

Finneti, C. (2011). Traditional knowledge and the patent system: Two worlds apart. *World Patent Information*, 33(1), 58-66.

Fitzgerald, A.L. & Stronza, L.A. (2009). Applied Biodiversity Science: Bridging Ecology, Culture and Governance for Effective Conservation. *Interciencia* 34 (8), 563-570

Folke, C., T. Hahn, P. Olsson and J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environmental Research* 30: 441-473.

Freedman, D. (2008). Types of scientific enquiry: the role of qualitative reasoning. In M Box-Steffensmeier, H.E. Brady and D. Collier (eds), *The oxford handbook of political methodology.* Oxford*:* Oxford University press.

Gagnon, C. A., & Berteaux, D. (2009). Integrating traditional ecological knowledge and ecological science: a question of scale. *Ecology and Society 14*(2), 19

Giddens, A. (1984). The Constitution of Society*:* Outline of the Theory of Structuration. Berkeley and Los Angeles: University of California Press.

Githui, F. W.; Mutua, F.; Bauwens, W. (2009). Estimating the impacts of land cover change on runoff using the soil and water assessment tool (SWAT): Case study of Nzoia catchment . Kenya Hydrological Science Journal 54(5) pp 899-02

Government of Kenya. (2002). *Water Act- 2002.* Nairobi: Government Printers

Government of Kenya (2004). *State of Environment Report Kenya.* Kenya: National Environment Management Authority. Nairobi: Government printers

Government of Kenya. (2005). *Forest Act.* Nairobi: Government Printers

Government of Kenya. 2006. Forest Act. Nairobi: Government Printers

Government of Kenya. (2007). Sessional paper, No.1 of 2007 on forest policy. Ministry of Environment and Natural Resources: Nairobi: Government Printers

Government of Kenya, (2008). Nandi Distict Development Plan 2008-2012. Nairobi, Kenya: Government Printers

Government of Kenya (2009). Population and Housing Census.CBS and Ministry of Finance and Planning. Nairobi: Government Printers

Gottlieb, R. & Joshi, A. (2010). *Food justice*. Massachusetts. Cambridge: MIT Press.

Greenbaum, T (2000). *Moderating Focus Groups.* Thousand Oaks, California: Sage publications, Inc.

Hemsted, C.S. (1923). The tribal organization of of the Nandi. Journal of East Africa and Uganda Nat. Hist. Soc., No. 18, pp3-15SHens, L. (2006). Indigenous knowledge and biodiversity conservation and management in Ghana. *Journal of Human Ecology* 20 (1), 21- 30.

Hollis, A.C. (1909). *The Nandi, their Language and Folke-lore*. Oxford, pp. 1-151, ethnography pp152-312, language.

Houde, N. (2007). The six faces of traditional ecological knowledge: challenges and opportunities for Canadian co-management arrangements. *Ecology and Society 12*(2), 34.

Huntingford, G.W.B. (2006). *The Nandi of Kenya: Tribal Control in a Pastoral Society.* London and New York: Routledge

Huntington, H. P. (2000). Using traditional ecological knowledge in science: methods and applications. *Ecological Applications* 10, 1270-1274.

Ipara, H. (2004). *"Indigenous Wildlife Resource Management Systems: A Study of the Isukha Community of Western Kenya".* An Unpublished Doctoral Thesis, Moi University, Kenya.

International Union for Conservation of Nature, 1991. Caring for the Earth: A strategy for sustainable living. IUCN. Gland, SwitzerlandIUCN, 1980. World conservation strategy: Living resource conservation for sustainable development. IUCN/ UNEP/WWF, Gland, Switzerland.

Jaryan, V., Uniyal, K.S., Singh, D.R. G., Kumar, A., & Sharma, V. (2010). Role of traditional conservation practices: highlighting the importance of sacred grove in biodiversity conservation; *Environmentalist* 30, 101- 110.

Jones, J.G., Andriamarovololona, M.M., Hockley, N. (2008). The importance of taboos and social norms to conservation in Madagascar. *Conservation Biology*, 22, 976-986.

Kajembe, G.C., Mbwambo, J.S., Mwakalobo, A., Kimaro, D. N. & Njana, M. A. (2010). *The role of indigenous knowledge in climate change adaptation and mitigation: Prospects and challenges*. A paper presented at 2010 Africa Environmental Day under the theme 'Africa Resilience to climate change: Protecting Biodiversity loss and Enhancing Traditional Knowledge at Arusha International Conference Centre (AICC), March 3- 4/ 2010.

Kalawole, O.D. (2004). Soil fertilty conservation practices among farmers. *Journal of Rural Communities and Indigenous Knowledge in a Changing World* pp. 283-284

Kamara, J. (2004). Indigenous knowledge in disaster reduction in Africa. www.environmenttimes.net/articles.cfm (last accessed 23/8/2006)

Kamau C. M. (2011). Traditional knowledge management and preservation: Intersections with Library and Information Science, *The International Information & Library Review, 44*(1), 13 -27

Kassilly, F.N., & Tingalia, H.M. (2009). Persistence and loss of cultural values of Tiriki Sacred Grovesin Hamisi District, Kenya: Implications for management (RH: Cultural Values of Tiriki Sacred Groves). *J Hum Ecol,* 27, 137-141.

Kerlinger, F. N (1973). *Foundations of Behaviour Research.* New York: Holt, Rhinehart and Winston incl,

Kideghesho, J.R. (2008). Co-existence between the traditional societies and wildlife in Western Serengeti, Tanzania: Its relevance in contemporary wildlife conservation efforts. *Biodiversity Conservation,* 17, 1861-1881.

Kenya National Bureau of Statistics (2009). *Kenya 2009 population and housing census: VOL IA: Population distribution by administrative units*. Nairobi: Kenya National Bureau of Statistics (KNBS)

Kobina, E.D. & Kofi, A.A. (2009). *Change and Continuity: Using Indigenous Knowledge to Achieve Environmental Sustainability in Ghana*. Paper presented at the 7th International Science Conference on the Human Dimensions of Global Environmental Change held in Germany, Bonn, on 26th -30th April, 2009 on the Theme. The Social Challenges of Global Change.

Kolb, D.A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. New Jersey: Prince-Hall, Upper Saddle River,

Kothari, C.R (2004). *Research methodology: Methods and Techniques* (2nd ed.). New Delhi: New Age International Publishers

Kweka, D. (2004). *The Role of Local Knowledge and Institutions in the Conservation of Forest Resources in the East Usambara.* Submitted to:UNESCO-Man and Biosphere (MAB) Young Scientist Programme.

Lamnek, S. (2005): Qualitative *socialforschung. Lehrbuch. 4. Auflage. Beltz Verlag. Weihuhein,* Basel.

Le Maitre, D. C., Van Wilgen, B.W., Gelderblom, C.M., Bailey, C., Chapman, R.A., Nel, J.A.(2002). Invasive alien trees and water resources in South Africa. Case studies of the cost and benefits of management. *Forest Ecology and Management. 160*, 143-159

Levi-Strauss C. (1962). *La pensée sauvage. Plon*: Paris. p.269.

Lingard, M., Raharison, N., Rabakonandrianina, E., Rakotoarisoa, J., Elmqvist, T. (2003).The role of local taboos in conservation and management of species: The radiated tortoise in Southern Madagascar: *Conservation and Society*, 1, 223-246.

Maffi, L., & Woodley, E. (2010). *Biocultural diversity conservation: a global sourcebook*. London: Earthscan

Maffie, J. (2009). 'In the end, we have the Gatling gun, and they have not': Future prospects of indigenous knowledge. *Futures 41*(1), 53-65.

Makenzi, P. (2004). *Indigenous Knowledge in Natural Resource Management; A Case of Forest Biodiversity Conservation in Baringo District, Kenya*. An unpublished Doctoral Thesis, Moi University, Kenya.

Manek, M. (2001). The implementation of biodiversity related conventions. *Cultural Survival Quarterly 24(4), 8-9*

Manyatsi, A.M. (2011). Application of indigenous knowledge systems in hydrological disaster management in Swaziland**,** *Current Research Journal of Social Sciences,* 3(4), 353-357.

Mapara, J. (2009). Indigenous knowledge systems in Zimbabwe: Juxtaposing postcolonialtheory. *Journal of Pan African studies* 3 (1), 139 -154

Martin, P.H., Canham, C.D. & Marks, P.L. (2009). Why forests appear resistant to exotic plant invasions: Intentional introductions stand dynamics, and the role of shade tolerance. *Frontiers in Ecology and the Environment*, 7, 142-149

Marvin H. (1966). The cultural ecology of India's sacred cattle: *Current Anthropology*, 7(1) 51-54

Matson, A.T.(2009). Nandi resistance to British rule: The volcano erupts. Nairobi: Trans Africa press

Mawere, M. (2010). Indigenous knowledge systems' potential for re-establishing a moral, virtuous society: Lessons from selected indigenous knowledge systems in Zimbabwe and Mozambique, *Journal of Sustainable Development in Africa,* 12(7), 209-221.

Mawere, M. (2011). *African Belief and Knowledge Systems: A critical perspective. Educational Research*, (2):874-883

Mercer, J., Kelman, I., Alfthan, B. & Kurvits, T. (2012). Ecosystem-Based Adaptation to Climate Change in Caribbean Small Island Developing States: Integrating Local and External Knowledge. *Sustainability 4*, 1908-1932.

Mercer, J., Kelman, I., Taranis, L. & Suchet-Pearson, S. (2009). Framework for integrating indigenous and scientific knowledge for disaster risk reduction in Papua New Guinea: *Geografiska Annaler Series B* 91(2), 157-183

Mironga, J.M. (2005). Effects of farming practices on wetlands. *Applied Ecology and Environmental Research 3* (2), 81-91

Mitinje, E., Kessy, J., & Mombo, F. (2007). Socio-economic factors influencing deforestation on Uluguru mountains, Morrogoro, Tanzania. *Discovery and Innovation. 19,* 139-148

Moller, H., Berkes, F., Lyver, P.O., & Kislalioglu, M. (2004).Combining Science and Traditional Ecological Knowledge: Monitoring Populations for Co-management. *Ecol Soc 9* (3).

Monder, M., Ntuli, L., Diedericks, N, & Mavundia, K.(2007). *South Africa's Traditional Medicine.* Natal: Mshanzu publishers.

Moran, M. (2009). *What job, which house?: Simple solutions to complex problems in indigenous affairs.* Australian Review of Public Affairs.

Motarjemi, Y. (2002). Impact of small scale Fermentation technology on food safety in developing countries. *International Journal of Food Microbiology* 75(3), 213-229

Msuya, J. (2007). Challenges and Opportunities in the Protection and Preservation of Indigenous knowledge in Africa; *International Review of Information Ethics*, 17, 1-8

Mugenda, O., & Mugenda, A. (1999). *Research methods; Quantitative and Qualitative Approaches.* African Centre for Technology Studies. Nairobi: Acts press

Murombedzi, J.C. (2003). "Devolving the Expropriation of Nature: The 'devolution' of wildlife management in southern Africa" In Adams W. and Mulligan, M. (eds.) *Decolonizing Nature: Strategies for Conservation in a Post-colonial Era.* London: Earthscan,

Musyoka, R. (2006). Non-compliance and formalisation: Mutual accommodation in land subdivision processes in Eldoret, Kenya. *International Development Planning Review 28*(2), 235.

Mutta, D., Chagala-Odera, E., Wairungu, S. & Nassoro, S. (2009). Traditional knowledgesystems for management of Kaya forests in coast region of Kenya. Traditional forest-related knowledge and sustainable forest management in Africa. *IUFRO World Series* 23, 122 – 129.

Mwaura, P. (Ed) (2008). *Indigenous Knowledge in Disaster Management in Africa.* Nairobi : Longhorn Publishers.

Nachmais, C. F., & Nachmais, D. (2008). *Research methods in the social science* (7th ed.). New York: Worth publishers

Nadasdy, P. (2007). Adaptive co-management and the gospel of resilience. In D. Armitage, F. Berkes, and N. Doubleday, (ed.). *Adaptive co-management: collaboration, learning and multi-level governance* (pp.208-226). Vancouver: University of British Columbia Press.

Naidoo, N. (2007). *Indigenous Knowledge in the National Curriculum Statement; From Policy to Practice for Environmental Education*. Thesis, University of Witwatersrand.

Nandi County Integrated Development plan, (2013). *Nandi County Integrated Development plan*

Nelson, M. (2005). Paradigm shifts in Aboriginal cultures? Understanding TEK in historical and cultural context. *Canadian Journal of Native Studies* 25(1), 289-310.

Nganje, M. (2009). *Harnessing Traditional Ecological Knowledge for Conservation of Forestry and Biodiversity*. XVII World Forestry Congress, Buenos Aires, Argentina 18 -23, October 2009.

Nuha, M. O., Isam, A. M. A. & Elfadil, E. B. (2010). Chemical composition, anti-nutrients and extractable minerals of Sicklepod (*Cassia obtusifolia*) leaves as influenced by fermentation and cooking. *International Food Research Journal:* 17, 775-785.

Nyong, A F.; Adesina, B.; Osman, E. (2007). The Value of Indigenous Knowledge in Climate Change Mitigation and Adaptation Strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change*, 12(5) pp 787-797

Ocholla, D. (2007). Marginalized knowledge: An agenda for indigenous knowledge development and integration with other forms of knowledge. *International review of information ethics* 7. 1- 10

Odhiambo, W, & Nyangito. (2002). Land Laws and Land use in Kenya: Implications for agricultural development. Kenya Institute for Public Policy Research and Analysis. *KIPPRA discussion paper*, No. 5

Odora-Hoppers, C., (ed.), 2002. Indigenous Knowledge and the Integration of Knowledge Systems; Towards a Philosophy of Articulation. South Africa: New Africa Books (pty) Ltd, pp 305-317

Odote, C. (2008). Wise use and sustainable management of wetlands in Kenya. In Okdidi. C.O., Evenvironmental Governance in Kenya: Implimenting the Framework law . Nairobi: East African Publishers, Pp 335-354

Odote, C. (2010).Retracing our ecological footsteps: Customary foundations for sustainable development and implications for higher education in Kenya. Paper prepared for the 7th Stratmore Annual conference.

Odote, C. (2012). Country Report: Constitutional provisions of the environment: *IUCN Academy of Environmental Law, e- Journal* (1), 136-145

Ofor, M.O. (2011). Traditional methods of preservation and storage of farm produce in Africa. *Science Journal , 4* (3).

Okoth-Ogendo, H. (2007). Formalising "informal" property systems: The problem of land rights reform in Africa. Commission on Legal Empowerment of the Poor Nairobi: United Nations Development Programme 26(1), 1-9

Okoth-Ogendo, H., & Oluoch-Kosura, W. (1995). Final report on land tenure and agricultural development in Kenya. Nairobi: The Ministry of Agriculture, Livestock Development and Marketing, Government of the Republic of Kenya and the Royal Netherlands Embassy

Ossai, B. N. (2010). African indigenous system. *Symbiosis 7*(2), 1 – 13.

Pejchar, L., & Mooney, H.A. (2009). Invasive species, ecosystem services and human well-being. *Trends in Ecology & Evolution. 24*, 497-504.

Pierotti, R., & Wildcat, D. (2000). Traditional ecological knowledge: the third alternative (commentary). *Ecological Applications 10*(5), 1333-1340.

Plummer, R., and D. Armitage. 2007. A resilience-based framework for evaluating adaptive co-management: linking ecology, economics and society in a complex world. *Ecological Economics* 61:62-74

Rabearivony, J, Fanameha, I. E., Mampiandra, J., & Thorstrom, R. (2008). Taboos and social contracts: Tools for ecosystem management - lessons from the Manambolomaty Lakes RAMSAR site, western Madagascar. *Madagascar Conservation and Development*, 3, 7-16.

Ramisch, J. J. (2005). Inequality, agro-pastrolal exchanges, and soil fertility gradient in South Mali; *Agriculture Ecosystems and Environment, 105*(1-2), 353-372

Reid, W. V., Berkes, F., Wilbanks, T. & Capistrano, D., (eds.), (2006). *Bridging Scales and Knowledge Systems, Concepts and Applications in Ecosystem Assessment*. Washington, D.C: Island Press.

Rist, S., & Dahdouh-Guebas, F. (2006). Ethnosciences: a step towards the integration of scientific and indigenous forms of knowledge in the management of natural resources for the future. *Environment Development and Sustainability 8,* 467-493.

Rival, L. (2011). *Ecological threats, new promises of sustainability, and the evolving political economy of land use change in Latin America*. Paper presented at the UNRISD conference Green Economy and Sustainable Development: bringing back the social dimension. Geneva. 69(6-69), 1219-1227

Robert, B.J.; Larry, B.C. (2010). Educational Research: Quantitative, Qualitative and Mixed approaches. 4th edition. London: SAGE Publications

Saj, T.L., Mather, C., & Sicotte, P. (2006). Traditional taboos in biological conservation: The case of *Colobus vellerosus* at the Boabeng-Fiema Monkey Sanctuary,Central Ghana. *Soc Sci Inform,* 45, 285-310.

Salick, J., Cellinese, N. & Knapp, S. (1997). Indigenous diversty of cassava: generation maintenance, use and loss among the Amuesha, Peruvian Upper Amazon. *Economic Botany. 51*,6-19

Sarfo-Mensah, P. & Oduro, W. (2010). *Changes in beliefs and perceptions about the natural environment in the forest-savannah transitional zone of Ghana: The influence of religion*. Fondazione Eni Enrico Mattei, Working papers. Global Challenge Series, Gianmarco I.P. Ottaviano (Ed.)

Sarfo-Mensah, P., & Oduro, W. (2007). Traditional Natural Resources Management Practices and Biodiversity Conservation in Ghana: A Review of Local Concepts and Issues on Change and Sustainability. *Fondziane Eni Envico Mattei. Working paper* 149

Schachenmann, P. (2006). Spiritual values in Madagascar: The starting point for endogenous conservation initiatives. *Mountain Research and Development*, 26, 323-327.

Shackelton, S, Shackelton, C. Netshilluhi, T, Geach, B, Ballace, A, Fairbanks, D. (2002). Use Patterns and Value of Savannah Resources in Three Rural Villages in South Africa. *Economic Botany* 56, 130-146.

Schoite, P,de Kort, S.Van Weerd, M. (2000). Flood plain rehabilitation in far North Camerron: Expected impact on bird life. Ostrich, 71: 112-117.Shackleton, C.M., Dovie, D.K.B., & Witkowski, E.T.F. (2002). "Direct–use values of woodland resources consumed and traded in a South African village". *International Journal of Sustainable Development & World Ecology*, 9(3), 269-283.

Shava, S.R., O'Donghue, M., Kransky, E., Zazu, C. (2009). Traditional food crops as a source of community resilience in Zimbabwe. *International Journal of African Renaissance 4*(1), 31-48

Shoko, K. (2012). Indigenous weather forecasting systems; Acase of biotic weather forecasting for ward 12 and 13 in Mberngwa District, Zimbabwe. *Journal of Sustainable Development in Africa*, *12*(7), 209-221.

Stevenson, M. (2005). *Traditional knowledge and sustainable forest Management; Sustainable Forest Management network; Edmonton*, Alberta, p18

Steward, J. (1955). *Theory of Cultural Change.* Urbana: University of Illinois Press 59(3), 540-542

Sutton, J.E. (1978). The Kalenjin. In Ogot, B.A. (ed) Kenya before 1900. Nairobi: Oxford University Press, pp 21-52

Syagga, P. (2006) Land ownership and use in Kenya: Policy prescriptions from an inequality perspective. Readings on Inequality in Kenya*: Sectoral Dynamics and Perspectives*, p. 289

Tanyanyiwa, I. V. & Chikwanha, M. (2011). The role of indigenous knowledge systems in The management of forest resources in Mugabe area, Masvingo, Zimbabwe. *Journal of sustainable development in Africa* 13(3), 132 – 149

Tazara, M., & Maposa, R. (2012). Indigenous weather forecasting: A phinomenogical study engaging the Shona of Zimbabwe. *Journal of Pan African Studies, 4*(9).

Tengo, M., Johansson, K., Rakotondrasoa, F., Lundberg, J., & Andriamaherilala, J.A. (2007). Taboos and forest governance: Informal protection of hot spot dry forest in Southern Informal protection of hot spot dry forest in Southern Madagascar. *Ambio*, 36(8), 683-691.

Thomas, G. (2011). *How to do your case study*. Thousand Oaks: Sage Publicaations.

Thuo, A. (2010). Geneology of land ownership, use and management problems in Kenya during the pre-August constitution period. A review. *International Journal of Engineering Research and Technology. 2 (8)* (IJERT) ISSN: 2278-0181

United Nations Conference on Environment and Development, (1992). *Agenda 21, Chapter 26: "Recognising and Strengthening the Role of Indigenous People and their Communities".* United Nations Conference on Environment and Development, June 3-4. Rio de Janeiro. Brazil paragraph 26.1-26.9

United Nations Environmental Programme, (2008). Indigenous knowledge in disaster management in Africa; United Nations Environmental Programme, Nairobi

United Nations Education, Scientific and Cultural Organization, (2010). *Statement and Recommendations from UNESCO international year of Biodiversity science policy conference.* Paris, 25- 29 January 2010, recommendation number 26 p5

United Nations (2000). *Systems and National Experience for Protecting Traditional Knowledge: Innovations and Practices*. United Nations Conference on Trade and Development, Commission on Trade in Goods and Services, an Commodities Expert Meeting on Systems and National Experiences for Protecting Traditional Knowledge, Innovations and Practices. Traditional Knowledge Booklet, Author.

Vanwey, L.K., D'Antona, A.O., & Brondizio, E.S., (2007). Household demographic change and land use/ cover change in the Brazilian Amazon. *Population and Environment, 28*. Pp 163-185.

Warren, D. M. (1995). "*Indigenous Knowledge, Biodiversity Conservation and Development."* Keynote Address presented at the International Conference on Conservation of Biodiversity in Africa: Local Inssitiatives and Institutional Roles, 30 August-3 September 1992, Nairobi, Kenya.

World Commission on Environment and Development (1987). *Our Common Future. The Commission on Environment and Development.* New York,: Oxford University Press, pp 41-59

Wekunda, M. (2012). Why protect Traditional Knowledge. *The African Technology Policy Studies Network. Biotechnology Trust Africa. Special paper series* NO. 44, pp 8-14

World Health Organization (2001). *Regional Committee of Western Pacific Region on Traditional Medicine*. NewYork: WIPO Publications.

Widgren, M. (2010). Besigeged paleaonegritics or innovative farmers: historical political Ecology of intensive and terraced Agriculture in West Africa and Sudan, *African Studies 69*(2), 323-343

Wily, L. A., & Mbaya, S. (2001). *The impact of land relations on the role of communities in forest future; Land Peoples and Forests at the beginning of the 21st century.* Nairobi, Kenya: IUCN,

Wohling, M. (2009). The problem of scale in indigenous knowledge: a perspective from northern Australia. *Ecology and Society 14*(1), 1.

World Trade Organization (2002). *Trading into the Future: The introduction to the WTO, Protection and Enforcement.*

Yin, R.K. (2009). *Case study research: Design and methods* (4th ed.). California: Sage Publications

York, R., Rosa, E.A. & Thomas, D. (2003a). Footprints on the Earth: The environmental Consequences of Modernity. *American Sociological Review, 68* (April), 279-300

Zazu, C. (2007). Exploring Opportunities and Challenges for Achieving the Integration of Idigenous Knowledge Systems into Environmental Education Processes. A

case study of the Sebakwe, Environmental Education Programme (SEEP) in Zimbabwe. Unpublished Master's Thesis, Rhodes University.

APPENDICES

APPENDIX I: Questionnaire

Dear Respondent,

This research is being conducted purely for ACADEMIC PURPOSES by PACIFICA C. MINING of School of Environmental Studies, Moi University. Kindly spare a few minutes and answer all the questions sincerely. The information given will be treated confidential.

Research Topic: Trends in Use and Application of IK: Implications to Natural Resource Management among Nandi People of Nandi County, Kenya.

I. GENERAL INFORMATION

Questionnaire number .....Interview date.....…….....

Residence: village…… Sub-location …….….....

Location…… Division….....

II. SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS

1.	What is your gender?	[1] Male [2] Female
2.	Marital Status	1] Married [2] Single [3] Divorced/ separated [4] Widowed [5] Any other (specify).....
3.	Age (tick one)	[1] Below 20 [2] 21-40 [3] 41-50 [4] 50-60 [5] 60 and over
4.	Education level (tick	[1] Never attended [2] Primary school

one)	[3] Secondary [4] Tertiary [5] University [5] Any other (specify).....
5. Occupation (tick appropriately)	[1] Unemployed [2] Self-employed [3] Formal/ salaried [4] Farmer [5]Any other (specify).....
6. Resident by (tick one)	[1] Birth [2] Immigrant [3] Any other (specify).....
7. Period of residence (tick one)	1] Less than a year [2] 1-5 years [3] 6-10 years [4] 11-20 years [5] More than 20 years (specify) …….
8. If immigrant state place of origin	……. In ……. District.
9. Size of land in acres/ hectares? (Specify average) (Tick one)	1] Less than 5 hectares. [2] 6-10 hectares [3] 11-15 hectares [4] Over 15 hectares.

III. TRENDS IN USE AND APPLICATION OF IK IN NATURAL RESOURCE MANAGEMENT SYSTEM

1. What was the traditional Nandi understanding of natural resources?

2. Did the Nandi community traditionally participate in natural resource conservation? (Tick appropriately)

[1] Yes [2] No [3] Do not know

3. If yes Name natural resources that were traditionally conserved and give reasons for conserving them.

LAND TENURE SYSTEM

1.	**Current land tenure? (Tick appropriately)** 1] Individual/ private [2] Communal [3] Government land [4] Any other (specify).....	**Traditional form of land tenure (tick appropriately)** 1] Individual/ private [2] Communal [3] Any other (specify).....

4. was communal land tenure an effective tool in enhancing natural resource conservation? (Tick one) [1]Yes [2] No [3] Do not know.

5) If yes, state in order of importance of the traditional communal land tenure in enhancing natural resource conservation (tick appropriately)

Order of Importance	**STATEMENT**
	Enabled individuals to manage and conserve natural resources of their choice only

	Led to the collective responsibility by the whole clan/ community to conserve all natural resource species on communal lands.
	Empowered both the traditional community and individuals to sustainably utilise natural resources and conserve them.
	Prescribed sustainable land use practices aimed at conserving wildlife resources.
	Was destructive to wildlife resources and their habitats.
	Any other (specify)

6).Has there been any change in recent years in the following (tick one)

(i) Land tenure? 1] Yes [2] No [3]	(ii) Land ownership? 1] Yes [2] No [3] Do not know	(iii) Land use activities? 1] Yes [2] No [3] Do not know

7) .If yes, which of the following changes have occurred? (Tick appropriately).

STATEMENT	
Sub- division of communal land.	
Individualization/privatization.	
Loss of equal access rights to communal land.	

Enhanced inequality in land ownership by all sexes.	
Change in land use activities	
Any other (specify)	

8).Identify effects resulting from changes in land tenure system over the past years (Tick appropriately)

STATEMENT	TICK
Depletion and destruction of natural resources	
Extinction of some natural resources that were traditionally conserved.	
Introduction of incompatible land use activities and land use patterns	
Encroachment on the National Reserve hence the illegal harvesting of forest products from the reserve.	
Individualization/privatization of tenure has led to breakdown in the indigenous natural resource management and conservation systems.	
Any other (specify)	

9).Which of the following components of traditional land tenure should be integrated in current approaches to natural resource conservation? (Use table below – tick appropriately)

Components of land tenure to be integrated	**Reasons for integration**
1. Communal ownership of land	

2. Traditional land ethos, rules and regulations	
3. Communal land systems	
4. Equal land ownership rights	
5. Sex balance in allocation of land use and access rights	
6. Any other (specify)	

LAND USE PRACTICES: CROP PRODUCTION

1. Which of the following activities do you practise on your farm? (Rank them in order of importance) [1] Crop farming [2] Livestock keeping

[3] Agro forestry [4] A forestation [5] any other (specify

b. ***If you have indicated crop farming in question 1 above please answer question 2. Below, otherwise move to question 3. Below***

2). Name traditional crops (grown in the past by the Nandi community) that you are currently growing [1]Pumpkin [2]Beans [3[sweet potatoes [4]Sorghum [5]Millet

Other, specify_____

3). which new crops have been introduced into the community?

[1] Maize [2] potatoes [3] Peas [4]Tea [5] pyrethrum

Other specify_____

4). When were these crops introduced into the area (community)?

[1]Colonial period [2] post- colonial

5. How was land chosen in the past for cultivation?

---

6). what methods were used in the past to clear land for cultivation?

[1]Slashing [2] Burning [3] other please specify

7) .Which new methods of clearing land have been introduced into the community over the years? (Kindly indicate the period when it was introduced)_____

_

8). List the tools that were used in the past to cultivate land.

[1]Iron hoe [2] a two pronged fork [3] Wooden digging Sticks [4] an axe [5] a bill-hook [6] other, specify

9).Name new farming tools that have been introduced to the community over the past years to the present? [1]Tractors [2] Planters [3] Harvesters [4] Tiller [5] Sheller [6] other

10). Describe how agriculture was practiced in the past and identify changes which have occurred over time under the following headings

Practice in the PAST	**Changes over time**
Planting: Seed selection:	Planting: Seed selection:
Weed control:	Weed control:
Pest control:	Pest control:
Soil fertility:	Soil fertility:
Control of soil erosion:	Control of soil erosion:
Harvesting:	Harvesting:
Storage /Food preservation:	

11). were there any cultural practices associated with cultivation of crops? Yes

No don't know

ANIMAL HUSBANDRY

1a). Name the types of livestock you keep.

[1]Cattle [2] Sheep [3] Goats [4] Donkeys [5] Other specify

b).Give reasons why the Nandi kept these livestock.

[1]Source of wealth [2] payment of dowry [3] Food [4] Clothing [5] other 2a).Were there limits to number of livestock kept by a household? [1]Yes [2]No

b). Please give reasons for your answer_____

_

3. List the new breeds and indicate the period when it was introduced.

_____

__

Indigenous Land use regulations

4). were there any traditional regulations on land use? [1]Yes [2]No

3).If YES above please mention the regulations that were in

place._____

_

4).Who was responsible for enforcement of regulations?

[1]Clan elders' [2]village elders [3]head of family [4]chiefs

5).Were the rules and regulations in controlling land resources effective?

[1] Effective [2] Fairly effective [3]Very effective [4]Not effective [5]Don't kno

FORESTS

1).What was the Nandi community understanding of forests

---

2). How were forests categorised in the past?

3).What products were collected from the forest?[1] Medicinal herbs [2] Building

[3]materials [4] Food [5] fodder [6]Firewood [7]any other please specify

4). Name Trees and Plants that were highly valued by the Nandi community in the past? (Use table below).

Name of tree/plant	**Value attached**

5).In your opinion what has contributed to the extinction of resources you mentioned above?

6).Are there any new species of plants, animals and birds that have been introduced into the forest over the years? Please list them.

7).Have you noticed any changes in terms of population of wild animals in the forest?

[1] Reduced significantly [2] Reduced [3] Increased [4]Increased significantly

If they have reduced significantly in population size, what would you attribute it to?

8).Name wild animals that were hunted in the forest in the past.

Wild Animal	Hunting Method	Why they were hunted

9). Was hunting of wild animals regulated. [1]Yes [2] No

10).If yes above, who regulated hunting activities in the community?

[1] Clan elders [2]Head of family [3] Village elders [4]Chiefs

11) .Have you observed any changes in methods of hunting over the years? Yes/ No

12).Please indicate the changes that have occurred.

13).Explain cultural practices associated with forests._____

14).Which forest products are currently in high demand?

[1]Hard wood [2]medicinal plants [3]Timber [4]Building poles [5]other specify

15).What do you think is the driving force for high demand of forest products?

[1]Population growth [2] urbanization [3]scarcity of land [4]high demand for cheap domestic fuel (charcoal and firewood) [5]other specify

16). Are you aware of any policies/laws regulating the use of forest products? [1]Yes [2] No

17) .If YES, who enforces these regulations?

[1] Chiefs [2] village elders [3] District officer [4] forest officers

18).Are the regulations effective in controlling use of forest products?

[1] Effective [2] Fairly effective [3] Very effective [4] Not effective [5] don't know

WATER

1). what conservation methods were used to conserve sources of water in the past?

2). Are there sources of water which have dried up over the past years? [1]Yes [2]No

3) .If YES, please list them.

4).In your opinion what may have caused the above mention sources of water to dry up?

[1]Cutting of trees [2] cultivation along river banks [3] draining for crop growing [4]diversion of water for irrigation [5] climatic changes

5). were there any traditional practices which involved water sources and its use in the community? [1]Yes [2]No

b).If YES please explain the traditional practices.

6) .Have you notice any changes which have occurred over the years on how people use the water sources in the community? Please indicate the changes;

7) .Are you aware of current regulations concerning use of water sources? [1]Yes [2]N0

8) .If YES above, how would you rate the effectiveness of th***ese*** regulations?

[1]Effective [2] Very effective [3] Fairly effective [4] Not effective [5] Don't know

9).Which components of indigenous natural resource management systems were used as traditional tools in conservation of the indicated resources?.....

1V: EFFECTS OF CHANGES IN APPLICATION OF IK ON NATURAL RESOURCES MANAGEMENT

CHANGE	**EFFECTS**
FORESTS	
New species introduced	
Hunting methods Firewood collection	
Clearing of forest	
Settlement in forest	
Policies	
WATER RESOURCES	
Rivers	
Dams	

Irrigation	
Wetlands	
Drainage	
Cultivation	
Brick making	
Streams: cultivation	
LAND USE	
Tiling of Land	
Crop types and systems	
Soil conservation Harvesting and storage of crops	
Livestock rearing	
Number of livestock	
Type of livestock	

V: INTERRELATIONSHIP BETWEEN IK AND MODERN METHODS OF NATURAL RESOURCE CONSERVATION

PRACTICE/METHOD	**TRADITIONAL**	**MODERN/CURRENT**
Land use practices		
Crop cultivation		
Soil fertility		
Soil erosion control Harvesting and storage		
Control of pests, Weeds		
Livestock rearing		
Grazing/feeding systems		
Disease control		
Administration Regulation on land use practices		
WATER SOURCES		
Rivers		
Wetlands		
Streams		

water collection/harvesting		
Rivers		
Wetlands		
Streams		
FORESTS		
Trees /plants		
Wildlife		

APPENDIX II: Interview Schedule for Policy Makers

The purpose of this is to:

- To understand the modern methods of natural resource conservation

1. What policies are in place to conserve land/wildlife and birds/water/forests currently?

2. From the discussion above, what has been borrowed from the indigenous/past modes of the native Nandi community?

3. What avenues are currently in place to ensure that integration of the past Nandi natural resource conservation methods and the modern/present conservation method is possible

APPENDIX III: Focus Group Discussion Guide

1. How was life generally in the past? / Was life interesting in the past compared to the present?

2 a. What was the Nandi understanding of Natural Resources?

3a. In a broad sense how was land as a resource conserved in the past by the Nandi community?

b. What are changes have you observed in use and management of land resources over the years?

5a.In a broad sense, how were water sources conserved in the past by the Nandi community?

b. what changes have you observed in the use and management of water resource over the years?

4a.In a broad sense, how were forests resources conserved in the past by the Nandi community?

b. What changes have you observe in the use and management of forest resources over the years.

5. How can this past knowledge be integrated into the present methods of forest conservation?

6a. In a broad sense, how were wild animals and birds conserved in the past by the Nandi community?

7. As a knowledgeable person in the past Nandi natural resource conservation methods, how best can you participate or be engaged in the present/current conservation culture?

8. In your own opinion, is enough being done currently in terms of conserving the natural resources? Why?

9a.what are the similarities between indigenous knowledge and modern methods of natural resource management

b. what differences exist between indigenous and modern methods of natural resource management

c. in your opinion what do you think should be done to integrate the Nandi indigenous knowledge with modern methods of natural resource management

10. In conclusion, are there any other issues in relation to the topic of discussion you would like to raise?

APPENDIX IV: Observation Guide

1. Village setup: homesteads; structures

2. Land uses: crops; farming methods; livestock

3. Forests: activities in the forest; forest cover; water catchment; types of trees; wildlife

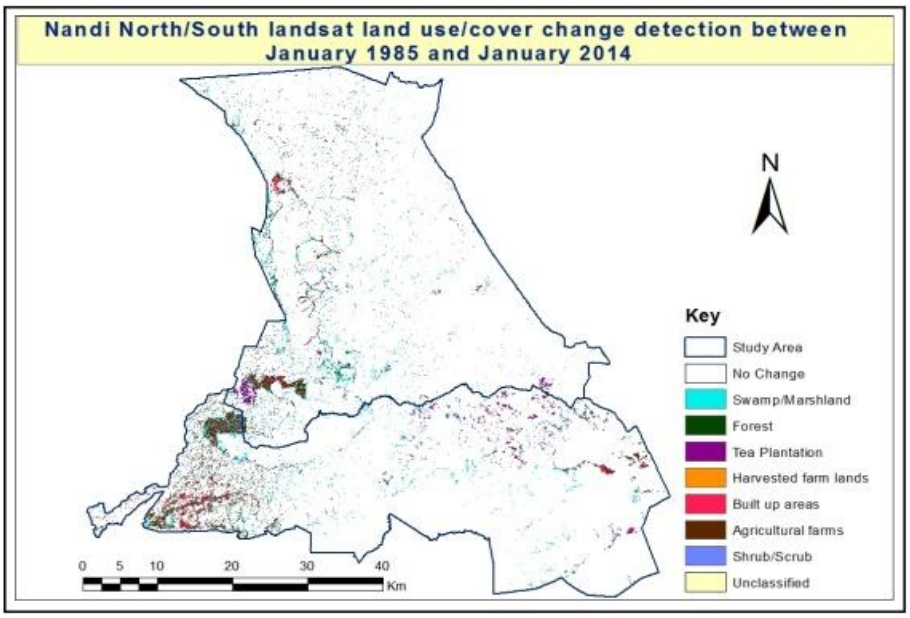
4. Water sources: Activities around rivers, streams, wetlands; vegetation

APPENDIX V: Geographical (*pororiet*) territory and sacred sites

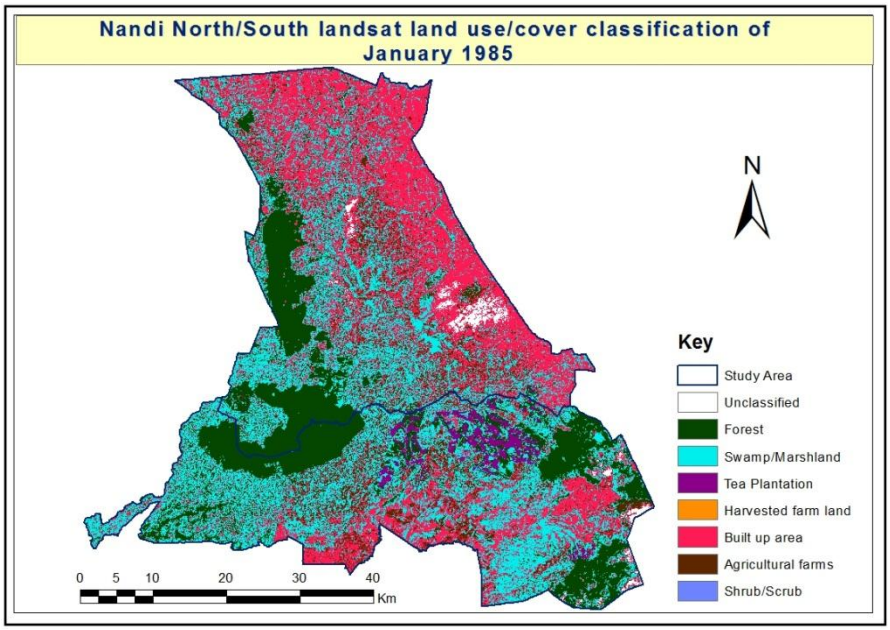
Pororiet/geographical territory	**Kapkoros/sacred site**
1.Kapchekendi • Kerekoi(Sirwo) • Muruto • Kapkobiis	Samituri Sireet Chepkikwen Siile Kapsimotwo Ollesos Kapng'etuny Mogobich Kapkobiis Kapsaos
2.Kakipooch • Kapianga	Chepoing'ony (Aldai) Terige Chepsiria Kechui
3.Kamelilo • Chemogoch • Chebarus • Kamasia	Koikoi (Kapkoros) Tereno Ng'atip Kong' Tindiret
4.Koilegei • Kipsigakyek • Kapsapityek	Mosombor Kipsigak Chapteerit Kosirai
5.Kaptumois • Kakimno • Mur Ap Tuk • Kapsiondoi	Kapkemich Chepsonoi Kiporgok Kapkechui Kapsile Koibo-Ngetuny (Maraba) Matambach (Kongoro)
6.Tibing'ot • Kapsile • Cheptol • Barsieny • Kapwareng'	Kaibui (Kapkoros) Cheptilil Suswo Kombe
7.Kaptalam	Kibongwa (-Kisorng'ot)

• Kiptaragoon • Kaptien • Kiptamukyek	Kapsapiit (Koyo) Kosoiywo Kilipwoni
•	

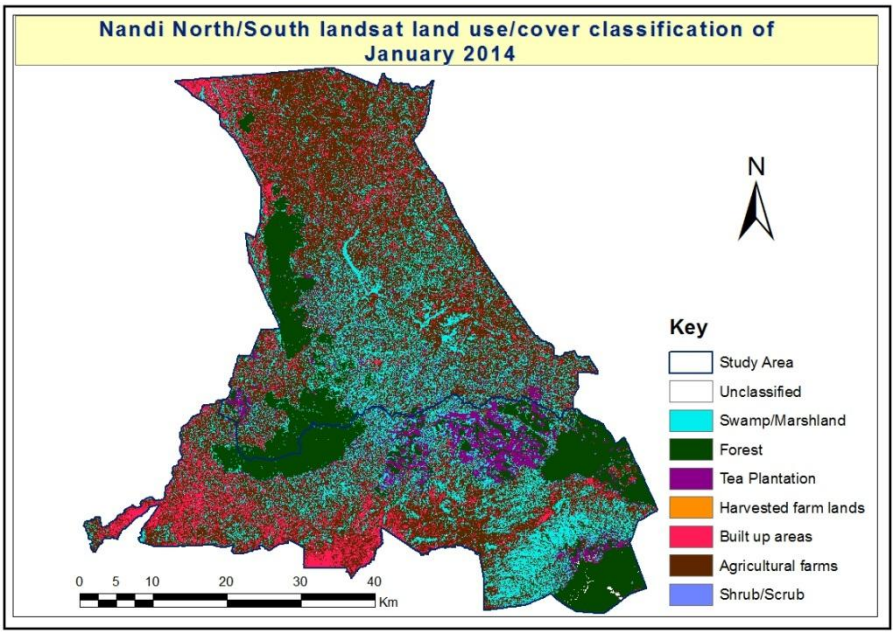
APPENDIX VI: Land cover/land use Jan 1985 and Jan 2014



Source: Landsat Image, 2014



Source: Landsat, 1985



Source: Landsat Image, 2014