THE INFLUENCE OF LIVESTOCK GRAZING ON PLANT SPECIES DIVERSITY AND DISTRIBUTION AT KIRANJERANJE WARD; KILWA DISTRICT -TANZANIA.

NEEMA MAGAMBO

A THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (ENVIRONMENTAL SCIENCE) OF THE OPEN UNIVERSITY OF TANZANIA

2015

CERTIFICATION

The undersigned certifies that they have read and hereby recommends for the acceptance by the Open University of Tanzania thesis entitled***: The influence of Livestock grazing on Plant species diversity and distribution at Kiranjeranje ward-Kilwa District*, *Tanzania*** submitted in fulfillment for requirements award of degree of Master of Science (Environmental Science) of the Open University of Tanzania.

____

Dr.Lawi Yohana

(1^{st} Supervisor)

____

Date

____

Dr. Cosmas Mligo

(2^{nd} Supervisor)

____

Date

COPYRIGHT

DECLARATION

I, **Neema Magambo** do hereby declare that this thesis is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature

Date

DEDICATION

This thesis is dedicated to my late parents Domina Faustin Komba and Paul Magambo Mbelwa

ACKNOWLEDGEMENT

My sincere gratitude is due to my supervisors, Dr. Lawi Yohana of Environmental Studies department (OUT) and Dr, Cosmas Mligo (UDSM) for their close assistance, guidance, advice and tireless constructive and genuine criticism during the whole period of my study. I also wish to express my thanks to the Government of United Republic of Tanzania through COSTECH for offering me financial sponsorship. Special thanks are due to Mr. H. Selemani and Almas Manumbu (Botany Department, UDSM) for giving necessary technical assistance during my fieldwork together with laboratory treatment and analysis of soil samples.

Special thanks are due to the father of my lovely daughter Tasilo K. Membe for his encouragement, good wishes, prayers, moral support and patience throughout my study. Last but not least I would like to express my sincere thanks to my Dean, Faculty of Science, Technology and Environmental studies, Dr. L. Fweja, My Former Head of Department, Life science Prof. E. S. P Kigadye, Former Head of Department , Environmental studies, Dr. J Saria and Dr. E Makundi for being there unconditionally and helpful whenever I needed their assistance.

ABSTRACT

The relationship between environmental variables and plant species Diversity and distribution in Kiranjeranje ward was studied using multivariate gradient analysis. Vegetation data were collected in 30 established plots using the stratified random sampling method. For each plot established environmental data on edaphic factors and anthropogenic disturbances were also collected. The plant species were classified using a computer program TWINSPAN and detrended correspondence analysis (DCA) in which three major plant communities were identified. Canonical correspondence analysis (CCA) revealed that Grazing intensity(r =-0.9439), silt(r = -0.7282), sand(r=0.7886) and clay(r = -0.7607) are Environmental variables with much influence on species distribution in the study area The Shannon - Weaver species diversity index was used to find the α- species diversity of the plant species .The ungrazed community had the highest α- species diversity (2.36577), followed by the moderately grazed community (2.35142) and the heavily grazed community had the lowest value (1.84805), this is due to the fact that overgrazing results into removal of plant species and severe depletion of vegetation resources The study recommends development of sustainable grazing system that combine traditional pastoral knowledge, scientific management principle and pastoral local institution, Also a long-term conservation plant in necessary to ensure grazing dos not threaten existing vegetation and biodiversity.

TABLE OF CONTENTS

LIST OF TBLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

CHAPTER ONE

1.0 INTRODUCTION

1.1 General Introduction

The Natural Vegetation of Coastal Tanzania mainly consists of woodlands, scattered along the Coast Landscape, on hills and at the foothills of the Mountains of Eastern Tanzania, the woodland give ways to patches of Coastal Forest. All the remaining natural coastal forests of Eastern Tanzania are of high conservation importance because they are rich in biodiversity. Furthermore, the Coastal forests are of special conservation importance because they have so many endemic plant species that are found nowhere else. Most Coastal forests are found between 0-50 m and 300-500 m above sea level, although in Tanzania they occur up to 1040 m (Burgess, 2000).

The East African Coastal forests have remarkably high level of endemism and diversity For example of the 190 recorded forest tree species in the low Coastal Region 92 are found nowhere else (White,1983).The Coastal forests of Eastern Africa forms an Archipelago of forests extending along the Coastal plain of East Africa from Southern Somalia to Northern Mozambique located within the so called ‘Swahili Regional Centre of Endemism and Swahili – Maputoland and Regional transition zone’ (Clarke, 2000).
These Forests forms one of the major centers of Endemism in Africa (Burgess and Clarke, 2000) The large number of Endemic species, high biodiversity, and concentration of rare and threatened taxa make the Coastal forests of East Africa one of the highest priority ecosystems for conservation in Africa and globally (Hawthorne, 1993; Burgess and Clarke, 2000; Myers, 2000; Brooks, 2001; Burgess, 2004). Despite their biological importance, the Unique Fauna and Flora of these forests are currently

threatened by human disturbance through increasing fragmentation and forest degradation (Hawthorne, 1993; Brooks, 2002).

The Earth is undergoing rapid Environmental changes because of human actions, Humans have greatly impacted the rates of supply of the major nutrients that constrain the productivity, composition, and diversity of terrestrial ecosystems. Coastal forests like other types of forests elsewhere have been shrinking over time due to various underlying factors, the case of anthropic (human) disturbance of the Coastal forests is documented by (Clarke and Karoma in Burgess and Clarke, 2000). Human disturbance affects Plant populations and can modify interactions among Species within communities however human activities are highly variable in their influence (Yohana, 2004)

Among the uses of land by Humans in Coastal Forests of Lindi is Livestock Grazing (Animal Husbandry). Grazing animals compact the topsoil which can change the hydrology of the site by increasing soil bulk density and decreasing soil macro porosity thus Grazing reduces the water holding capacity of the soil which increases surface runoff and increases the risk of soil nutrient loss (Chunli, 2008).The degree of grazing by domestic animals strongly affects the structure, composition, quality and productivity of vegetation (Mligo,2003) and is considered as one of the most important types of disturbances altering natural processes affecting species persistence and influencing the structure and composition of plant communities (Olff and Ritchie, 1998 in Alexandra, 2011) . Grazing animals may exert beneficial or mutual influences on the vegetation for their own good but on the other hand large concentration of them have harmful effects on plants because of selectivity and overgrazing (Kamau, 2004) However short lived plant species benefited from grazing disproportionately increases both their species richness and their proportion in the species composition (Alexander,2011) . Effects of grazing on plant species richness vary with management regime and across environmental gradient (Bakker, 1998 in Juha, 2007) and are considered to increase Plant Species richness in productive environments but decreases in low productive environment (Olff and Ritchie 1998 in Juha, 2007)**.**

Livestock grazing plays a unique role in any Ecosystem since they are nearly completely under Human control and their impacts range from undetected removal of plant material to severe depletion of vegetation resources and extensive erosion. Also the magnitude of impact is not the same across a region. Lindi Coastal Forest is among the African forests that are not well explored biologically and many new species of plants and animals could be found there in the near future. It is for this reason that it is very important to undertake a study on the influence of livestock grazing on plant species diversity and its distribution on the coastal forest of Lindi - Kilwa district.

1.2 Statement of the Problem

The recent influx of Pastoralist and Agro-pastoralists Livestock keepers into the district has made Livestock keeping an important component in the Farming system in Kilwa District. The major threat that is posed by the increasing number of Livestock is the creation of more grassland areas from forest and bush lands to meet the grazing demand. It is estimated that a single head of cattle requires about 10 acres of grassland per year for grazing. Extended dry periods and high incidence of bushfires may force the grazing area per head to go beyond the standard 10 acre requirement. This will lead to more forest being cleared to create grasslands for grazing (Miya, Ball and Nelson, 2012).

Since introduction of these Livestocks from IHEFU only few research have been conducted in the study area and most of these researches focuses on Economic impacts of eviction of these Pastoralists and if the eviction follows legal procedures.

Very little research in the study area focus on impacts of these Livestock on the existing ecosystem, but this is very important because Tanzanian Coastal forests are part of 34 global biodiversity conservation hotspots. Anthropogenic activities in these forests such as fire, clearing of forests for cultivation ,harvesting of woody species for fuel, production of charcoal, building of poles, timber and traditional medicine causes disturbance that contribute to degradation and loss of Plant Species **(**Mligo, 2011). Livestock grazing in particular plays a unique role since they are nearly completely under human control and their impacts, range from undetected removal of plant material to severe depletion of vegetation resources and extensive erosion. Also the magnitude of impact is not the same across a region, that’s why it is very important to investigate the influence of Environmental factors on plant species diversity and its distribution.

1.3 General Objectives

The general objective of the present study is to assess the Influence of Livestock Grazing and Anthropogenic factors on Plant Species Diversity and Distribution.

1.4 Specific Objectives

1. To examine the influence of livestock grazing on plant Species Diversity
2. To determine the influence of environmental variables (Nitrogen, Phosphorus, Soil texture, Soil pH and Moisture) on Plant distribution pattern

1.5 Significance of the Study

Studies on the influence or impacts of environmental factors (both natural and anthropogenic) on Plant species diversity are very important as tools for biodiversity conservation of Ecosystems and for sustainable management of our forests. Therefore, it is important to undertake this current study so as to collect data that will reveal the relationship between environmental variables and plant species diversity .This will provide background information as to how best grazing can be used as management tool for biodiversity conservation. The conservation of coastal ecosystem especially Forests should be given high priority because they are currently under high pressure from growing human populations and most importantly because they harbor thousands of endemic species whose potential use to mankind is yet to be discovered.

1.6 Hypothesis

1. Extensive grazing significantly increases plant species diversity in a study area
2. There is a significant positive correlation between environmental parameters(Nitrogen, Phosphorus, soil texture, pH and moisture and grazing) and plant species distribution
3. The plant species diversity in a study area highly disturbed by human activities is significantly lower than in undisturbed area

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 East African Coastal Vegetation:

The East African Coastal Forests are comprised of the Northern and Southern Zanzibar-Inhambane coastal forest mosaics. It stretches from Southern Somalia through Kenya and Tanzania to Southern Mozambique and is characterized by Tropical dry forests within a mosaic of savannas, grassland habitats and wetlands areas. Generally the Forests are found just inland from the coast with outliers occurring along rivers and several locations where it grades into sub-montane forests at the foothills of mountain ranges. The Eastern African coastal strip contains a tiny chain of patches of lowland tropical dry forest. They were previously considered to be of low conservation priority in terms of endemism and species diversity, but research since the mid-1980s has shown that their biological richness is comparable to other important tropical forest types in Africa (Neil, Burgess and Clarke, 2000).

2.2 Classification of Vegetation of the East African Coastal Forests

2.2.1 The Eastern Africa Coastal Dry Forests

These are typically semi-evergreen or evergreen undifferentiated dry forests as described by (White, 1983) with the amendments that Eastern African Coastal dry forests can occur where atmospheric humidity is high (about 100%) throughout the Dry season. Eastern Africa Coastal dry forests may have a lower canopy than the minimum limit of 10 m adopted by White 1983, representative samples include the *Cynometra webberi Manilkara sulcata* community of the Arabuko-Sokoke forest in Kenya (Moomaw, 1960) and the forest on the Gendagenda hill in Tanzania (Clarke and Stubblefield, 1995).

2.2.2 The Eastern Africa Coastal Scrub forests

These forests are intermediate in physiognomic structure between forests with a canopy height above 10 m and bush land or thicket with a canopy height of less than 10 m (White, 1983), White also recognizes that Scrub forest occurs as a narrow band separating the Zanzibar-Inhambane (Swahilian) forest from the much drier vegetation of the Somalia-Masai region but this vegetation formation type occurs elsewhere in Eastern Africa particularly over coral rag near the coast (Hawthorne, 1993). Representative examples include the scrub forest near Raas Kamboni in Somalia (Friis and Vollesen, 1989) and the scrub forest on Mbudya Island near Dar es Salaam in Tanzania (Hall, 1986).

2.2.3 The Eastern Africa Coastal Brachystegia forests

These are transition Vegetation types between Forest and Grassland (White, 1983) dominated by either *Brachystegia spiciformis* or *Brachystegia microphylla.* Forests of this type occur in degraded areas, canopies do not interlock and Lianas are usually scarce. Representative examples include parts of the Arabuko-Sokoke forest in Kenya (Moomaw, 1960, White, 1983) and parts of the Tongomba forest in Tanzania (Clarke and Stubblefield, 1995).

2.2.4 The Eastern Africa Coastal Riverine, Ground water and Swamp Forests

These are Forests occurring in areas where the water table is high or where drainage is poor (White, 1983). Canopy trees are predominantly of species with wide distribution throughout Tropical Africa (Medley, 1992) this formation sub-type is transitional between Riverine forest and Somalia-Masai Riparian Forest. Representative examples include the riparian forest along the Tana River in Kenya (Medley, 1992) as well as forest vegetation on valley bottom areas of the Pugu hills (Hawthorne, 1993) and Kazimzumbwi forests in Tanzania (Clarke and Dickson, 1995).

2.2.5 The Eastern Africa Coastal Afro mantane Transitional forests

These are Forests occurring in Lowland areas at the base of the Eastern Arc Mountains and Chimanimani mountains in Tanzania and near the summit of the Shimba hills in Kenya (White, 1983). In a well drained forest such as in the East Usambara this type of forest is replaced by Eastern Africa dry forest, representative examples include Kimboza forest (Rodgers, 1983 Clarke and Dickson, 1995) and the Lowland forest of the East Usambara in Tanzania (White, 1983).

2.3 Plant Species Diversity and Distribution relations in Coastal Forest Communities.

2.3.1 Diversity

Plant Species Diversity has two components Species richness, which is the number of Plant species in a given plant community and Species evenness or equitability which is the number of individuals of each species. Hart, 1987 proposed a number of mechanisms as being important in maintaining Tropical forests diversity *viz*., change in substrate quality, succession, and plant mortality and disturbance regime. He then used these to derive a list of expected patterns in forest composition, structure and physical environment (Yohana, 2004).Soil fertility which is a prime factor in determining Plant Species Diversity is a component of substrate quality and greatly determines which Plant species can exist in a certain locality for different Plant species have different responses to variations in Soil fertility levels.

The importance of succession on species diversity is based on the fact that the species that have successfully invaded a biotope dominate the scene for a period and form a closed community. However living things modify their own habitat so as to cause one community to give way to another in a variety of ways. For instance as the trees increase in size they provide more shade, higher humidity and different conditions of food and cover. New types of animals and plant species can find suitable living conditions under these modified habitat conditions and hence species diversity increases. On the other hand, the community that can maintain itself indefinitely in each biotope is known as the climax community and will have lower species diversity. Moderate disturbance regimes and plant mortality create new gaps in the climax community where regeneration can take place thereby increasing plant species diversity (Ndangalasi and Rulangaranga, 1995).

2.3.2 Plant Community Distribution patterns

Distribution evidence allows the appreciation of Environmental change over a wide geographical scale. An aspect of distribution which is most stressed is the difference between places which have had relatively little change over long periods being rich in the number of species and endemics while areas subject to severe disturbance are impoverished due to both natural and human influence (Hamilton, 1982). Species that are restricted in their geographic distribution tend to be scarce whereas widespread species are likely to occur at high densities. This relationship may seem self-evident surely there is a positive link between measures of a species success on a local scale (its density) and on a regional scale (its geographic distribution). Yet although a larger area is more likely to be able to sustain a higher total number of individuals of a species, it is not clear why the density (number of individuals in a given area) should also increase (Wilco, 2011).

2.4 Environmental Parameters Influencing Plant Species Diversity

2.4.1 Soil pH

Is a measure of the acidity or alkalinity in the soil, It is also called soil reaction. Soil pH is one of the most important soil properties that affect the availability of nutrients. Chemical characteristics of soils such as Salinity, electro-conductivity and extremes of pH greatly determine the type of vegetation in an area as they directly influence nutrient uptake (Lyaruu , 2010).

2.4.2 Soil Texture

Soil texture describes the size (diameter) of the soil particles where larger mineral particles predominate the soil is gravelly ($d > 2$mm), or sandy ($0.05 < d < 2$); where smaller, colloidal mineral particles are dominant, the soil is clay ($d < 0.002$) (Brady and Weil, 1999). Soil texture refers to the relative size distribution of the primary particles in a soil particle size, using the USDA classification scheme is divided into three measurements: sand (2.0–0.05 mm), silt (0.05- 0.002 mm) and clay (0.002 mm) (Gee and Bauder, 1986 in Kettler et *al,* 2001). Soil texture affects how well nutrients and water are retained in the Soil. Clays and Organic soils hold nutrients and water much better than sandy soils. As water drains from sandy soils it often carries nutrients along with it this condition is called leaching. When nutrients leach into the soil, they are not available for plants to use.

2.4.3 Soil Plant Nutrients

The most commonly limiting resources of terrestrial habitats are Nitrogen, Phosphorus and Water. Nitrogen limitation is common because the parent materials in which soils are formed contain almost no Nitrogen rather the chemically stable form of nitrogen is atmospheric N_2 which is usable only by N-fixing plants via microbial symbionts. Non-N-fixing plants obtain Nitrogen as nitrate ammonium or organic Nitrogen. Some soils are either initially low in other mineral elements especially phosphorus and calcium or become low in these after millennia of leaching. The greatest changes in plant community biomass, composition and diversity came from Nitrogen addition in the grasslands of both Rothamsted and Cedar Creek, Minnesota (Tilman , 2001).

2.4.3.1 Nitrogen

Nitrogen is important for growth because it is a major part of all amino acids, which are the building blocks of all proteins, including the enzymes, which control virtually all biological processes. A good supply of nitrogen stimulates root growth and development, as well as the uptake of other nutrients. Plants deficient in nitrogen tend to have a pale yellowish green color (chlorosis), have a stunted appearance and develop thin, spindly stems (Brady and Weil, 1999) .Much of the nitrogen reserve is stored in the soil as organic matter and most of this organic fraction is found in the upper soil horizons.

At surface mines the upper soil horizons are usually removed and stockpiled prior to disturbance. The storage of topsoil allows for relatively rapid conversion of organic nitrogen to soluble nitrate and is subject to leaching or conversion to nitrogen gas which volatilizes out of solution into the atmosphere. Thus, when stored topsoil is spread on a disturbed landscape, nitrogen reserves may be depleted or altered by several chemical and biological phenomena and the healthy cycling of nitrogen through the ecosystem inhibited or prevented (Munshower, 1994).

Nitrogen is very dynamic and is constantly changing chemical species and concentrations. In most soils, nitrate is the common ionic form of plant-available nitrogen, but this element may also exist as Ammonium or Nitrite as well as other ions. Nitrogen is also incorporated in organic matter and microbes. When organic matter decomposes by microbial processes or when the microbes themselves die and decompose, nitrogen is released in various forms into the soil solution (Brady and Weil, 1999).

2.4.3.2 Phosphorous

Phosphorous enhances many aspects of plant physiology, including the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting (including seed production), and maturation. Root growth, particularly development of lateral roots and fibrous rootlets, is encouraged by phosphorous. Phosphorous uptake by plants is about one-tenth that of nitrogen and one-twentieth that of potassium. Its deficiency is generally not as easy to recognize in plants as are deficiencies in many other nutrients. A phosphorous-deficient plant is usually stunted, thin-stemmed, and spindly, but its foliage is often dark, almost bluish, and green. Thus, unless much larger, healthy plants are present to make a comparison, phosphorous-deficient plants often seem quite normal in appearance. In severe cases, phosphorous deficiency can cause yellowing and senescence of leaves (Brady and Weil, 1999).

Phosphorous is usually plant-available in soil as inorganic phosphate ions and sometimes as soluble organic phosphorous. The major portion of the total soil phosphorous - 96% to 99% - is not plant-available. Most of these phosphorous groups have very low solubility and are not readily available for plant uptake. When soluble sources of phosphorous, such as fertilizers and manures, are added to soils, they are fixed and, in time, form highly insoluble compounds that are not plant available. Fixation reactions in soils may allow only small fractions (10% to 15%) of the phosphorous in fertilizers and manures to be taken up by plants in the year of application (Brady and Weil, 1999).

2.4.4 Influence of Grazing on Vegetation Structure

Livestock grazing is one of the most important disturbance agents in ecosystems. Its ecological and environmental impacts have been documented such as effects on plant species richness, biodiversity and productivity (Huakun Zhou et al, 2006) The impact of grazing on vegetation refers to modifications to plant morphology and physiology resulting from direct effects such as defoliation and trampling and indirect effects such as the alteration of growth conditions. The combination of the direct and indirect effects can cause the destabilization of competitive interactions between plants. In time this can alter the dynamics of plants via the impacts on species natality, density and mortality and eventually may cause directional changes in the structure and composition of plant communities (Torrano and Valderrabano, 2004).

The impact of grazing on different plant species appears to depend on what use different herbivores make of them, the efficacy of the tolerance mechanisms to herbivory that each species develop and the competitive interactions between different plants(Briske,1991;Herms and Mattson,1992). The direct effect of Livestock grazing includes consumption of the species and soil trampling which can destroy the structure and composition of plant communities (Zarekia, *et al.*, 2013). Normally vegetation biomass, vegetation height and canopy cover percentage are reduced with increasing the gazing intensity (Milchunas *et al.*, 1998). However, the light and moderate grazing intensities can cause an increase in species diversity and pant production in comparison with rangelands under heavy grazing intensity (Huang, *et al.*, 2011).

Kilwa district has more Scrubland and Woodland than arable land .The major threat that is posed by increasing number of livestock is the creation of more grassland areas from forest and bush lands to meet the grazing demand. It is estimated that a single head of cattle requires about 10 acres of grassland per year for grazing. (Miya ,Ball and Nelson FD,2012).

2.4.5 Influence of Soil Characteristics on Vegetation

Soil characteristics may determine the type of vegetation cover of an area; some soils may have an adsorptive characteristic that enables them to hold certain nutrients in forms that are not available for uptake by plants (Mligo , 2003).As soils are the most common terrestrial substrate for plant growth, it would be seem logical that their properties(Texture , Structure , Depth ,Nutrient etc) would have a major influence over which species become established and persist thus on the structure and floristic of the vegetation at any site. Soils and vegetation are also theoretically dependent on the same independent factors such as parent materials, topography, climate, organism-availability and time (Rankin *et al*, 2007).

The ability of the soil to continue supporting plant life can be effected by effects of overgrazing that lead to soil erosion (Mligo, 2003), this is due to the fact that Overgrazing by animals can alter soil physical and chemical properties due to trampling and defoliation, thus reducing productivity. Furthermore, soil properties can influence the regions water cycle and balance directly altering wetland dynamics and wildlife habitats (Wang, *et al*, 2008*)*

CHAPTER THREE

3.0 MATERIAL AND METHODS

3.1 Location of the Study Area

Kilwa district is located in Lindi Region in southern Tanzania. It lies on latitude 8°20 to 9°56 and longitude 38°36 to 39°50 east of Greenwich. To the north it borders with Rufiji district, Coast region, Lindi and Ruangwa districts in the south, Liwale district in the west and to the east, it borders with Indian Ocean. The total district area is 13, 347.50 squire Kilometers (1,334,750 ha) of which 12, 125.9 squire kilometers is surface land and 1,221.52 square kilometers is the ocean. The total population in 2002 was 171, 057 living in 36,549 households. It is administratively divided into 6 divisions, 20 wards and 97 registered villages (Masoko and Kivinje urban areas inclusive).

Kiranjeranje lies within a latitude of -9.5 (9°30'0S) and a longitude of 39.48 (39°28' 60E).The location is situated 629Km south east (129°) of the approximate centre of Tanzania and 301Km south (176°) of the capital Dar es Salaam

Figure 3.1 : Map Showing Location and Vegetation cover of Study area

3.2 Soil Characteristics of the Study Area

In terms of soils, the lowland areas have deep, leached sandy soils derived from terrestrial sands, gravels, calcretes and laterites of Miocene to Pleistocene age. The escarpments have a mixture of ancient coral rag and sandy loam and clay soils. (Andrew, Charles and Nike , 2008)

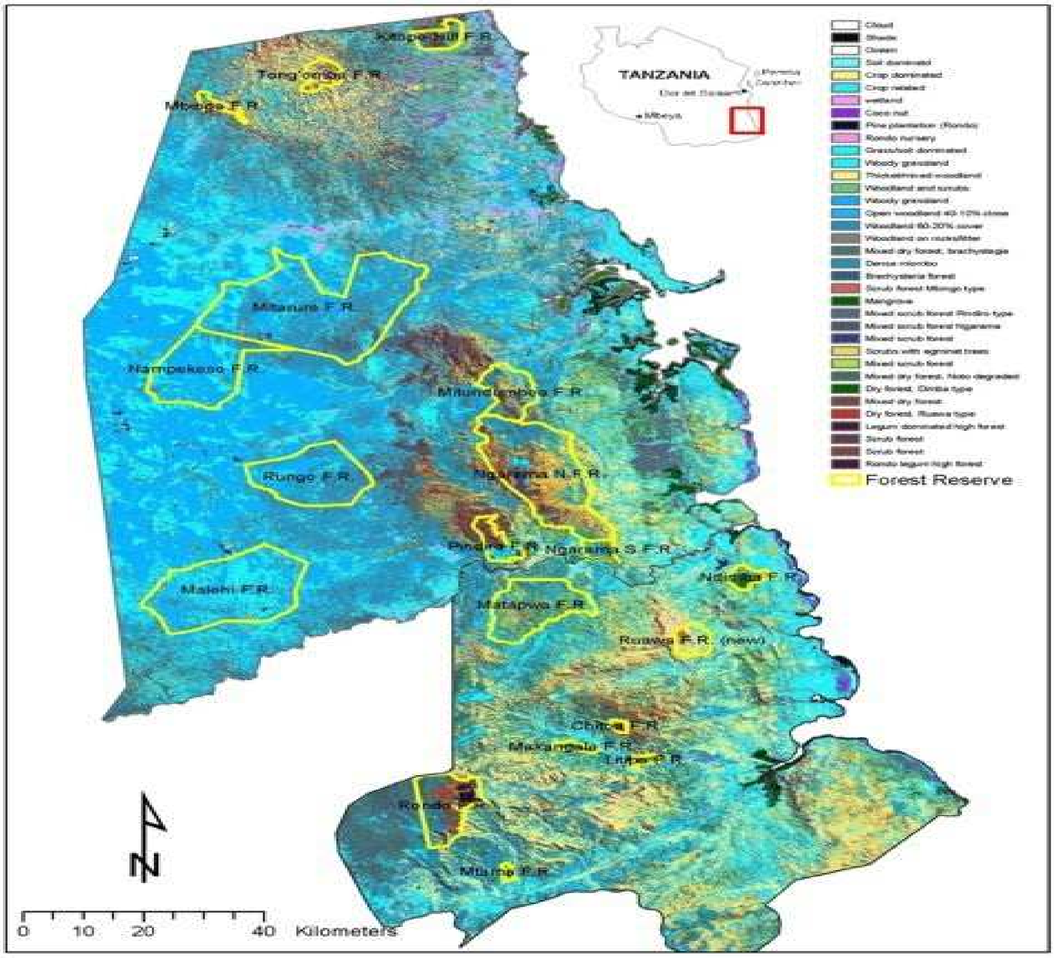

Figure 3.2 : The general vegetation distribution patterns in Kilwa district.

Source:Prins and Clarke, 2007

3.3 Sampling procedure

3.3.1 Vegetation sampling procedures

Vegetation community types, habitats available and extent of disturbance were identified during reconnaissance survey which is very important for site familiarization.

This was followed by systematically subdivision of study site into three sampling site which were ungrazed area (Nachikalala village), overgrazed (Magoyogoyo village) and moderately grazed area (Nandumbili village). At each sampling site one transect of 1 Km long was established within which 10 sampling plots were established making a total of 3 transects and 30 plots, The distance between one sampling point and another was 100 m.

The nested Quadrat sampling technique (Stohlgren *et al* 1995) was used in the sampling of plant species in the sampling sites, the technique involves the use of rectangular quadrats because it cut across several microhabitat conditions, minimize edge effect and increases the chance of including most species in the sample (Mligo, 2011).Measurements for nested Quadrat were 20 m x 25 m for the big Quadrat and 2 m x 5 m for the Quadrat placed inside the big Quadrat.

Parameters of vegetation data collection includes all plant species composition, trees includes specie's names, Diameter at Breast Height (DBH), crown cover, phenology and browsing intensity. For shrubs, frequency was recorded in addition to relative cover, height, browsing intensity and their phenology. For grasses and herbs, information on species identity, relative cover, grazing intensity, average height and the overall vegetation cover of the quadrat was estimated. Grazing intensities was observed using a six point scale.

Figure 3.3 : Nested Quadrat for Sampling Plant Species in the Study site.

3.3.2 Measurement of Edaphic Factors

At each sampling point that was established, soil samples were collected in triplicate at depths of 0 – 10 cm, 10 – 20 cm and 20 – 30 cm using a soil auger. This means a total of 30 soil samples per sampling site. The collected soil samples (90 soil samples) were kept in labeled plastic bags and then brought to the laboratory for analysis. Keeping them in plastic bag prevents moisture loss and maintains their original status. Variables that were determined using collected soil samples were (a) Soil texture, (b) Soil moisture content, (c) Soil pH, (d) Available soil phosphorus and (e) Total soil nitrogen

Figure 3.4 : Soil Sampling at the Study area

3.3.3 Estimate of Site Disturbance level

Any indication of the existing disturbance and previously occurred disturbance will be qualitatively observed and recorded on a 0 -5 point scale on the basis of the severity of disturbance in question. For this present study grazing was the anthropogenic factor observed. Table 3.1 below explained (Yohana, 2004).

Table 3.1 : Percentage Estimates of Relevé Disturbance Regime in Kiranjeranje - Kilwa Grazing area.

Disturbance code	**% of Relevé disturbed**
0	No grazing
1	1-20 % grazed
2	21-40 %grazed
3	41-60% grazed
4	61-80%grazed
5	81-100% grazed

Source: Yohana, 2004.

3.4 Data analysis

3.4.1 Laboratory Soil Analysis

3.4.1.1 Soil Texture

Soil texture was determined using the pipette method as described by Gee and Bauder (1986). The total weight was obtained from the formula: -

$$Ws + Wp + W_f = Wt$$

Where Ws = weight of the sand fraction (the amount of filtrate)

Wp = weight of the fraction taken by the pipette (clay and silt)

W_f = weight of the floccculent

Wt = total oven dry weight

The Data obtained were as percent (of total dry weight) sand, silt and clay and the texture was determined according to the texture classification system of the International Soil Science Society System (ISSSS) (Gee and Bauder, 1986).

3.4.1.2 Soil Moisture Content

Soil moisture content determination was done in the laboratory using the gravimetric method (Gardner, 1986). The method involved oven drying of the fresh soil at $105^{o}C$. Water content was calculated by dividing the difference between the wet and oven dry weight of the soil by the mass of the oven dry soil and then multiplied by 100 to obtain the percentage moisture content.

3.4.1.3 Soil pH

Soil pH was measured electrometrically using a Metrohm E510 pH meter (model; Co) using a ratio of 1:1 soil: water mixture which was stirred and allowed to equilibrate in a beaker for 30 minutes (McLean, 1982). The pH of the stirred suspension was observed from the pH meter and recorded as pH in water (pHw).

3.4.1.4 Available Soil Phosphorus

Available soil phosphorus was extracted using the Olsen extraction method as described by Olsen and Sommers, (1982) and Emteryd (1989). One gram of air-dried soil was transferred into a 250 ml flat-bottomed flask, 50 ml of 0.5N Sodium bicarbonate solution was added and the mixture was then shaken for 30 minutes following with filtration process. Ortho-phosphate was determined calorimetrically using a spectrophotometer according to the ascorbic acid method of Allen (1989) and Olsen and Sommers (1982). The amount of phosphorus in the sample was obtained from the calibration curve of standard phosphate of potassium hydrogen phosphate (Allen, 1989).

3.4.1.5 Total Soil Nitrogen

Total soil nitrogen was determined using a semi-micro Kjeldahl digestion method (Allen 1989) and colorimetric determination of the resultant ammonium by color reaction (Endo-phenol blue method). The amount of total nitrogen in the sample was obtained from the calibration curve that had been prepared using known concentrations of ammonium ions (NH_4^+) that had been prepared from ammonium chloride (Allen, 1989).

3.4.2 Vegetation Data Classification

Vegetation classification was aided by a computer program known as TWINSPAN -two way indicator species analysis (Hill 1979) TWINSPAN creates groups and also finds indicator species for those groups. In this case, hierarchical clustering was used to identify groups for vegetation classification. TWINSPAN produces no graphical output. The biggest volume of the result is the description of each division. For each division, TWINSPAN identifies the indicator pseudo species and their signs (positive or negative for one end of the ordination or the other) and lists the samples assigned to each subgroup**.** This method works with qualitative data only. In order not to lose the information about the species abundances, the concepts of pseudo-species and pseudo-species cut levels will be introduced. Each species can be represented by several pseudo-species, depending on its quantity in the sample. A pseudo-species is present if the species quantity exceeds the corresponding cut level.

3.4.3 Ordination

This is a way of predicting variations in ecological information whose elements define spatial relationship among them. The ecological elements include species and the environmental or habitat variables. The ordination method clarifies the degree of similarity among the individual species and the way they are correlated with the environmental variables. Ordination primarily endeavors to represents samples and species relationship as faithfully as possible at low dimension space (Mligo, 2003).

Ordination of the vegetation data may either be directly or indirectly effected (Whittaker, 1973).These are two important approaches involved in investigating the relative importance of the ecological parameters in vegetation analysis. The direct gradient analysis gives an ordination with an optimal environmental basis; it does show only those patterns in the species data that can be explained by the available environmental data. The vegetation sub units are arranged in ecological space along axes of moisture, nutrients and other properties of the soils and their influence on the vegetation distribution. The ordination axes are aggregates of environmental variables that best explain the species data (Constrained or canonical ordination).This is a form of regression analysis whereby the environment via a small number of ordination axes explains species distribution patterns (Mligo, 2003).

3.4.4 Multivariate analysis of Vegetation versus Environmental data

The multivariate analysis technique was used to decipher the relationship between the distribution of vegetation types and the environmental variables, and in this case direct gradient analysis was applied in particular Canonical Correspondence Analysis (CANOCO).This technique helps in assessing the effect of anthropogenic activities on vegetation type's distribution. Two spread sheet data files were used one is that of primary data comprises of plant species recorded in terms of presence absence of species from every sampling point and the other one is that of secondary data which contains the level of anthropogenic disturbances recorded from each sampling point as an environmental data matrix.

3.4.5 Species Diversity analysis

Diversity was calculated using Shannon- Weaver diversity index (Shannon and weaver 1949) as follows:

Diversity index (H') = $\sum_{i}^{\infty} pi\ In\ pi$ Where pi = ni/N, the number of individuals found in the ith species as a proportion of the total number of individuals found in all species.

In = Natural logarithm to the base e.

Shanon –Weaver diversity index assumes that individual species are sampled randomly from an even larger population and that each representative sample species has equal chance of being included at each sampling point (Mligo, 2011)

Evenness (E) =H'/ In S, where H' is the Shanon –Weaver diversity index and S is the total number of species in a site. Analysis of variance was used to compare species diversity and evenness among vegetation community types in the study site.

CHAPTER FOUR

4.0 RESULTS

4.1 Vegetation Data

The coastal forest of Kilwa were found to have different vegetation distribution pattern The study sites in which these observations were made and the plant species recorded includes Nandumbili, Magoyogoyo and Nachikalala villages.Although the species occurred on these areas seems to be repetitive, separations between the vegetation segments during data analysis were noted based on abundance of some species in the existing vegetation communities. In the 30 plots studied, a total of 69 plant species were observed (Appendix, 1).

4.1.1 Vegetation Classification

TWINSPAN (Hill *et al*., 1979) was used in classifying the vegetation data. Sites with similar vegetation characteristics were grouped together reflecting the influence of common environmental variables among the areas from which such vegetation data were collected. The Environmental influence on the vegetation grouping has been shown by the indicator species in order to reflect the similarity in the vegetation from various sites.

Results show that three Plant communities were distinguished (Figure 4.1)

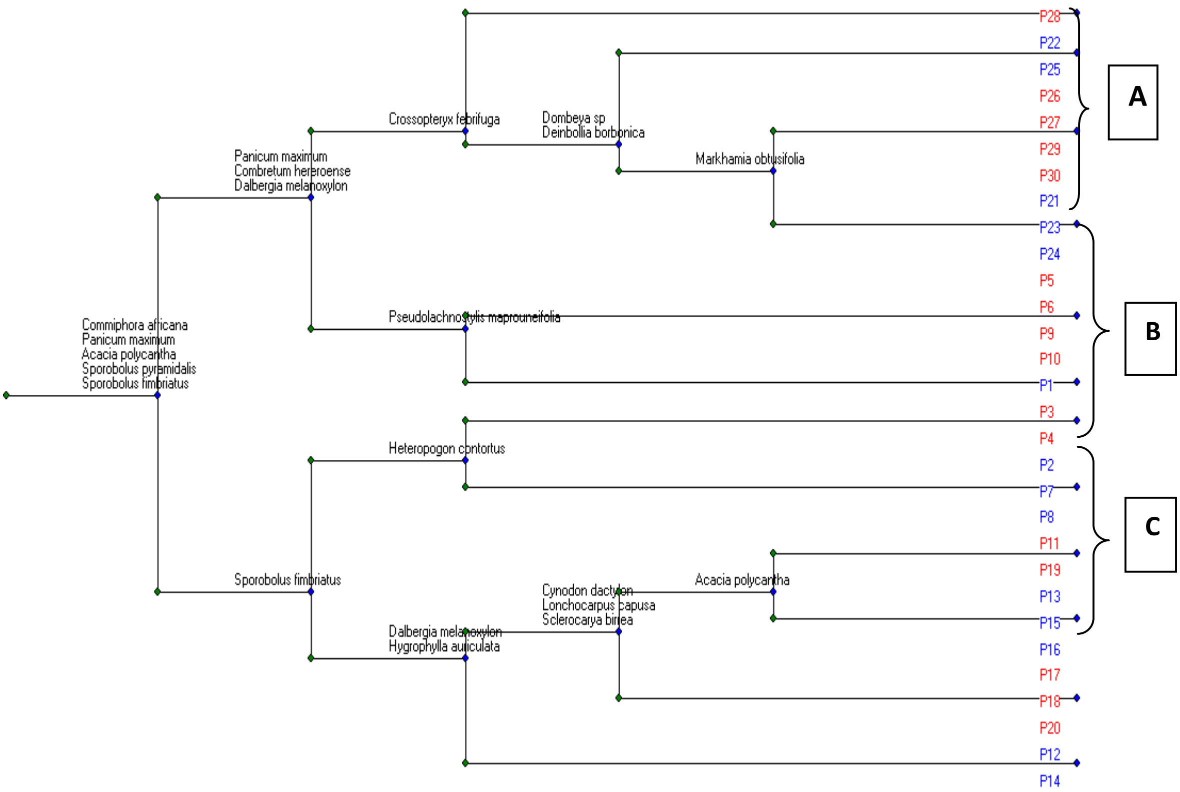

Figure 4 1 : TWINSPAN Dendrogram output for plots established at Kiranjeranje ward

The differences and similarities among groups of the study sites were detected by the indicator species. This was then characterized by the Eigen values as a measure of variations among site groups. From the TWINSPAN results three major communities were obtained as described below.

4.1.1.1 Plant Community A

This group comprises of plots 21, 22, 23, 24, 25, 26, 27, 28, 29, 30 whereby the dominant species were *Dombeya cincinata, Panicum maximum, Hypharhemia rufa, Grewia conocarpa, Catunaregum spinosa* and *Combretum collinum.*This is Ungrazed area.

4.1.1.2 Plant Community B

This group comprises of plots 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 whereby the dominant species were *Dalbergia melanoxylon, Markhamia obtusifolia* and *Acacia nigrescens* .This is moderately grazed area.

4.1.1.3 Plant Community C

This group comprises of plots 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 whereby the dominant species were *Sporobolus fimbriatus* and *Sporobolus pyramidalis.* This is heavily grazed area.

The grouping of the plots as described above was also confirmed using DCA programme as shown in Figures 4.2.Three Groups were recognized, Group A on the left side contains plots that were mainly found in Ungrazed area of the study area, these plots were as follows 21, 22, 23,24,25,26, 27, 28, 29 and 30.

The second group, (B) at the centre of the ordination diagram consists of plots 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10. These were found in the moderately grazed area.

The third group (C) on the right side of the ordination diagram represents the heavily grazed area comprises of plots 11, 12, 13,14,15,16,17,18,19 and 20.

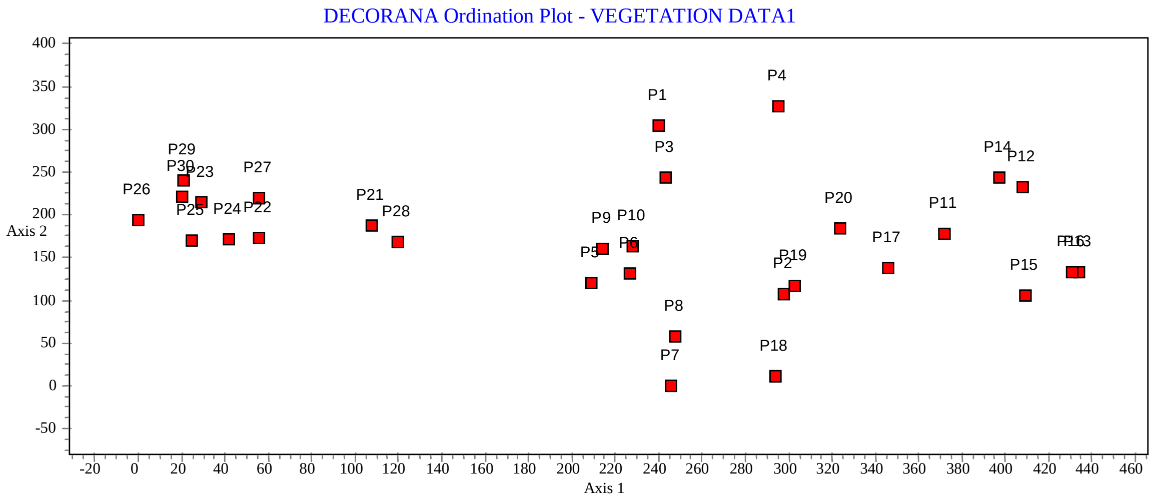

Figure 4. 2 : Ordination of relevés based on Detrended Corresponding Analysis (DCA)

4.1.2 Ordination

The ordination of Plant species and Environmental variables obtained from CCA is presented in the Figure 4.3, whereby each point represent a species and the distance between the points reflect the degree of similarity in their distribution across the plot.

Taking into consideration that Grazing is one of the major factor that account for vegetation composition and distribution in the study area, it can be noted that plots in the heavily grazed area (right side of the ordination diagram) are dominated by species such as *Sporobolus fimbriatus* and *Sporobolus pyramidalis*. Moderately grazed area of the study area (in the middle of the ordination diagram) are dominated by species such as *Dalbergia melanoxylon* ,*Markhamia obtusifolia* and *Acacia nigrescens,* whereas the ungrazed area on the Left hand side is dominated by *Piliostiguna thonningii*,*Panicum maximum*,*Catunaregum spinosa*, and *Dombeya cincinata*

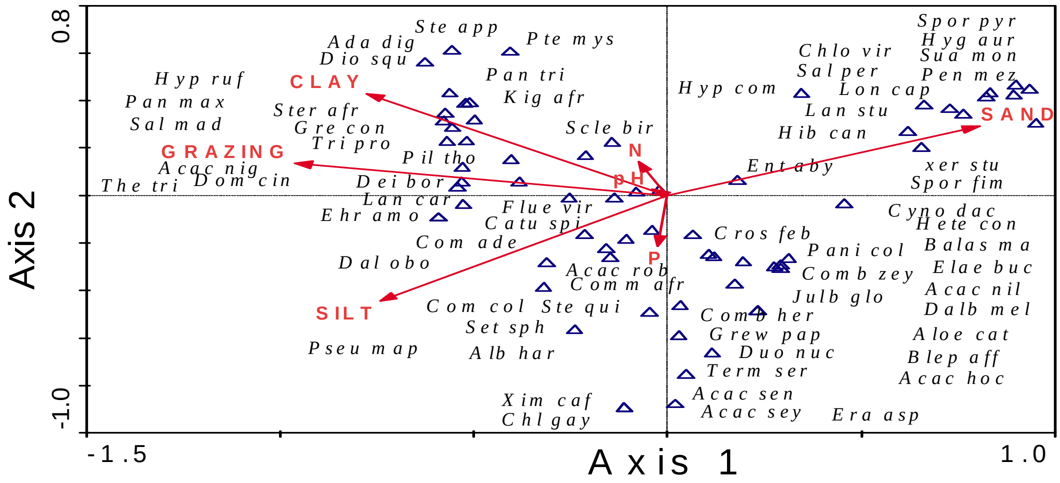

Figure 4.3 : Ordination diagram based on Canonical Correspondence Analysis of Plant Species with respect to Environmental variables

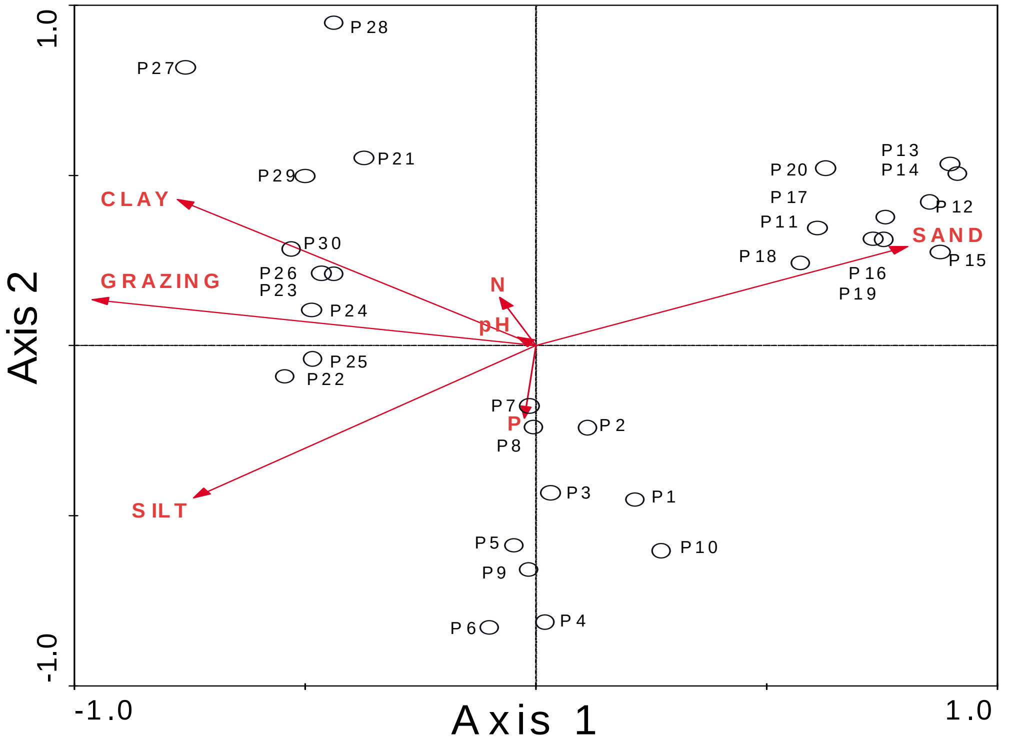

Figure 4.4 : Ordination diagram based on Canonical Correspondence Analysis of Plant communities with respect to Environmental variables

4.2 Environmental data

Environmental data collected from Kiranjeranje ward as presented in Table 4.1 showed considerable variation of both Physical and Chemical characteristics in various communities in the study area. Example Nitrogen ranges from 0.22% to 2.54% while Phosphorus ranges from 0.23% to 2.29%.The soils in the study area are acidic though few plots in the moderately grazed area have slight alkaline soil(Plot 8 and 10). In case of soil texture, the large percentage was sand soil especially in the heavily grazed area and the percentage decreases as the disturbance level decrease. The percentage of silt soil was high in the ungrazed and moderately grazed areas. (Table 4.1).

4.2.1 Results of Data analysis

The relationship between plant species distribution and environmental variables was determined using canonical correspondence analysis (CCA). The CCA resulted in ordination diagrams presented in Figures 4.3 and 4.4 for Species and Plots respectively simultaneously displayed the main patterns of community variations as far as these relate to environmental variations and the main pattern in the weighted averages of each of the species with respect to environmental variables (ter Braak, 1986, 1987). Each species/sample was also examined in relation to the environment gradient of most importance in defining plant/community assemblage composition (Table 4.3, and the summary is presented in Table 4.4).

A comparison of the Environmental variables to each other by Monte Carlo permutation test (Table 4.2) showed that Grazing is the most significant environmental variable in the study area ($F > 3.199$; $P < 0.05$) determining the distribution of plant species in the study area .

Table 4.1 : Environmental data collected from 30 sample plots in Kiranjeranje

PLOT	pH	%N	%P	%CLAY	%SILT	%SAND	GRAZING SCALE
1	5.6	0.55	0.48	1	50	49	2
2	7.1	0.07	0.83	1.5	34	64.5	2
3	6.5	1.17	1.28	3.3	56	40.7	2
4	4.8	0.08	1.17	7.3	88.7	4	2
5	5.6	0.26	0.19	9.3	74	14.7	2
6	5.5	1.03	1.93	7.3	76.7	12.7	2
7	7.9	1.89	0.52	2.2	38	59.8	2
8	8.3	0.39	0.23	1.5	30	68.5	2
9	6.3	2.45	0.82	2.7	70.7	26.7	2
10	8.8	0.93	0.39	1.7	51	47.3	1
11	6.3	1.3	0.6	2	21	77	1
12	5.9	0.22	0.75	1.3	13.3	85.3	1
13	5.8	0.38	0.63	0.3	7.3	92.3	1
14	5.7	1.72	0.51	0.3	12.7	87	1
15	5.7	0.24	0.6	0	16.7	83.3	1
16	6.3	1.19	0.73	1.5	21.8	76.7	1
17	6.4	1.41	1.35	1.3	21.3	77.3	1
18	5.8	0.91	0.76	8.7	31.3	56.7	1
19	6.1	1.58	1.07	7.3	44	48	1
20	6.6	0.05	2.29	6.7	24.7	68.7	1
21	6.3	2.54	0.34	11.3	64.7	29.3	3
22	5.9	1.83	0.83	12.7	65.3	20	3
23	5.7	0.34	0.75	14	59.3	26.7	3
24	6.1	0.81	0.98	12.7	60	27.3	3
25	6.8	0.66	1.52	8.7	58	35.3	3
26	6.5	0.37	1.33	14.7	55.3	30	3
27	7.9	0.69	0.91	22.7	54	23.3	3
28	4.9	0.12	0.48	24	62.7	13.3	3

29	5.5	1.46	0.5	18.7	68	13.3	3
30	6.1	0.2	0.51	14	65.3	22.7	3

Table 4.2 : Results of Monte Carlo Permutation test

Environmental variable	F-value	P-value
Grazing	3.29	0.0020
Silt	1.73	0.0060
Clay	1.51	0.0060
Sand	1.31	0.0880
Nitrogen	1.20	0.1660
pH	1.19	0.1980
Phosphorus	0.96	0.5860

The weighted average indicates the centre of a species distribution along an environmental variable gradient (Yohana, 2004) .The distance between points on the graph is a measure of the degree of similarity or difference between plots, thus points which are close together represent plots that are similar in floristic composition whereas the further apart any two points are the more dissimilar the plots are (Yohana, 2004). Also Length of environmental vector indicates its importance to the ordination, Direction of the vector indicates its correlation with each of the axes and Angles between vectors indicates the correlation.

Table 4.3 : Weighted correlation matrix (Weight=sample total

	SPEC AX1	SPEC AX2	SPEC AX3	SPEC AX4	ENVI AX1	ENVI AX2	ENVI AX3	ENVI AX4	pH	N	P	CLAY	SILT	SAND	GRAZING
SPEC AX1	1														
SPEC AX2	-0.0313	1													
SPEC AX3	0.0021	0.0238	1												
SPEC AX4	0.0155	-0.0287	-0.0234	1											
ENVI AX1	0.9812	0	0	0	1										
ENVI AX2	0	0.9037	0	0	0	1									
ENVI AX3	0	0	0.9362	0	0	0	1								
ENVI AX4	0	0	0	0.9454	0	0	0	1							
pH	-0.0388	0.0237	0.1222	-0.0572	-0.0395	0.0263	0.1305	-0.061	1						
N	-0.074	0.1283	0.4685	-0.008	-0.075	0.142	0.5004	-0.008	0.084	1					

	4				9										
P	-0.0244	-0.1932	0.0766	-0.1388	-0.0249	-0.214	0.0818	-0.147	-0.1233	-0.0943	1				
CLAY	**-0.7607**	0.3877	0.1801	0.2028	-0.7753	0.429	0.1924	0.2146	-0.2026	-0.0038	0.0029	1			
SILT	**-0.7282**	-0.402	0.0717	0.3459	-0.7422	-0.445	0.0766	0.3658	-0.3148	0.089	0.1295	0.5435	1		
SAND	**0.7886**	0.2641	-0.1434	-0.3186	0.8036	0.2922	-0.1532	-0.337	0.3308	-0.0507	-0.1321	-0.7047	-0.975	1	
GRAZING	**-0.9439**	0.1233	-0.1535	-0.0821	-0.962	0.1364	-0.164	-0.087	-0.0822	0.0862	-0.0394	0.7587	0.6499	-0.71	1

4.2.2 CCA Result

The ordination axes produced come out in descending order of importance shown by their Eigen values, with the first axis summarizing more variation (63.5%), followed by the second axis (38.2%), then the third axis (27%) and finally the fourth axis (23.1%) respectively (Table 4.4).

Table 4.4 : Correlation coefficients between axes and variable obtained with CCA on all plots and all environmental explanatory variables.

Axes	**1**	**2**	**3**	**4**	**Total Inertia**
Eigen values	0.635	0.382	0.27	0.231	5.767
Species - Environment Correlations	0.981	0.904	0.936	0.945	
Cumulative Percentage variance of species data	11	17.6	22.3	26.3	
Cumulative Percentage variance of species-Environment relation:	31.9	51.1	64.7	76.3	

The First four CCA axes indicated high species –environmental correlation index value (Table 4.4), this shows the significance of the measured environmental variables (Soil properties and Grazing intensity) on the distribution and diversity of plant species.

The CCA ordination analysis gave more weight to the measured environmental variables indicated by much longer arrow for both CCA diagrams for sample site and species (Figure 4.3 and 4.4).

Environmental variables observed to have much influence on variation the study area were grazing intensity, silt, sand and clay. In the figures 4.3 and 4.4, the distribution of individual species and plots groupings are shown clearly in relation to arrows representing environmental variables and gradients.

The first four CCA axes indicated high Species – Environmental correlation index values 0.9812, 0.9037, 0.9362 and 0.9454 respectively (Table 4.4) which shows the significance of the measured environmental variables on the distribution and diversity of plant species.

Species axis one represents the influence of clay, silt, sand and grazing on the distribution of plant species at Kiranjeranje Kilwa. Generally Sand soil shows positive correlation (r=0.7886) while silt, grazing and clay shows negative correlation (r = -0.7282, -0.9439 and -0.7607 respectively).In areas with sand soil dominant species were *Suaeda monoica, Pennisetum mezianum, Entada abyssinea* and *Xeroderis stuhlmannii* (Figure 4.3).

Grazing also affect the distribution of species as well as nutrients and had negative correlation in both Species axis one (r = -0.9439) and Environmental axis one (r = -0.962) (Table 4.3).Plant species dominant in areas with high grazing intensity were *Acacia nigrescens, Maximum panicum, Hypharrhemia rufa* and *Thameda triandra.*

4.3 Species Diversity

Summary of ∝ diversity indices (Figure 4.5, Appendix 2) was prepared from the results on species composition of different plots presented in Appendix 1 and this shows that, the mean diversity indices were 2.35142, 1.84805 and 2.36577 for moderately grazed area, heavily grazed area and Ungrazed area respectively. (a)Moderately Grazed area

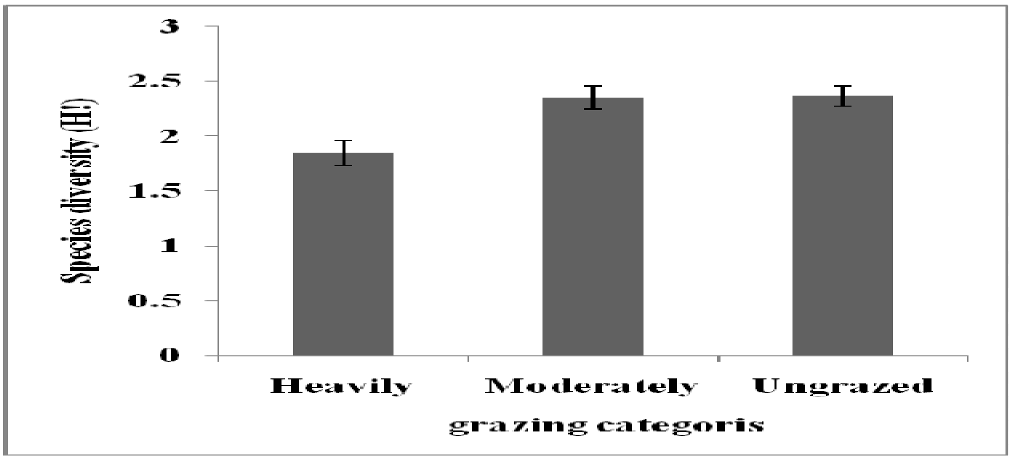

Figure 4.5 : Species diversity in relation to plant communities in Kiranjeranje study area

The Turkey- Kramer Multiple Comparison Test was performed from these results to examine if there were significant differences between the ∝ diversity indices of various parts of the study area. The results of the test (Table 4.5) showed that, there was a significant difference of mean ∝ diversity indices between heavily grazed area and moderately grazed area ($q = 5.062$; $p < 0.01$), Also the significance difference was observed between heavily grazed area and ungrazed area ($q = 5.207$; $p < 0.01$) but no significance different between moderately grazed area and ungrazed area ($q = 0.1449$; $p > 0.05$).

Table 4.5 : Results of Turkey-Kramer Multiple Comparison test for species diversity differences among pairs of sites

Comparison	Mean.difference	q-Value	P-Value	Significance
Heavily vs Moderately grazed area	0.5033	5.062	$P<0.01$	**
Heavily vs Ungrazed area	0.5177	5.207	$P<0.01$	**
Moderate vs Ungrazed area	0.01441	0.1449	$P>0.05$	ns

If the value of q is greater than 3.649 then P value is less than 0.05

** Very significant   ns –Not significant

The relationship between species diversity and the degree of grazing intensity showed that species diversity was almost the same between the ungrazed area and moderately area and low in the heavily grazed area. The reason behind may be no new species colonize the moderately grazed area though grazing can open space for colonization.

4.4 Species Evenness

Results on species evenness shows that values were 0.51302, 0.436468 and 0.558742 for moderately grazed area, heavily grazed area and ungrazed area respectively (Figure 4.6, Appendix 3).

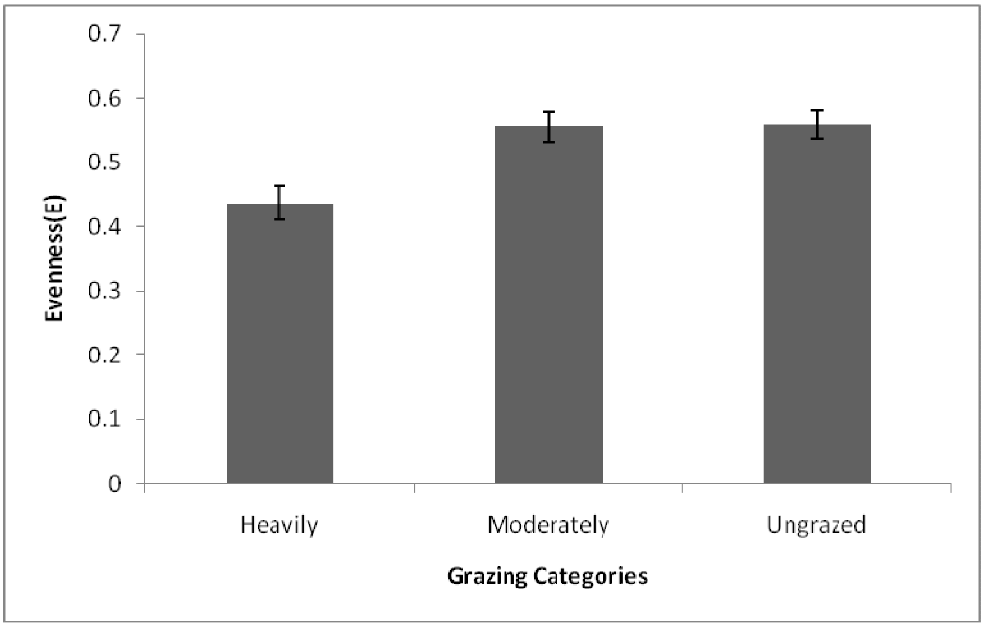

Figure 4.6 : Species evenness in relation to plant communities at Kiranjeranje study area

Turkey Kramer Multiple comparison test (Table 4.6) shows that there were significance difference between Heavily and Moderately grazed area and also Heavily and Ungrazed area but no significance difference between Moderate and Ungrazed area.

Table 4.6 : Results of Turkey-Kramer Multiple Comparison test for species evenness differences among pairs of sites

Comparison	Mean.difference	q-Value	P-Value	Significance
Heavily vs Moderately grazed area	0.1189	5.062	$P<0.01$	**
Heavily vs Ungrazed area	0.1223	5.207	$P<0.01$	**
Moderate vs Ungrazed area	0.003405	0.1450	$P>0.05$	ns

If the value of q is greater than 3.649 then P value is less than 0.05

** Very significant
ns –Not significant

4.5 Species Richness

Species richness results were as follows 11.0 for moderately grazed area 6.7 for heavily grazed area and 11.1 for ungrazed area (Figure 4.7, Appendix 4).

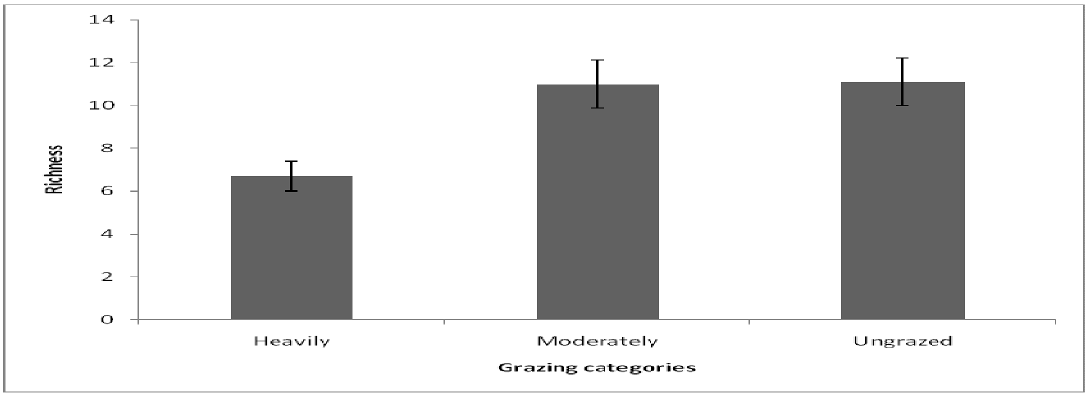

Figure 4.7 : Species richness in relation to plant communities at Kiranjeranje study area

Turkey Kramer Multiple comparison test (Table 4.7) shows that there were significance difference between Heavily and Moderately grazed area and also Heavily and Ungrazed area but no significance difference between Moderate and Ungrazed area.

Table 4.7 : Results of Turkey-Kramer Multiple Comparison test for species richness differences among pairs of sites

Comparison	**Mean.difference**	**q-Value**	**P-Value**	**Significance**
Heavily vs Moderately grazed area	4.300	4.652	P<0.05	*
Heavily vs Ungrazed area	4.400	4.760	P<0.01	**
Moderate vs Ungrazed area	0.1000	0.1082	P>0.05	ns

If the value of q is greater than 3.649 then P value is less than 0.05
** -Very significant
*- Significant
ns –Not significant

CHAPTER FOUR

5.0 DISCUSSION

5.1 Plant Species composition

During the present study at Kiranjeranje ward Kilwa district 69 plant species were observed and recorded (Appendix 1) of which species like *Milicia excelsa*, *Pteleopsis myrtifolia* and *Zanthoxylum* which were expected to be part of the Mixed dry forest of the study area (Eriksen *et al*., 1994) were not observe.UTUMI (2002) also clarifies that most of the scrub forest in the area is dominated by *Grewia* sp, *Hymenocardia ulmoides*, *Cussonia zimmermannii*, *Bombax rhodognaphalon* and *Vitex schliebenii* but only some of these plant species were spotted and recorded in the study (Appendix 1).Absence of these species may be due to sampling biases as the location of plots were randomly placed following the stratified random sampling or the area may be secondary regenerating coastal forest previously cleared for farmland hence most of these species were replaced by other invaded species (Utumi, 2002). The other reason may be a result of grazing activities taking place in the study area which results into loss of some plant species (see plates 5.1, 5.2 and 5.3)

Plate 4.1 : Heavily Grazed area at Magoyogoyo village – Kiranjeranje

Plate 4.2 : Heavily grazed area at Magoyogoyo village

Plate 4.3 : Heavily grazed land totally cleared by grazing activities

5.2 Vegetation distribution in relation to Environmental variables

Plant community type in the study area categorized as ungrazed differs from that of heavily grazed area although not much from moderately grazed area. Existence of variations in different plant communities in the coastal forest were also reported by Mligo, (2014).

Vegetation types recorded in the Kiranjeranje ward were positioned with environmental variables studied in the Ordination biplots (Figures 4.3 &4.4). Generally these Ordination figures reflect the zonation in terms of distribution of the vegetation which also represents their correlation with the distribution of Environmental variables. Grazing and Soil texture (Clay, Sand and Silt) were probably the most significant factors correlated with species distribution in the study area, these variables are displayed with long arrows in the Ordination diagrams and have high correlation coefficients with Species axis 1, 2, 3 and 4(Table 4.3).

The areas which were categorized as ungrazed area were characterized by presence of woodland and bush land (Plates 5.4 and 5.5) and the dominant species are *Dombeya cincinata*, *Panicum maximum*, *Hypharhemia rufa*, *Grewia conocarpa*, *Catunaregum spinosa* and *Combretum collinum.*

The heavily grazed area of the study area was characterized by lack of forest trees, bare soil and patches of grassland (Plates 5.1, 5.2 and 5.3). Grazing intensity can be regarded as a very important factor controlling vegetation distribution in Kiranjeranje ward.

Plate 5.4 : Ungrazed area in Kiranjeranje Study area, Dominated by woodland

Plate 5.5 : Ungrazed area at Kiranjeranje ward

Evidence of recovery of the original floristic characteristics of the forest is still not promising because grazing activities was still taking place during the present study (Plate 5.2). Generally both Moderately and Heavily grazed areas lack Endemic species.

In the ordination diagram, Grazing is represented by axis two and the only variable which seems to correlate positively with it is clay. Several reasons can be explained on this relationship, Grazing always cause compaction of the soils the higher the grazing intensity the finer the soil particles. This is also supported by Greenwood and McKenzie (2001) who said that susceptibility of soils to compaction increases with increasing clay content, Also Morris and Reich (2013) explained that clays are characterized by fine soil particles and this make them more compactable.

Ordination diagrams also shows that Grazing had very low correlation (the correlation is not significant) with pH,N and P, this suggests that grazing activities had so far no significant impact on pH and soil nutrient in the study area , the reason may be time because these livestock in the study area came in 2006/07 after being evicted from IHEFU and this data were collected in 2014 meaning only seven year these Livestocks exist in the study area hence it is possible that the impact on soil chemical properties is still not measurable. This variation is probably due to the great number of variables involved in the nutrient loss process and to the considerable effect the relative timing of management and weather factors can have on nutrient movement.

Plate 6.6 : Moderately grazed area at Kiranjeranje

Plate 5.7 : Moderately grazed area

Plate 5.8 : Water hole in the study area with no vegetation covers around due to grazing

Plate 4.9 : Plate 4.9 Man made water hole in the study area (indicator of grazing activities in the study area

5.3 Species diversity

Species diversity showed negative correlation with the level of grazing intensity in the study area. This is contrary to hypothesis number 1 ,the ungrazed area of the study area had a species diversity index of 2.36577 followed by moderately grazed area 2.35142 while the heavily grazed area had the least species diversity 1.84805 (Figure 4.5)

Figure 4.5 clearly shows that there is higher species diversity in the ungrazed area (2.36) than in the heavily grazed area (1.84) and their difference is very significant ($P<0.01$) Table 4.5. Furthermore results on species evenness and richness show that the Ungrazed area are higher than heavily grazed area (Table 4.6 and 4.7). These results show that heavily grazing can probably result into environmental degradation and loss of plant species.

A comparison of species diversity values shows that the ungrazed area in the study site had higher species diversity compared to heavily grazed area. This is contrary to Hypothesis 1 which emphasize that Extensive grazing significantly increases plant species diversity in the study area because it is believed that disturbance such as grazing open space for new colonization. Species diversity in terms of richness is higher when disturbance is maintained at an intermediate level (Yohana , 2004).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The main findings of this study have been on several relationships of ecological and environmental factors to the vegetation distributions in the Coastal forest of Kiranjeranje, Kilwa district.

The major finding was the influence of Livestock grazing on Plant species diversity and distribution in the study area. It had been hypothesized that extensive grazing significantly increases species diversity. Results recorded in the present study shows that the higher the grazing intensity the lower the species diversity. However there is a very slight difference of species diversity between the ungrazed area and moderately grazed area. This indicates a significant negative influence of grazing on species diversity on the study area studies. The difference in species diversity that was recorded on different communities in the study area may have been due to differences in the level of grazing.

Taking into consideration of the results recorded in the present study, it can therefore be concluded that moderately grazing can in time lead to increase in species diversity and this is due to opening up of space for new colonization. Heavily grazing causes severe Environmental degradation and totally loss of plant species and this may lead to change of plant community from forest to grassland.

6.2 Recommendation

The present study examines the influence of livestock grazing on plant species diversity and distribution in Kiranjeranje, Kilwa district which is a coastal forest area. The results obtained are valid for Coastal forest communities only. Long term monitoring study is very important in the study area because with that, the more clear relationship between grazing and plant species diversity can be obtained.

In respect to biodiversity conservation, the present study recommends the following:

- For the Policy makers there is a need for long term conservation plan on the study area, this is because with time grazing pressure will threaten the existing vegetation and biodiversity at large. Also developing a "sustainable grazing system" which combines traditional pastoral knowledge, scientific range management principles and pastoral local institutions.
- For Local Government there is a need to ensure, the grazing systems in the study area to be innovated, that means livestock mobility are only allowed to some extent. Also provide community education regarding grazing and its impact to Environment should be given.
- For Further studies , research on Impact of Livestock grazing on Soil chemical properties is very important because its impacts is more significant after a period of time.

REFERENCES

Brady, C. N and Weil, R. R. (1999). The Nature and Properties of Soils. Prentice-Hall, Inc. Upper Saddle River, New Jersey.

Burgess, N. D. (2000) .Coastal Forests of Eastern Africa. IUCN Gland, Switzerland and Cambridge, UK.

Clarke, G. P. & Dickinson, A. (1995). Status Reports for 11 Coastal ... Frontier-Tanzania Technical Report No. 17. The Society for. Environmental Exploration, U.K./The University of Dar es Salaam, Tanzania. Pbk. ISSN: 0960 - 2437.

Ellison, L. (1960).Influence of Grazing on Plant succession of rangelands.Bot.Review 26 (1):1 – 78.

Fiona, C. C. (2010).Impact of Livestock Grazing on Soil Physical Quality and Phosphorus and Suspended sediment losses in surface runoff. A thesis for the award of Doctor of Philosophy degree at Lincoln University, New Zealand.145 pp.

Hill , M. O. (1979). TWINSPAN-A FORTRAN Program for arranging Multivariate Data in an ordered two-way table by classification of the individuals and attributes. Cornell University, Ithaca, New York.

Juha, P. (2007). Maintaining Plant Species Richness by cattle grazing, Mesic semi natural grasslands as focal habitat. A dissertation for the Award of Msc, University of Helsinki.Finland.

Kettler, A. K, Doran, J.W and Gilbert, T.L. (2001). Simplified Method for Soil particle-size determination to accompany soil quality analyses. Soil Science Society.Vol 65: 849 - 852

Miya, M, Ball, S. M. J and Nelson, F. D. (2012). Drivers of Deforestation and Forest Degradation in Kilwa Distict.

Mligo, C. (2012). Anthropogenic disturbance on the vegetation in Makurunge woodland, Bagamoyo district,Tanzania.Tanzania Journals of Science.Vol 37.

Mligo, C, Lyaruu, H. V. M and Ndangalasi, H. J. (2011). The effect of anthropogenic disturbances on population structure and regeneration of *Scorodophloeus fischeri* and *Manilkara sulcata* in Coastal Forests of Tanzania. Forest Science .Vol 73 (1):33 – 40.

Morris, K. and Reich, P. (2013) Understanding the relationship between livestock grazing and wetland condition. Arthur Rylah Institute for Environmental Research Technical Report Series No. 252. Department of Environment and Primary Industry, Heidelberg, Victoria.

Ngailo, J. A. (2010). Assessing the Effect of Eviction on household Food Security of Livestock keepers from Usangu wetlands in SW Tanzania.Livestock Research and Rural Development.Vol 23 (3).

Prins, E and Clarke, G. P. (2007). Discovery and Enumeration of Swahilian Coastal Forests in Lindi Region, Tanzania. Biodiversity and Conservation .Vol 16(5):1551-1561.

Pokharel, A. (2005). Effects of Grazing on Plant Species Diversity and above ground biomass in a Trans-Himalayan rangeland: Nepal Journals Online. Vol 17(1):25 - 31

Tanzania Ministry of Foreign Affairs (2002). Utumi Biodiversity Surveys Report. Government of Tanzania.77 pp.

Yohana, L. (2004). The Effect of Edaphic factors and anthropogenic disturbances on the distribution of woody plant species distribution in Pande Game reserve. A dissertation for the award of MSC degree at UDSM, Tanzania.117 pp.

APPENDICES

Appendix 1 : Composition of Plant species observed and recorded in Kiranjeranje Kilwa District and their cover value

PLOT	TYPE OF SPECIES	COVER VALUE
1	1. *Acacia hockii*	1
	2. *Acacia Senegal*	2
	3. *Aloe catrosalea*	1
	4. *Balanites sp*	1
	5. *Catunaregum spinosa*	1
	6. *Combretum hereroense*	1
	7. *Commiphora Africana*	1
	8. *Cynodon dactylon*	1
	9. *Dalbergia melanoxylon*	3
	10. *Elaeodendrom buchannii*	1
	11. *Flueggea virosa*	1
	12. *Grewia papilosum*	1
	13. *Heteropogon contortus*	1
	14. *Markhamia obtusifolia*	2
	15. *Panicum coloratum*	1
	16. *Pseudolachnostylis maprouneifolia*	1
	Total	20
2	1. *Acacia nigrescens*	3
	2. *Acacia robusta*	1
	3. *Combretum hereroense*	1
	4. *Combretum zeyheri*	1
	5. *Crossopteryx febrifuga*	1
	6. *Cynodon dactylon*	1
	7. *Dalbergia spinosa*	2
	8. *Elaeodendrom buchanii*	1
	9. *Julbernardia globiflora*	1

	10. Panicum coloratum	1
	Total	13
3	*1. Acacia nigrescens*	2
	2. Acacia nilotica	1
	3. Blepharis affinus	1
	4. Catunaregum spinosa	1
	5. Combretum collinum	1
	6. Crossopteryx febrifuga	1
	7. Dalbergia melanoxylon	3
	8. Elaeodendrom buchannii	1
	9. Heteropogon contortus	1
	10. Terminalia sericea	1
	Total	13
4	*1. Acacia nilotica*	1
	2. Acacia Senegal	3
	3. Acacia seyal	1
	4. Balanites sp	1
	5. Combretum hereroense	1
	6. Dalbergia melanoxylon	4
	7. Elaeodendrom buchannii	1
	8. Entada abyssiniea	1
	9. Flueggea virosa	1
	10. Heteropogon contortus	1
	11. Terminalia sericea	1
	Total	16
5	*1. Acacia polycantha*	1
	2. Catunaregum spinosa	1
	3. Combretum adegonium	1
	4. Combretum hereroense	1
	5. Combretum zeyheri	1
	6. Commiphora Africana	1

	7. Crossopteryx febrifuga	1
	8. Cynodon dactylon	1
	9. Dalbergia melanoxylon	1
	10. Duosperuna nucrenata	1
	11. Heteropogon contortus	1
	12. Piliostiguna thonaingii	1
	13. Setaria sphacelata	1
	14. Thameda triandra	1
	Total	14
6	*1. Acacia Senegal*	3
	2. Albizia sp	1
	3. Chloris gayana	1
	4. Combretum adegonium	1
	5. Combretum collinum	1
	6. Combretum hereroense	1
	7. Combretum zeyheri	1
	8. Commiphora Africana	1
	9. Crossopteryx febrifuga	1
	10. Dalbergia melanoxylon	3
	11. Duosperuna nucrenata	1
	12. Eragrostis aspera	1
	13. Flueggea virosa	1
	14. Panicum coloratum	1
	15. Setaria sphacelata	1
	16. Setaria sphacelata	1
	17. Sterculia quinqueloba	1
	18. Ximenia caffra	1
	Total	22
7	*1. Acacia robusta*	1
	2. Combretum hereroense	1
	3. Dalbergia melanoxylon	4

	4. *Duosperuna nucrenata*	1
	5. *Setaria sphacelata*	1
	6. *Thameda triandra*	1
	Total	9
8	1. *Acacia nigrescens*	1
	2. *Acacia robusta*	1
	3. *Combretum hereroense*	1
	4. *Commiphora Africana*	1
	5. *Crossopteryx febrifuga*	1
	6. *Dalbergia melanoxylon*	3
	7. *Sclerocarya birrea*	1
	8. *Setaria sphacelata*	1
	9. *Sporobolus fimbriatus*	1
	Total	11
9	1. *Acacia polycantha*	2
	2. *Albizia sp*	1
	3. *Combretum hereroense*	1
	4. *Commiphora Africana*	1
	5. *Dalbergia melanoxylon*	3
	6. *Heteropogon contortus*	1
	7. *Sclerocarya birrea*	1
	8. *Sporobolus fimbriatus*	1
	Total	11
10	1. *Acacia polycantha*	2
	2. *Combretum zeyheri*	1
	3. *Commiphora Africana*	1
	4. *Dalbergia melanoxylon*	3
	5. *Duosperuna nucrenata*	1
	6. *Heteropogon contortus*	1
	7. *Sclerocarya birrea*	2
	8. *Sporobolus fimbriatus*	1

	9. *Terminalia sericea*	1
	Total	13
11	1. *Acacia nilotica*	1
	2. *Acacia polycantha*	1
	3. *Chloris virgata*	1
	4. *Hyphaene compressa*	1
	5. *Salvadora persica*	1
	6. *Sporobolus fimbriatus*	2
	7. *Sporobolus pyramidalis*	1
	8. *Suaeda monoica*	1
	Total	9
12	1. *Entada abyssiniea*	1
	2. *Hygrophylla auriculata*	1
	3. *Panicum coloratum*	1
	4. *Sporobolus fimbriatus*	3
	5. *Sporobolus pyramidalis*	3
	6. *Suaeda monoica*	1
	Total	10
13	1. *Cynadon dactylon*	1
	2. *Pennisetum mezianum*	1
	3. *Sporobolus fimbriatus*	2
	4. *Sporobolus pyramidalis*	1
	Total	5
14	1. *Elaeodendrom buchanii*	1
	2. *Heteropogon contortus*	1
	3. *Hygrophylla auriculata*	1
	4. *Sporobolus fimbriatus*	2
	5. *Suaeda monoica*	1
	Total	6
15	1. *Combretum hereroense*	1
	2. *Crossopteryx febrifuga*	1

	3. Dalbergia melanoxylon	1
	4. Pennisetum mezianum	1
	5. Sporobolus fimbriatus	2
	6. Sporobolus pyramidalis	1
	7. Suaeda monoica	1
	8. Xeroderis stuhlmannii	2
	Total	10
16	*1. Cynodon datylon*	1
	2. Pennisetum mezianum	1
	3. Salvadora persica	1
	4. Sporobolus fimbriatus	2
	Total	5
17	*1. Combretum zeyheri*	1
	2. Dalbergia melanoxylon	1
	3. Flueggea virosa	1
	4. Hygrophylla auriculata	1
	5. Lannea stuhlmannii	1
	6. Lonchocarpus capusa	1
	7. Salvadora persica	1
	8. Sclerocarya birrea	1
	9. Sporobolus fimbriatus	3
	10. Sporobolus pyramidalis	1
	11. Suaeda monoica	1
	Total	13
18	*1. Acacia nigrescens*	1
	2. Dalbergia melanoxylon	1
	3. Hyphaene compressa	1
	4. Lonchocarpus capusa	1
	5. Sclerocarya birrea	1
	6. Sporobolus fimbriatus	2
	7. Sporobolus pyramidalis	1

	8. *Thameda triandra*	1
	Total	9
19	1. *Acacia polyacantha*	1
	2. *Combretum hereroense*	1
	3. *Cynodon dactylon*	1
	4. *Dalbergia melanoxylon*	1
	5. *Hibiscus canabinus*	1
	6. *Salvadora persica*	1
	7. *Sclerocarya birrea*	2
	8. *Sporobolus fimbriatus*	2
	Total	10
20	1. *Balanites sp*	1
	2. *Sclerocarya birrea*	1
	3. *Sporobolus fimbriatus*	2
	4. *Sporobolus pyramidalis*	1
	Total	5
21	1. *Acacia nigrescens*	1
	2. *Acacia polycantha*	1
	3. *Andropogon gayana*	2
	4. *Catunaregum spinosa*	1
	5. *Combretum zeyheri*	1
	6. *Commiphora Africana*	1
	7. *Entada abyssiniea*	1
	8. *Heteropogon contortus*	1
	9. *Hyphaene compressa*	1
	10. *Hypharhemia rufa*	2
	11. *Markhamia obtusifolia*	2
	12. *Panicum maximum*	1
	13. *Piliostiguna thonningii*	1
	14. *Pteriopsis mystifolia*	2
	15. *Salacia madagascariensis*	2

	16. *Sclerocarya birrea*	1
	17. *Sterculia appendiculata*	2
	18. *Themeda triandra*	1
	Total	24
22	1. *Acacia polycantha*	1
	2. *Albizia sp*	1
	3. *Combretum collinum*	1
	4. *Dalbergia melanoxylon*	1
	5. *Dalbergia obovata*	1
	6. *Deinbollia borbonica*	1
	7. *Dombeya sp*	5
	8. *Ehretia amoena*	1
	9. *Flueggea virosa*	2
	10. *Grewia conocarpa*	1
	11. *Hypharrhemia rufa*	1
	12. *Markhamia obtusifolia*	1
	13. *Panicum maximum*	1
	14. *Salacia madagascariensis*	1
	15. *Sclerocarya birrea*	1
	16. *Themeda triandra*	2
	Total	22
23	1. *Acacia polycantha*	1
	2. *Andropogon gayana*	1
	3. *Dombeya sp*	1
	4. *Heteropogon contortus*	2
	5. *Markhamia obtusifolia*	2
	6. *Panicum maximum*	1
	7. *Panicum trichocladum*	2
	8. *Piliostiguna thonningii*	3
	9. *Sclerocarya birrea*	1
	Total	14

24	*1. Acacia nigrescens*	1
	2. Andropogon gayana	1
	3. Catunaregum spinosa	2
	4. Commiphora africana	2
	5. Dombeya sp	4
	6. Hypharrhemia rufa	2
	7. Markhamia obtusifolia	2
	8. Panicum maximum	4
	9. Salacia madagascaensis	1
	10. Sclerocarya birrea	1
	11. Sterculia quinqueloba	1
	12. Tridax procumber	1
	Total	22
25	*1. Acacia polycantha*	1
	2. Acacia robusta	1
	3. Deinbollia borbonica	1
	4. Dombeya sp	5
	5. Kigelia Africana	2
	6. Lannea carcuta	2
	7. Markhamia obtusifolia	1
	8. Panicum maximum	1
	9. Pseudolachnostylis maprouneifolia	1
	10. Salacia madagascaensis	1
	11. Sclerocarya birrea	2
	12. Sterculia appendiculata	2
	Total	20
26	*1. Acacia polycantha*	1
	2. Andropogon gayana	3
	3. Combretum collinum	3
	4. Diospyros squarrosa	3

	5. Hypharrhemia rufa	3
	6. Kigelia africana	2
	7. Panicum maximum	1
	8. Piliostiguna thonningii	1
	9. Sclerocarya birrea	1
	10. Sterculia Africana	1
	Total	20
27	*1. Acacia polycantha*	1
	2. Adamsonia digitata	1
	3. Commiphora africana	1
	4. Flueggea virosa	1
	5. Hypharrhemia rufa	1
	6. Panicum maximum	1
	7. Sclerocarya birrea	1
	Total	7
28	*1. Acacia polycantha*	1
	2. Combretum adegonium	1
	3. Crossopteryx febrifuga	1
	4. Flueggea virosa	1
	5. Kigelia Africana	1
	6. Sclerocarya birrea	2
	7. Sterculia appendiculata	1
	Total	8
29	*1. Acacia polycantha*	1
	2. Adamsonia digitata	1
	3. Catunaregum spinosa	4
	4. Diospyros squarrosa	1
	5. Grewia conocarpa	4
	6. Heteropogon contortus	1
	7. Panicum trichocladum	2
	8. Salacia madagascaensis	2

	9. Sclerocarya birrea	1
	10. Sterculia appendiculata	1
	Total	18
30	*1. Adamsonia digitata*	2
	2. Catunaregum spinosa	3
	3. Deinbollia borbonica	1
	4. Heteropogon contortus	1
	5. Hypharrhemia rufa	4
	6. Kigelia africana	1
	7. Panicum maximum	1
	8. Piliostiguna thonningii	1
	9. Sporobolus pyramidalis	2
	Total	16

Appendix 2 : Summary of diversity indices among three sites of Kiranjeranje ward –Kilwa

Summary of diversity indices among three sites of Kiranjeranje ward –Kilwa

(a)Moderately Grazed area

Plot	**Disturbance level**	**Mean Shanon –Wiever Diversity**
1	3	2.7726
2	3	2.3026
3	2	2.3026
4	3	2.3979
5	2	2.6391
6	2	2.8332
7	3	1.7918
8	3	2.1972
9	3	2.0794
10	2	2.1972
		Total mean diversity 2.35142

(b)Heavily Grazed area

Plot	**Disturbance level**	**Mean Shanon –Wiever Diversity**
11	0	2.0794
12	0	1.7918
13	1	1.3863
14	1	1.7918
15	1	2.0794
16	0	1.3863
17	1	2.3026
18	1	2.0794
19	1	2.1972
20	0	1.3863
		Total mean diversity 1.84805

©Ungrazed area

Plot	**Disturbance level**	**Mean Shanon –Wiever Diversity**
21	5	2.8904
22	5	2.7726
23	4	2.1972
24	4	2.4849
25	5	2.4849
26	4	2.3026
27	4	2.0794
28	5	1.9459
29	5	2.3026
30	4	2.1972
		Total mean diversity 2.36577

Appendix 3 : Results showing Plant species evenness in Kiranjeranje Kilwa

Results showing Plant species evenness in Kiranjeranje Kilwa

(a)Moderately Grazed area

Plot	Disturbance level	Evenness
1	3	0.65482
2	3	0.54382
3	2	0.54382
4	3	0.56633
5	2	0.62329
6	2	0.66914
7	3	0.42317
8	3	0.51893
9	3	0.49112
10	2	0.51893
		Total mean evenness 0.51302

(b)Heavily Grazed area

Plot	Disturbance level	Evenness
11	0	0.49112
12	0	0.42317
13	1	0.32741
14	1	0.42317
15	1	0.49112
16	0	0.32741
17	1	0.54382
18	1	0.49112
19	1	0.51893
20	0	0.32741
		Total mean evenness 0.436468

(c)Ungrazed area

Plot	**Disturbance level**	**Evenness**
21	5	0.68264
22	5	0.65482
23	4	0.51893
24	4	0.58688
25	5	0.58688
26	4	0.54382
27	4	0.49112
28	5	0.45958
29	5	0.54382
30	4	0.51893
		Total mean Evenness 0.558742

Appendix 4 : Plant species richness in Kiranjeranje Kilwa

Plant species richness in Kiranjeranje kilwa

(a)Moderately Grazed area

Plot	**Disturbance level**	**Richness**
1	3	16
2	3	10
3	2	10
4	3	11
5	2	14
6	2	17
7	3	06
8	3	09
9	3	08
10	2	09
		Total mean richness 11.0

(b)Heavily Grazed area

Plot	**Disturbance level**	**richness**
11	0	08
12	0	06
13	1	04
14	1	06
15	1	08
16	0	04
17	1	10
18	1	08
19	1	09

20	0	04
		Total mean richness 6.7

(c)Ungrazed area

Plot	**Disturbance level**	**Richness**
21	5	18
22	5	16
23	4	09
24	4	12
25	5	12
26	4	10
27	4	08
28	5	07
29	5	10
30	4	09
		Total mean Richness 11.1