ENVIRONMENTAL AND HUMAN INFLUENCES ON INDIGENOUS PLANT COMMUNITY STRUCTURE OF EMBOBUT FOREST RESERVE IN ELGEYO MARAKWET COUNTY, KENYA

BY

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DECLARATION

Declaration by the student

This thesis is my original work and has not been presented for examination in any other university. No part of this thesis may be reproduced without a prior permission of the author and/or the University of Eldoret.

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DEDICATION

This research work is dedicated to my wife, children and grandchildren, my dad, mum, siblings and all my close friends who have shared with me all my past and present hardships, tribulations and successes. To the Almighty God, with whose enduring grace, ensured that I had the strength and motivation to do this work, be glory and honor.

ABSTRACT

Embobut Forest Reserve is affected by the natural environmental variation and human activities that have not been studied. This study determined the plant species composition, abundance and diversity in relation to environmental variation and human activities at four designated sites in Embobut Forest Reserve. The sites were classified in the form of valley floor, escarpment, upland forest and montane region based on altitude ranges. Based on vegetation sampling, there were 645 plant species belonging to 456 genera and 116 families in the entire basin. Among the plant species recorded, there were 41 trees, 60 shrubs, 7 lianas and 126 herbs in 11 forms belonging to herbaceous plant species. Spatial variations in the plants species was significant ($P < 0.05$). Trees were most abundant in the valley floor (16) while shrubs in escarpment (28) but were both least abundant in montane region (8) and (11) respectively. Tree species diversity was recorded highest at the montane region (3.15), shrubs at escarpment (3.05), lianas and herbs at valley floor (3.15) and (2.87) respectively. Environmental variables influenced the species composition, abundance and diversity in species-specific patterns. Temperature, rainfall, relative humidity, wind speed and altitude significantly ($P < 0.05$) affected the various life forms sampled in this ecosystem. However, aspect and slope had negative or no significant effect on different life forms. The most frequent human activities were grazing (25) logging (14) and collection of firewood (10). Important human activities influencing most tree species composition were logging, burning, cultivation and grazing while settlements, cultivation, charcoal burning greatly affected the composition of herbs. All life forms depicted highest species abundance and diversities where there were none or minimum human activities except diversity of herbs. There were 208 useful plant species within the area based on assessment. About 51% of the plant species used by people living around Embobut Forest Reserve were herbs and 23.5% shrubs. The plant species were mostly used for fodder (65.4%), firewood (54.8%) and fencing (53.8%). On the other hand the use of leaf (72.1%), stem (62.5%) and branches (49.0%) was popular in the region. The use value index of the plants species was related to the abundance of the plant species and the more the use value the plant species, the higher was the abundance of the plant species. A strategy for management of Embobut Forest Reserve should focus on the multiple-use conservation approaches where environment and human factor will be at play. Some of the areas within the forest showing signs of relatively little human impacts can be designated for strict conservation so that they may act as repositories of biodiversity and possibly as a source of forest genetic resources, alongside sustainable use of the already exploited forest. Conservation, in order to be effective, must strive to balance the protection of countable objects of diversity and the use of natural processes, the balance which should entail a broad assortment of programs on a variety of spatial and organizational scales.

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LIST OF ABREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
ARG	Annual Research Grant
BIEA	British Institute in Eastern Africa
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CCA	Canonical Correspondence Analysis
ERB	Embobut River Basin
FAO	Food and Agricultural Organization
CFA	Community Forest Association
FGD	Focus Group Discussion
GIS	Geographical Information System
GoK	Government of Kenya
HSD	Honestly Significant Difference
IEK	Traditional Ecological Knowledge
IGP	Institute of Global Prosperity
ILRI	International Livestock Research Institute
JICA	Japanese International Cooperation Agency
KFS	Kenya Forest Service
KNBS	Kenya National Bureau of Statistics
MDS	Multidimentional Scaling
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organization
PATN	Pattern Analysis
PCA	Principal Component Analysis

RDA	Redundancy Analysis
TEK	Traditional Ecological Knowledge
TMK	Traditional Medical Knowledge
UCL	University College London
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization.

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CHAPTER ONE

INTRODUCTION

1.1. Background of the study

Forest flora is characterized by trees, shrubs, herbs and lianas where their composition, abundance and diversity reflects the influence of natural physical and chemical environment (Quaresma *et al.*, 2018; Tashev *et al.*, 2018). Floral distribution in terms of species composition, abundance and diversity vary widely across ecosystems (McGlinn *et al.*, 2019; Norberg *et al.*, 2019; Soriano-Redondo *et al.*, 2019). Knowledge of the spatial pattern of biodiversity is crucial to assess the consequences of forest degradation and habitat loss due to natural and human causes (Neves *et al.*, 2017). In a variety of ecosystems, mountainous regions rank as some of the richest in floral diversity (Bogale *et al.*, 2017; Malanson *et al.*, 2019; Niu *et al.*, 2019). Amongst the diverse mountainous landscapes, Afromontane ecosystems are actually the most plant species-rich ecosystems on earth (Gadow *et al.*, 2016; Asfaw, 2018; Awoke and Mewded, 2019; Reshad and Alemayehu Beyene, 2019). The tropical Afromontane ecosystem, have high species composition and diversity (Mbuni *et al.*, 2019) accounted for by their pristine nature (Shumi *et al.*, 2019), minimal or restrained human activities in human landscapes (Steinbauer *et al.*, 2018; Gonmadje *et al.*, 2019) as well as good climatic conditions (Steinbauer *et al.*, 2018; Lézine *et al.*, 2019).

The changes experienced in species, composition, abundance and diversity in most of the tropical Afromontane regions occur due to environmental heterogeneity in these ecosystems which largely control the floral species distribution (Medvecká *et al.*, 2018; Pourrhamati *et al.*, 2018). Among the environmental variables that have largely controlled plant species composition include elevation (Rumpf *et al.*, 2018; Yang *et al.*, 2018), aspect (Måren *et al.*, 2015; Hill *et al.*, 2017), temperature (Steinbauer *et al.*, 2018), slope (Argumedo-Espinoza *et al.*, 2018; Gonmadje *et al.*, 2019), rainfall (Rezende *et al.*, 2018), aspect (Marselis *et al.*, 2018), wind speed and humidity (Cronin *et al.*, 2015; Gillman *et al.*, 2015). The effects of these environmental factors affect the species distribution in site specific ways differing at the global, regional and local scale, thus superimposing the trends from one region on another region is less practical (González-M *et al.*, 2018). Subsequently, more studies are required to understand the relationships between environmental variables and plant species composition, abundance and diversity.

In several Afromontane regions, there are a number of human activities which constitute a significant factor at the basin scale that increasingly may affect forest structure and functioning (Weinzettel *et al.*, 2018; Shumi *et al.*, 2019). These diverse activities include land cultivation (Aleixandre-Benavent *et al.*, 2017), logging (Abood *et al.*, 2015), charcoal production (Specht *et al.*, 2015; Goldammer, 2016), urban expansion (Laurance *et al.*, 2017), road construction (Laurance *et al.*, 2017; Nor *et al.*, 2017), dam construction (Chen *et al.*, 2015), unsustainable cattle grazing (Brandt *et al.*, 2018; Pulungan *et al.*, 2019), plant harvesting for diverse domestic uses (Gaoue *et al.*, 2016) and mining (Fisher *et al.*, 2018). The Afromontane areas of Eastern Africa, particularly in Kenya, constitute vivid examples of tropical forest ecosystems that have exceptional species richness and high concentrations of endemic species, under great human land-use pressure. This is due to the fact that the same environmental conditions that nurture high species diversity also render these forest areas suitable for human activities. As human populations grow, there is increasing land use activities that may affect the forest ecosystem. However, there is still scarcity of information on how the human activities within these landscapes affect the plant species composition, abundance and diversity.

In several regions of Africa, there is tendency of people to settle in areas dominated by indigenous plants, thus increasing the utilization of these plants (Shelef *et al.*, 2017). Plant species loss in Africa is occurring at an alarming speed thus greatly reducing the plants gene pools available for future use and is likely to lead to the loss of medicinal, food and other useful plants that may be crucial to the future generations (Agisho *et al.*, 2014; Kandari *et al.*, 2015; Dzerefos *et al.*, 2017). The recognition of the local community knowledge, cultures, and the relationships with the indigenous plants species has been used by various stakeholders to enhance sustainable utilization and conservation of these resources (Hutton *et al.*, 2017; Salako *et al.*, 2018). Rather than legislation and/or regulation, it is now widely accepted that suitable strategies to enhance sustainable utilization of indigenous plants should focus on local approaches involving ecological knowledge (Pieroni *et al.*, 2015; Blanco and Carrière, 2016).

In most of the areas where people have settled, there is diverse use of the plants by the people. In the advent of using the plants, the local community need to utilize the plants with a view of sustainable use and conservation, recommend cataloguing knowledge of plants primarily in the tropical areas (Corlett, 2016). There are numerous published works on the plant diversity of tropical environments (Kimondo *et al.*, 2015; Sosef *et al.*, 2017; Ulian *et al.*, 2017; Vellend *et al.*, 2017; Droissart *et al.*, 2018; Kigen *et al.*, 2019), most of these are still based on purely scientific work that excludes the contribution of the households. Changes in cultural norms, practices, westernization and globalization, particularly in Africa (Reese *et al.*, 2019), have led to the negation of plant species utilization in ongoing efforts to ensure sustainable management of plant resource. There is still an obvious lack of practical recognition for identification, sustainable utilization and conservation of indigenous plants resources.

In Kenya there has been increasing role of human activities over the past decade in once pristine forest environments. Addressing the floral composition based on environmental data of the past 30 years is not only misleading but also rather simplistic. The Embobut Forest Reserve is the largest block in the Cherangani Hills. The forest is, however, under threat because of illegal squatters who have destroyed the natural habitat and the forest ecosystem thus causing streams in the area to dry (Rotich, 2019). There have been previous reports of increased human activities such as intensive agricultural activities, livestock grazing, subsistence agriculture, pastoralism and urban development (Larsen, 2015; Winkelhuijzen, 2017) that may pose threats to the integrity of this forest. Yet there is little research output from this forest to document the influence of these activities on the species composition, abundance, diversity and use of the plant species.

1.2. Statement of the problem

There are numerous human activities that have been reported to directly or indirectly affect species composition, abundance, diversity, distribution and utilization in many forests in Kenya (Kiringe, 2005; Bleher *et al.*, 2006; Farwig *et al.*, 2008; Bürgi *et al.*, 2017). In the North Rift Region of Kenya, the Embobut Forest Reserve has undergone massive human settlements who currently obtain forest resources unsustainably leading to massive deforestation through encroachment of the forest leading to loss of biodiversity, soil erosion, fragmentation and degradation (Larsen, 2015). The same forested environment may also be undergoing natural environmental perturbations that may further modify forest species structure. Regular ecosystem monitoring may enable the establishment of changes in the floral diversity owing to human activities and environmental pertubations. However, absence of specific studies in the North Rift regions makes it difficult to establish the causes and consequences of human induced changes on the plant species. Recently, floristic surveys in Kenya have been well documented in large forests ecosystems in Kenya such as Kakamega forest (Seswa *et al.*, 2018), South Nandi Forest (Njunge and Mugo, 2011; Maua *et al.*, 2018), Mt Kasagau (Medley *et al.*, 2019), Aberdares and Elgon forests (Hitimana *et al.*, 2010) ignoring floristically rich small sized forests such as Embobut yet due to their vast numbers, they are important component of the Kenyan vegetation cover. The skewed knowledge from these forests limits their potential utilization, making prospective biodiversity conservation difficult. Ecology of constituent species in most cases are not studied hence baseline and trend information needed for effective conservation of these forests continue to remain scanty. Continued absence of such data will continue to hinder conservation of forests undergoing human disturbances in Kenya.

1.3. Justification of the study

Embobut Forest Reserve and lower catchment area is under severe threat as aresult of intensive pressure from agriculture and overuse of its resources. Knowledge of the biodiversity in Embobut Forest Reserve will be useful in creating awareness among the households, Kenya Forest Service (KFS), Community Forest Associations (CFAs), Kenya Wildlife Services (KWS), county government of Elgeyo Marakwet on the need for forest conservation. In order, therefore, to mitigate the problem of forest degradation, promote effective conservation and optimize the benefits from the remaining natural forest patches, ecological studies aimed at providing accurate information about forest components and processes are required. It is envisaged that this study will contribute towards a better understanding of the diversity and distribution of plant species in Embobut Forest Reserve and evaluate some of the factors that dictate the patterns of floral distribution.

Results from this study will also inform the development of biological monitoring indices for monitoring forests in Kenya, which was earlier noted as absent. Such indices will be useful as baseline for developing monitoring tools for other forests in Kenya, which are undergoing human encroachment. Results and information generated from the study may be used by Kenya Forest Services (KFS) and Elegeyiyo Marakwet County in conservation of Embobut Forest Reserve and may also be applicable in other river basins in Kenya facing similar problems.

1.4. Objectives of the study

1.4.1. Broad objective

To determine the environmental and human influences on the plant communitues in Embobut Forest Reserve.

1.4.2. Specific objectives

The specific objectives of the study were to:

1. Determine the plant species spatial distribution in Embobut Forest Reserve
2. Determine the status of plant species composition, spatial distribution, abundance and diversity in Embobut Forest Reserve

3. Determine the influence of selected environmental aspects on the species composition, abundance and diversity in Embobut Forest Reserve
4. Evaluate the influence of human activities on plant species composition, abundance and diversity in Embobut Forest Reserve
5. Determine the relationship in plant utilization and abundance Embobut Forest Reserve

1.5. Hypothesis

To realize the above objectives, the following hypotheses were formulated

H_{01}: There is no significant spatial distribution in plants species in Embobut Forest Reserve

H_{02}: There is no significant influence of differences in plant species composition, spatial distribution, abundance and diversity in Embobut Forest Reserve

H_{03}: There is no significant influence of environmental aspects on the plant species composition, abundance and diversity in Embobut Forets Reserve

H_{04}: There is no significant influence of human activities on the species composition, abundance and diversity in Embobut Forest Reserve

H_{05}: There are no significant difference in the utilization and abundance of plant resources in Embobut Forest Reserve

1.6 Scope of the study

The study covered the spatial distribution of plant species, their composition, abundance and diversity and how they are influenced by environmental factors and human activities and assessement of their utilization by the local community living adjacent to Embobut Forest Reserve. The study was carried out for 12 months from March 2016 to March 2017.

CHAPTER TWO

LITERATURE REVIEW

2.1 Plant species spatial distribution

The wide variation in floral species across ecosystems reflects the health of these ecosystems. However, at present, floristic inventories and data on plant species distribution patterns are far from complete in many parts of the world. Among the various ecosystems in the world, mountainous regions rank among the richest in general floral biodiversity (Bogale *et al.*, 2017; Malanson *et al.*, 2019; Niu *et al.*, 2019).

Studies on tree species distribution patterns have demonstrated that the traditional dichotomy between seasonal forests based on physiognomy, and climate is coherently corresponded by a floristic differentiation though it invariably comes out as a continuum of species turnover rather than highly distinct plant floras. While assessing this forest dichotomy across several montane forests, it was established that the plant species were less differentiated (Sainge *et al.*, 2019). The exceptional tropical forests and the outstanding physiognomic heterogeneity of their vegetation justifies a floristic analysis focused in the region, particularly when they help in clarifying some controversial issues regarding its classification into biogeographic provinces, the differentiation among forest types, and the distribution patterns of both species richness and endemism.

Absence of site-specific studies on plant species distribution make generalization of the drivers of floral changes based on data from other studied areas unrealistic for local biodiversity studies.

2.2 Plant species composition, abundance and diversity

There are a number of factors that affect plant species in their natural habitats. These parameters are associated with plant/vegetation community structure and do not affect plant species in their natural habitats. These include but not limited to species composition, abundance and diversity.

2.2.1 Plant species composition

Plants can occur in different forms including trees, shrubs, lianas or herbs, lichens, ferns. However, it is their distributions that are of importance and fundamental unit of biogeographical study, providing information about where a species is present and its interaction with other species and their environment (Komonen and Elo, 2017). Regardless of the forms of the plants, the distribution can be established in terms of species composition (Fraser *et al.*, 2015; Steinbauer *et al.*, 2018). Species composition refers to the types of species, in terms of family, genus, species or [sub]species within the ecosystem, but its spread within the ecosystem allows its distribution to be recognized (Pasion *et al.*, 2018; Prevedello *et al.*, 2018). Species composition can be evaluated in terms of presence/absence data or occurrence and percent occurrence of the species among sites calculated as prevalence. The term species composition has also been used interchangeably with richness and sometimes erroneously as counts of the particular species available (Rabosky and Hurlbert, 2015; Fischer *et al.*, 2016).

Some theoretical studies have suggested a direct positive relationship between species composition and richness which has sometimes proven to be different components (Zobel, 2016; Shiferaw *et al.*, 2018; Woldearegay *et al.*, 2018). More recent empirical studies reveal that the relationship between species composition, richness and evenness is quite complex and depends on the type of species in question (Alroy, 2018; Pergl *et al.*, 2018; Ulrich *et al.*, 2018). Most of the studies of plant species in forest ecosystems have been conducted generating a large inventory of information for trees, shrubs, lianas and herbs (Huang *et al.*, 2018; Qian *et al.*, 2018; Ter Steege *et al.*, 2019). A closer look at most of these studies indicates that closed forests have received relatively large focus compared to other ecosystems such as the Afromontane plant communities that are still relatively unstudied. Therefore studies on plant species composition still remain valid as they were five decades ago (Droissart *et al.*, 2018).

2.2.2 Plant species abundance

Abundance is a far better measure of the effects a species has on its local ecosystem than simply whether it is present or absent (Turkington *et al.*, 2015). Species abundance refer to quantitative counts of species per unit of sampling, normally per hectare or per unit of quadrat (Magurran and Henderson, 2018). As such, it is one of the most basic descriptions of an ecological community. A species abundance also refers to the description of the number of individuals observed for each different species encountered within a community (de la Riva *et al.*, 2016; de la Riva *et al.*, 2017). The number of individuals, or the abundance of a species in an area is a fundamental ecological parameter and a critical consideration when making management and conservation decisions (Ehrlén and Morris, 2015). Geographical patterns of the abundance of species underlie some of the most fundamental issues in ecology, including the causes of species range limits, gene flow within populations, population dynamics and explanations for macroecological patterns such as the species-area relationship.

Given the importance of abundance distributions to ecological theory and applications, it is surprising to find that much of the work on these topics presumes a particular geographical distribution of abundance and makes assumptions about the mechanisms that underlie it (Deák *et al.*, 2018). For species of value to humans, estimates of future abundance will be essential for regulating current and future harvests. Finally, abundance will be a much stronger indicator than presence alone of the carry-on effects that one species will have upon interacting species in the community. As a result, there are numerous studies documenting the abundance of trees (Slik *et al.*, 2015; Lebrija ‐ Trejos *et al.*, 2016; Pennington and Lavin, 2016), shrubs (Stagakis *et al.*, 2016; Tonteri *et al.*, 2016; Shiferaw *et al.*, 2018), lianas (Argumedo-Espinoza *et al.*, 2018; Droissart *et al.*, 2018; Schnitzer, 2018), and herbs (Mulugeta *et al.*, 2015; Aynekulu *et al.*, 2016; Woldearegay *et al.*, 2018; Seta *et al.*, 2019) in several tropical environments.

Most studies have also been conducted in Afromontane region of Ethiopia and few in other areas. However, given the massive and rapid changes in plant composition in these forests, constantly determining the abundance remains a key priority in management. As a result, more studies are required on plant species abundance to keep abreast with anticipated ecological changes in Afromontane forests which are described in ecological realm as rapid and instantenous (Caroline *et al.*, 2016; Lillo *et al.*, 2019).

2.2.3 Plant species diversity

Diversity refers to the spatial variation in species abundance between sampling units or area overlapp (Hatfield *et al.*, 2018; Lüttge, 2019) and has both an aspect of species richness, number of species, and the way species quantities are distributed (Jost, 2006; Banda *et al.*, 2016). Diversity is widely used in ecological studies, but there is uncertainty about the degree of redundancy among the metrics available and the facets of diversity being measured (Mouchet *et al.*, 2010; Argumedo-Espinoza *et al.*, 2018). The value of a diversity index increases both when the number of types increases and when evenness which is the relative abundance of the different species in an area increases. Subsequently, the number of studies investigating species diversity has been comparatively high in ecological field (Rabosky and Hurlbert, 2015; Ibanez *et al.*, 2018; Schweiger *et al.*, 2018).

Empirical measures of species diversity can be used to delineate biotic regions and to inform the optimal configuration of reserves (LaManna *et al.*, 2017). They also help in evaluating the ecological implications of plant species as well as to assess the effects of any envisaged change on biotic homogenization (Lei *et al.*, 2016; Liu and Lv, 2019; Metcalfe *et al.*, 2019). Turnover in species diversity also has important implications for ecosystem functioning and monitoring responses to natural and other changes in the environment (Rabosky and Hurlbert, 2015).

2.2.4 Plant species composition, abundance and diversity in Afromontane regions

The highly threatened remnants of most Afromontane regions, are presently a focus of an increasing number of studies on the spatial distribution of plant species traits across scales that vary from whole geographic ranges to fragmented habitats (Frisch *et al.*, 2015). Many studies of the kind are constrained by the difficulty of selecting and collecting abundant and reliable information from a highly diverse biota and its complex ecological network (Rutten *et al.*, 2015; Prada and Stevenson, 2016). In the same context, the analysis of metadata at geographic scales is seriously affected by the fact that these forests have been poorly and irregularly collected throughout their area, and the known range of many taxa is therefore liable to constant changes (Ibanez *et al.*, 2018). These studies have made important contribution to the knowledge on the distribution patterns of tree species and helped assessing the floristic consistency most of which were originally produced from descriptions of climatic patterns and vegetation types only (Apaza ‐ Quevedo *et al.*, 2015).

Tropical montane forests have also been the subject of a number of occurrence of particular species of plants (Cárate ‐ Tandalla *et al.*, 2018; Wilson and Rhemtulla, 2018). This has seen large studies focusing on the tree species (Frisch *et al.*, 2015; Refuge *et al.*, 2016; Schäfer *et al.*, 2016; Brambach *et al.*, 2017; Cuni-Sanchez *et al.*, 2017; Fujiki *et al.*, 2017; Gonmadje *et al.*, 2019), shrubs and lianas as well as herbs (Díaz-García *et al.*, 2017) and lichens (Frisch *et al.*, 2015). Analyses of these studies indicate large spatio-temporal heterogenity of plants species even within regions that show high geographical similarities. Plant species composition, abundance and diversity in these ecosystems have been shown to be associated with habitat area, with habitat connectivity, with the type and intensity of current management and with habitat land-use. Species distribution patterns showed no particular distinct trends. Therefore more wide-scale quantitative assessments of the species variation are needed to establish the variation patterns of plants species in the tropical montane region.

According to (Ricklefs and He, 2016), fewer samples exist for tropical forests than for temperate forests, possibly because most of the former were altered or destroyed before scientific interest in species richness arose, or because species inventory in temperate forests provides a smaller payoff in new scientific knowledge.

Despite their important contribution to those mainstream studies and also to conservation initiatives, there are not many wide-scale quantitative assessments of the present-day tree species distribution of Afromontane regions. Therefore, floristic studies need to be carried out to generate baseline information crucial for drawing plant biodiversity management. However, despite the presence of species checklists in a number of studies on the basin environments in Kenya (Makokha *et al.*, 2017; Zhou *et al.*, 2018; Kipkoech *et al.*, 2019), there are no detailed and reliable studies documented on the floristic richness in forests undergoing human encroachment such as Embobut Forest. On the basis of the foregoing argument the current study was undertaken to determine the species composition, abundance and diversity of Embobut River Basin Basin.

2.3 Environmental influences on plant species composition, abundance and diversity

The pattern of plants species composition, abundance and diversity is not uniformly distributed across the globe due to a number factors key of which the environmental factors rank among the most important factor (Moreira *et al.*, 2015; Schultz, 2019). As a consequence, plant assemblage and organizational orientation along environmental gradients has remained a central theme of plant community ecology regardless of whether the analysis was done at the local, regional or continental scales (Ehrlén and Morris, 2015; Kraft *et al.*, 2015; D'Amen *et al.*, 2018). It is also reported that the regional patterns of species richness are consequences of many interacting factors, such as plant productivity, competition, geographical area, historical or evolutionary development, regional species dynamics, regional species pool, and environmental variables, all of which are related to environmental heterogeneity (Huang *et al.*, 2018; Klaus *et al.*, 2018; Thiele *et al.*, 2018). Although several researchers have suggested that decoding the influence of environmental variables on plant species require large coverage, it has been shown that the role of environmental factors in shaping the patterns of plant species composition, abundance and diversity are strong in areas with mininal human disturbances (Andersen *et al.*, 2015; Alroy, 2018).

Several studies have shown that abiotic environmental factors, such as wind speed and humidity can be important sources of variation of plant diversity when considering large landscape (Zhang *et al.*, 2016; Callaghan *et al.*, 2019). Other environmental factors such as slope and aspect may act at more local scale in influencing the distribution pattern of plant species (Oke and Thompson, 2015; Tang, 2015; Cavender-Bares, 2016). Meanwhile it has also been shown in several studies that the plant community within a region is strongly influenced by altitude (Oke and Thompson, 2015; Al-Aklabi *et al.*, 2016; Keppel *et al.*, 2017; Tikhonov *et al.*, 2017) where several studies have established that species diversity generally tends to decrease with increasing altitude (Sahoo and Rocky, 2015; Miyamoto *et al.*, 2016; Xu *et al.*, 2017).

In the case of tropical forests covering altitudinal gradients, several studies have identified remarkable differences in terms of vegetation structure, plant species composition, plant species richness and the relative contribution of life-history strategies including life form, seed dispersal and pollination mode (Khan *et al.*, 2015; Mota *et al.*, 2018). Altitude affects temperature, moisture, radiation and atmospheric pressure thereby influencing the growth and development of plants and their distribution (Neto, 2015). In general, the distribution, abundance and diversity patterns of species can result from the interaction between biotic and abiotic factors at different spatial and temporal scales which can only be unraveled through studies of the influence of environmental factors on species composition, abundance and diversity.

Due to the close proximity of different habitats and communities and resulting high beta diversity along the slope, tropical montane forests constitute one of the biologically richest landscapes on earth (LaManna *et al.*, 2017) and often contain a large number of endemic species. Along tropical mountain slopes, two principal patterns of plant alpha diversity change with elevation have been observed; a hump-shaped pattern, often found in herbs and ferns (Lebrija ‐ Trejos *et al.*, 2016), with monotonic decline with elevation, apparently prevalent in trees.

The influence of rainfall on vegetation across biomes is well known. For a given rainfall intensity, a change implies a shift in species composition and assemblages (Sainge *et al.*, 2019). Although the influence of other topography variables on temperature many shape species distribution, there is need for continued research into this realm. Rainfall has been used to determine species richness, regional biodiversity patterns, forest canopy health, species distributions and gradients of species (Figueiredo *et al.*, 2018). This is driven in part by the global availability of high resolution elevation data (e.g. www.landcover.org) coupled with the availability of high speed computing platforms (Neto, 2015). Studies have since utilised these tools to highlight gaps in the network of conservation areas, quantify threats and prioritize areas for conservation (González-M *et al.*, 2018). Topographically based analyses are especially insightful in mountainous regions, presumably due to the extent of topography-related heterogeneity. In a study on tropical montane forests, topography-related variation in rainfall accounted for differences in forest communities (Wisz *et al.*, 2013). Similarly, a study in an Indonesian tropical montane forest revealed that rainfall induced variation in relative humidity and wind velocity influenced presence of species (Dietz *et al.*, 2007)

Some studies have examined changes in species composition and diversity across environmental and geographic gradients, but vegetation structure and composition are also influenced strongly by elevation (Andersen *et al.*, 2015; Alroy, 2018). Vegetation systems at different elevations on different substrates in montane ecosystems differ in biomass production, carbon storage and biodiversity conservation value (Rezende *et al.*, 2018). Globally, although the biodiversity of elevational gradients in the tropics have seen much attention, this subject remains little studied in many Afromontane forests in Kenya. Plants with contrasting life forms are also expected to respond differently to environmental change, due to differences in their morphological and physiological adaptations.

There are several studies that have been conducted to determine the influence of single environmental factors on plant species distribution. Previous studies on the relationship of vegetation, soil and slope, aspect, altitude, temperature, humidity, rainfall and wind speed are largely available. However, an analysis of the combined environmental factors is more robust in showing changes as a result of the combined environmental influences. Such studies are still rare in the tropical forested environment.

2.4 Human activies influences on plant species composition, abundance and diversity

Forest ecosystems are among the most important biological ecosystems on earth because of the biodiversity and services they perform (Corlett, 2016). The concept of "Forest health" or "Forest ecological integrity" has been understood by the general public and evokes social concern about human impacts on forests (Bürgi *et al.*, 2017; Li *et al.*, 2018; Wang *et al.*, 2018b). Even though this term is commonly used worldwide, there is no general consensus in its meaning. In the context of a forest ecosystem, ecological integrity is the maintenance of all internal and external processes and attributes that interact with the forests in such a way that the biotic community corresponds in the natural state of specific aquatic and terestrial habitats (Trumbore *et al.*, 2015; Hamelin and Innes, 2016). In simple terms, high forest ecological integrity is reflected by good forest species composition, abundance and diversity (Sambaraju *et al.*, 2016).

Factors that negatively affect the functioning of the forest ecosystems are threats to the ecological integrity of the same systems. As a result of the increased population settling within forests, which have increased the need for more natural resources to provide basic ecological goods (Gosselin and Callois, 2018; Maxwell *et al.*, 2019), there are numerous factors that may affect the ecological integrity of the forest species (Mahmoud and Gan, 2018). Natural variability and change within the forest ecosystem processes, ecosystem communities and individual organisms in many cases are adapted to the different natural variations in the environmental conditions unless they occur in extreme magnitudes (Bax and Francesconi, 2018).

The anthropogenically driven land use practices and development sectors in the vicinity of many environments have resulted in the most profound changes (Wang *et al.*, 2018a; Müller *et al.*, 2019). These practices include agricultural activities (Aleixandre-Benavent *et al.*, 2017), forest logging (Abood *et al.*, 2015), burning (Goldammer, 2016), urbanization (Laurance *et al.*, 2017), road construction (Laurance *et al.*, 2017; Nor *et al.*, 2017), contruction of waterways (Chen *et al.*, 2015), and settlement (Brandt *et al.*, 2018; Pulungan *et al.*, 2019), which incidentally are responsible for changes in the ecological integrity of forest ecosystems (Tekalign *et al.*, 2018). For instance, land use changes denude the native vegetation, increase runoff and erosion, alter forest geomorphology and substrata characteristics, modify forest structure and enhance transport of nutrients and sediments within the forest ecosystem (Tormos *et al.*, 2013) with varied implications for stream ecological integrity.

The integrity of the forest ecosystems will potentially continue to face pressure due to the continued settlement near forests and accompanying intensification of human activities. The situation is dire in forests adjacent to settlement with poor agricultural practices (Whitlock *et al.*, 2018). The human impacts on forests have led to need for precise assessment, of the forest structure thereof. Although a lot of studies have been conducted over the the last five decades on the impacts of human activities on forest species composition, less is still known on species composition response to human activities in forests of the developed countries (Kuosmanen *et al.*, 2018; Mahmoud and Gan, 2018; Maxwell *et al.*, 2019).

Many tropical forests especially in Sub Saharan Africa are undergoing severe anthropogenic modifications such as cutting down of indigenous forest for plantation establishment, poor farming techniques, poor hunting and trapping practices (Chaturvedi *et al.*, 2017; Pelletier *et al.*, 2017). Human activities directly or indirectly influence vegetation characteristics at a point. Direct human activities include but are not limited to total clearing, cultivation, selective cutting and burning. Indirect activities including livestock grazing, habitat modification, and pollution (Tekalign *et al.*, 2018). In fact, many studies have found that the highest diversity occurs at intermediate frequencies of human disturbances. In Kenya there are numerous studies on the impacts of human activities in the forests ecosystems (Oyugi *et al.*, 2008; Tormos *et al.*, 2013). However, how combinations of human activities influence specific plant species has rarely been investigated.

2.5 Utilization of plant resources

Plants are sources of food, fibers, firewood, shelter and medicine. Since majority of people have settled in area dominated by indigenous plants, there is increased utilization of the indigenous plants at the global scale (Jiang *et al.*, 2015; Shelef *et al.,* 2017; Kariuki *et al.*, 2018), which may fuel loss of indigenous plant species. Plant species loss in Africa is occurring at approximately 35%. This loss is greatly reducing the store of genetic material available for future adaptation and likely involves the loss of medicinal, food and other useful plants that may be crucial to future generations (Agisho *et al.*, 2014; Kandari *et al.*, 2015; Dzerefos *et al.*, 2017).

The recognition of the households have allowed for various stakeholders to enhance sustainable utilization and conservation of indigenous plant species (Hutton *et al.*, 2017; Wehi and Lord, 2017; Salako *et al.*, 2018). Rather than legislation and/or regulation, it is now widely accepted that suitable strategies to enhance sustainable utilization of indigenous plants should focus on local approaches involving traditional ecological knowledge (Pieroni *et al.*, 2015; Blanco and Carrière, 2016). Here, traditional ecological knowledge refers to the cumulative body of knowledge, innovations, practices and beliefs of indigenous and local communities that evolves through adaptive processes (Huntington, 2000). As a case in point, in developing measures for the use and protection of indigenous plants, the Convention on Biological Diversity (CBD) advocates for the enhancement of traditional ecological knowledge to achieve this goal (Pilgrim *et al.*, 2009).

The effectiveness of plant utilization in the protection and conservation of biodiversity, rare species, protected areas and ecological processes is well recognized (Molnár and Berkes, 2018; Negi *et al.*, 2018; Rana *et al.*, 2019). However, changes in cultural norms, practices, westernization and globalization, particularly in Africa (Reese *et al.*, 2019), have led to the negation of plant species use and management in ongoing efforts to ensure sustainable management of plant resource. Although plant utilization have been applied in understanding the utilization and conservation of plant species (Sanoussi *et al.*, 2015; Irakiza *et al.*, 2016; Kariuki *et al.*, 2018), it still preclude vast areas with rich plant biodiversity. In Kenya, attempts have been made to recognize the importance of useful plants in understanding the indigenous plant species among various stakeholders (Shiracko *et al.*, 2016; Tian, 2017). Nevertheless, there is still an obvious lack of practical recognition that useful plants are central for identification, sustainable utilization and conservation of indigenous plants resources.

The use of indigenous plants in human medicine is well documented (Srivastava, 2018). Current knowledge on medicinal plants as a source for relief from illness dates back to the early civilization in China, India and the Near East, and thus appear to be practiced as old as mankind. Indeed plants provide the predominant ingredients of medicines in most medical traditions (Shakya, 2016; Van Wyk and Wink, 2017; Huang *et al.*, 2019). It is an estimated that 60–80% of people worldwide rely on traditional herbal medicine to meet their primary healthcare needs (Krupa *et al.*, 2018; Silveira *et al.*, 2018).

Accordingly, the World Health Organization (WHO) put the figures that rely on herbal medicine at 60% of the world's population and about 80% of the population in developing countries (Huang *et al.*, 2019). There is no reliable figures for the total number of medicinal plants on Earth, and numbers in various regions and countries also vary greatly (Hamilton, 2004). However, China is currently leading in the number of plant species for herbal medicine (Vasisht *et al.*, 2016). As a result the number of plants being recommended as cure for various diseases has continued to increase (Chen *et al.*, 2016; Rathore and Mathur, 2018). The demand for traditional herbal medicine also appears to be on the rise globally, especially in Asia and Africa (Sen and Chakraborty, 2015; Dar *et al.*, 2017; Amzat and Razum, 2018; Zhang *et al.*, 2018). This culminates from the affordability and accessibility of traditional medicine as a source of treatment in the primary healthcare system of resource poor communities (Chukwuma *et al.*, 2015; Van Andel *et al.*, 2015; Zizka *et al.*, 2015). In terms of the number of species individually targeted, indigenous plants as medicines represents by far the highest human use of the natural world.

The study of plant resources is becoming increasingly important in defining strategies and actions for conservation. Most of the information on the use medicinal plants has been derived from China through: (1) Traditional scholarly medical systems, containing the written traditions of documentation of knowledge, pharmacopoeias for doctors and institutions for training doctors; (2) Shamanistic medicine, which has a strong spiritual element and which can only be applied by specialist practitioners (Shamans). The special significance of medicinal plants in conservation stems from the major cultural, livelihood or economic roles that they play in many people's lives.

Although there are numerous published work on plant species diversity in the tropical environment (Kimondo *et al.*, 2015; Sosef *et al.*, 2017; Ulian *et al.*, 2017; Vellend *et al.*, 2017; Droissart *et al.*, 2018; Kigen *et al.*, 2019), most are still based on scientific work withput attempts at explaining their utility. There is a lot of work largely focusing on the plant checklists, utilization of plants (Zizka *et al.*, 2015; Mukungu *et al.*, 2016; Tugume *et al.*, 2016; Phumthum *et al.*, 2018; Kigen *et al.*, 2019) with little emphasis on how utilization affect species abundance. There is also enormous use of indigenous medicinal plants in Kenya over the last decades (Odongo *et al.*, 2018; Kigen *et al.*, 2019). In light of this therefore, there is a need to examine the utilization of the plant species in light of of their use.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study area

This study was conducted along the Embobut Forest and lower catchment of Embobut Forest Reserve which is one of the remnants of Afromontane forests in the tropical reigon. The region is in Elgeyo Marakwet County at latitude 1°10' to 1°14'N and longitude 35°27' to 35°42'E. Embobut is one of the administrative wards for the Marakwet East Subcounty in Elgeyo Marakwet County, Kenya. The Embobut Forest in this region covers an area of 21,655 hectares and is the source of Embobut River. The upper catchment is a hilly plateau with altitude ranging between 2200−3400 meters above sea level while the lower part of the study area has altitude ranging between 1000-2200 meters above sea level. Rainfall in the region is unreliable and unevenly distributed but has two peaks in April to May and August to October and a drier spell from November to February (Rotich, 2019). The daily temperature is 28°C during the wet season with a maximum of 35°C during the dry season and a minimum of 21°C in the cold season (lower parts) and upper region with temperatures going as low as 9°C during the cold season. February is the hottest month, and June is the coolest. Soils in Embobut basin are ferrallitic, thick, freely draining, weakly acidic dominated by iron and aluminium sesquioxides with quartz sand and kaolinite clays. Based on vegetation cover and leaching, the soils characteristically contain no reserve of weatherable minerals rending them infertile (Matthew, 2014). Streams to the west of the watershed feed the Nzoia River system while to the east, they flows to Kerio River system.

The bordering highland areas are characterized by moderately weathered dark-reddish brown soils with a clay-loam texture, which are all associates of the Rift Valley volcanic soils. Embobut Forest Reserve of Chelagani hills is made of metamorphic rocks with conspicuous quartzite ridges and occasional veins of marble.

The population of communities living around Embobut Forest Reserve is 21,096 households (Kenya National Bureau of Statistics, 2010). The main human activities within the study areas include livestock grazing, pastoralism, crop and dairy farming. The main crops cultivated are maize (*Zea mays*), beans (*Phaseolus vulgaris*), cabbage (*Brassica oleracea var capitata*), kales (*Brassica oleracea var acephala*) and mangoes (*Mangifera indica*). Most of Embobut Forest Reserve and the lower catchment area has been converted to farmland in the last 20 years (Chebet *et al.*, 2017).

3.2 Site selection and demarcation

On the basis of topography (mainly slope, aspect and altitude) differences in indigenous vegetation formations and human disturbance disturbance gradient, the Embobut Forest Reserve was stratified into four zones viz: the valley floor, escarpment, upland forests and montane region as primary units (Figure 3.1 and 3.2). This exercise was achieved by conducting a ground pre-survey, guided by existing maps, existing literature and information from indigenous local people on site. Also, aerial photos where available were consulted.

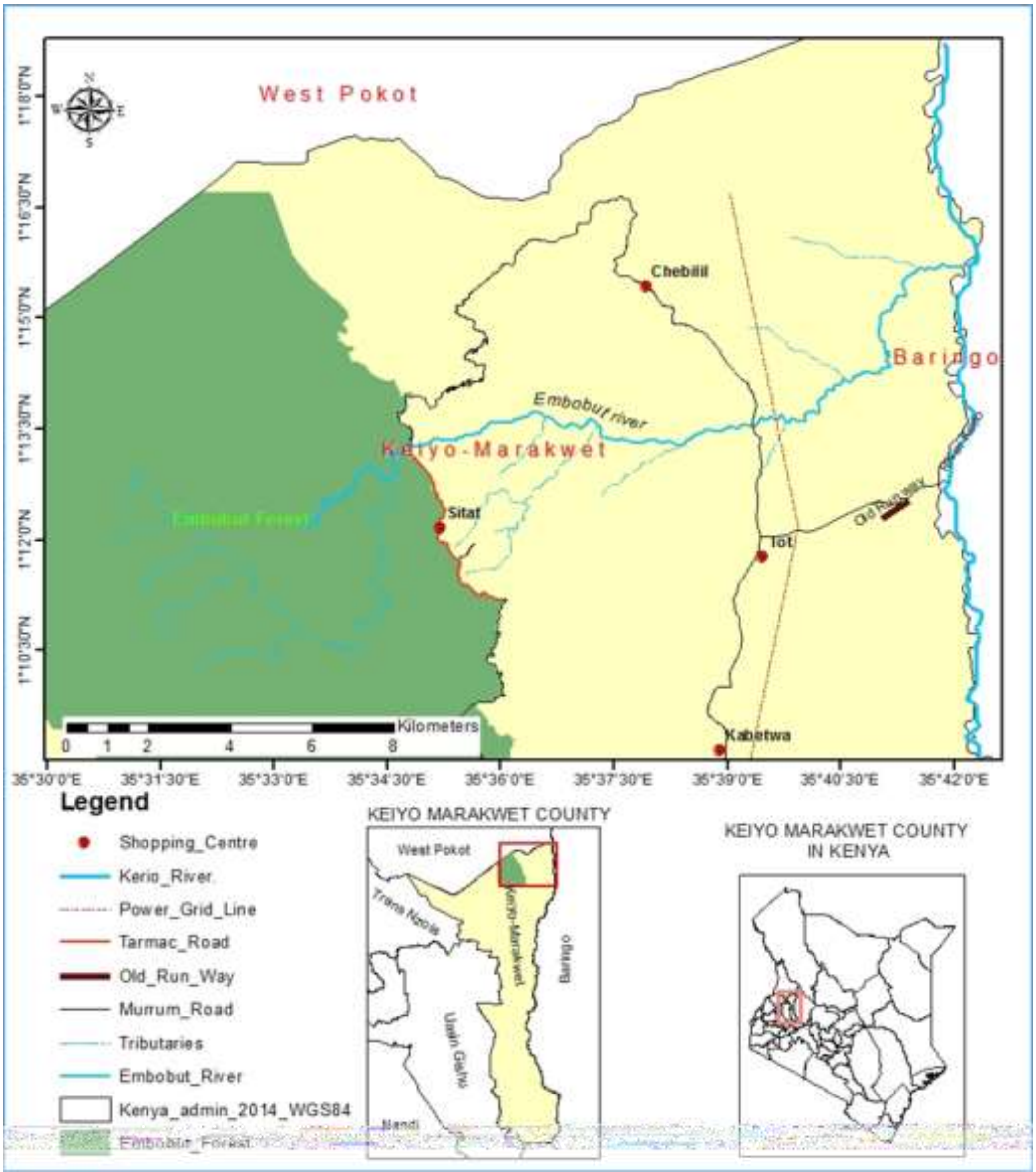

Figure 3.1: Map showing location of study transect sites
(**Source: Google map 2016)**

3.3 Vegetation sampling procedure

During the survey, three transects measuring 500 m long each were established in each of the sampling sites. Nested quadrats were used because different plant forms were sampled within the same quadrat. For sampling trees, three plots measuring 20 m × 20 m, were systematically placed at 220 m interval along the transect. Data collected included tree scientific, common and local names, their count and their diameter at breast height (DBH). In each plot of the 20 m × 20 m plots, a further four 5 m × 5 m sub-plots were nested inside the big plot and two randomly selected for quantifying shrubs where the names, count and percent cover data were recorded. A further twenty five (1 m × 1 m) subplots were nested inside 5 m × 5 m plots and three randomly selected to assess grasses and herbaceous plant species as previously described (Queloz *et al.*, 2005). Also any other plant forms encountered along transect were collected and identified as voucher specimens.

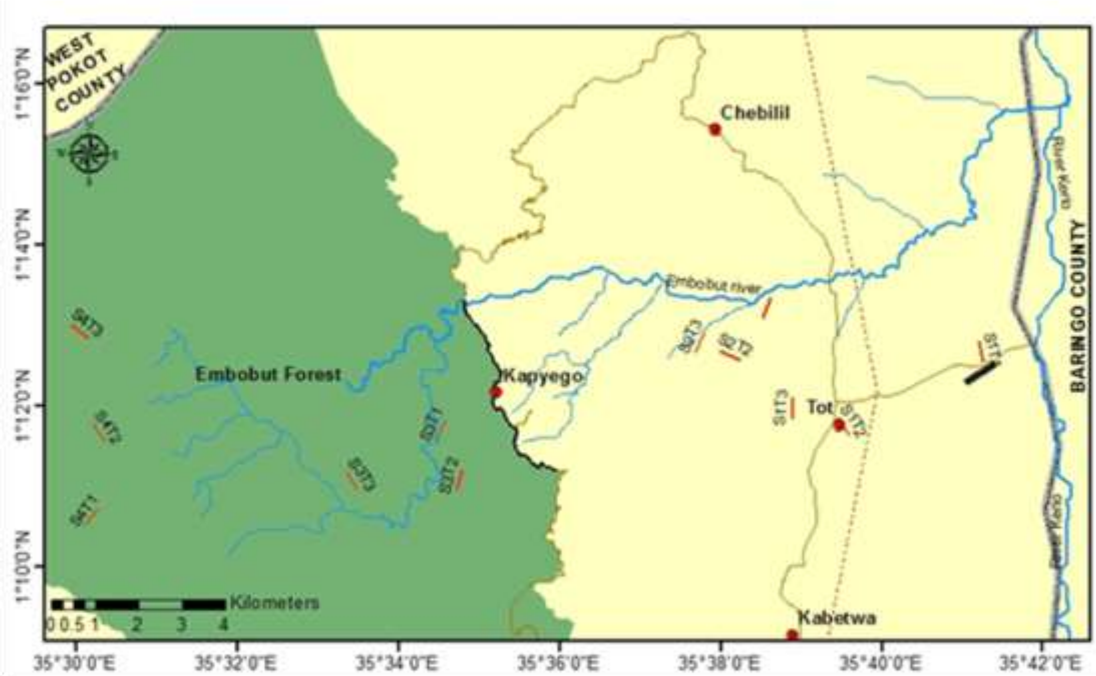

Figure 3.2: A map of the study area showing the location of the transects (Source: Google map 2016)

Key
S1, Valley floor
S2, Escarpment
S3, Montane region
S4, Upland forest

3.4 Human activities

Evidence of human and animal activities that included grazing, logging, charcoal-burning, firewood collection, cultivation and many others within the sampling areas were recorded along transects. The intensity of human activities was determined by the frequency of occurrence at the transects.

3.5 Assessment of local environmental factors

The environmental parameters included slope of the plot, aspect of plot, altitude, temperature, rainfall, humidity and wind speed which were measured and related to plant species composition and abundance. The definition of each environmental factor and measurement tools are shown in Table 3.1.

Table 3.1: Selected parameters of local topography and climatic factors studied

Parameter	Definition	Measurement tool
Slope of the plot	Steepest Inclination (%) from the plot centre	GIS
Aspect of plot	Compass direction relative to sun angle	GIS
Altitude	Elevation of meter above sea level	Electronic altitude meter
Temperature	Degree or intensity of heat present in a substance or object	Thermometer
Rainfall	The quantity of water, usually expressed in millimeters or inches, that is precipitated in liquid form in a specified area	Rain gauge
Humidity	Amount of water vapour in the air	Hygrometer
Wind speed	Variation in the speed of wind in the landscape	Anemometer

3.6 Plant species utilization

In order to determine plants use, an assessment of the useful plants was conducted in the regions. The uses of the plants including food, medicines, fiber, building and construction material, thatch, firewood, fodder, and cultural use were noted and recorded during the study period. The plants cited were later placed into the various use-categories.

3.7 Data analysis

All statistical analyses were performed with a version of STATISTICA 10.0 (Hilbe, 2007; Weiß, 2007) or Statistical Package for Social Sciences (SPSS 23.1) statistical packages (Morgan *et al.*, 2004). In case where data was found not to follow normal distribution (heteroscedastic), log transformation was used to normalize all the biological data (Rahm and Do, 2000) prior to statistical analyses. Differences in plant community (abundance, and diversity) were analyzed using One-Way ANOVA. All results were declared significant at $P < 0.05$. Significant differences were analysed by *post hoc* Tukey's HSD test.

To establish plant distribution and community structure, the percentages of species contribution were subjected to exploratory cluster analysis, and similar stations were classified in terms of species composition and plant structure. Ordination was used to examine spatial patterns in vegetation assemblage structure relative to environmental variables and human activities. Ordination was undertaken on presence-absence and plant cover data sets. For each data set the Bray-Curtis dissimilarity measure was used to produce an association matrix of dissimilarities between sites. The association matrix was ordinated using Principal Component Analysis (PCA). The ordination was rotated (Varimax rotation) to simplify interpretation. Principal Axis Correlation was used to correlate environmental variables and human activities with the ordination space. This procedure uses multiple regression to fit attributes to an ordination space as vectors of best fit (Belbin, 1995). The significance of correlation coefficients produced by Principal Axis Correlation was tested using a Monte-Carlo procedure (Monte-Carlo Attributes and Ordination procedure) and 1000 randomizations. The utility of plants taxa to discriminate between site groups were examined using measures of constancy and fidelity. Constancy is the proportion of sites within any group in which a taxon occurs.

Species encountered were identified, counted and abundance determined as the number of species per m^2. The total species abundance of each species in the various sites were used to calculate the Shannon-Weiner index using the standard equation (Kent & Coker, 1992; Ludwig & Reynold, 1988)

$$H' = \sum_{i=1}^{n} P_i (LnP_i)$$

Where: H' = Shannon's diversity index

P_i = the abundance of the ith species expressed as a proportion of total cover.

n = number of species

The similarity/dissimilarity of the human activities on plant species composition from the four sites was graphically visualized by multi-dimensional scaling ordination (MDS). Preceding the MDS analysis, proximity distance was calculated using the Euclidean distances of the standardized data. The reliability and validity of the MDS solution was determined by calculating the index of fit (R-square).

The local importance of each species cited was calculated using the Use-Value equation (Silva and Albuquerque, 2004): UV = ∑Ui/n.

Where: Ui = the number of uses for a given species n = the total number of uses. The use value was correlated with abundance by use of (R-square) statististics.

CHAPTER FOUR

RESULTS

4.1 Plant species spatial distribution in Embobut Forest Reserve

This study determined a total of 645 species belonging to 456 genera in 116 families were recorded in the entire region of Embobut Forest Reserve (Appendix 1). They were categorized into trees, shrubs, lianas and herbs as presented in the subsequent sections.

4.1.1 Tree species spatial distribution in Embobut Forest Reserve

The species *Vachellia tortilis, Senegalia mellifera*, *Boscia coriacea*, *Bersama abysinica, Balanites pedicellaris*, *Grewia bicolor* and *Nuxia congesta* had a wider distribution (Figure 4.1). Meanwhile those species with a narrow distribution range included *Acacia hockii*, *Afrocrania volkensii*, *Combretum apiculatum*, *Combretum molle, Elaeodendron buchananii*, *Euphorbia candelabrum*, *Hypericum revolutum*, *Lannea schimperi*, *Lonchocarpus eriocalyx*, *Neoboutonia macrocalyx*, *Pittosporum viridiflorum*, *Rapanea melanopholeos*, *Schefflera volkensii* and *Terminalia brownii*.

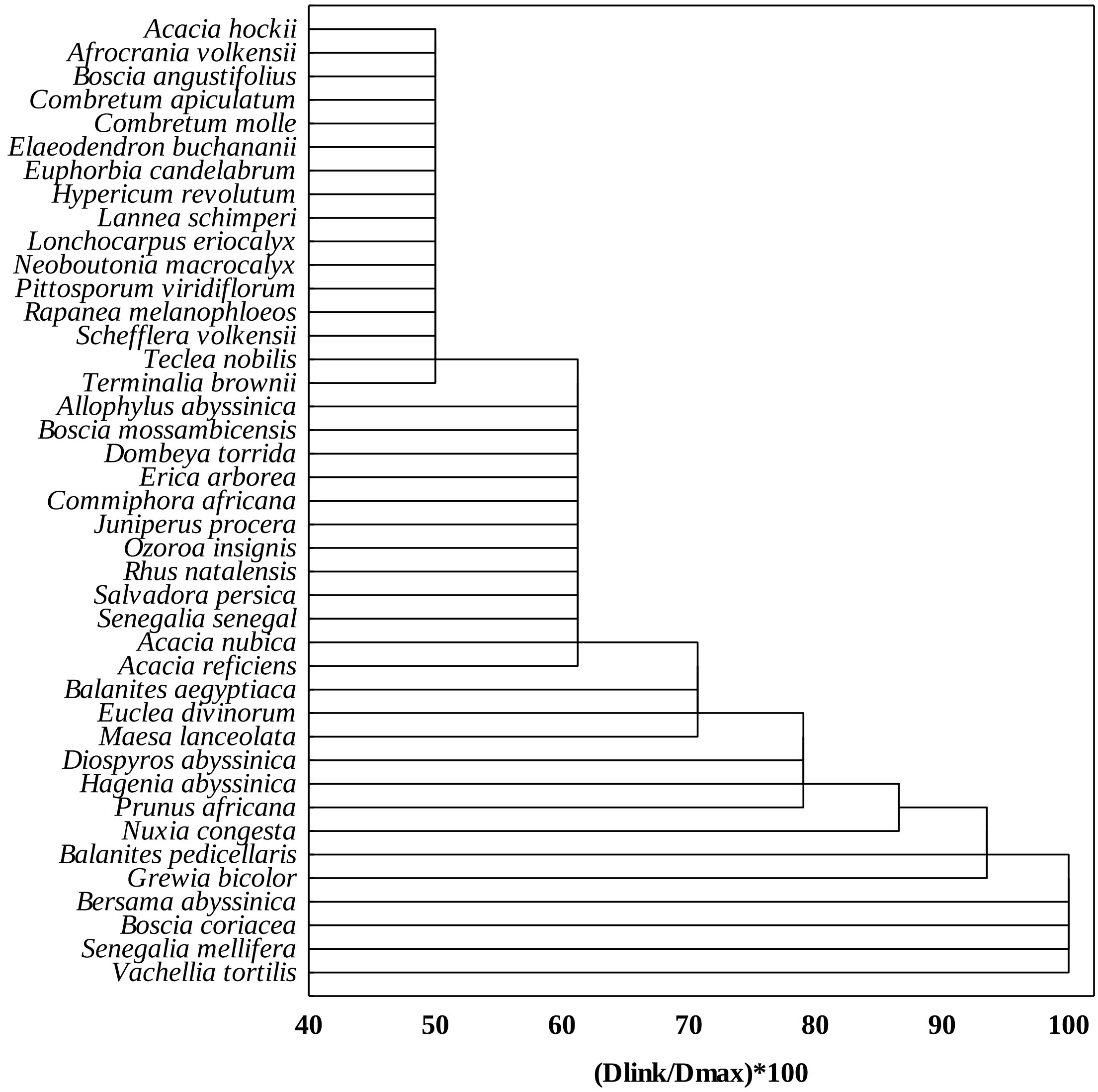

Figure 4.1: Dendrogram from a cluster analysis showing the distribution of tree species in Embobut Forest Reserve

4.1.2 Spatial distribution of shrub species in Embobut Forest Reserve

Plectranthus barbatus, *Barleria acanthoides*, *Aloe tweediae*, *Croton dichogamus*, *Euphorbia heterochroma*, *Helichrysum argyranthum* and *Erica arborea* were widely distributed in terms of composition, while *Acalypha volkensii*, *Achyranthes aspera*, *Vernonia hymenolepis*, *Solanum terminale* and *Hibiscus diversifolius* showed a narrow distribution (Figure 4.2).

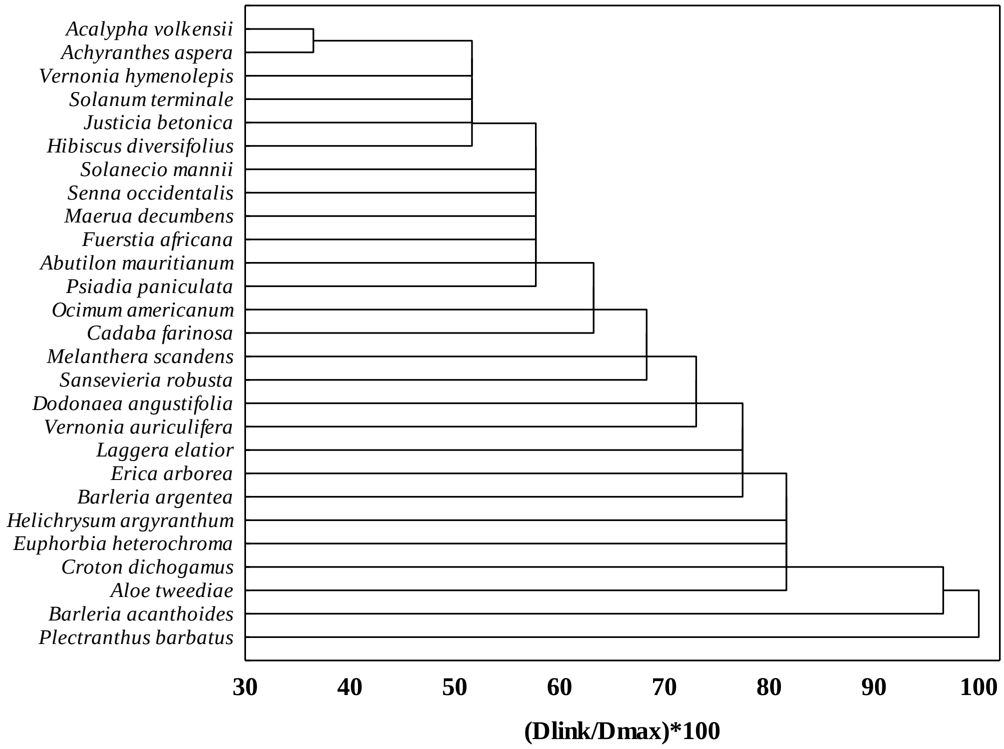

Figure 4.2: Dendrogram from a cluster analysis showing the distribution of most abundant shrub species at the four sampling sites in Embobut Forest Reserve

4.1.3. Spatial distribution of lianas in Embobut Forest Reserve

In terms of distribution *Cissus quadrangularis, Cissus rotundifolia* and *Jasminum abyssinicum* were the only species showing a wide distribution while the remaining species had a narrow distribution pattern (Figure 4.3).

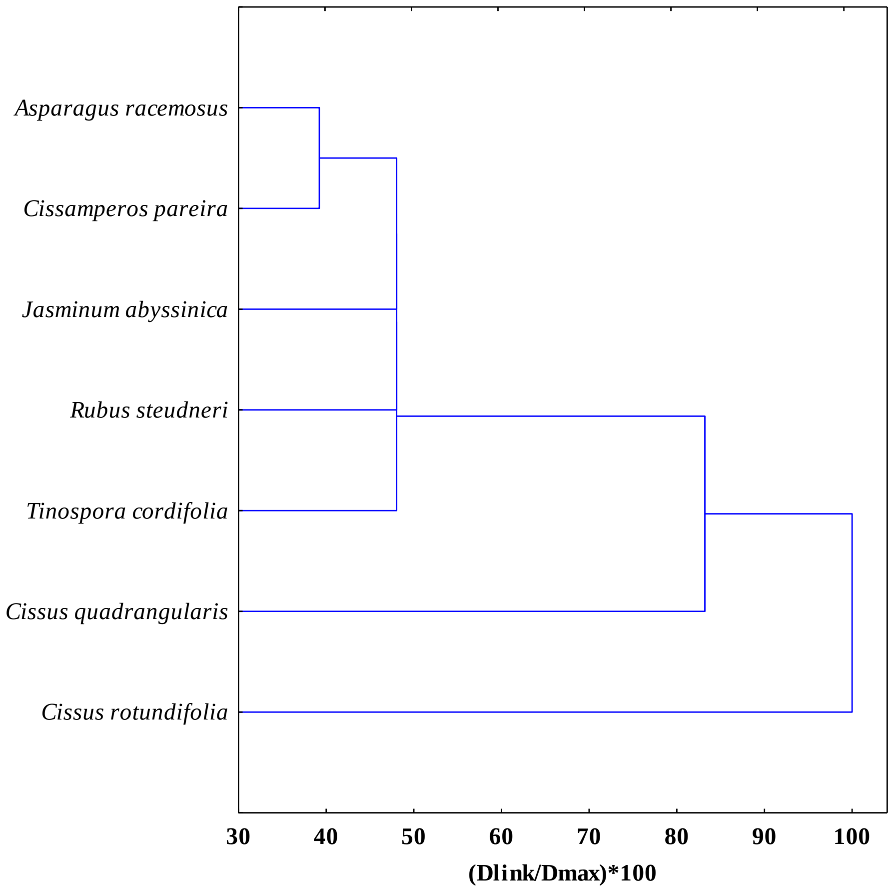

Figure 4.3: Dendrogram from a cluster analysis showing the distribution of the lianas based on site taxa matrix in Embobut Forest Reserve

4.1.4. Distribution of herbaceous species in Embobut Forest Reserve

In terms of distribution, erect herbs, grasses, and creepers showed a wide distribution (Figure 4.4). The erect herbs, grasses and creepers aoccured at all the sampling sites within the reserve. Meanwhile parasitic plants, prostrate herbs and rosette herbs were least in distribution being restricted to only one sampling block.

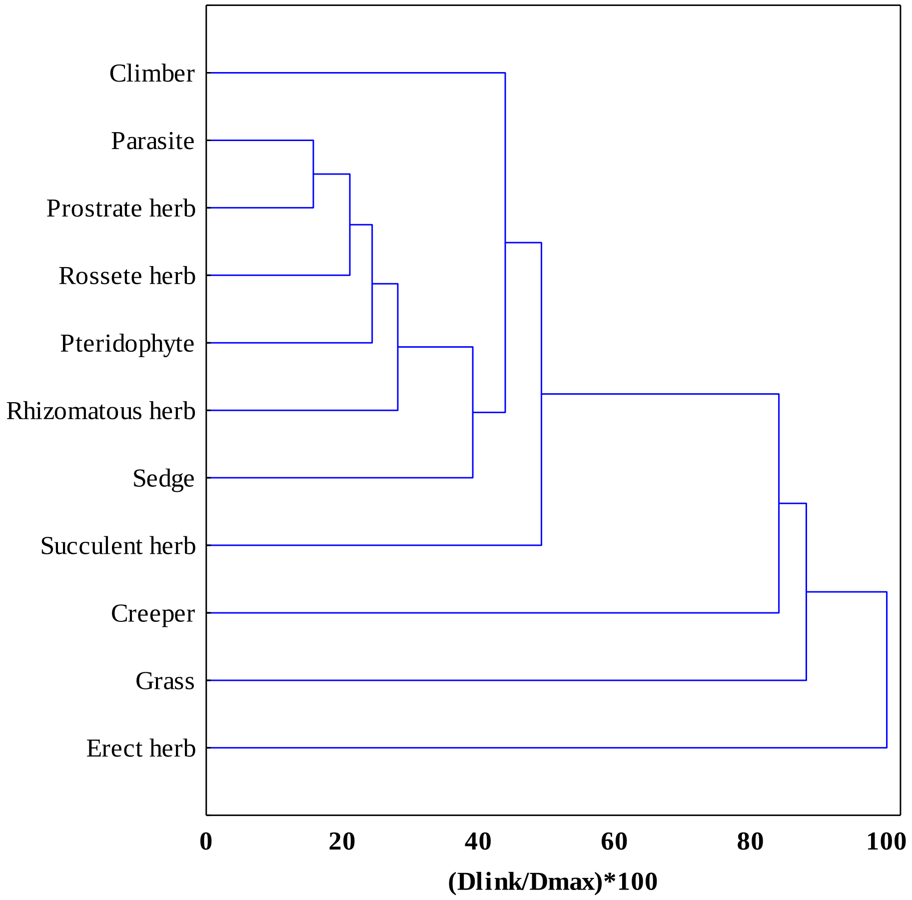

Figure 4.4: Dendrogram from a cluster analysis showing the distribution of the herbs life forms based on site taxa matrix in Embobut Forest Reserve

4.2 Plant species composition, abundance and diversity

This section presents information on the plant species composition, abundance and diversity in in Embobut Forest Reserve

4.2.1 Plant species composition

This section describes the composition of plants in terms of trees, shrubs, lianas and herbs in Embobut Forest Reserve

4.2.1.1 Tree species composition

Results from the quantitatively assessed quadrats showing the presence and absence of tree species at the four sites in Embobut Forest Reserve are provided in Table 4.1. There was a total of 41 tree species belonging to 24 families. The valley floor had the highest number of tree species (16) followed by the escarpment (15), then upland forest (9) and least in montane region (8). There was no single tree species that occurred concurently in all the sampling sites. The valley floor was dominated by species in the family Fabaceae (*Senegalia mellifera*, *Senegalia senegal*, *Acacia nubica*, *Acacia reficiens* and *Vachellia tortilis*) and Capparaceae family mainly *Boscia angustifolia*, *Boscia coriacea* and *Boscia mossambicensis* while in the escarpment the dominant species belonged to family Fabaceae (*Acacia hockii*, *Lonchocarpus eriocalyx* and *Senegalia mellifera*), Anacardiaceae (*Lannea schimperi* and *Ozoroa insignis*), Combretaceae (*Combretum apiculatum* and *Combretum molle*), Ebenaceae (*Diospyros abyssinica* and *Euclea divinorum*).

Table 4.1: Tree species comparison in Embobut Forest Reserve

		Location			
Family	Species	Valley floor	Escarpment	Upland forest	Montane region
Anacardiaceae	*Lannea schimperi* Hochst. *Ex A.Rich.*	-	+	-	-
	Ozoroa insignis Delile	-	+	-	-
	Rhus natalensis Berhn. Ex Krauss.Krauss.	+	-	-	-
Araliaceae	*Schefflera abyssinica (Hochst. ex A.Rich.) Harms*	-	-	-	+
Burseraceae	*Commiphora africana* (A.Rich.) Endl.	+	-	-	-
Capparaceae	*Boscia angustifolia* A. Rich.	+	-	-	-
	Boscia coriacea Pax.	+	-	-	-
	Boscia mossambicensis Klotzsch	+	-	-	-
Cerastraceae	*Elaeodendron buchananii* Loes. Loes	-	-	-	+
Combretaceae	*Combretum apiculatum* Sond.	-	+	-	-
	Combretum molle R.Br. Ex G. Don.	-	+	-	-
	Terminalia brownii Fresen.	+	-	-	-
Cornaceae	*Afrocrania volkensii* (Harms.) Hutch.	-	-	+	-
Cupressaceae	*Cupressus lusitanica* Miller	-	-	-	+
Ebenaceae	*Diospyros abyssinica* Hiern.	+	+	-	-
	Euclea divinorum Hiern.	-	+	-	-
Ericaceae	*Erica arborea* L.	-		-	+
Euphorbiaceae	*Euphorbia candelabrum* Kotschy	-	+	-	-
	Neoboutonia macrocalyx Pax	-	-	+	-
Fabaceae	*Acacia hockii* De Willd.	-	+	-	-
	Lonchocarpus eriocalyx Harms.	-	+	-	-
	Senegalia mellifera (M. Vahl) S. & *Ebinger*	+	+	-	-
	Senegalia senegal (L.) Britton.	+	-	-	-

	Acacia nubica Benth.	+	-	-	-
	Acacia reficiens (Wawra) Kya & Boatwr.	+	-	-	-
	Vachellia tortilis (Forssk.) Galasso & *Banfi*	+	+	-	-
Hypericaceae	*Hypericum revolutum* Vahl	-	-	-	+
Malvaceae	*Grewia bicolor* Juss	+	+	-	-
Francoaceae	*Bersama abyssinica* Fresen	-	-	+	-
Pittosporaceae	*Pittosporum viridiflorum* Sims	-	-	+	-
Primulaceae	*Maesa lanceolata* Forsk.	-	-	+	-
	Rapanea melanophloeos (L.) Mez	-	-	-	+
Rosaceae	*Hagenia abyssinica* Willd.	-	-	+	+
	Prunus africana (Hook.f.) Kalkman	-	-	-	+
Rutaceae	*Teclea nobilis* Delile.	-	+	-	-
Salvadoraceae	*Salvadora persica* L.	+	-	-	-
Sapindaceae	*Allophylus abyssinicus* (Hochst.) Radlk.	-	-	+	-
Sterculiaceae	*Dombeya torrida* (J.F. Gmel.)Bamps	-	-	+	-
Stilbaceae	*Nuxia congesta* R.Br. ex Fresen.	-	-	+	-
Zygophyllaceae	*Balanites aegyptiaca* (L.) Delile	+	-	-	-
	Balanites pedicellaris Mildbr & (Welw) Mildbr &	+	+	-	-
	Total	16	15	9	8

+ shows presence and – absence

There was no occurence of any one family with two species in the upland forest. However, some trees occurred as single specialized species like *Schefflera volkensii* (Araliaceae), *Afrocrania volkensii* (Cornaceae), *Neoboutonia macrocalyx* (Euphorbiaceae), *Bersama abyssinica* (Francoaceae), *Pittosporum viridiflorum* (Pittosporaceae), *Maesa lanceolata* (Primulaceae), *Hagenia abyssinica* (Rosaceae), *Allophylus abyssinica* (Sapindaceae), *Dombeya torrida* (Malvaceae) and *Nuxia congesta* (Stilbaceae) in the upland regions.

The family Rosaceae dominated the montane region with two species *Hagenia abyssinica* and *Prunus africana* while the other five families represented by*;* (*Schefflera volkensii* (Araliaceae), *Elaeodendron buchananii* (Celastraceae), *Juniperus procera* (Cupressaceae), *Erica arborea* (Ericaceae), *Hypericum revolutum* (Hypericaceae), *Rapanea melanophloeos* (Myrsinaceae) occurred as single species in each family.

4.2.1.2. Composition of shrub species in Embobut Forest Reserve

The results on the presence and absence of the quantitively assessed shrubs at the four sites in Embobut Forest Reserve are as shown in Table 4.2.

Table 4.2: Shrubs species composition in Embobut Forest Reserve

		Location			
Family	**Species**	Valley floor	Escarpment	Upland forest	Montane
Acanthaceae	*Barleria acanthoides* Vahl.	+	+	–	–
	Barleria argentea Rolf. f.	+	+	–	–
	Blephalis edulis (Forssk.) Pers.	–	+	–	–
	Justicia betonica L.	+	–	–	–
Amaranthaceae	*Achyranthes aspera* L.	+	–	–	–
	Aerva lanata (L.) Schultes	–	+	–	–
Apocynaceae	*Adenium obesum* (Forssk.) Roem & Schult.	+	–	–	–
Asparagaceae	*Sansevieria frequens* Chahin.	+	–	–	–
	Sansevieria robusta N.E. Brown	+	–	–	–
Asphodelaceae	*Aloe kendongensis* Reynolds	–	+	–	–
	Aloe tweediae Christian	+	+	–	–
Asteraceae	*Bothriocline fusca* (S. Moore) M. Gilbert.	–	–	–	+
	Euryops brownei S. Moore	–	–	–	+
	Helichrysum argyranthum O. Hoffm.	–	–	+	+
	Kleinia odora (Forsk.) DC.	+	–	–	–
	Laggera crispata (Vahl) Hepper & J.R.I. Wood	–	–	–	+
	Laggera elatior R.E.Fr.	–	–	+	+
	Melanthera scandens (Schumach.) Roberty	–	–	+	–
	Microglossa densiflora (Lam.) Kuntze				
	Microglossa pyrifolia (Lam.) Kuntze	–	+	–	–
	Psiadia paniculata (DC.) Vatke.	–	+	–	–
	Solanecio manii (Hook. f.) C. Jeffrey	–	+	+	–
	Vernonia auriculifera Hiern	–	–	+	–
	Vernonia hymenolepis A. Rich	–	+	+	–
Cactaceae	*Opuntia monacantha* Haw	–	+	–	–
Campanulaceae	*Lobelia giberroa Hemsl.*	–	–	–	+
Capparaceae	*Cadaba farinosa* Forssk.	+	+	–	–
	Capparis tomentosa Lam.	+	–	–	–
	Maerua decumbens (Brogn.) DC. Wolf	+	–	–	–
Ericaceae	*Erica arborea* L.	–	–	–	+

Euphorbiaceae	*Acalypha fruticosa* Forsk	+	–	–	–
	Acalypha volkensii Pax	+	–	–	–
	Croton dichogamus Pax.	–	+	–	–
	Euphorbia heterochroma Pax.	+	+	–	–
Fabaceae	*Indigofera atriceps* Hook.f.	–	+	–	–
	Senna occidentalis (L.) Link.	+	+	–	–
Flacourtiaceae	*Dovyalis abyssinica* (A. Rich.) Warb	–	–	+	–
Hypericaceae	*Hypericum revolutum* Vahl	–	–	–	+
Lamiaceae	*Achyrospermum schimperi* (Hochst. Ex Briq.) Perkins	–	–	+	–
	Fuerstia africana T.C.E. Fries	–	+	–	–
	Ocimum americanum L.	+	+	–	–
	Ocimum basilicum L.	+	–	–	–
	Plectranthus barbatus Andrews.	+	+	+	–
	Plectranthus laxiflorus Benth.	–	+	–	–
	Pycnostachys meyeri Gürke ex Engl	–	–	+	–
Malvaceae	*Abutilon mauritianum* (Jacq.) Medic.	+	+	–	–
	Grewia similis K. Schum	+	–	–	–
	Hibiscus diversifolius Jacq.	–	+	–	–
Myrsinaceae	*Myrsine africana* L. .	–	–	–	+
Poaceae	*Yushania alpina* (K.Schum.) W.C. Lin	–	–	+	–
Rhamnaceae	*Rhamnus prinoides* L. Her.	–	–	+	–
Sapindaceae	*Dodonaea angustifolia* L.f.	–	+	–	–
Scrophulariaceae	*Buddleja polystachya* Fresen	–	+	–	–
Solanaceae	*Solanum aculeastrum* Dunal	–	–	+	–
	Solanum incanum L.	+	+	–	–
	Solanum mauense Bitter	–	–	+	–
	Solanum sessilistellatum Bitter	–	–	+	–
	Solanum terminale Forssk.	–	–	–	+
Talinaceae	*Talinum portulacifolium* (Forssk.) Asch. ex Schweinf.	+	–	–	–
Thymelaeaceae	*Struthiola thomsonii* Oliv.	–	–	–	+
Verbenaceae	*Lippia javanica* (Burm f.) Spreng	–	+	–	–
	Total	23	28	15	11

- denotes shrub was absent + denotes shrub was present at the sampling site

There was a total of 60 species of shrubs belonging to 25 families at the four sampling locations. The valley floor and escarpment had the highest counts of shrubs species 23 and 28 respectively followed by upland forest (15) and least in montane region (11). The valley floor and escarpment had higher abundance of shrub species of the family Acanthaceae which were absent in the upland and montane region. Generally only the family Capparaceae and Euphorbiaceae had more than one species and the rest such as (Amaranthaceae) *Achyranthes aspera*, (Apocynaceae) *Adenium obesum*, (Asparagaceae) *Sansevieria frequens*, (Asteraceae) *Kleinia odora*, (Lamiaceae) *Ocimum basilicum*, (Malvaceae) *Grewia similis* and (Talinacaeae) *Talinum portulacifolium* found localized in the valley floor had one species each.

At the escarpment the species that were dominant included: (Amaranthaceae) *Aerva lanata*, (Asparagaceae) *Aloe kedongensis*, (Asteraceae) *Microglossa densiflora*, *Microgrossa pyrifolia*, *Psiadia paniculata*, *Solanecio mannii*, *Psiadia puniculata*, *Solanecio mannii*, *Vernonia hymenolepis*, (Cactaceae) *Opuntia monacantha*, (Lamiaceae) *Fuerstia africana*, *Plectranthus barbatus*, *Plectranthus laxifolius*, (Malvaceae) *Hibiscus diversifolius*, (Sapindaceae) *Dodonaea angustifolia*, (Scrophulariaceae) *Buddleja polystachya* and (Verbenaceae) *Lippia javanica*.

In upland forest and montane region, the dominant species were *Helichrysum argyranthum*, *Laggera elatior*. However, species that mainly dominated the montane region were of the family Asteraceae and these included *Bothriocline fusca*, *Euryops brownei*, *Helichrysum argyranthum*, *Laggera crispata*, *Laggera elatior*, (Campanulaceae) *Lobelia giberroa*. Others included; (Ericaceae) *Erica arborea*, (Hyperaceae) *Hypericum revolutum*, (Myrsinaceae) *Myrsine africana*, (Solanaceae) *Solanum terminale* and (Thymelaeaceae*) Struthiola thomsonii*.

4.2.1.3 Composition of lianas in Embobut Forest Reserve

The presence and absence of lianas at the sampled sites in Embobut Forest Reserve is shown in Table 4.3. There were no lianas recorded in the montane region during the study period. However, there were seven species of lianas of which only family Vitaceae had two species (*Cissus quadrangularis* and *Cissus rotundifolia*). The rest of the families namely; Asparagaceae (*Asparagus racemosus)*, Capparaceae (*Cissampelos pareira*), Menispermaceae (*Tinospora cordifolia*), Oleaceae (*Jasminum abyssinica*) and Rosaceae (*Rubus steudneri)* were represented by only one species each.

Table 4.3: Presence (+), absence (-) of lianas in Embobut Forest Reserve

Family	Species	Location		
		Valley Floor	Escarpment	Upland forest
Asparagaceae	*Asparagus racemosus* Willd.	–	–	+
Capparaceae	*Cissampelos pareira* L.	+	–	–
Menispermaceae	*Tinospora cordifolia (*Willd.) Miers	+	–	–
Vitaceae	*Cissus quadrangularis* L.	+	+	–
	Cissus rotundifolia Vahl	+	+	–
Oleaceae	*Jasminum abyssinicum* Hochst. ex DC.	–	+	+
Rosaceae	*Rubus steudneri* Schweinf.	–	+	–
	Total	4	4	2

4.2.1.4 Composition of Herbaceous plant species in Embobut Forest Reserve

Herbacous plant species identified at the sampling site with reference to life forms, family and species in the Embobut Region are shown in Table 4.4. There was a total of 126 species of herbs belonging to 36 families and 11 life forms. The vast majority of the herbs belonged to the life form erect herbs which had 42 species in 17 families. Creepers had 13 families and 21 species while the single largest family with highest number of species was poaceae with 23 species.

Table 4.4: Checklist of herbs species observed in Embobut Forest Reserve

Form	Family	Species
Climbers	Fabaceae	*Rhynchosia minima* (L.) DC., *Rhynchosia usambarensis* Taub ex Desc, *Glycine wightii* (Wight & Arn.) Verdc.
	Rubiaceae	*Galium aparine* L., *Galium scioanum* Chiov, *Galium thunbergianum* Eckyl & Zeyh.
	Vitaceae	*Cyphostemma cyphopetalum* (Fresen.)Desc. Ex Wild & R. Drum
Creepers	Amaranthaceae	*Pupalia lappacea* (L.) A.Juss.
	Apiaceae	*Centella asiatica* (L.) Urban
	Rubiaceae	*Conostomium quadrangulare* (Rendle) Cufod, *Oldenlandia monanthos* (A. Rich.) Hiern
	Convolvulaceae	*Convolvulus alsinoides* (Linn.) Linn, *Dichondra repens* J.R. & G. Forst.
	Euphorbiaceae	*Euphorbia prostrata* Aiton
	Nyctaginaceae	*Commicarpus grandiflorus* (A. Rich) Standl
	Euphorbiaceae	*Phyllanthus boehmii* Pax.
	Rosaceae	*Alchemilla ellenbeckii* Engl, *Alchemilla rothii* Oliv.
	Fabaceae	*Desmodium repandum* (Vahl) DC., *Parochetus communis* D. Don, *Trifolium cryptopodium* A.Rich., *Trifolium lugardii* Bullock, *Trifolium semipilosum* Fresen.
	Oxalidaceae	*Oxalis corniculata* L.
	Scrophulariaceae	*Veronica abyssinica* Fresen., *Diclis bambuseti* R. E. Fries
	Violaceae	*Viola abyssinica* Oliv.
	Zygophyllaceae	*Tribulus terrestris* L.
Erect herbs	Acanthaceae	*Blephalis edulis* (Forssk.) Pers., *Crabbea velutina* S. Moore, *Hypoestes forskaolii* (Vahl) R.Br, *Hypoestes triflora* (Forsk.) Roem & Schultes., *Justicia flava* Vahl
	Amaranthaceae	*Achyranthes aspera* L., *Aerva lanata* (L.) Schultes, *Cyathula cylindrica* Moq.
	Apiaceae	*Agrocharis incognita* (Denzin) Heyw & July., *Tolilis arvensis* (Huds.) Link
	Asteraceae	*Acanthospermum hispidum* DC., *Berkheya spekeana* Oliv., *Bidens pilosa* L., *Carduus kikuyorum* R.E.Fr., *Galinsoga parviflora* Cav., *Gnaphalium unionis* Oliv & Hiern., *Helichrysum kilimanjari* Oliv., *Tagetes minuta* L., *Tridax procumbens* L.
	Boraginaceae	*Cynoglossum coeruleum* Hochst. ex A.DC.
	Caprifoliaceae	*Scabiosa columbaria* L.
	Ericaceae	*Blaeria filago* Alm & Th. Fries
	Fabaceae	*Crotalaria incana* L.
	Nyctaginaceae	*Boerhavia coccinea* Mill.
	Plantaginaceae	*Plantago palmata* Hook. f.
	Polygalaceae	*Polygala sphenoptera* Fres

	Polygonaceae	*Oxygonum sinuatum* (Hochs. & Steud ex Meisn.) Dammer, *Rumex bequaertii* De Wild
	Scrophulariaceae	*Hebenstretia angolensis* Rolfe
	Urticaceae	*Didymodoxa caffra* (Thunb.) Friis & Wilmot-Dear, *Urtica massaica* Mildbr.
	Geraniaceae	*Geranium arabicum* Forsk.
	Lamiaceae	*Leucas calostachys* Oliv, *Leucas deflexa* Hook. f., *Leucas glabrata* (Vahl.) R.Br., *Leucas martinicensis* (Jacq.) Ait. f., *Micromeria biflora*, *Micromeria biflora* (D.Don) Benth, *Plectranthus kamerunensis* Guerke, *Plectranthus laxiflorus* Benth., *Salvia nilotica Jacq.*
Grasses	Poaceae	*Agrostis keniensis* Pilg., *Aira caryophyllea* L., *Aristida adoensis* Hochst. Ex A. Rich, *Aristida kenyensis* Henr., *Brachiaria decumbens* Stapf., *Cymbopogon pospichilii (*K. Schum) C.E. Hubb, *Cynodon transvaalensis* Burtt Davy, *Dactyloctenium aegyptium* (L.) Willd., *Digitaria scalarum* (Schweinf.) Chiov, *Digitaria velutina* (Forssk.) P. Beauv., *Eleusine jaegeri* Pilg., *Enteropogon macrostachyus* (A. Rich) Benth, *Eragrostis minor* Host., *Ehrharta erecta* Lam., *Harpachne schimperi* A. Rich., *Heteropogon contortus* (L.) Roem & Schult., *Hyparrhenia anamesa* Clayton, *Loudetia simplex* (Nees) C.E. Hubb, *Panicum calvum* Stapf., *Pennisetum clandestinum* Hochst. ex Chiov, *Rhynchelytrum roseum* (Nees) Stapf and C.E. Hubb., *Setaria plicatilis* (Hochst.) Hack ex. Engl, *Sporobolus pyramidalis* P. Beauv.
Parasite	Orobanchaceae	*Alectra sessiliflora* (Vahl) Kuntze.
Prostrate herb	Asteraceae	*Cotula abyssinica* Sch.Bip. ex A.Rich.
	Rubiaceae	*Oldenlandia monanthos* (A. Rich.) Hiern
Pteridophyte	Aspleniaceae	*Asplenium aethiopicum* (Burm.f.) Bech., *Asplenium theciferum* (Kunth) Mett.
	Dryopteridaceae	*Dryopteris inaequalis* (Schltdl.) Kuntze
	Pteridaceae	*Actiniopteris dimorpha* P.C. Serm., *Pellaea calomelanos* (Sw.) Link
Rosette herb	Oxalidaceae	*Biophytum abyssinicum* Steud ex A.Rich
	Acanthaceae	*Crabbea velutina* S. Moore, *Crossandra subcaulis* C.B. Clarke
	Fabaceae	*Chamaecrista mimosoides* (Fresen) Wild & Drum.
Succulent herbs	Portulacaceae	*Portulaca commutata* M. Gilbert., *Portulaca kermesina* N.E. Br., *Portulaca oleracea* L.
	Commelinaceae	*Commelina africana* L., *Commelina benghalensis* L., *Commelina latifolia* Hochst ex A. Rich.
	Crassulaceae	*Crassula granvikii* Mildbr., *Kalanchoe densiflora* Rolfe, *Kalanchoe lanceolata* (Forsk.) Pers.
Sedge	Cyperaceae	*Carex elgonensis* Nelmes, *Cyperus esculentus* L., *Cyperus rigidifolius* Steud., *Isolepis fluitans (L.) R.Br.*, *Kyllinga bulbosa* P.Beauv., *Pycreus elegantulus* (Steud.) C.B. Clarke, *Pycreus nitidus* (Lam.) J. Raynal.
Rhizomatous herb	Oxalidaceae	*Oxalis obliquifolia* Steud ex A. Rich
	Apocynaceae	*Edithcolea grandis* N.E.Br.
	Asparagaceae	*Drimia indica* (Roxb.) Jessop
	Gentianaceae	*Sebaea leiostyla* Gilg.

4.2.2 Plant species abundance

This section describes the abudance of plants in terms of trees, shrubs, lianas and herbs in Embobut Forest Reserve.

4.2.2.1 Abundance of trees species in Embobut Forest Reserve

Species showing highest abundance in the valley floor were *Boscia coriacea* (46), *Vachellia tortilis* (32), *Balanites pedicellaris* (28), *Diospyros abyssinica* and *Salvadora persica* (14) (Table 4.5). In the escarpment high abundance was contributed to by *Vachellia tortilis* (30) and *Diospyros abyssinica* (15) while in Upland forest the dominant forms were *Bersama abyssinica* (23) and *Maesa lanceolata* (20). In the montane forest the dominant species were *Rapanea melanophloeos* (24) and *Hypericum revolutum* (10).

Table 4.5: Tree species abundance in Embobut Forest Reserve

Species	Valley floor	Escarpment	Upland forest	Montane region
Acacia hockii De Willd.	0	4	0	0
Allophylus abyssinicus (Hochst.) Radlk.	0	0	4	0
Afrocrania volkensii (Harms.) Hutch.	0	0	1	0
Balanites aegyptiaca (L.) Delile	9	0	0	0
Balanites pedicellaris Mildbr & (Welw) Mildbr	28	1	0	0
Bersama abyssinica Fresen	0	0	23	1
Boscia angustifolia A. Rich.	1	0	0	5
Boscia coriacea Pax.	46	0	0	0
Boscia mossambicensis Klotzsch	13	0	0	0
Combretum apiculatum Sond.	0	1	0	0
Combretum molle R.Br. Ex G. Don.	0	6	0	0
Commiphora africana (A.Rich.) Endl.	3	0	0	0
Diospyros abyssinica Hiern.	15	15	0	0
Dombeya torrida (J.F. Gmel.)Bamps	0	0	9	0
Elaeodendron buchananii Loes. Loes	0	0	0	3
Erica arborea L.	0	0	0	1
Euclea divinorum Hiern.	0	10	0	0
Euphorbia candelabrum Kotschy	0	3	0	0
Grewia bicolor Juss	7	8	0	0
Hagenia abyssinica Willd	0	0	3	2
Hypericum revolutum Vahl	0	0	0	10
Juniperus procera Hochst. ex Endl.	0	0	0	2
Lannea schimperi Hochst. Ex A.Rich.	0	1	0	0
Lonchocarpus eriocalyx Harms.	0	1	0	0
Maesa lanceolata Forsk.	0	0	20	0
Neoboutonia macrocalyx Pax	0	0	1	0
Nuxia congesta R.Br. ex Fresen.	0	0	14	0
Ozoroa insignis Delile	0	3	0	0
Pittosporum viridiflorum Sims	0	0	1	0
Prunus africana (Hook.f.) Kalkman	0	0	0	1
Rapanea melanophloeos (L.) Mez	0	0	0	24
Rhus natalensis Berhn. Ex Krauss.Krauss.	2	0	0	0
Salvadora persica L.	14	0	0	0
Schefflera volkensii (Hochst. ex A.Rich.) Harms	0	0	0	1
Senegalia mellifera (M. Vahl) S. & Ebinger	11	5	0	0
Senegalia senegal (L.) Britton.	8	0	0	0
Teclea nobilis Delile.	0	5	0	0
Terminalia brownii Fresen.	2	0	0	0
Acacia nubica De Willd.	8	0	0	0
Acacia reficiens (Wawra) Kya & Boatwr.	7	0	0	0
Vachellia tortilis (Forssk.) Galasso & Banfi	32	30	0	0
Total	206	93	76	50

4.2.2.2 Abundance of shrubs in Embobut Forest Reserve

The valley floor had the highest abundance of shrubs (486) followed by escarpment (473), then upland forest (292) and the least in the montane region (191). Species showing highest abundance in the valley floor were *Barleria acanthoides* (117), *Acalypha fruticosa* (76), *Talinum portulacifolium* (65), *Sansevieria robusta* (55) and *Aloe tweediae* (29). In the escarpment high shrub abundance was contributed to by *Plectranthus barbatus* (73), *Acalypha fruticosa* (57), *Sansevieria robusta* (53) *Barleria argentea* (44) and *Croton dichogamus* (44) while in the Upland forest the dominant forms were *Achyrospermum schimperi* (114), *Melanthera scandens* (58), *Laggera elatior* (24) and *Vernonia auriculifera* (21). In the montane forest the abundant species were *Erica arborea* (64), *Lobelia giberroa* (46), *Hypericum revolutum* (28) and *Helichrysum argyranthum* (16) (Table 4.6).

Table 4.6: Shrubs abundance at the four sites in Embobut Forest Reserve

Family	Species	Valley floor	Escarpment	Upland forest	Montane region
Acanthaceae	*Barleria acanthoides* Vahl.	117	26	0	0
	Barleria argentea Rolf. f.	22	44	0	0
	Blephalis edulis (Forssk.) *Pers.*	0	15	0	0
	Justicia betonica L.	14	0	0	0
Amaranthaceae	*Achyranthes aspera* L.	8	0	0	0
	Aerva lanata (L.) Schultes	0	2	0	0
Apocynaceae	*Adenium obesum* (Forssk.) Roem & Schult.	1	0	0	0
Asparagaceae	*Sansevieria frequens* Chahin.	5	5	0	0
	Sansevieria robusta N.E. Brown	55	53	0	0
Asphodelaceae	*Aloe kedongensis* Reynolds	0	3	0	0
	Aloe tweediae Christian	29	9	0	0
Asteraceae	*Bothriocline fusca (S. Moore) M. Gilbert.*	0	0	0	2
	Euryops brownei S. Moore	0	0	0	7
	Helichrysum argyranthum O. Hoffm.	0	0	12	16
	Kleinia odora (Forsk.) DC.	1	0	0	0
	Laggera crispata (Vahl) Hepper & J.R.I. Wood	0	0	0	1
	Laggera elatior R.E.Fr.	0	0	24	1
	Melanthera scandens (Schumach.) Roberty	0	0	58	0

	Microglossa densiflora Hook.f.	0	2	0	0
	*Microgrossa pyrifolia (*Lam.) Kuntze	0	2	0	0
	Psiadia puniculata (DC.) Vatke.	0	8	0	0
	Solanecio mannii (Hook. f.) C. Jeffrey	0	8	1	0
	Vernonia auriculifera Hiern	0	0	21	0
	Vernonia hymenolepis A. Rich	0	1	6	0
Cactaceae	*Opuntia monacantha* Haw	0	3	0	0
Campanulaceae	*Lobelia aberdarica R.E & T.C.E. Fries*	0	0	0	46
Capparaceae	*Cadaba farinosa* Forssk.	16	1	0	0
	Capparis tomentosa Lam.	2	0	0	0
	Maerua decumbens (Brogn.) DC. Wolf	10	0	0	0
Ericaceae	*Erica arborea* L.	0	0	0	64
Euphorbiaceae	*Acalypha fruticosa* Forsk	76	57	0	0
	Acalypha volkensii Pax	6	0	0	0
	Croton dichogamus Pax.	0	44	0	0
	Euphorbia heterochroma Pax.	26	24	0	0
Fabaceae	*Indigofera atriceps* Hook.f.	0	0	5	0
	Senna occidentalis (L.) Link.	15	18	0	0
Flacourtiaceae	*Dovyalis abyssinica* (A. Rich.) Warb	0	0	2	0
Hypericaceae	*Hypericum revolutum* Vahl	0	0	0	28
Lamiaceae	*Achyrospermum schimperi* (Hochst. Ex Briq.) Perkins	0	0	114	0
	Fuerstia africana T.C.E. Fries	0	5	3	0
	Ocimum americanum L.	8	8	0	0
	Ocimum basilicum L.	0	5	0	0
	Plectranthus barbatus Andrews.	2	73	9	0
	Plectranthus laxifolius Benth.	0	4	0	0
	Pycnostachys meyeri Gürke ex Engl	0	0	1	0
Malvaceae	*Abutilon mauritianum (*Jacq.) Medic.	5	6	0	0
	Grewia similis K. Schum	0	1	0	0
	Hibiscus diversifolius Jacq.	0	16	0	0
Myrsinaceae	*Myrsine africana* L.	0	0	0	1
Poaceae	*Yushania alpina* (K.Schum.) W.C. Lin	0	0	5	0
Rhamnaceae	*Rhamnus prinoides* L. Her.	0	0	2	0
Sapindaceae	*Dodonaea angustifolia* L.f.	0	27	0	0
Scrophulariaceae	*Buddleja polystachya* Fresen	0	1	0	0
Solanaceae	*Solanum aculeastrum* Dunal	0	0	8	0
	Solanum incanum L.	3	1	0	0
	Solanum mauense Bitter	0	0	20	0
	Solanum sessilistellatum Bitter	0	0	1	0
	Solanum terminale Forssk.	0	0	0	6
Talinaceae	*Talinum portulacifolium* (Forssk.) Asch. ex Schweinf.	65	0	0	0
Thymelaeceae	*Struthiola thomsonii* Oliv.	0	0	0	19
Verbenaceae	*Lippia javanica* (Burm f.) Spreng	0	1	0	0
	Total	486	473	292	191

4.2.2.3 Abundance of lianas in Embobut Forest Reserve

The abundance of lianas at the four sampling sites is shown in Table 4.7. It was highest in the valley floor (35) followed by escarpment (24) and least in the upland region (16) while in the montane region, there were no occurrence of lianas. *Cissus rotundifolia* dominated the escarpment and the valley floor with 20 and 22 individuals respectively. Upland region was dominated by *Jasminum abyssinicum* with 15 individuals.

Table 4.7: Abundance of lianas in Embobut Forest Reserve

Family	Species	Valley floor	Escarpment	Upland Forest
Capparaceae	*Cissampelos pareira* L.	2	0	0
Vitaceae	*Cissus quadrangularis* L.	10	1	0
	Cissus rotundifolia Vahl	22	20	0
Oleaceae	*Jasminum abyssinicum* Hochst. ex DC.	0	1	15
Rosaceae	*Rubus steudneri* Schweinf.	0	2	0
Asparagaceae	*Asparagus racemosus* Willd.Willd.	0	0	1
Menispermaceae	*Tinospora cordifolia* (Willd.) Miers	1	0	0
	Total	35	24	16

4.2.2.4 Abundance of herbaceous plants in Embobut Forest Reserve

The abundance of herbs was highest at the montane region (247) individuals followed by escarpment (185), upland forest (173) and least at the valley floor (76). Succulent herbs dominated the valley floor (27), erect herbs (70) in escarpment, upland forest grasses (63) and montane region being dominated by creepers (88) (Table 4.8).

Table 4.8: Abundance of herbs life forms in Embobut Forest Reserve

Habit	Valley floor	Escarpment	Upland forest	Montane
Climber	0	18	5	13
Creeper	7	5	33	88
Erect herb	19	70	39	77
Grass	5	60	63	42
Parasite	0	1	0	0
Prostrate herb	1	0	7	2
Pteridophyte	2	11	7	4
Rhizomatous	10	5	0	0
Rosette herb	4	6	0	0
Succulent herb	27	9	4	6
Sedges	1	0	15	15
Total	**76**	**185**	**173**	**247**

4.2.3 Plant species diversity

This section describes the diversity of plants in terms of trees, shrubs, lianas and herbs in Embobut Forest Reserve.

4.2.3.1 Tree species Diversity in Embobut Forest Reserve

The tree species diversity was also determined for the four study locations (Figure 4.5). The montane region had the highest (3.15 ± 0.04) species diversity followed by escarpment (2.97 ± 0.03) and the least diversity sites being the valley floor (2.86 ± 0.04) and upland forest (2.92 ± 0.02).

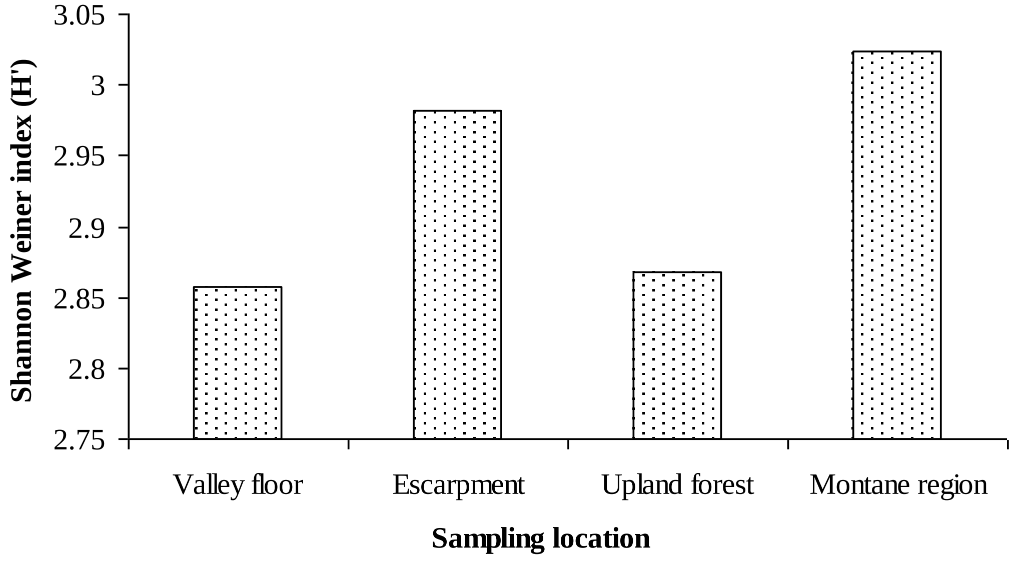

Figure 4.5: Shannon-Weiner Diversity Index of the tree species in Embobut Forest Reserve

4.2.3.2 Diversity of shrubs in Embobut Forest Reserve

The escarpment had the highest shrub species diversity (3.05) followed by valley floor (2.92) and montane region (2.76) while the upland region had the least species diversity (2.73) (Figure 4.6).

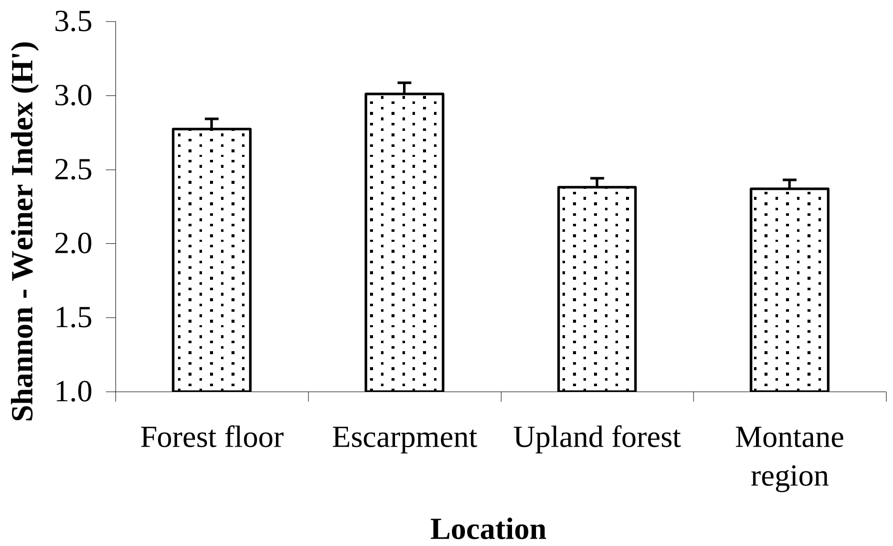

Figure 4.6: Shannon Weinner Diversity index of shrubs in Embobut Forest Reserve

4.2.3.3 Diversity of lianas in Embobut Forest Reserve

The lianas species diversity was also determined (Figure 4.7). The upland forest had the least species diversity (2.13 ± 0.28). The highest species diversity occurred at the valley floor (2.87 ± 0.34) followed by the escarpment (2.71 ± 0.32) which had the least liana diversity among all the sites.

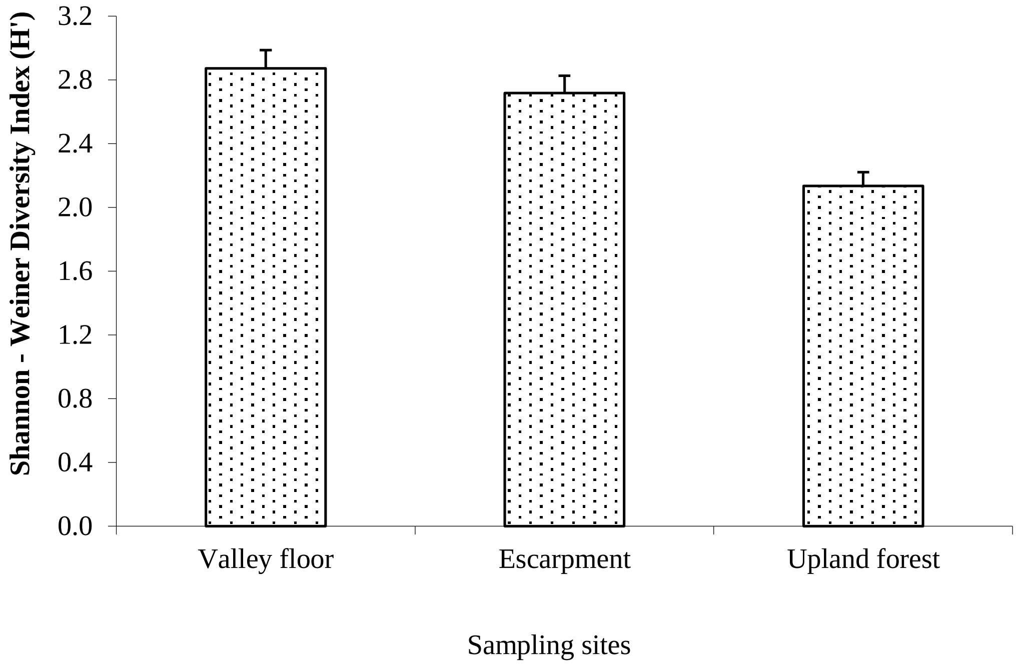

Figure 4.7: Shannon-Weiner diversity index for the liana species at three sites in Embobut Forest Reserve

4.2.3.4 Diversity of herbaceous plants in Embobut Forest Reserve

The valley floor had the highest species diversity (2.9 ± 0.3) followed by escarpment (2.7 ± 0.2) and the least abundant region was the montane region (2.7 ± 0.3). The species diversity exhibited a marked decrease with increasing altitude from the valley floor to the montane region (Figure 4.8).

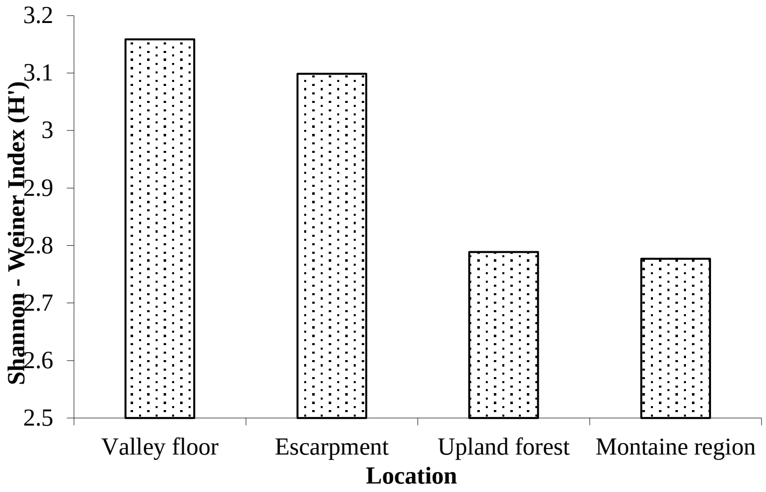

Figure 4.8: Shannon-Weiner diversity index for the herb species at the four sites in Embobut Forest Reserve

4.3 Influence of environmental factors on the species composition, abundance and diversity of plants in Embobut Forest Reserve

The second objective of the study was to determine the influence of several environmental aspects on plant species composition, abundance and diversity in Embobut Forest Reserve.

4.3.1 Influence of environmental factors on plant species composition

This section provides data and interpretation in the influence of environmental factors on plant species composition. The plants were trees, shrubs, lianas and herbs.

4.3.1.1 Environmental influence on tree species composition

An analysis of tree species composition with respect to environmental variable is shown in Figure 4.9 while the loading and relative contribution of each factor to the variability in PCA is shown in Table 4.9. Based on the Principal Component Analysis (PCA) diagram and factor loading, rainfall affected the distribution of species such as *Balanites aegyptiaca*, *Commiphora africana*, *Boscia mossambicensis*, *Vachellia tortilis*, *Acacia nubica*, *Acacia reficiens*, *Senegalia senegal*, *Diospyros abyssinica*, *Terminalia brownii* and *Salvadora persica* (loading to PCA = 0.488). Meanwhile humidity, temperature and altitude determined the distribution of *Hagenia abyssinica*, *Rhus natalensis*, *Prunus africana* and *Maesa lanceolata* (loading to PCA = 0.412). *Boscia coriacea*, *Euclea divinorum* and *Allophylus abyssinica* distribution were influenced by aspect (loading to PCA = 0.318) and slope while wind speed affected the occurrence of *Grewia bicolor, Senegalia mellifera* and *Balanites pedicellaris* (loading to PCA = 0.212).

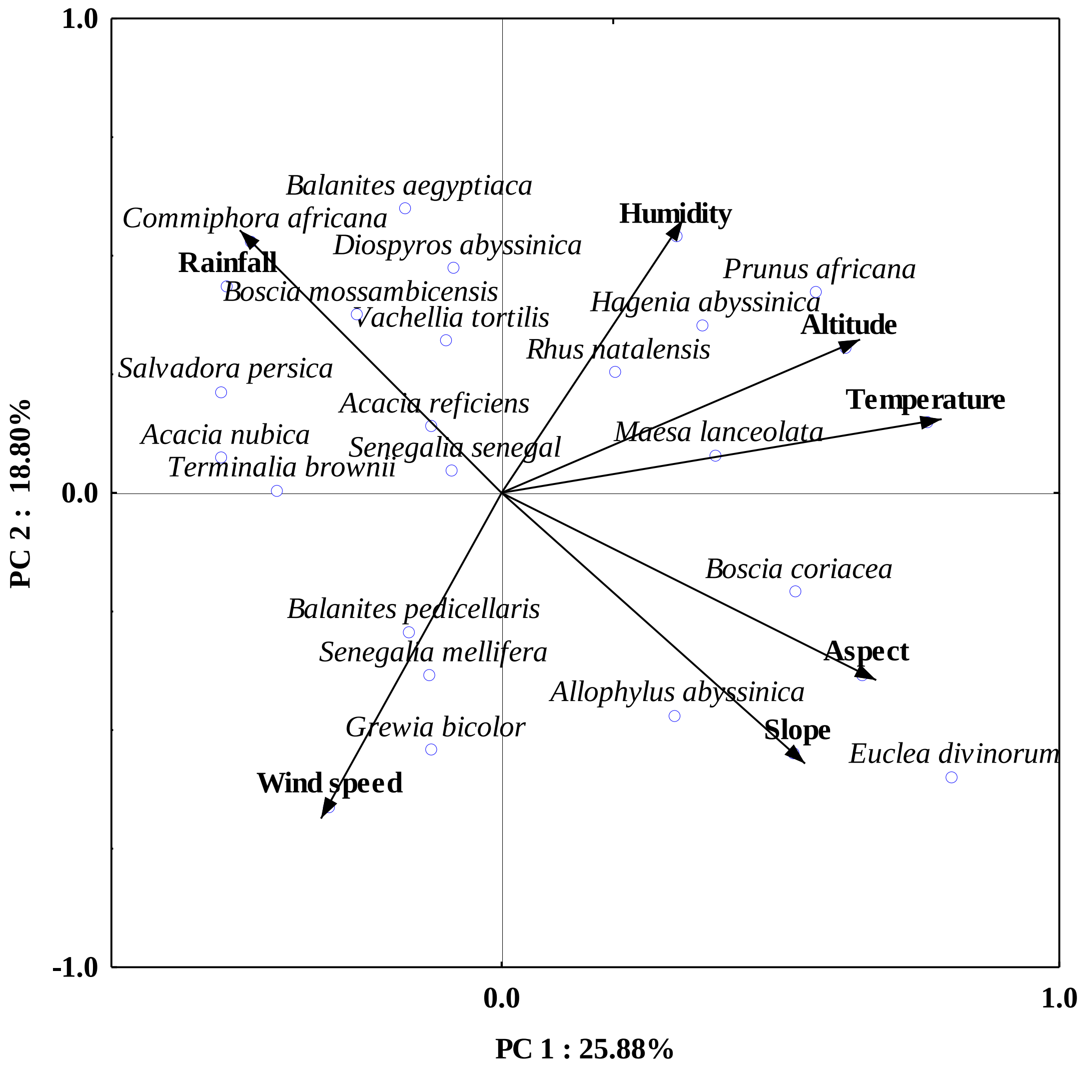

Figure 4.9: Results of Principal Component Analysis on environmental variable vectors and tree species composition in Embobut Forest Reserve

Table 4.9: Loadings of the variables on the Principal Component Analysis (PCA) factors analysed for the environmental variables in tree species abundance (eigen values > 1).

Variables	Factor 1	Factor 2	Factor 3
Explained variance	5.232	3.127	1.034
Proportion of explained variance	51.336	30.006	9.941
Cumulative % variance	51.336	81.342	91.283
Factor loading			
Rainfall	0.243	0.017	0.021
Humidity	0.012	0.132	0.229
Altitude	0.020	0.279	0.059
Temperature	0.030	0.037	0.001
Aspect	0.130	0.001	0.043
Slope	0.086	0.142	0.005
Wind speed	0.262	0.001	0.014
Acacia nubica	0.263	0.007	0.024
Allophylus abyssinicus	0.015	0.100	0.239
Balanites aegyptiaca	0.030	0.057	0.001
Balanites pedicellaris	0.130	0.001	0.043
Boscia coriacea	0.003	0.066	0.108
Boscia mossambicensis	0.022	0.001	0.009
Commiphora africana	0.002	0.000	0.017
Diospyros abyssinica	0.005	0.032	0.034
Euclea divinorum	0.002	0.011	0.053
Grewia bicolor	0.008	0.001	0.108
Hagenia abyssinica	0.006	0.004	0.025
Maesa lanceolata	0.013	0.002	0.042
Prunus africana	0.030	0.279	0.059
Rhus natalensis	0.009	0.000	0.013
Salvadora persica	0.005	0.003	0.016
Senegalia mellifera	0.013	0.002	0.042
Terminalia brownii	0.003	0.001	0.019
Vachellia tortilis	0.029	0.035	0.011

4.3.1.2 Influence of environmental factors on composition of shrubs

The composition of shrubs with respect to environmental variables for the most abundance shrub species is shown in Figure 4.10 while the loading and relative contribution of each factor to the variability in PCA is shown in Table 4.10. Based on the PCA, rainfall affected the occurrence of species such as *Barleria acanthoides, Acalypha fruticosa* and *Croton dichogamus* while aspect influenced the occurence of *Barleria argentea*, *Dodonaea angustifolia* and *Plectranthus barbatus* (loading to PCA = 0.427). Wind speed affected the occurrence of *Euphorbia heterochroma, Helichcrysum argyranthum, Achyrospermum schimperi, Erica arborea* and *Aloe tweediae* (loading to PCA = 0.337). Temperature, altitude, relative humidity and slope affected the occurence of *Vernonia auriculifera*, *Melanthera scandens* and *Laggera elatior* (loading to PCA = 0.284).

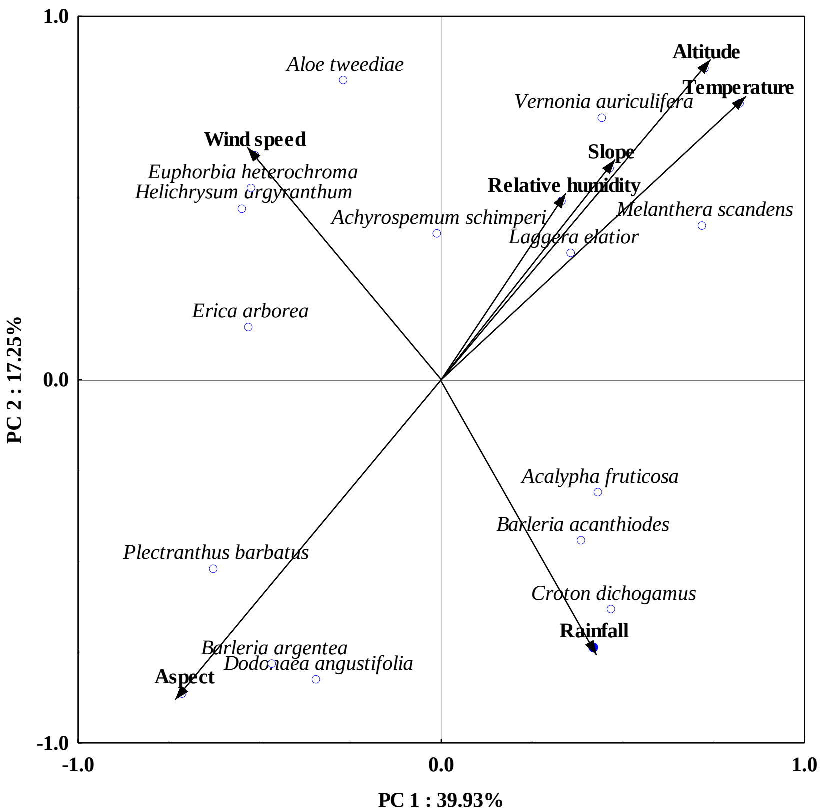

Figure 4.10: Results of Principal Component Analysis on environmental variable vectors and shrubs structure in Embobut Forest Reserve

Table 4.10: Loadings of the variables on the Principal Component Analysis (PCA) factors analysed for the environmental variables in shrubs abundance (eigen values > 1)

Variables	Factor 1	Factor 2	Factor 3
Explained variance	3.232	2.127	1.239
Proportion of explained variance	38.476	25.325	14.751
Cumulative % variance	38.476	61.801	78.552
Factor loading			
Rainfall	0.242	0.122	0.019
Humidity	0.209	0.18	0.068
Altitude	0.039	0.082	0.006
Temperature	0.011	0.139	0.013
Aspect	0.043	0.002	0.187
Slope	0.005	0.094	0.005
Wind speed	0.014	0.008	0.034
Acalypha fruticosa	0.108	0.121	0.011
Plectranthus barbatus	0.009	0.033	0.008
Barleria acanthoides	0.003	0.005	0.003
Helichrysum argyranthum	0.007	0.001	0.042
Euphorbia heterochroma	0.013	0.014	0.341
Croton dichogamus	0.032	0.001	0.017
Aloe tweediae	0.003	0.007	0.002
Achyrospemum schimperi	0.013	0.002	0.001
Laggera elatior	0.001	0.012	0.002
Erica arborea	0.053	0.037	0.002
Dodonaea angustifolia	0.019	0.002	0.028
Barleria argentea	0.108	0.075	0.057
Vernonia auriculifera	0.025	0.053	0.059
Melanthera scandens	0.011	0.147	0.010
Sansevieria robusta	0.042	0.001	0.001
Ocimum americanum	0.019	0.001	0.003
Solanecio mannii	0.042	0.001	0.000
Maerua decumbens	0.042	0.003	0.003
Fuerstia africana	0.014	0.005	0.002
Abutilon mauritianum	0.012	0.002	0.006
Vernonia hymenolepis	0.023	0.012	0.008
Solanum terminale	0.023	0.001	0.004
Psiadia paniculata	0.013	0.011	0.023
Justicia betonica	0.101	0.035	0.021

4.3.1.3 Environmental influences on composition of lianas

Lianas species composition in relation to environmental variables is shown in Figure 4.11 while while the loading and relative contribution of each factor to the variability in PCA is shown in Table 4.11. Based on the PCA diagram, rainfall, slope, and aspect affected the occurrence of species such as *Jasminum abyssinica* and *Cissus rotundifolia* (loading to PCA = 0.327), while temperature and altitude affected the occurrence of *Rubus steudneri* and *Asparagus racemosus* (loading to PCA = 0.327). Humidity and wind speed affected the existence of *Tinospora cordifolia* and *Cissus quadrangularis* (loading to PCA = 0.377). *Cissampelos pareira* was not affected by any environmental factor (loading to PCA = 0.003).

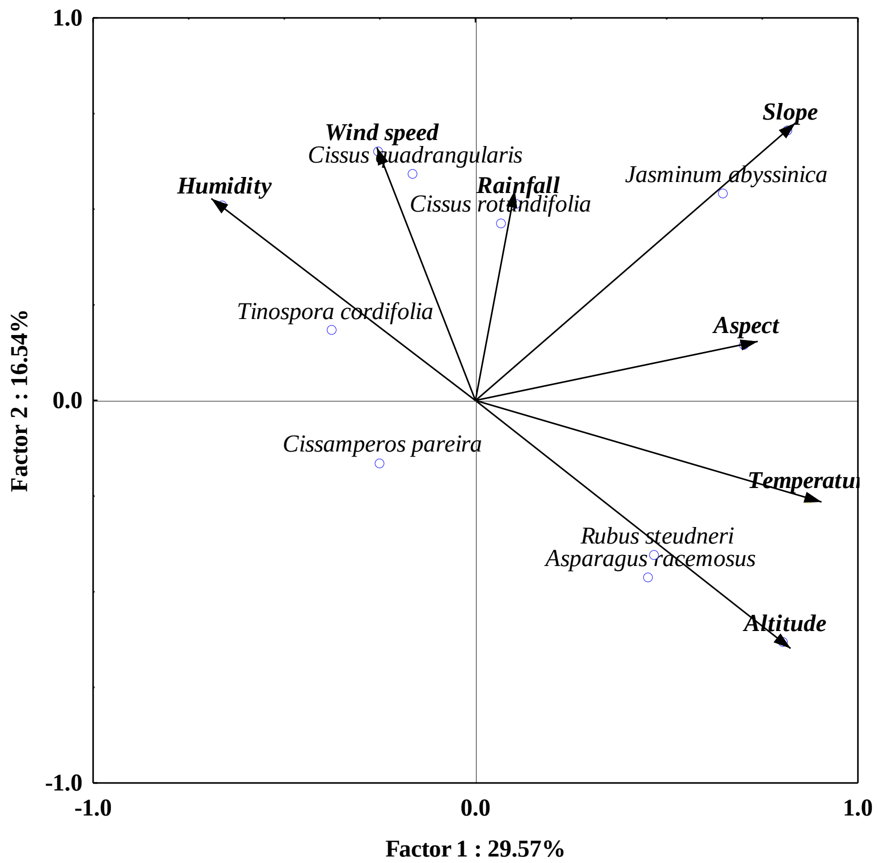

Figure 4.11: Results of Principal Component Analysis on environmental variable vectors and lianas structure in Embobut Forest Reserve

Table 4.11: Loadings of the variables on the Principal Component Analysis (PCA) factors analysed for the environmental variables in liana abundance (eigen values > 1)

Variables	Factor 1	Factor 2	Factor 3
Explained variance	2.232	1.127	1.002
Proportion of explained variance	37.245	18.748	16.746
Cumulative % variance	37.245	55.993	72.739
Factor loading			
Rainfall	0.242	0.122	0.019
Humidity	0.209	0.18	0.068
Altitude	0.039	0.082	0.006
Temperature	0.011	0.139	0.013
Aspect	0.043	0.002	0.187
Slope	0.005	0.094	0.005
Wind speed	0.014	0.008	0.034
Asparagus racemosus	0.108	0.129	0.003
Cissamperos pareira	0.009	0.033	0.013
Cissus quadrangularis	0.003	0.005	0.001
Cissus rotundifolia	0.007	0.001	0.047
Jasminum abyssinica	0.017	0.004	0.344
Rubus steudneri	0.034	0.001	0.017
Tinospora cordifolia	0.003	0.005	0.002

4.3.1.4 Influences of environmental factors on composition of herbaceous plants species

The overall distribution of herbs life forms in relation to environmental variables is shown in Figure 4.12 while while the loading and relative contribution of each factor to the variability in PCA is shown in Table 4.12. The PCA diagram shows that slope, rainfall and wind speed affected the distribution of rhizomatous herbs, erect herbs, pteridophytes, rossete herbs, and climbers (loading to PCA = 0.475). Creepers were affected more by humidity variations while altitude, temperature and aspect affected the occurrence of prostate herbs and grasses (loading to PCA = 0.392). Sedges and parasites as well as succulent herbs were not affected by the environmental factors (loading to PCA = 0.224).

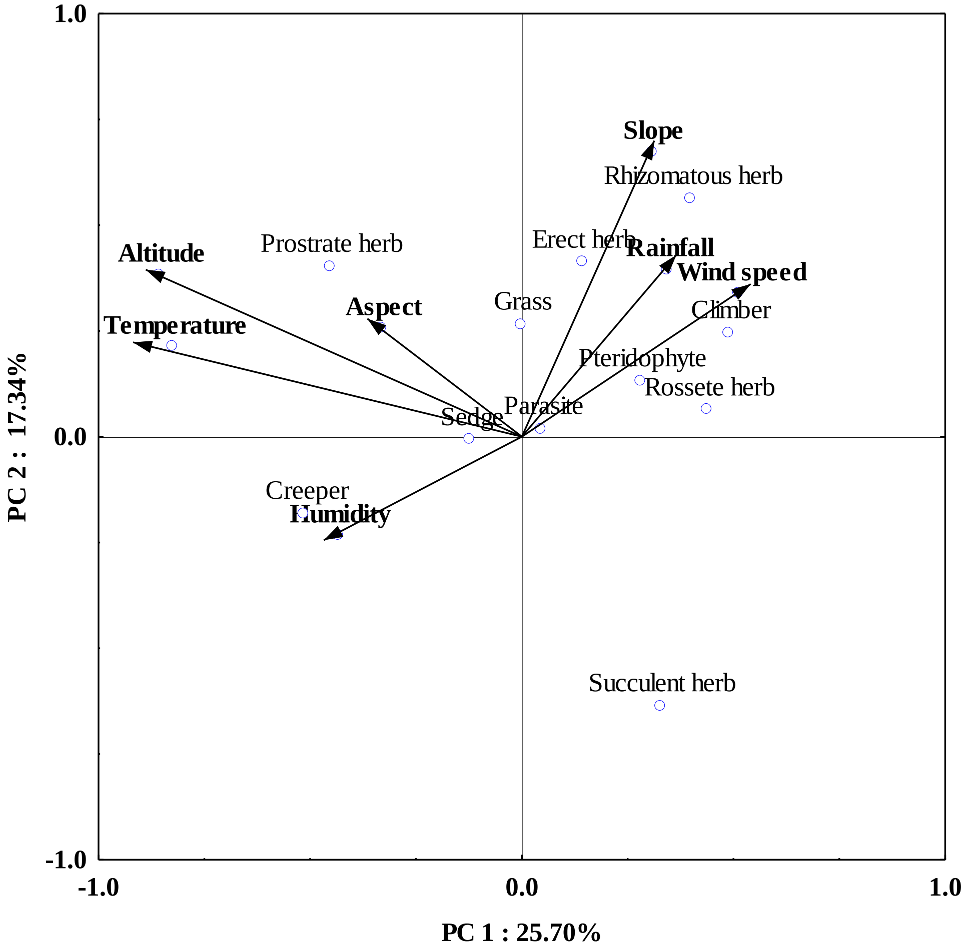

Figure 4.12: PCA diagram showing the relationship between environmental variables on distribution of herbs life form in Embobut Forest Reserve

4.3.2 Influence of environmental factors on plant species abundance

This section provides data and interpretation in the influence of environmental factors on plant species abundance with reference to trees, shrubs, lianas and herbs.

4.3.2.1 Environmental influence on tree species abundance

Results showing the relationship between environmental variables and tree species abundance are provided in Figure 4.13. Temperature, rainfall, humidity, wind speed and altitude were significant ($R^2 > 0.4225$, $P < 0.05$). Whereas temperature, rainfall, humidity and wind speed were positively correlated with abundance, the altitude was negatively related to the plant abundance. Meanwhile, aspect and slope were did not affect abundance of the trees.

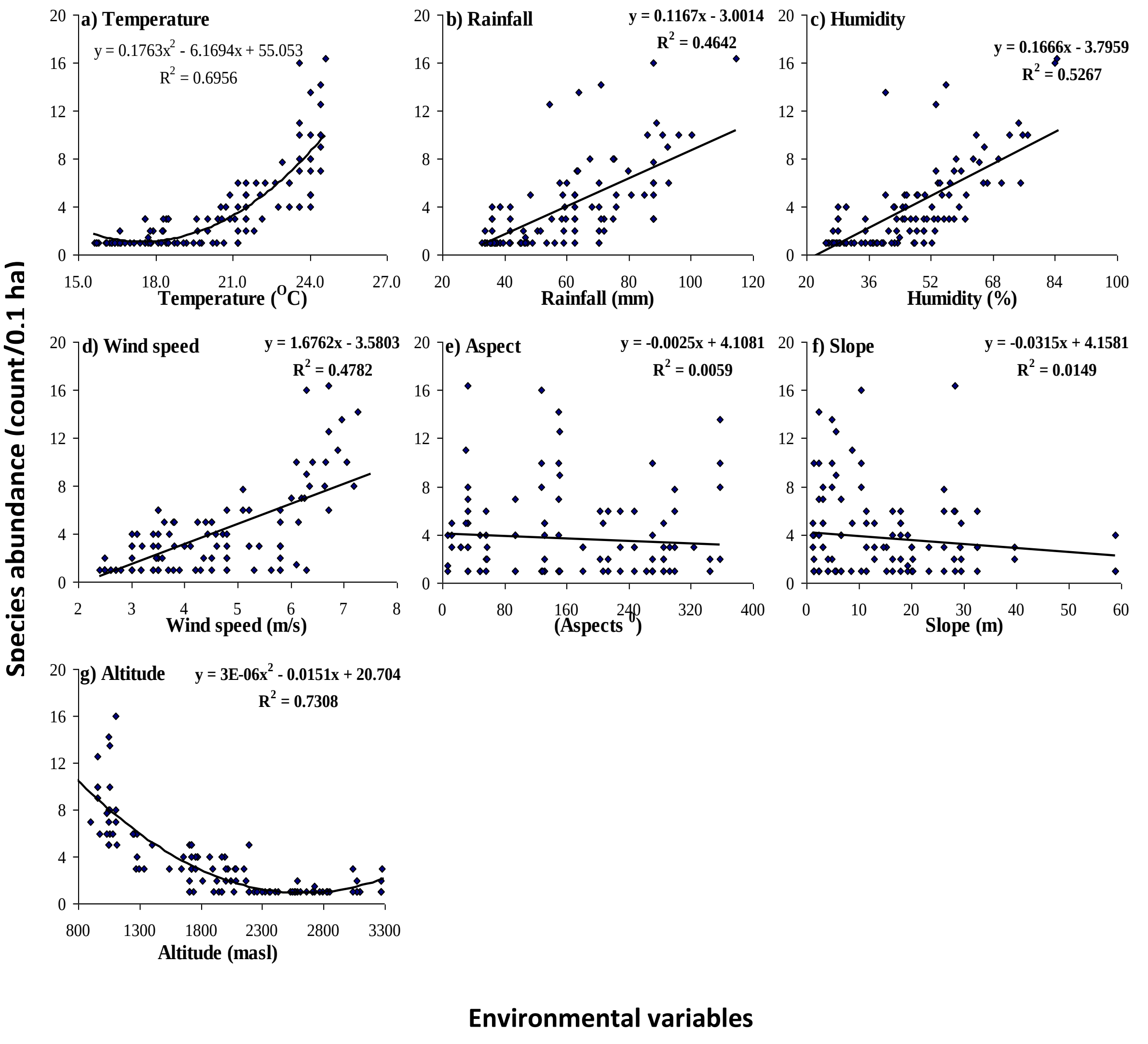

Figure 4.13: Bivariate regression analysis showing the relationships between environmental variables and tree species abundance in Embobut Forest Reserve

4.3.2.2 Environmental influences on abundance of shrubs

The relationships between environmental variables and shrub species abundance are provided in Figure 4.14. The results indicate that temperature, rainfall, humidity, wind speed and altitude were significant ($R^2 > 0.4225$, $P < 0.05$). Whereas temperature, rainfall, humidity and wind speed were positively correlated with abundance, the altitude aspect and slope were negatively related to the shrubs abundance.

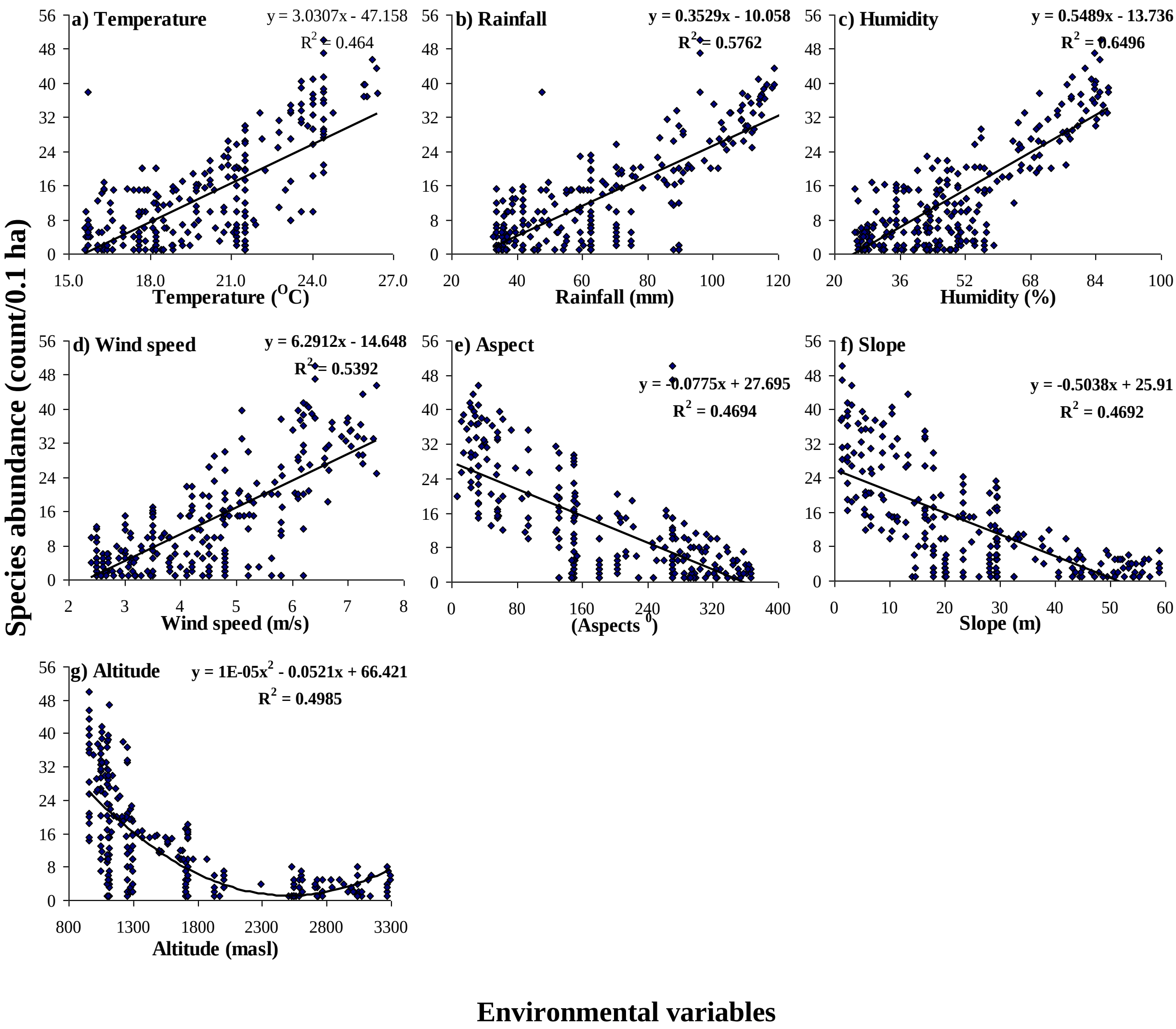

Figure 4.14: Bivariate regression analysis showing the relationships between environmental variables and shrub species abundance in Embobut Forest Reserve

4.3.2.3 Environmental influences on lianas abundance

Temperature and altitude showed parabolic effects on abundance being higher at low and higher values but decreased at mid-ranges values of these parameters. Rainfall, humidity, wind speed and slope significantly ($R^2 > 0.4225$, $P < 0.05$) were positively correlated with abundance, while aspect was negatively related to the lianas abundance (Figure 4.15).

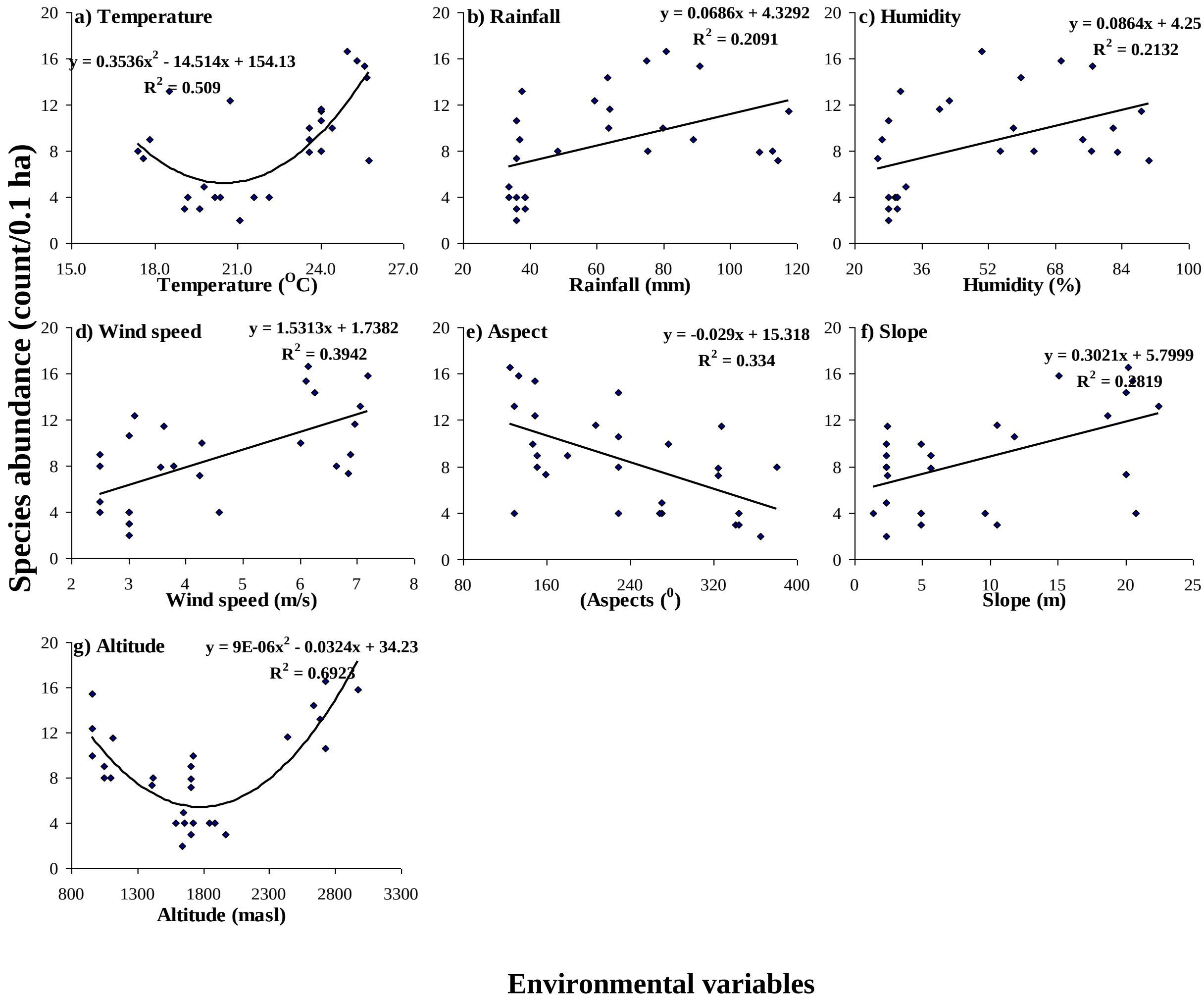

Figure 4.15: Bivariate regression analysis showing the relationships between environmental variable vectors and liana abundance in Embobut Forest Reserve

4.3.2.4 Environmental influences on abundance of herbaceous plant species

Temperature and altitude showed parabolic effects on abundance being higher at low and higher temperatures but decreased in mid temperature ranges. Rainfall, humidity and wind speed significantly ($R^2 > 0.4225$, $P < 0.05$) affected abundance positively while slope negatively. Meanwhile, aspect did not affect abundance of the herbaceous species (Figure 4.16).

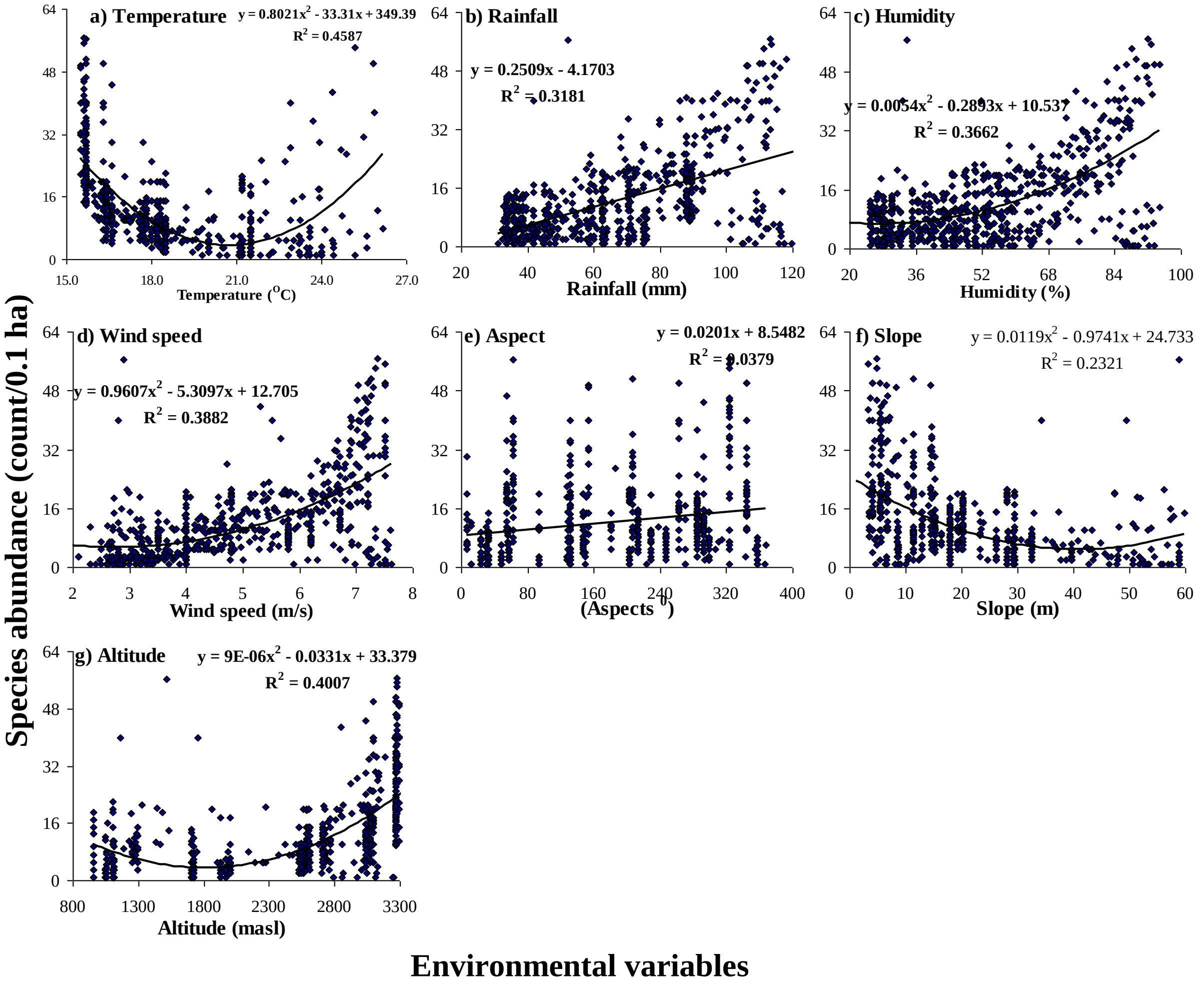

Figure 4.16: Bivariate regression analysis showing the relationships between environmental variable abundance of herbaceous species in Embobut Forest Reserve

4.3.3 Influence of environmental factors on plant species diversity

This section provides data and interpretation in the influence of environmental factors on plant species diversity with reference to trees, shrubs, lianas and herbs.

4.3.3.1 Environmental influence on tree species diversity

The relationships between environmental variables and tree species diversity are provided in Figure 4.17. Based on the results, temperature, rainfall, humidity and wind speed significantly affected diversity positively ($R^2 > 0.4225$, $P < 0.05$) whereas aspect and altitude were negatively related to the trees diversity. Slope did not affect the diversity of trees.

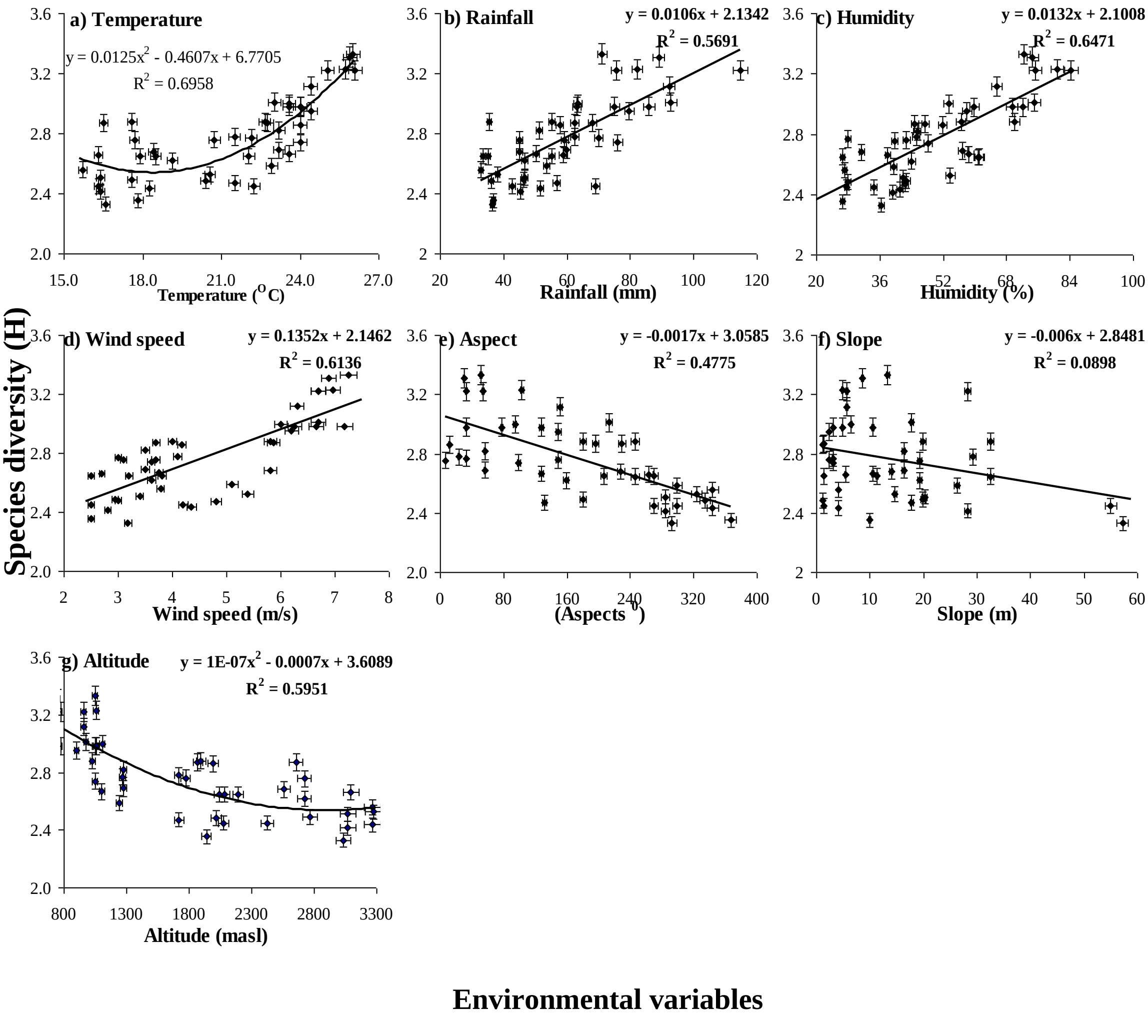

Figure 4.17: Bivariate regression analysis showing the relationships between environmental variables on tree species diversity in Embobut Forest Reserve

4.3.3.2 Influence of environmental factors on shrub species

Temperature, rainfall, humidity, wind speed and altitude significant affected shrubs positively ($R^2 > 0.4225$, $P < 0.05$) whereas slope affected negatively the shrub diversity (Figure 4.18).

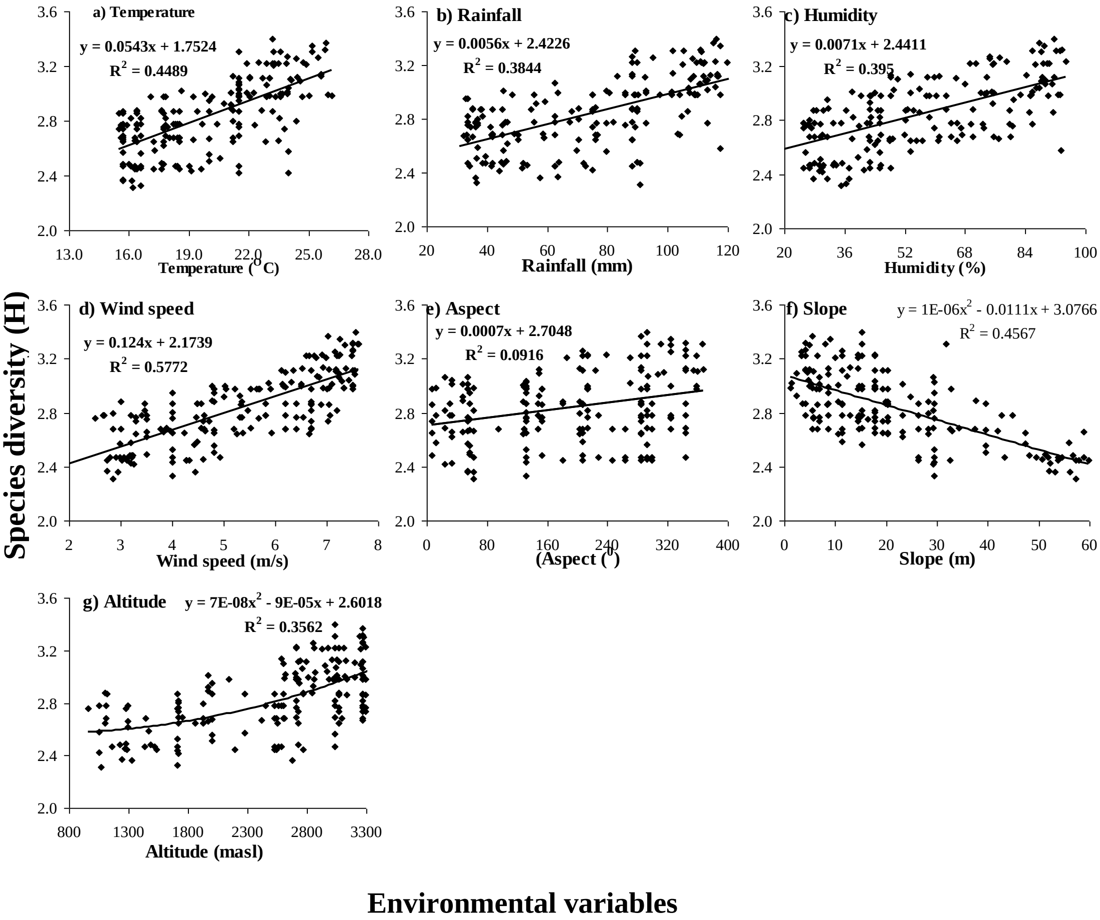

Figure 4.18: Bivariate regression analysis showing the relationships between environmental variables and shrub species diversity in Embobut Forest Reserve

4.3.3.3 Environmental influences on lianas diversity

According to the results, temperature, rainfall, humidity and aspect were significant factors affecting liana diversity positively ($R^2 > 0.4225$, $P < 0.05$) whereas wind speed and slope negatively affected to the lianas abundance significantly ($R^2 > 0.4225$, $P < 0.05$) (Figure 4.19).

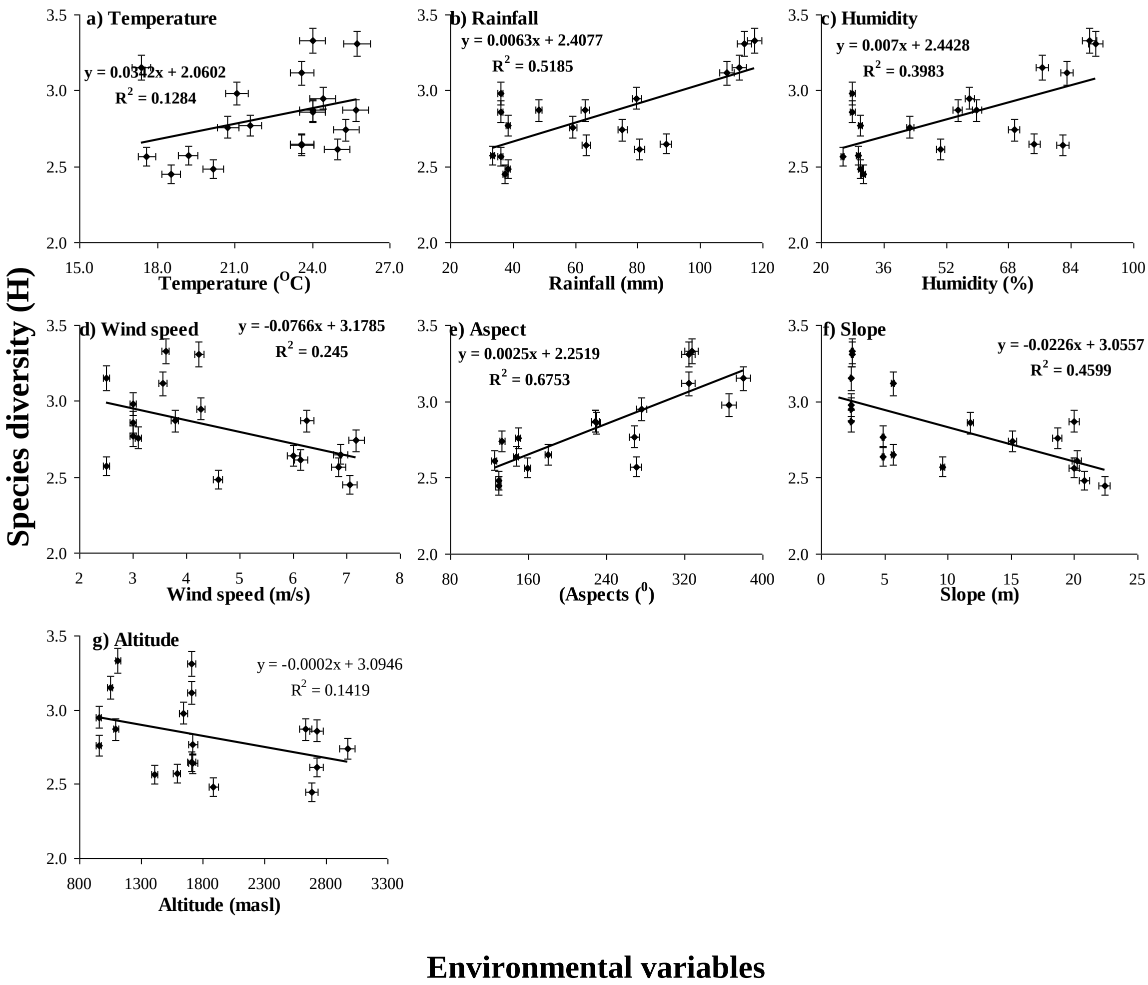

Figure 4.19: Bivariate regression analysis showing the relationships between environmental variable vectors and liana species diversity in Embobut Forest Reserve

4.3.3.4 Environment on diversity of herbaceous plant species

Temperature, rainfall, humidity, wind speed and altitude significantly affected shrubs positively ($R^2 > 0.4225$, $P < 0.05$) whereas slope negatively influenced the herbs diversity (Figure 4.20).

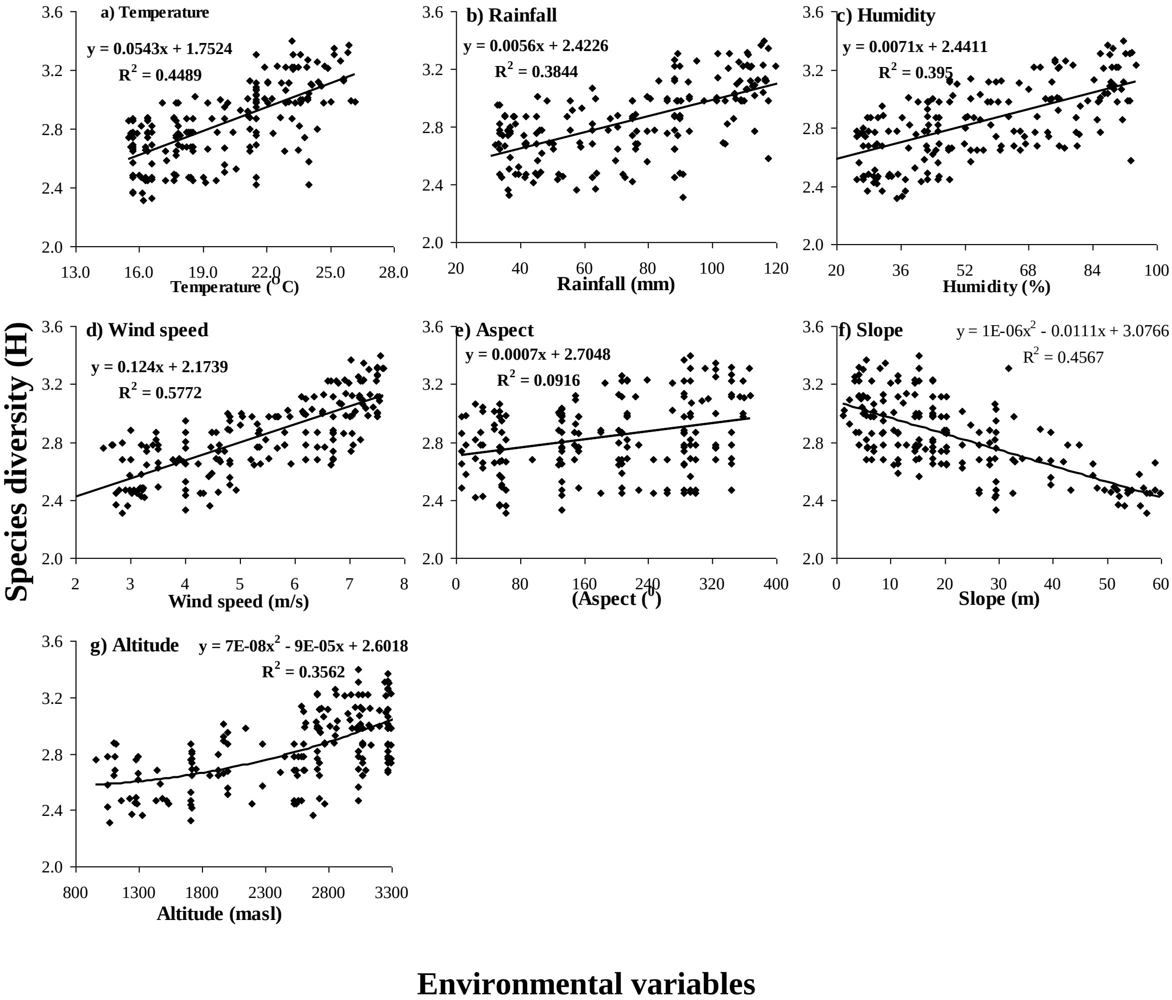

Figure 4.20: Bivariate regression analysis showing the relationships between environmental variable and diversity of herbaceous species in Embobut Forest Reserve

4.4 Influence of human activities on the species composition, abundance and diversity of plants in Embobut Forest Reserve

The fourth objective of the study was to determine the Influence of human activities on the species composition, abundance and diversity of plants in Embobut Forest Reserve

4.4.1 Human activities in Embobut Forest and River Basin

The result shows that the most frequent activities were grazing (25) followed by logging (14), collection of firewood (10), path constructions (9) and charcoal burning (7) which were more frequent than others; then cultivation (3) burning (2), artisanal mining (1), bamboo harvesting (1), settlements (1) and grass cutting (1) (Figure 4.21).

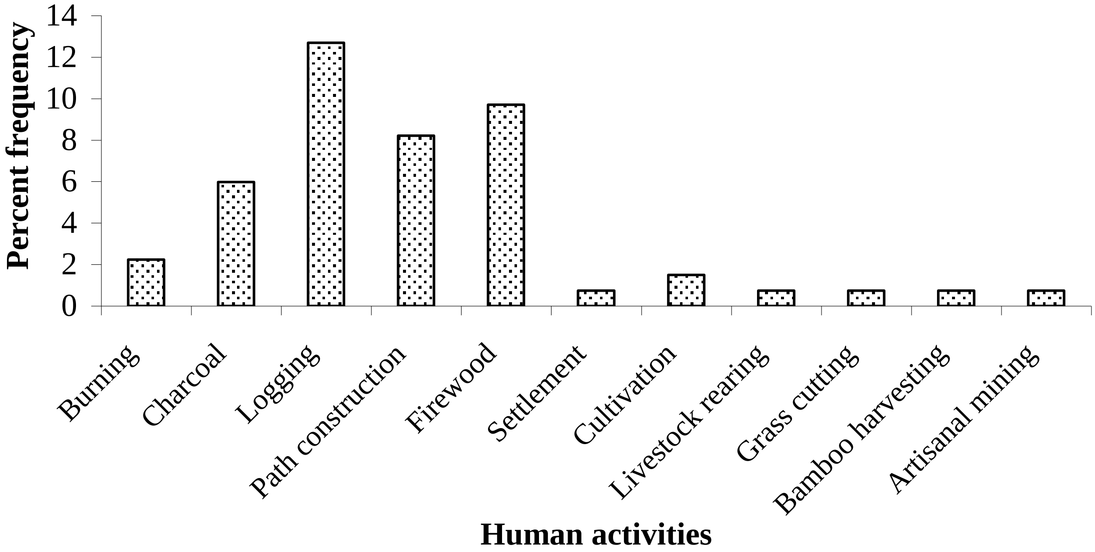

Figure 4.21: Frequency of human activities in the Embobut Forest Reserve

4.4.2 Influence of human activities on plant species composition, abudance and diversity

This section provides data and interpretation in the influence of human activities on plant species composition, abundance and diversity of trees, shrubs, lianas and herbs.

4.4.2.1 Influence of human activities on tree species composition

The MDS diagram shows that areas with intense activities such as firewood collection, charcoal burning, path construction, grass cutting and settlements had higher presence of *Vachellia tortilis*, *Euclea divinorum*, *Boscia mossambicensis*, *Boscia coriacea, Hagenia abyssinica, Balanites pedicellaris, Balanites aegyptiaca* and *Commiphora africana*. On the other hand, areas with plant harvesting and cowsheds had higher presence of *Terminalia brownii* and *Rhus natalensis*. Burning, logging, cultivation and grazing encouraged the proliferation of *Senegalia mellifera*, *Senegalia senegal*, *Maesa lanceolata, Diospyros abyssinica*, *Nuxia congesta*, *Grewia bicolor*, *Acacia reficiens*, *Acacia nubica* and *Prunus africana*. Artisanal mining affected the presence of *Bersama abyssinica* and *Salvodora persica* (Figure 4.22).

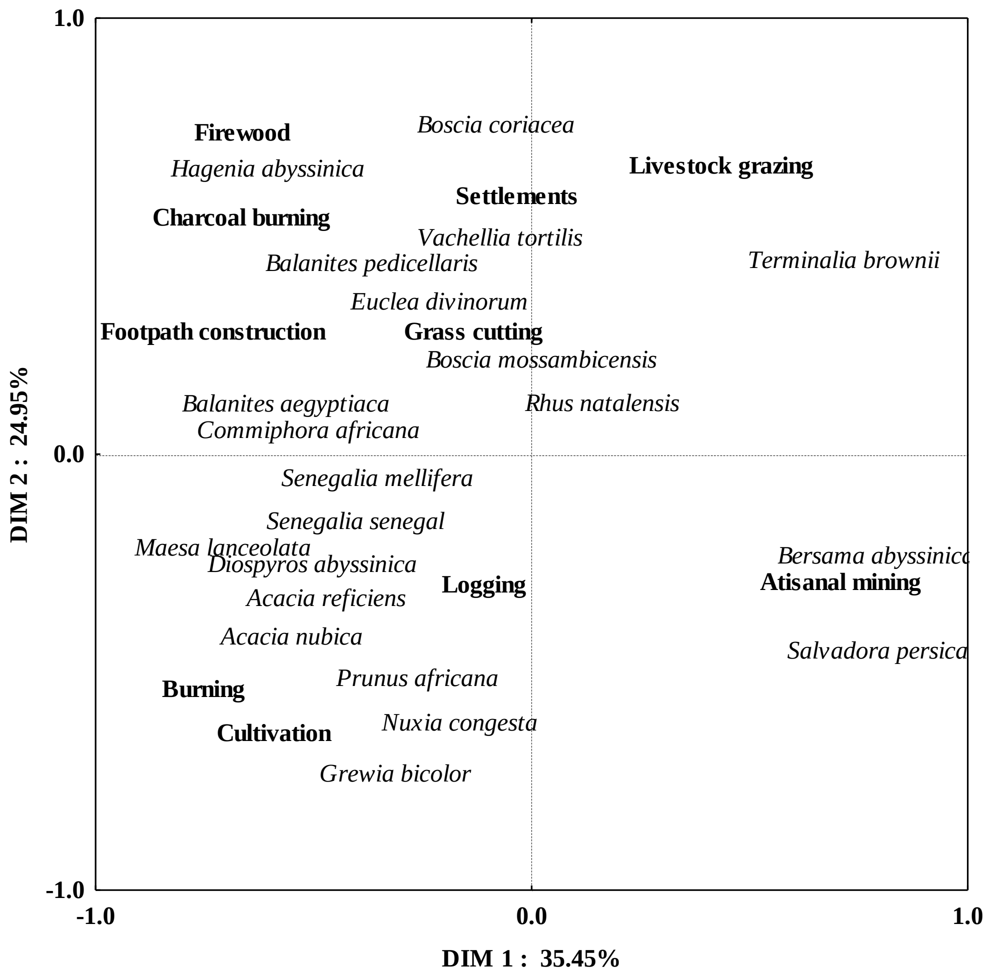

Figure 4.22: MDS diagram showing the relationship between human activities and presence of trees in Embobut Forest Reserve

4.4.2.2 Influence of human activities on composition of shrubs

The MDS diagram shows that areas with intense activities such as charcoal burning, settlements and cowsheds, cultivation and uncontrolled burning had higher presence of *Dodonaea angustifolia*, *Melanthera scandens*, *Justicia betonica*, *Plectranthus barbatus*, *Psiadia paniculata*, *Euphorbia heterochroma*, *Barleria acanthoides* and *Sansevieria robusta*. Meanwhile areas where there were firewood collection, grazing and path constructions had higher occurrence of *Croton dichogamus*, *Helichrysum argyranthum*, *Laggera elatior* and *Acalypha fruticosa*. Logging affected the composition of *Vernonia auriculifera*, *Solanecio mannii*, *Solanum terminale*, *Achyrospermum schimperi* and *Erica arborea*. Herbal medicine collection, artisanal mining, grass cutting and bamboo harvesting affected the occurrence of *Aloe tweediae*, *Ocimum americanum*, *Maerua decumbens*, *Barleria argentea*, *Abutilon mauritianum*, *Vernonia hymenolepis* and *Fuerstia africana* (Figure 4.23).

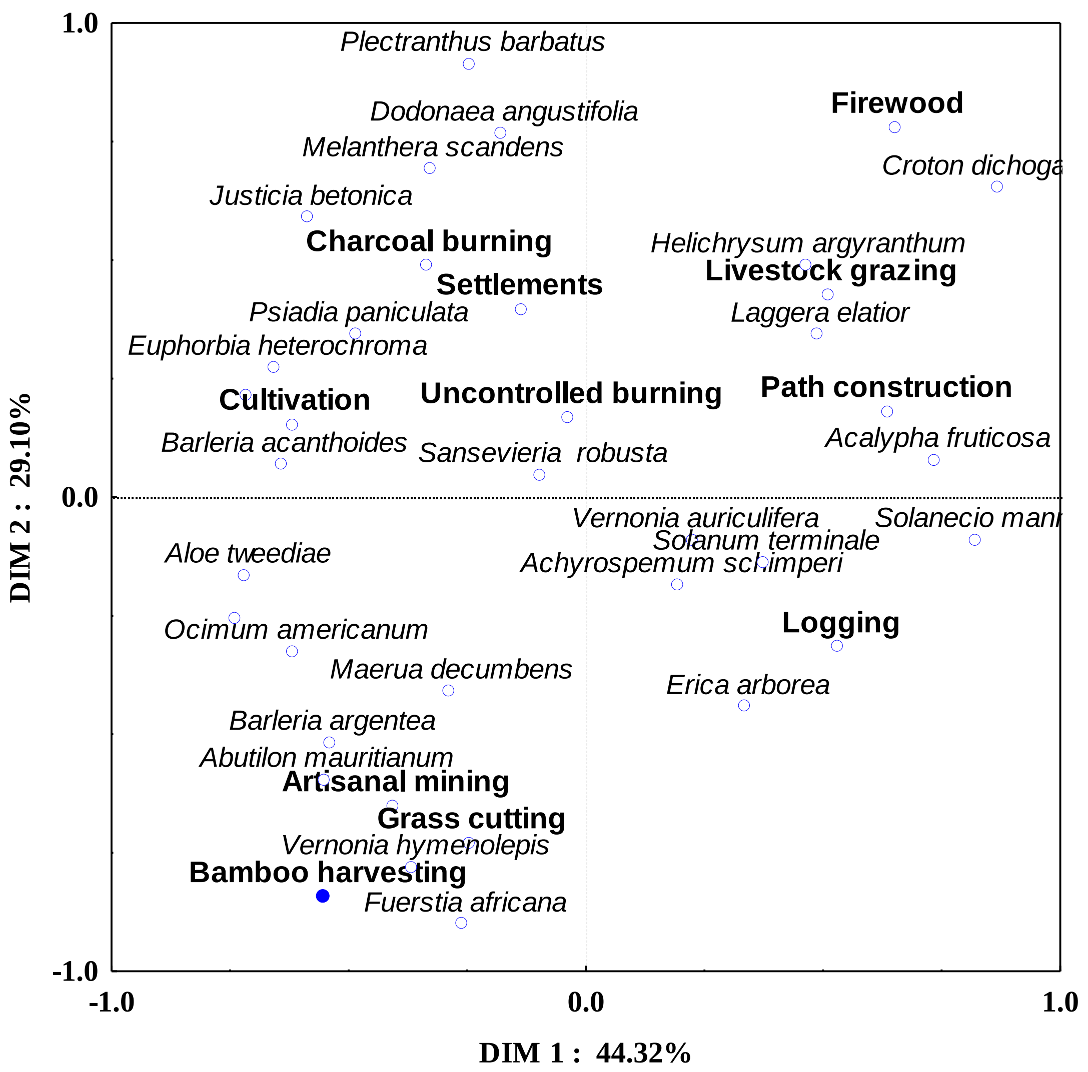

Figure 4.23: MDS diagram showing the relationship between human activities and presence of shrubs in Embobut Forest Reserve

4.4.2.3 Influence of Human activities on liana species composition

The MDS diagram shows that artisanal mining affected the distribution of *Rubus steudneri*. Logging and grazing affected occurrence of *Cissus rotundifolia*, *Cissus quadrangularis*, *Cissampelos pareira* and *Jasminum abyssinica* while firewood affected the distribution of *Tinospora cordifolia* and *Asparagus racemosus* (Figure 4.24).

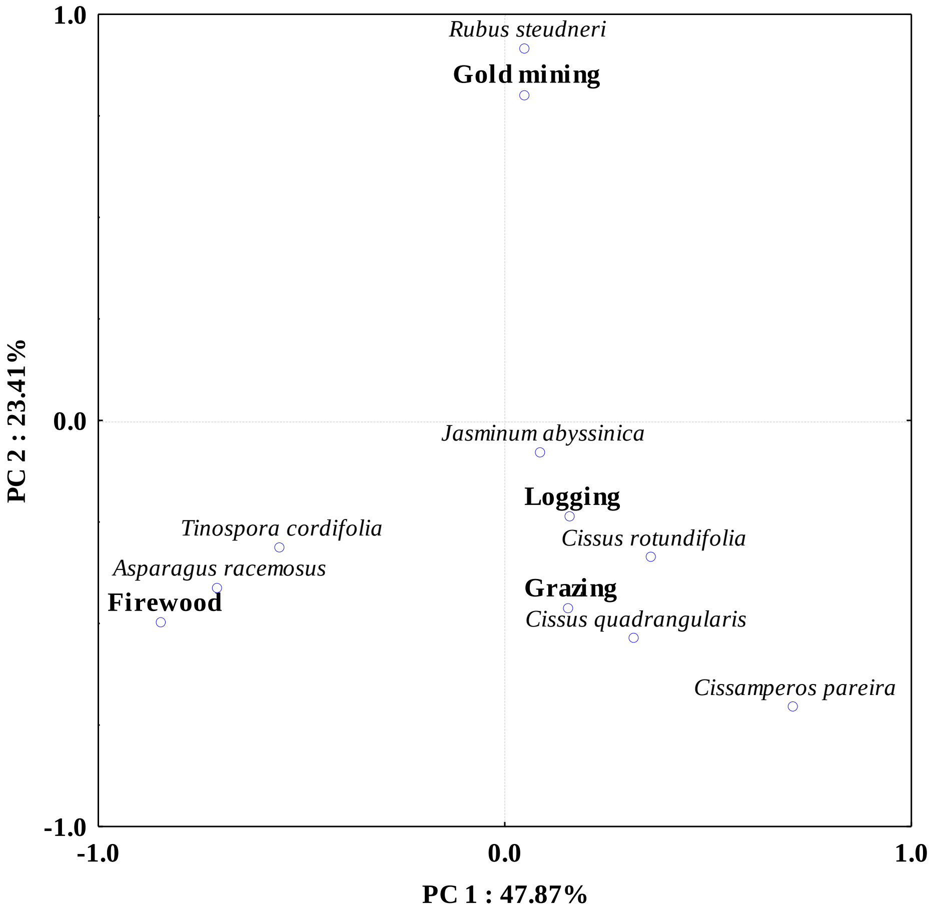

Figure 4.24: MDS diagram showing the relationship between human activities on the presence of lianas in Embobut Forest Reserve

4.4.2.4 Influence of human activities on composition of herbaceous plant species

The MDS diagram shows that areas with intense activities such as firewood and path constructions had higher presence of rhizomatous herbs while areas dominated by charcoal burning, cultivation, settlements and cowsheds affected the occurrence of creepers and erect herbs. Uncontrolled burning, grazing, grass cutting, logging and collection of herbal medicine affected the distribution of grasses, prostrate herbs and succulent herbs. Climbers, parasites, pteridophytes, sedges and rosette herbs were affected by environmental factors other than human activities (Figure 4.25).

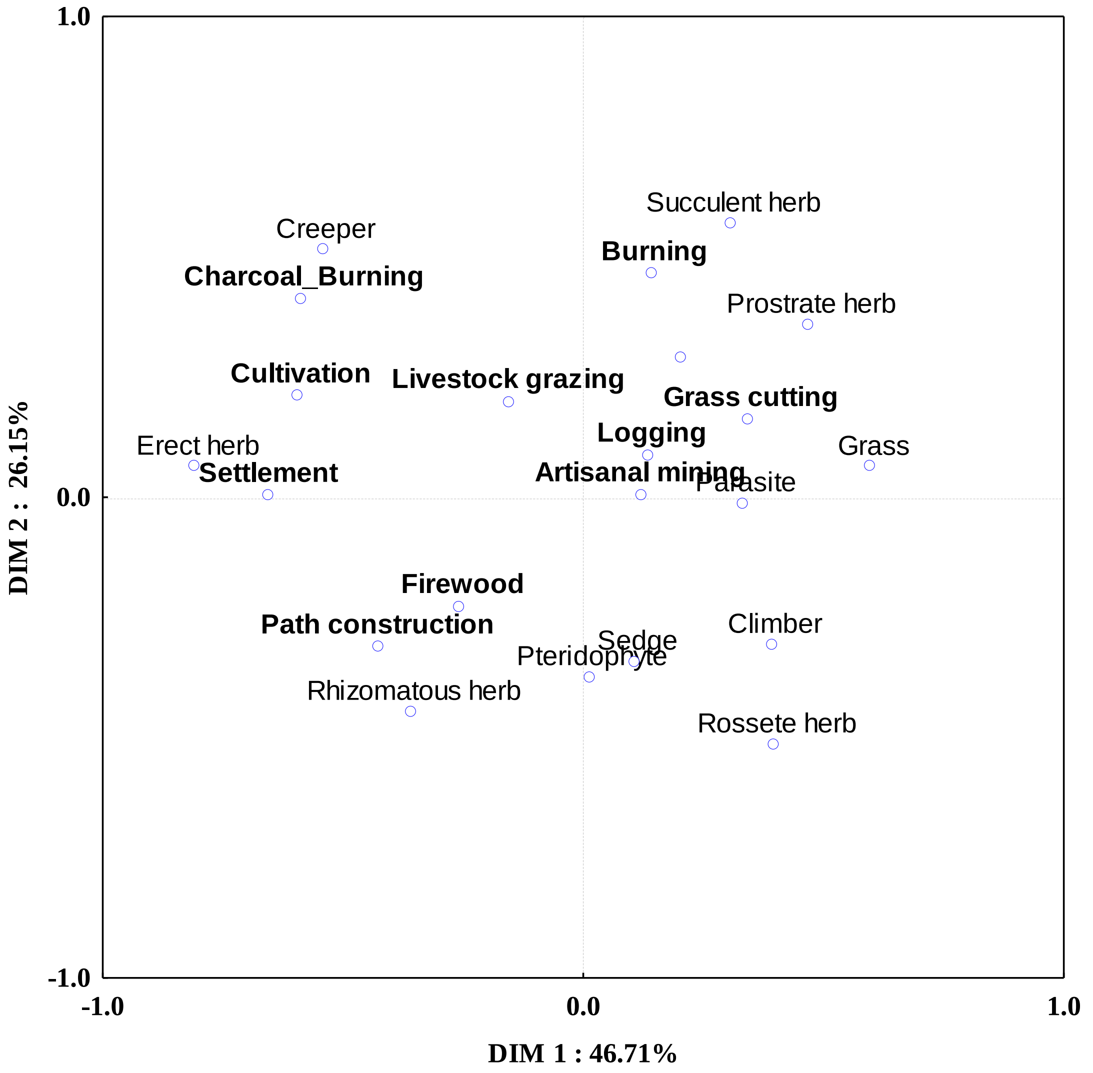

Figure 4.25: MDS diagram showing the relationship between human activities on distribution of herbs life forms in Embobut Forest Reserve

4.4.3 Influence of human activities on plant species abudance

This section provides data and interpretation on the influence of human activities on plant species abundance of trees, shrubs, lianas and herbs.

4.4.3.1 Human activities on tree species abundance

Plant species abundance in areas with human activities, highest tree species abundance occurred in areas with levestock rearing (10.2 ± 1.2), charcoal burning (7.6

± 1.1) and settlements (1.2 ± 0.4) while the lowest abundance of tree species occurred in areas where there was rampant burning (1.1 ± 0.2), and logging of trees (2.1 ± 0.3) (Figure 4.26).

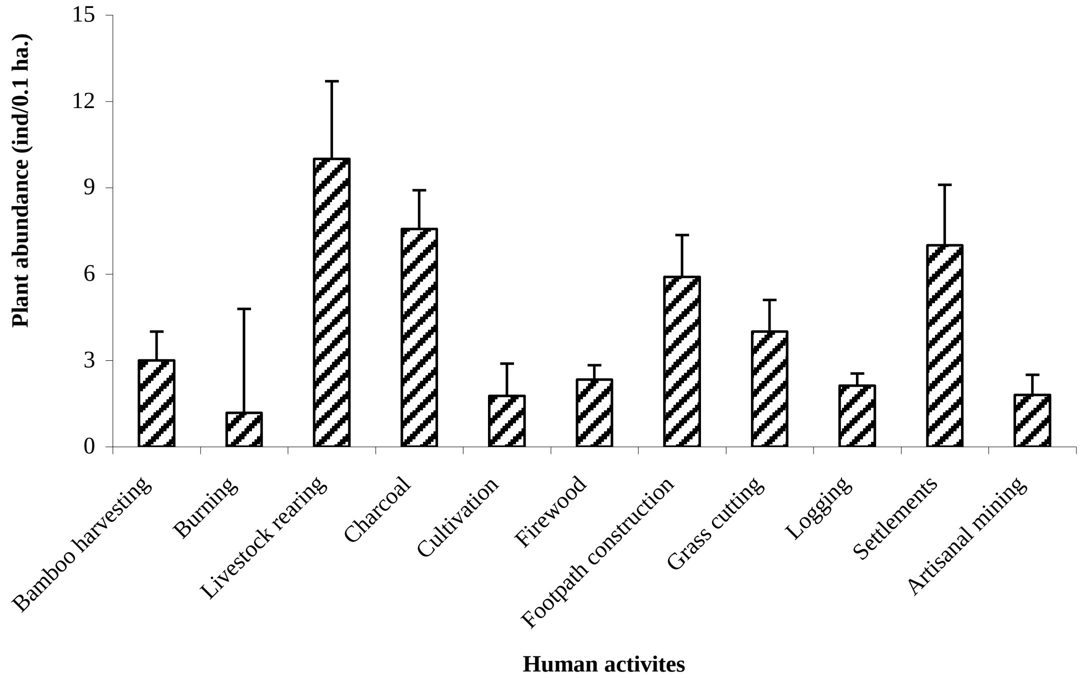

Figure 4.26: Tree species abundance and human activies in Embobut Forest Reserve

4.4.3.2 Human activities influence on abundance of shrubs

Plant species abundance was highest where there was none or minimal human activities (48.7 ± 5.1). Among areas whith human activites, highest shrubs species abundance occurred in areas with cattle boma (38.9 ± 4.3) and settlements (43.2 ± 5.5) while the lowest abundance of shrubs species occurred in areas where there were rampant burning (15.3 ± 2.1), logging (14.9 ± 1.8), cultivation (13.4 ± 1.5), and harvesting of medicinal plants (15.4 ± 2.1) (Figure 4.27).

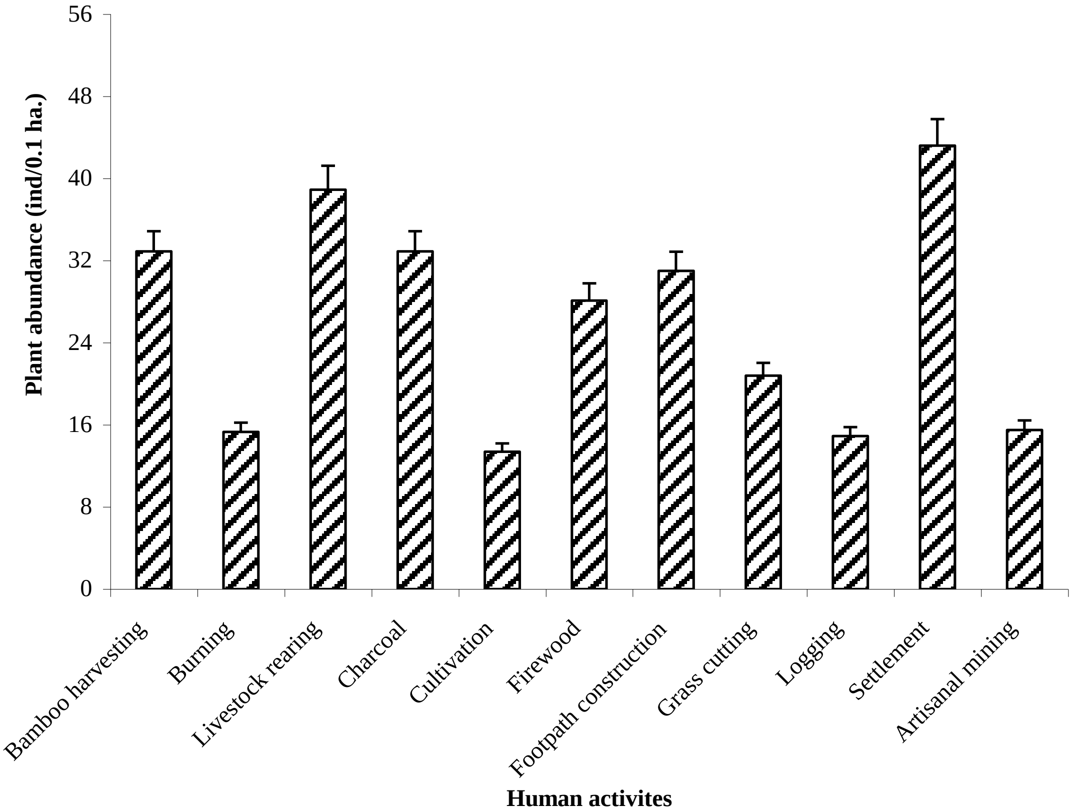

Figure 4.27: Shrub species abundance and human variables Embobut Forest Reserve

4.4.3.3 Influence of human activities on abundance of lianas

Liana species abundance was highest where there was no or minimal human activities (19.1 ± 1.2). Among areas with human activities, highest liana species abundance occurred in areas with cattle boma (19.8 ± 1.3) followed by areas with collection of firewood (14.2 ± 1.5) while the lowest abundance of lianas species occurred in areas where there was rampant burning (3.2 ± 0.3), cultivation (3.1 ± 0.2), logging (3.3 ± 1.1) and grazing (3.1 ± 0.2) (Figure 4.28).

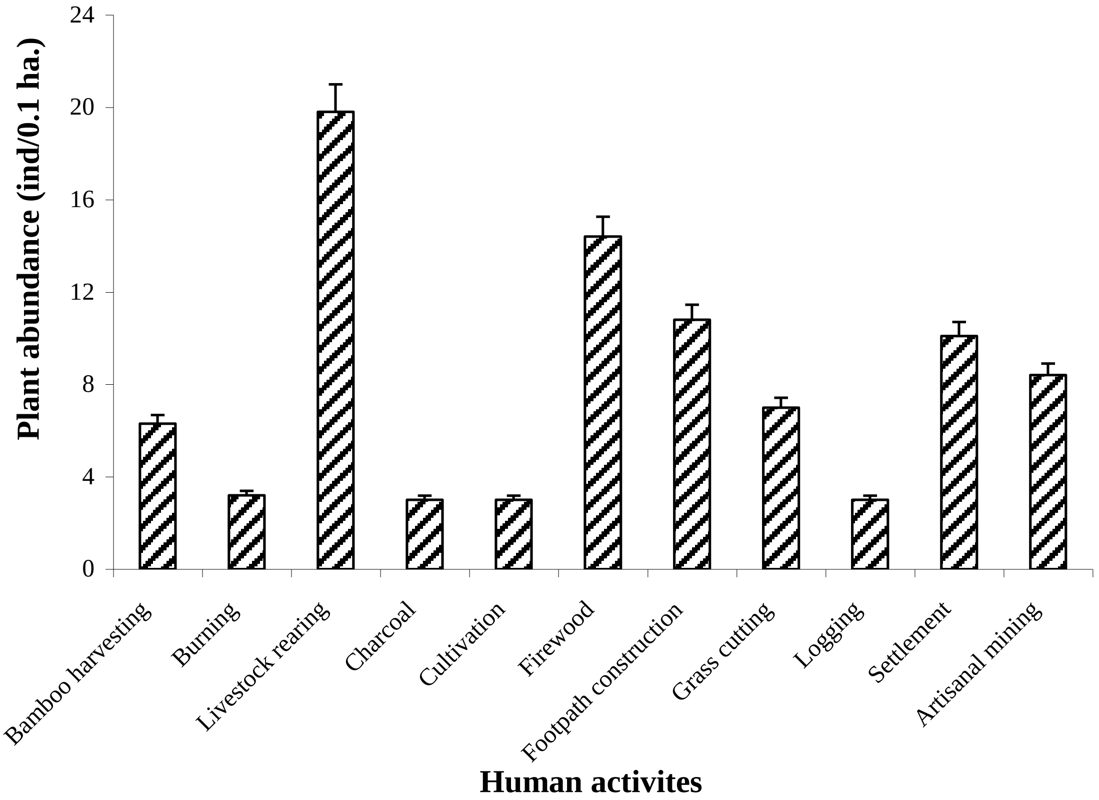

Figure 4.28: Liana species abundance and human variables in Embobut Forest Reserve

4.4.3.4 Influence of human activities on abundance of herbaceous plant species

Herbaceous species abundance was highest where there was no human activities (56.2 ± 2.1). Among areas with human activities, areas with cattle boma (52.5 ± 2.3), bamboo harvesting (49.2 ± 1.3) and grazing (46.2 ± 1.7) had the highest abundance. Meanwhile, the lowest abundance of herbs species occurred in areas where there was collection of firewood (8.4 ± 1.1), harvesting of medicinal plants 7.6 ± 0.4) and rampant burning (6.1 ± 0.4) (Figure 4.29).

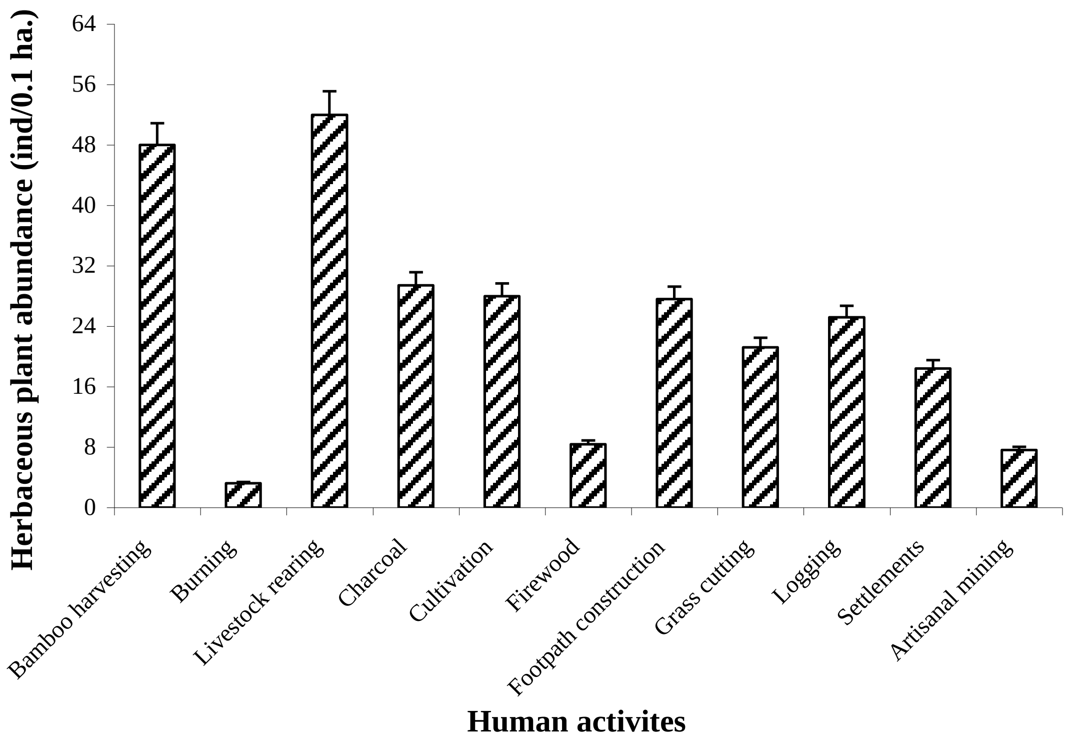

Figure 4.29: Herbaceous plants species abundance and human variables Embobut Forest Reserve

4.4.4 Influence of human activities on plant species diversity

This section provides data and interpretation on the influence of human activities on plant species diversity for trees, shrubs, lianas and herbs.

4.4.4.1. Human activities on tree species diversity

Plant species diversity was highest where there was none or minimal (3.41) activities. Among areas with human activities, highest tree species diversity occurred in areas with cattle boma (2.69 ± 0.32) and settlement (3.01 ± 0.43), while the lowest diversity of tree species occurred in areas where there was rampant burning (0.94 ± 0.21), cultivation (1.27 ± 0.11) and logging (1.25 ± 0.14) of trees (Figure 4.30).

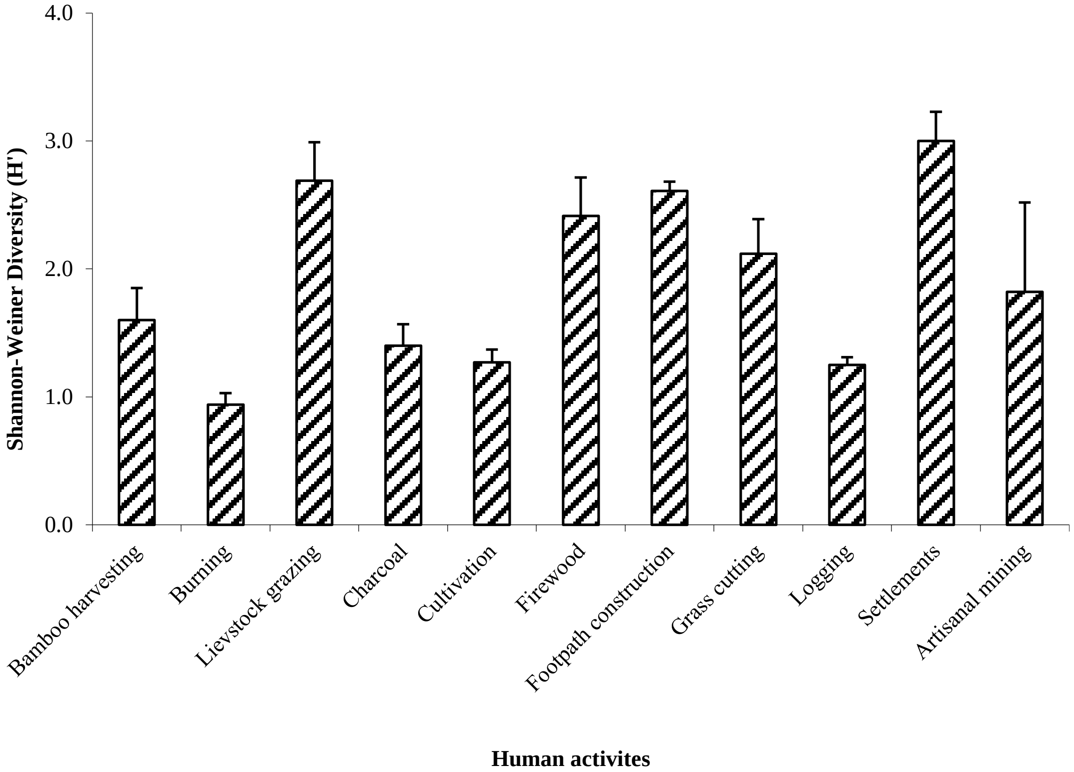

Figure 4.30: Tree species diversity and human variables in Embobut Forest Reserve

4.4.4.2 Influence of human activities on diversity of shrubs

Plant species diversity was highest where there was no or minimal activities (3.4 ± 0.4). Among areas with minimal human activites, highest shrub species abundance occurred in areas with firewood collection (2.6 ± 0.5) and grazing (3.1 ± 0.4), while the lowest abundance of shrub species occurred in areas where there was rampant burning (0.94 ± 0.2), cultivation (0.8 ± 0.2) and collection of herbal plants species (0.7 ± 0.2) (Figure 4.31).

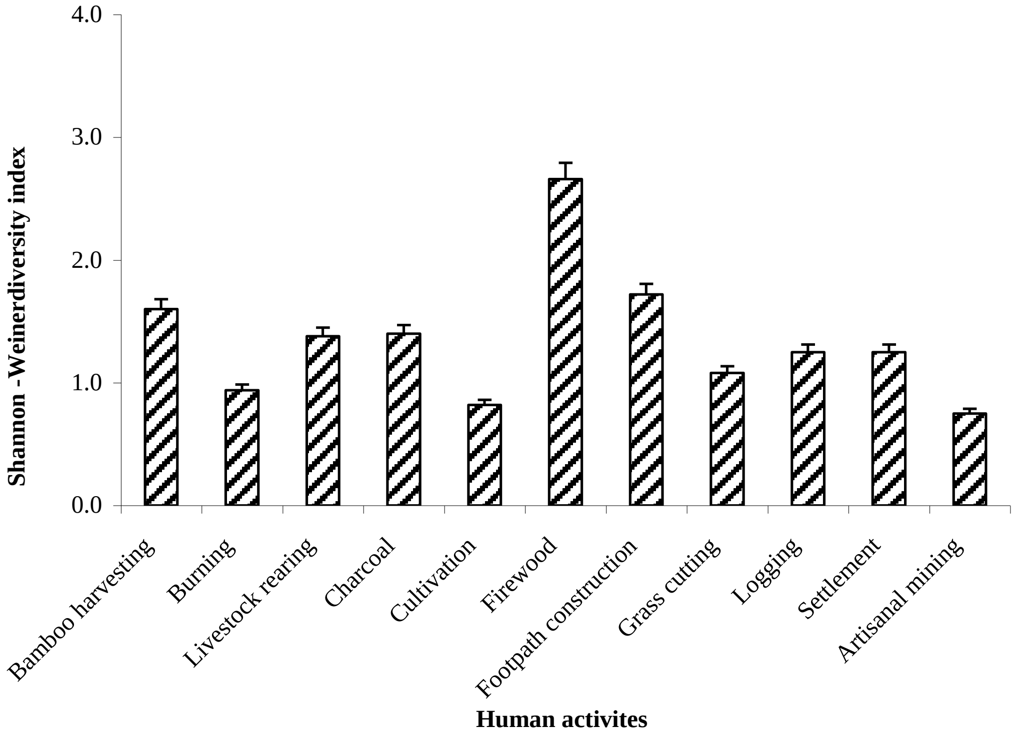

Figure 4.31: Shrub species diversity and human variables in Embobut Forest Reserve

4.4.4.3 Influence of human activities on diversity of lianas

Liana species diversity was highest where there was no or minimal human activities (2.95 ± 0.23). Among areas with human activities, highest lianas species diversity occurred in areas with grazing (2.74 ± 0.22) and collection of firewood (2.32 ± 0.19), while the lowest diversity of lianas species occurred in areas where there was rampant burning (0.94 ± 0.27), cultivation (0.81 ± 0.44) and collection of herbal plants species (0.75 ± 0.34) (Figure 4.32).

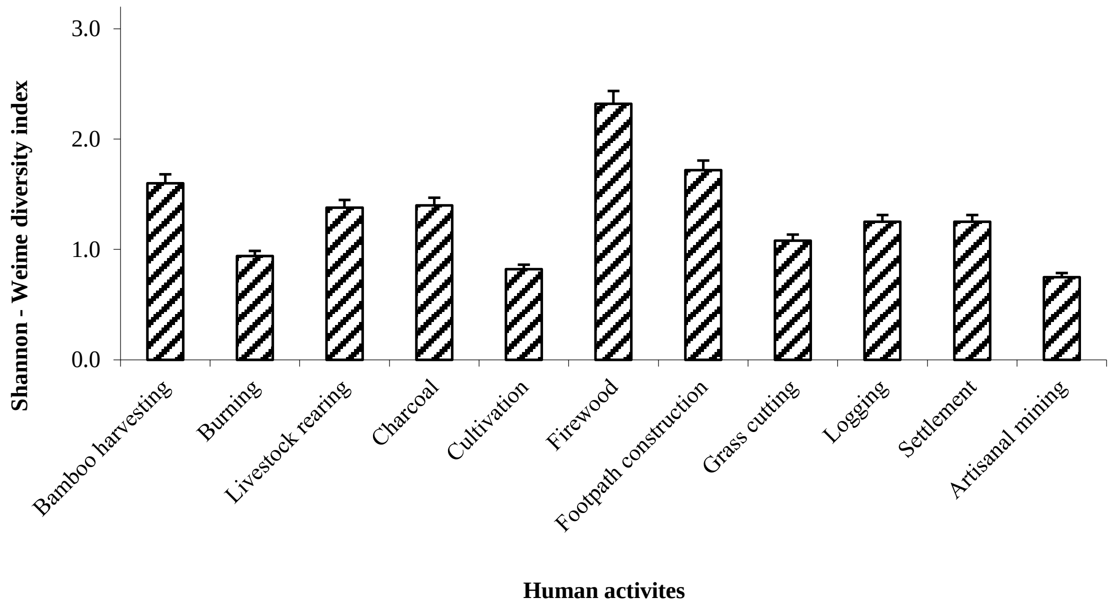

Figure 4.32: Lianas species diversity and human variables in Embobut Forest Reserve

4.4.4.4. Influence of human activities on diversity of herbaceous plant species

Herbaceous species diversity was high where there was no or minimal activities (2.82 ± 1.2). Among areas with human activites, highest herbaceous plant species abundance occurred in areas with intense grazing (3.11 ± 0.49) and firewood collection (2.87 ± 0.52), while the lowest diversity of herbaceous species occurred in areas where there was rampant burning (0.91 ± 0.12), cultivation (0.76 ± 0.26) and collection of herbal plants species (0.54 ± 0.52) (Figure 4.33).

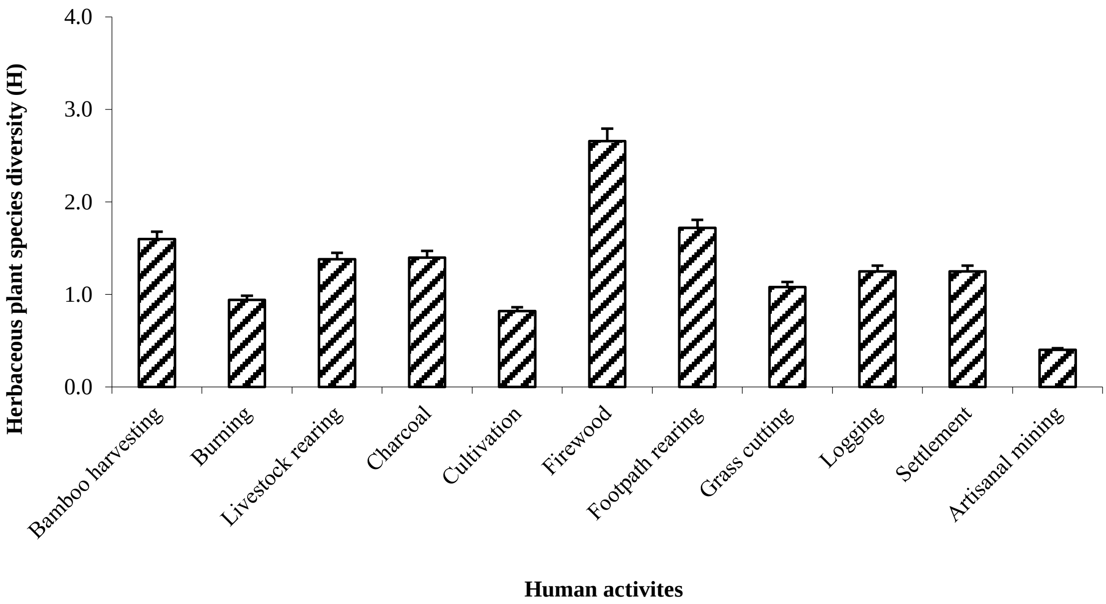

Figure 4.33: Herbaceous species diversity and human variables Embobut Forest Reserve

4.5 Utilization of plant resources in Embobut Forest Reserve

The fourth objective of the study was to determine the utilization of plant resources in Embobut Forest Reserve. There were 208 plant species within the area based on assessment. They belonged to 168 genera in 68 families (Appendix 3, Local name checklist). Majority of the species belonged to the (sunflower) family Asteraceae (19), (legumes) Fabaceae (19), followed by (potato) Solanaceae (9), (spurge) Euphorbiaceae (8) and (mints) Lamiaceae (8). About 51% of the plant species used by people living around the four Embobut Forest Reserve were herbs and 23.5% shrubs.

Among the 208 species identified, 152 were found to have other uses other than medicinal to the region where there were 12 use groups (Table 4.12). The plant species were mostly used for fodder (65.4%), firewood (54.8%), fencing (53.8%), building poles (52.4%) and ornamental plants (56%).

Table 4.12: Plant use among the households in Embobut Forest Reserve

Uses	Number of species used	Percent plant species used
Fencing	112	53.8
Poles	79	38.0
Charcoal	81	38.9
Fodder	136	65.4
Ornamentals	21	10.1
Fruit	62	29.8
Firewood	114	54.8
Handcraft	10	4.8
Nectar	22	10.6
Rope	19	9.1
Timber	40	19.2
Vegetable	15	7.2

The plants parts that were used were: roots, leaves, fruits, bark, branches, canopy, stick, thorns, bulb and flowers (Table 4.13). Plant parts used was low and elicited less than 50% of the response except for leaves (72.1%) and fruits (36.5%).

Table 4.13: Plant parts used for each of the identified species

Plant part used	Number of plant used	Percent plant parts used
Root	93	44.7
Stem	130	62.5
Branches	102	49.0
Leaf	150	72.1
Fruit	76	36.5
Bark	72	34.6
Thorn	38	18.3
Flower	93	44.7

The people living around the Embobut Forest Reserve use various parts of the species for different purposes (Table 4.14). For example, plant stems have many uses except as food, thatching material, for rope making, cleaning of utensils, mulch and manure.

Roots were mainly used for medicinal purposes and as firewood. Leaves were used more as fodder for livestock, medicine, cultural purposes, thatch material and as mulch. Tree barks were used for building and rope making while fruits were consumed as food and flowers as fodder, medicine, manure or for cultural purposes.

Table 4.14: Frequency of use (%) of various plant parts of the plants in Embobut Forest Reserve

	Stem	Roots	Leaves	Bark	Fruits	Flowers
Food	0.0	0.0	21.3	0.0	16.0	0.0
Building	21.3	0.0	0.0	1.3	0.0	0.0
Fodder	7.5	0.0	88.8	0.0	0.0	2.5
Medicinal	1.3	11.3	16.3	0.0	0.0	2.5
Cultural usage	3.8	0.0	27.5	0.0	0.0	1.3
Firewood	32.5	7.5	0.0	0.0	0.0	0.0
Mat use	17.5	0.0	0.0	0.0	0.0	0.0
Fence	20.0	0.0	0.0	0.0	0.0	0.0
Thatching	0.0	0.0	61.3	0.0	0.0	0.0
Rope making	0.0	0.0	0.0	2.5	0.0	0.0
Utensil cleaning	0.0	0.0	5.0	0.0	0.0	0.0
Seat making	3.8	0.0	0.0	0.0	0.0	0.0
Brick covering	7.5	0.0	0.0	0.0	0.0	0.0
Mulching	0.0	0.0	2.5	0.0	0.0	0.0
Manure	0.0	0.0	0.0	0.0	0.0	1.3

The use value of the various common plant species are presented in Appendix 5. Tree species use values are provided in Table 4.15. Species with markedly higher use values (0.71) were: *Dombeya torrida*, *Olea capensis*, *Olea europaea*, *Prunus africana*, *Sclerocarya birrea*, *Zanthoxyllum chalybeum* which all had 9 uses each. They were followed by: *Schefflera volkensii*, *Senegalia senegal*, *Lannea schweinfurthii*, *Syzygiun cordatum*, *Syzygium guineense*, *Nuxia congesta* and *Vachellia tortilis*. The least useful tree species were: *Garcinia livingstonei*, *Allophyllus abyssinicus*, *Ficus sycomorus* and *Ximenia americana.*

Table 4.15: Tree species use value index in Embobut Forest Reserve

Ser. No	Species checklist	Uvi	Ser. No	Species checklist	Uvi
1	*Lonchocarpus eriocalyx*	0.21	44	*Zanthoxyllum chalybeum*	0.71
2	*Garcinia livingstonei*	0.19	45	*Nuxia congesta*	0.63
3	*Senegalia mellifera*	0.24	46	*Acacia hockii*	0.55
4	*Xymalos monospora*	0.24	47	*Meyna tetraphylla*	0.47
5	*Afrocrania volkensii*	0.31	48	*Teclea nobilis*	0.31
6	*Euphorbia candelabrum*	0.31	49	*Juniperus procera*	0.29
7	*Gardenia ternifolia*	0.47	50	*Combretum apiculatum*	0.47
8	*Acacia brevispica*	0.31	51	*Acacia nubica*	0.55
9	*Acacia gerrardii*	0.47	52	*Ficus sycomorus*	0.16
10	*Euclea divinorum*	0.21	53	*Rhus natalensis*	0.43
11	*Faidherbia albida*	0.39	54	*Vachellia nilotica*	0.51
12	*Harrisonia abyssinica*	0.39	55	*Dombeya torrida*	0.71
13	*Boscia angustifolia*	0.31	56	*Neoboutonia macrocalyx*	0.55
14	*Dobera glabra*	0.31	57	*Syzygium guineense*	0.63
15	*Balanites pedicellaris*	0.43	58	*Ximenia americana*	0.12
16	*Myrica salicifolia*	0.39	59	*Ziziphus mucronata*	0.47
17	*Balanites aegyptiaca*	0.34	60	*Sterculia stenocarpa*	0.24
18	*Acacia elatior*	0.32	61	*Terminalia brownii*	0.47
19	*Albizia gummifera*	0.39	62	*Commiphora mildebraedii*	0.32
20	*Berchemia discolor*	0.47	63	*Rapanea melanophloeos*	0.55
21	*Boscia mossambicensis*	0.29	64	*Faurea saligna*	0.47
22	*Elaeodendron buchananii*	0.47	65	*Croton macrostachyus*	0.63
23	*Cordia sinensis*	0.39	66	*Ekebergia capensis*	0.55
24	*Lannea schimperi*	0.25	67	*Vachellia tortilis*	0.63
25	*Vachellia seyal*	0.35	68	*Warbugia ugandensis*	0.31
26	*Acacia lahai*	0.47	69	*Senegalia senegal*	0.63
27	*Allophyllus abyssinicus*	0.19	70	*Diospyros abyssinica*	0.55
28	*Cussonia spicata*	0.39	71	*Albizia anthelmintica*	0.55
29	*Grewia bicolor*	0.22	71	*Lannea schweinfurthii*	0.63
30	*Ziziphus mauritiana*	0.39	73	*Osyris lanceolata*	0.49
31	*Commiphora africana*	0.31	74	*Prunus africana*	0.71
32	*Croton ciliatoglandulifer*	0.39	75	*Schefflera volkensii*	0.70
33	*Cupressus lusitanica Miller*	0.44	76	*Sclerocarya birrea*	0.71
34	*Hagenia abyssinica*	0.52	77	*Ozoroa insignis*	0.55
35	*Boscia coriacea*	0.31	78	*Ficus thoningii*	0.53
36	*Grewia villosa*	0.39	79	*Flacourtia indica*	0.47
37	*Lannea fulva*	0.47	80	*Polyscias kikuyuensis*	0.47
38	*Pittosporum viridiflorum*	0.39	81	*Psidium guajava*	0.47
39	*Syzygium cordatum*	0.63	82	*Kigelia africana*	0.47
40	*Maesa lanceolata*	0.39	83	*Ficus natalensis*	0.55
41	*Olinia rochettiana*	0.55	94	*Olea europaea*	0.71
42	*Salvadora persica*	0.39	85	*Olea capensis*	0.71
43	*Vachellia xanthophloea*	0.55			

The use value of shrubs are presented in Table 4.16. Species with markedly higher use values (0.45) were: *Rhamnus prionoides*, *Carrisa edulis*, *Dovyalis abyssinica*, *Myrsine africana*, *Solanum aculeastrum* and *Ensete ventricosum*. This was followed by *Urera hypselodendron*, *Uvaria scheffleri*, *Scutia myrtina* and *Berberis holstii*. Meanwhile shrubs with the least use value were: *Indigofera arrecta*, *Ricinus communis, Maerua decumbens, Saba comorensis, Cadaba farinosa*, *Crotalaria polysperma*, *Asparagus falcatus*, *Indigofera atriceps* and *Vernonia auriculifera*

Table 4.16: Shrubs species use value index in Embobut Forest Reserve

Ser. No	Species checklist	UVI	Ser. No	Species checklist	UVI
1	*Indigofera arrecta*	0.16	20	*Vangueria madagascariensis*	0.31
2	*Ricinus communis*	0.16	21	*Dodonaea angustifolia*	0.24
3	*Maerua decumbens*	0.16	22	*Artemisia afra*	0.24
4	*Saba comorensis*	0.16	23	*Aloe cheranganiensis*	0.24
5	*Cadaba farinosa*	0.16	24	*Plectranthus barbatus*	0.24
6	*Crotalaria polysperma*	0.16	25	*Urera hypselodendron*	0.39
7	*Monanthotaxis buchananii*	0.24	26	*Solanum incanum*	0.31
8	*Asparagus falcatus*	0.16	27	*Gnidia glauca*	0.31
9	*Canthium schimperiana*	0.24	28	*Keetia gueinzii*	0.31
10	*Indigofera atriceps*	0.16	29	*Uvaria scheffleri*	0.39
11	*Vernonia auriculifera*	0.16	30	*Carrisa edulis*	0.47
12	*Toddalia asiatica*	0.31	31	*Scutia myrtina*	0.39
13	*Yushania alpina*	0.24	32	*Berberis holstii*	0.39
14	*Clutia abyssinica*	0.24	33	*Dovyalis abyssinica*	0.47
15	*Leptadenia hastata*	0.24	34	*Myrsine africana*	0.47
16	*Croton dichogamus*	0.24	35	*Solanum aculeastrum*	0.47
17	*Crateva adansonii*	0.24	36	*Ensete ventricosum*	0.47
18	*Aloe tweediae*	0.24	37	*Rhamnus prionoides*	0.55
19	*Clerodendrum johnstonii*	0.24			

The use value of herbeceous species is presented in Table 4.17. Species with markedly higher use values (> 0.4) were: *Vernonia amygdalina*, *Urtica massaica, Pergularia daemia*, *Periploca linearifolia*, *Peucedanum aculeolatum*, *Clematis simensis* and *Momordica foetida*. The least useful herbeceous species species were: *Physalis peruviana*, *Digera muricata*, *Dryopteris inaequalis* with single uses.

Table 4.17: Herbaceous plants species use value index in Embobut Forest Reserve

Species checklist	UV
Dryopteris inaequalis	0.03
Sphaeranthus ukambensis	0.08
Amaranthus spinosus	0.08
Physalis peruviana	0.07
Senecio hadiensis	0.11
Cyperus esculentus	0.16
Digera muricata	0.05
Chenopodium ambosioides	0.16
Cleome gynandra	0.09
Chenopodium opulifolium	0.16
Cucurbita maxima	0.24
Cyphostemma cyphopetalum	0.24
Solanum nigrum	0.31
Acanthus eminens	0.24
Lagenaria siceraria	0.24
Zehneria scabra	0.31
Mikaniopsis bambuseti	0.31
Basella alba	0.31
Clematis simensis	0.39
Momordica foetida	0.39
Momordica anigosantha	0.37
Vernonia amygdalina	0.55
Urtica massaica	0.55
Peucedanum aculeolatum	0.44
Periploca linearifolia	0.48
Pergularia daemia	0.49

The relationship between use value index and abundance of the plants species in Embobut Forest Reserve is shown in Figure 4.34. The use value index of the plants species was related to the abundance of the plant species.

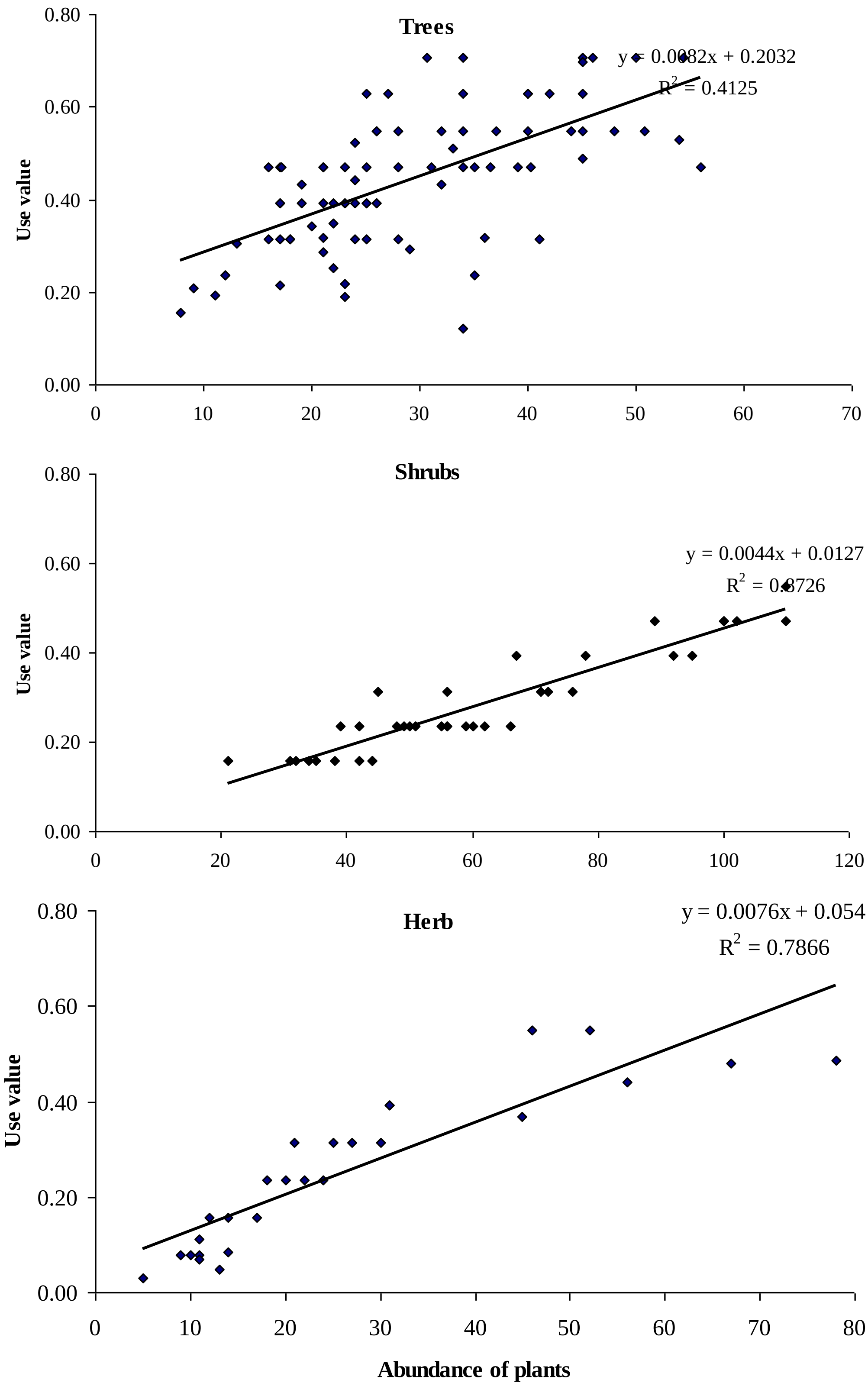

Figure 4.34: Bivariate regression plot showing the relationship between use value index and abundance of the plants species in Embobut Forest Reserve

CHAPTER FIVE

DISCUSSION

5.1 Species spatial distribution in Embobut Forest Reserve

In Embobut Forest Reserve, a total of 645 species belong to 425 genera and 116 families of plants aggregated as tree, shrubs, lianas and herbs suggesting a high number of individual plant species composition. These results concur with several studies undertaken in the Kenyan Forest Basins where number of plant species are largely very high number of plant species (Rongoei *et al.*, 2014; Njue *et al.*, 2016).

Assessment in Embobut Forest Reserve indicated presence of lower number of indigenous tree species than in other tropical river basins in Kenya including Mau Forest (Seswa *et al.*, 2018), South Nandi Forest (Njunge and Mugo, 2011; Maua *et al.*, 2018), Aberdares and Elgon Forests (Hitimana *et al.*, 2010) but higher than Kasigau Forest (Medley *et al.*, 2019). The low number of species than other tropical rainforest within the same region could be a sign influence by human activities (Chebet *et al.*, 2017), which are likely to reduce the diversity of species for various human needs. It is also possible to attribute the species counts to unprotected status of the forest mainly because a comparison of the species count in this forest with protected forests in Kenya such as Taita Hills indicates that the number of species in the unprotected Afromontane forests rarely exceeded 200 (Aerts *et al.*, 2011; Muriithi, 2016).

5.2 Species compositionabundance and diversity of plants species in Embobut Forest Reserve

In terms of composition, the high number of plants at the valley floor shows that the region had favourable conditions for growth of plants. Abundance of species found in Fabaceae (*Senegalia mellifera*, *Senegalia senegal*, *Acacia nubica*, *Acacia reficiens* and *Vachellia tortilis*) and Capparaceae (*Boscia angustifolia, Boscia coriacea* and *Boscia mossambicensis*) in the valley floor shows that these plant species are aggressive and have the inherent ability to colonize and survive in human dominated landscapes (Báez and Homeier, 2018). On the other hand dominance of *Vachellia tortilis* and *Senegalia senegal* may be attributed to their high value to the local community and therefore are likely to be conserved within the valley floor (Daoub *et al.,* 2018; Yadeta *et al.,* 2018).

In the escarpment the dominant species belonged to family Anacardiaceae (*Lannea schimperi* and *Ozoroa insignis*), Combretaceae (*Combretum apiculatum* and *Combretum molle*), Ebenaceae (*Diospyros abyssinica* and *Euclea divinorum*) Euphorbiaceae (*Euphorbia candelabrum*, different species of family Fabaceae (*Acacia hockii*, *Lonchocarpus eriocalyx*, *Senegalia mellifera*) which can grow and survive well in rocky areas e.g. *Combretum molle, Ozoroa insignis* and *Euphorbia candelabrum* where there is little human interference as was observed during the study.

There was no dominance of any family in the upland forest. For instance, *Schefflera volkensii* (Araliaceae), *Afrocrania volkensii* (Cornaceae), *Neoboutonia macrocalyx* (Euphorbiaceae), *Bersama abyssinica* (Francoaceae), *Pittosporum viridiflorum*

(Pittosporaceae), *Maesa lanceolata* (Primulaceae), *Hagenia abyssinica* (Rosaceae), *Allophylus abyssinica* (Sapindaceae), *Dombeya torrida* (Malvaceae) and *Nuxia congesta* (Stilbaceae) occurred as single species in the upland regions which may indicate low species specialization in the region.

The occurrence of single specialized species within the upland forest and montane region observed compares with other studies in Kakamega forest (Seswa *et al.*, 2018), South Nandi Forest (Njunge and Mugo, 2011; Maua *et al.*, 2018), Mt Kasagau (Medley *et al.*, 2019), Aberdares and Elgon forests (Hitimana *et al.*, 2010) all in Kenya in which, most families and genera were also represented by single species. The observation of single species of tree species is an indicator of absence of specialization in the high elevation and limitation of growth and proliferation by low temperature, high pressure and wind (Apaza ‐ Quevedo *et al.*, 2015).

In terms of tree species distribution *Vachellia tortilis*, *Senegalia mellifera*, *Boscia coriacea*, *Bersama abysinica* and *Balanites pedicellaris*, *Grewia bicolor* and *Nuxia congesta* showed a wide distribution. Most of these tree species are forest gap-colonizer species and are characterized by early succession and colonization in most parts of the forest (Hitimana *et al.*, 2010; Thijs *et al.*, 2014; Mutiso *et al.*, 2015). They are also able to shed their leaves during dry seasons to survive in the forest even when the conditions are harsh (Mullah *et al.*, 2014). These tree species abundance could also be an indicator that the forest is changing from being a closed to open canopy.

There was also low number of shrubs species (60 species of shrubs belonging to 25 families) lower than other areas in the region such as Kasagala Forest Reserve in

Uganda (Gwali *et al.*, 2010). The escarpment and valley floor had the highest counts of shrubs species a clear indication that these sites had good growth conditions for shrubs. Previously, shrubs species are dominant in many Afromontane regions due to the favourable soil conditions (Platts *et al.*, 2010; Melly *et al.*, 2020). Lack of any dominant shrubs species may however indicate a high degree of specialization of the the shrubs at the various sites in Embobut Forest Reserve.

Dominance of acanthaceae and asparagaceae at the valley floor and escarpment may indicate that these plant species can withstand diverse human interference (MacFarlane *et al.*, 2015). Indeed, the species of family Capparaceae, Euphorbiaceae and individual species such as *Achyranthes aspera*, *Adenium obesum*, *Sansevieria frequens*, *Kleinia odora*, *Ocimum basilicum*, *Grewia similis* and *Talinum portulacifolium* often grow in areas where conditions are not favourable and therefore may suggest a very hostile environment in the region. Most of the species found in the valley floor are drought resistant due to their morphological and physiological characteristics such as *Adenium obesum*, *Sansevieria frequens*, *Kleinia odora, Aerva lanata, Aloe kedongensis* and *Opuntia monacantha* while others are unpalatable such as *Adenium obesum, Psiadia paniculata* and *Dodonaea angustifolia.*

Species that singly dominated the montane region were mainly of the family Asteraceae such as *Bothriocline fusca*, *Euryops brownei*, *Helichrysum argyranthum*, *Laggera crispata* and *Laggera elatior*. Other species included *Lobelia giberroa*, *Erica arborea*, *Hypericum revolutum*, *Myrsine africana*, *Solanum terminale and Struthiola thomsonii.* Majority of the shrubs in the upland forest and montane region are typically of very high elevation species (moorland) such as *Euryops brownei, Erica* *arborea, Lobelia giberroa, Hypericum revolutum* and *Struthiola thomsonii* (Zhou *et al.*, 2018; Zhou *et al.*, 2019)

In terms of shrub species distribution *Plectranthus barbatus, Barleria acanthoides, Acalypha fruticosa, Aloe tweediae, Croton dichogamus, Euphorbia heterochroma, Helichrysum argyranthum, Barleria argentea* and *Achyrospermum schimperi* showed wide distribution in terms of composition which is associated with the tolerance of most of these species to harsh environmental heterogeneity and also their unpalatability (Kibet, 2011) as well as the high moisture content in the region of which is required by these plants (Kibet, 2010).

Among the shrubs, the escarpment had the highest species diversity followed by valley floor and montane region while the least diversity of shrub species was found in upland region. The main reason of recording high diversities in escarpment and valley floor was accounted for by inaccessibility for the case of escarpment due to harsh terrain. There are also minimal human activities in escarpment while in the valley floor, landscape contributed to high diversity due to topography and influence of geomorphology as explained by (Casalini *et al.*, 2019) which seem to be the case in our studies.

The distribution in presence and absence of lianas at the four sites in Embobut Basin indicated that *Cissus quadrangularis* was the only species showing wide distribution while the remaining species had low number of individuals. In previous study, the abundance-based dominance rank of liana species differed between the censuses, suggesting a limitation in distribution of the lianas (Valencia *et al.*, 2004). The percent cover of lianas was highest at the valley floor followed by escarpment and least at the upland region while at the montane region; there were no occurrence of lianas. Higher occurrence in the valley floor may be associated with suitable environmental cues for the growth and reproduction of these plants (Mulugeta *et al.*, 2015).

There was a high abundance of herbaceous species mainly erect herbs, grasses, and creepers than in many highland forest basin in the region (Mulugeta *et al.*, 2015; Mbuni *et al.*, 2019). Succulent herbs in the valley floor were an indication of prolonged dryness while dominance of grasses in upland forest was an indication of presence of domestic animals where deforestation and continued grazing discouraged regeneration of indigenous trees and encouraged proliferation of such grasses like *Pennisetum clandestinum* and *Digitaria scalarum*. Dominance of creepers in montane region was also as a result of scarcity of trees and shrubs coupled by low temperature, coldness and the boggy nature of the area discouraging plant species that had organs exposed to the harsh environment (Seswa *et al.*, 2018). The valley floor had the highest herbaceous species diversity followed by escarpment and the least abundant region was the montane region. Here, topography heterogeneity and the mesic conditions influenced the distribution of the herbaceous species in the escarpment and the valley floor as explained by (Srivastava *et al.*, 2016). Herb species composition was established to be high as has been observed in the majority of moist, low-disturbance tropical forests. Also area with deposits of sediments from upper grounds tend to support greater diversity (Arias *et al.*, 2018) of herbaceous species which happen to be the case of the lower escarpment and the valley floor.

5.3 Influence of environmental factors on the species composition, abundance and diversity of plants in Embobut Forest Reserve

In the present study, the environmental variables resulted in differential variability in species composition, abundance and diversity. Rainfall affected the distribution of species such as *Balanites aegyptiaca*, *Commiphora africana*, *Boscia mossambicensis*, *Vachellia tortilis*, *Salvadora persica* majority of which are regarded as sight specific species (Bilal, 2019). Meanwhile the humidity, temperature and altitude determined the distribution of *Hagenia abyssinica*, *Rhus natalensis*, *Prunus africana* and *Maesa lanceolata* which indicate that most of these species are influenced by different altitudinal variations. Indeed *Hagenia abyssinica*, *Prunus africana* and *Maesa lanceolata* are high altitude trees (Guillozet *et al.*, 2015). Studies on the complete vascular plant flora on the slope of Mount Kinabalu (Borneo) have confirmed the existence of both elevation patterns for the groups of ferns/herbs and trees (Grytnes and Beaman, 2006).

Boscia coriacea, *Euclea divinorum* and *Allophylus abyssinica* distribution was affected by the aspect and slope. Indeed *Euclea divinorum* was common in the slopy east facing slopes while *Allophyllus abyssinica* was found in steep west facing slopes of upland forest and *Boscia coriacea* in relatively flat area. The occurrence of the mentioned plant species could have been controlled by intensity of light where high intensity of light during favoured growth of drought resistants trees like *Boscia coriacea* with thick cuticle and coriaceous leaves discourage evapotranspiration while *Allophyllus abyssinica* require low light intensities provided and enhanced by shade condition of the morning hours (Koenen *et al.*, 2015; Tura and Reddy, 2015). Wind speed affected the distribution of *Grewia bicolor*, *Senegalia mellifera* and *Balanites* *pedicellaris*. These species were present in the valley floor where wind speeds were relatively low. The sheltered nature of the valley floor trim down wind speeds thus retaining the moisture content of the plants (González-M *et al.*, 2018).

The relationship between environmental variable and tree species abundance indicate that five variables amongst the seven investigated vis; temperature, rainfall, wind speed, humidity, and altitude influenced the tree species abundance of which amongst the five, four had significant positive influence but altitude had negative influence where as elevation increased, abundance decreased. On the other hand tree species diversity was influenced by temperature, rainfall, humidity, windspeed, altitude and negatively by aspect. Recently, topographical variables have been used to determine species richness, regional biodiversity patterns, forest canopy health, species distribution and gradients in exotic species (Chanthorn *et al.*, 2018).

The composition of shrubs with respect to environmental variables for the most abundant shrub species indicated that rainfall affected the composition of species such as *Acalypha fruticosa*, *Barleria acanthoides* and *Croton dischogamus* while aspect influenced the distribution of *Barleria argentea*, *Dodonaea angustifolia* and *Plectranthus barbatus*. While plant species influenced by rainfall are mainly dryland plants, plant like *Dodonaea angustifolia* generally found at a certain elevation midway on hill facing eastwards (Quaresma *et al.*, 2018). Wind speed affected the distribution of *Euphorbia heterochroma* and *Aloe tweediae* found at the foothill of the escarpment where there is sheltering and hence they are drought torrelant and low wind speeds prevent evapotranspiration in these plants. Also *Erica arbore*a and *Achyrospermum schimperi* are highland plants where wind speeds are generally high.

However, *Achyrospermum schimperi* is a forest undergrowth shrub. This seems to suggest that the former could be well adapted to high windspeeds while the later could be existing in this environment because of the sheltering by other vegetation (Aynekulu *et al.*, 2016).

The combination of temperature and altitude and humidity affected the distribution of *Vernonia auriculifera*, *Melanthera scandens*, and *Laggera elatior*. This agrees with several studies (Oke and Thompson, 2015; Al-Aklabi *et al.*, 2016; Keppel *et al.*, 2017; Tikhonov *et al.*, 2017). Based on multiple regression statistics, the overall influence of temperature, rainfall, wind speed, humidity, aspect, slope and altitude moderately influenced the shrubs species abundance with more influence from temperature, rainfall, slope and altitude on the overall shrubs species abundance. There was also significant positive influence of the above factors but negative influence was depicted by aspect. Slope did not have any effect on diversity of shrubs probably because shrub can support themselves in steep slopes due to their light weight as opposed to trees.

As regards to the liana species composition, the study established that rainfall, slope, temperature and aspect affected the distribution of species such as *Jasminum abyssinica*, while temperature and altitude affected the distribution of *Rubus steudneri* and *Asparagus racemosus*. Humidity and wind speed affected the distribution of *Tinospora cordifolia* and *Cissus quadrangularis*. Species such as *Rubus steudneri* is a high-altitude dweller where temperatures are low while *Tinospora cordifolia* and *Cissus quadrangularis* can survive in low humidity, high temperature areas. However, there was a negative influence of wind speed and altitude where the higher the

altitude/windspeed, the lower diversity or absence of liana species suggesting that composition of lianas in the region do not thrive under high altitude and wind speed.
The overall distribution of herbaceous life forms indicated that slope, rainfall, wind speed affected the distribution of grasses, rhizomatous herbs, erect herbs, pteridophytes, rossete herbs and climbers. High rainfall encourage growth of such herbaceous species like *Geranium arabicum*, *Hebenstretia angolensis*, *Helichrysum* spp., *Scabiosa columbaria*, *Agrocharis incognita*, *Carduus kikuyorum* and *Urtica massaica* all of which are contained in the above mentioned life forms which agrees with previous studies (Razafindratsima *et al.*, 2018; Seta *et al.*, 2019). Low rainfall encourages growth of drought resistant herbs including *Aerva lanata*, *Boerhavia coccinea* and *Commicarpus grandiflorus*. The exudate produced by these plants could be means of conserving water hence their colonization in this arid environment (Swamynathan, 2013; Lüttge, 2019). Creepers such as *Alchemilla* spp., *Diclis bambusetti*, *Viola abyssinica* and *Parochetus communis* were affected more by high humidity while altitude, temperature and aspect affected the distribution of prostate herbs (*Cotula abyssinica* and *Oldenlandia monanthos*).

There was a positive environmental influence of temperature, rainfall, wind speed, humidity, slope and altitude moderately influenced the herb species abundance with more significant factors being temperature, wind speed, altitude and humidity on the overall herbs species abundance. Also temperature, rainfall, humidity, wind speed and altitude influenced herbs positively whereas slope negatively influenced herbs diversity. Many researchers (Ehrlén and Morris, 2015; Kraft *et al.*, 2015; D'Amen *et al.*, 2018) have emphasised, in diverse contexts, which multiple environmental factors will affect the abundance of various forms of vegetation including herbaceous species.

5.4 Influence of human activities on the species composition, abundance and diversity of plants in Embobut Forest Reserve

There were a number of human activities in the study area of which logging followed by collection of firewood, and charcoal burning were more frequent than burning, artisanal mining, bamboo harvesting and grass cutting was the most important. These results corroborate other studies from Afromontane region where human activities are widely reported (Specht *et al.*, 2015; Brandt *et al.*, 2018; Fisher *et al.*, 2018; Weinzettel *et al.*, 2018; Pulungan *et al.*, 2019; Shumi *et al.*, 2019). In Kenya, there is massive settlement of people who practice various forms of human activities in close vicinity of the forests.

The study established that human activities affected the distribution of trees with activities such as firewood, charcoal burning, path construction, grass cutting and settlements affecting *Vachellia tortilis*, *Euclea divinorum*, *Boscia mossambicensis*, *Boscia corriacea* and *Hagenia abyssinica* while cowsheds and grass cutting influenced mostly *Terminalia brownii*. This higher plant diversity in intermediately disturbed forest was explained by (Aleixandre-Benavent *et al.*, 2017). Also, at intermediate levels of disturbance, diversity is maximized because both competitive and opportunistic species can coexist. On the contrary, Specht *et al.*, 2015 reported a peak in diversity in an undisturbed area and it was argued that the type of disturbance that existed in the forest might have bene responsible for the low diversity in the disturbed forests. Similar results were obtained by (Muhati *et al.*, 2018), who explained that past harvesting and farming activities were responsible for reducing diversity in the disturbed forests.

In areas with pronounced burning, logging, cultivation and grazing the most abundant tree species include; *Senegalia mellifera*, *Senegalia senegal*, *Maesa lanceolata*, *Diospyros abyssinica*, *Acacia reficiens*, *Acacia nubica* and *Prunus africana*.

Artisanal mining influenced the distribution of *Bersama abyssinica* and *Salvodora persica*. Among these human activities, there was positive influence of settlements, charcoal burning, path constructions grass cutting and grazing. The pattern of species abundance along a disturbance may vary from one species to another. Whereas tree species abundance peaked at less disturbed (cattle boma, settlements, path constructions) level, (Dzerefos *et al.*, 2017) recorded higher tree species abundance in an undisturbed stand than in a disturbed stand. Highest of trees diversity has been obtained in intermediate disturbed forest type in some studies (Hutton *et al.*, 2017; Wehi and Lord, 2017; Salako *et al.*, 2018). On the other hand, studies have reported higher species diversity in undisturbed stands in relation to other forest types (Larsen, 2015; Davies and Moore, 2016; Winkelhuijzen, 2017; Kipkemoi, 2018). Whatever be the case, it is clear that species diversity is negatively affected by intensive disturbance as observed by (Alroy, 2017). The occurrence of higher species diversity at intermediate disturbance level has been explained by the presence of intermediate resource levels which many species make use of. It has also been previously explained (Luck *et al.*, 2003) that mild disturbance provides greater opportunity for species turnover, colonization and persistence of high species diversity.

The distribution of shrub species was also influenced by human activities where charcoal burning, settlements, cowsheds, cultivation and uncontrolled burning had higher presence of *Dodonaea angustifolia* , *Melanthera scandens*, *Justicia betonica*, *Psiadia paniculata*, *Euphorbia heterochroma*, *Barleria acanthoides* and *Sensevieria* *robusta*. Their distribution may be accounted for by the fact that most of the shrub are not paratable to livestock like *Euphorbia heterochroma, Psiadia paniculata, Dodonaea angustifolia* and *Sansevieria robusta*. Presence of settlements, cowsheds and cultivation is an indication of habitation by human and livestock. Meanwhile areas where there was intense collection of firewood, grazing and path constructions had higher occurrence of *Croton dichogamus*, *Helichrysum argyranthum*, *Laggera elatior* and *Acalypha fruticosa*. Logging affected the distribution of *Vernonia auricurifera*, *Solanecio mannii*, *Solanum terminale*, *Achyrospermum schimperi* and *Erica arborea*. *Solanum terminale*, *Vernonia auriculifera* and *Solanecio mannii* are forest gap colonizers of the recently cut (Knapp and Vorontsova, 2016) trees and hence their occurrence in where logging was prevalent.

In areas dominated by collection of herbal medicine, there were changes in several medicinal plants such as *Aloe tweediae*, *Ocimum americanum*, *Maerua decumbens*, *Barleria argentea* and *Abutilon mauritanianum*. Again here, *Aloe tweediae*, *Maerua decumbens* and *Ocimum americanum* are plants that are locally used by the community for medicinal value. Therefore such plants are locally protected by the inhabitants. Indeed cattle boma, bamboo harvesting, settlements, uncontrolled burning, charcoal burning, path constructions and firewood collection were the main human activities significantly influencing the abundance of shrubs species mainly because cattle boma provided manure that encouraged growth of shrubs with improved soils and human activities such as charcoal burning, bamboo harvesting, path constructions opened up gaps for colonization of shrub species, but firewood collection and grazing were the main activities that significantly influenced the high diversity of shrubs. Rampant burning, cultivation and collection of herbal medicines recorded the lowest diversity an indication that the human activities in question were reducing the cover of the shrubs (Maxwell *et al.*, 2019).

The distribution in lianas species distribution were also influenced by human activities. It was established that artisanal mining influenced the distribution of *Rubus steudneri*, logging and grazing influenced the distribution of *Cissus rotundifolia*, *Cissus quadrangularis* and *Cissampelos pareira* while firewood influenced the distribution of *Tinospora cordifolia* and *Asparagus racemosus*. Among the human activities, there was positive influence of grazing and logging on the liana species distribution.

Charcoal burning and cultivation influenced the distribution of creepers and erect herbs, uncontrolled burning, grazing, grass cutting, logging and artisanal mining influenced the distribution of grass, prostrate herbs and succulent herbs. However, the number of herbaceous plant species remained higher in the disturbed sites compared to the undisturbed sites. Most studies on herbaceous plant species have reported increasing plant species along an increasing disturbance gradient. While higher species of trees in undisturbed forests was attributed to absence of human disturbance, that of herbs in the disturbed forest has been explained by their ability to reach maturity quickly; the so-called opportunistic, pioneer species, in frequently disturbed areas.

5.5 Utilization of plant resources in Embobut Forest REserve

In this study, interviews held with the households showing there were 208 indigenous plant species belonging to 168 genera and 68 families suggesting a high diversity of species in the region as reported in several parts of the tropical environment (Medley *et al.*, 2017; Abebe, 2019; Ojelel *et al.*, 2019). The high species diversity is not surprising since the area has favorable Afromontane type of environment for optimal growth of plants.

In the past, an understanding of the traditional ecological knoweldge has been called for. Therefore in this study the knowledge of plants species, use and conservation among the households was determined. In Kenya, the Marakwet sub-ethnic group have long history of using plants for a number of uses and therefore large numbers of studies have been conducted in the region (Kipkore *et al.*, 2014). The households were supposed to positively identify to help in the preservation of the traditional knowledge.

Among the 208 species identified, the households were able to identify 36 use groups. These include 12 described in addition to others such as boundary, brewing, broom, basketry, cleaning utensils, thatching, toiletry, gum arabica, making gutters, mole traps, shade and walking sticks as well as for making soap. In Kenya, the plant resources provide important social and economic contribution to rural livelihoods (Otieno and Analo, 2012). The cultural uses of indigenous plants presented in the study are further supported by observations that the Marakwets use a great variety of wild species for a diverse range of purposes. The households obtain plants in which their livelihood depend on for such resources as fodder, fuel, fruits, vegetables, furniture, and roof thatching. Therefore use of the plants remains important.

The use of charcoal elicited more responses (68%). More than 50% of the households indicated knowledge of species against fencing (51.5%), building poles (52.4%) and ornamental plants (50.2%). Plant species for all the other use groups were known but the aggregate was less than 50% of the overall response. Therefore, despite the varied use of the plants it is clear that the households are not aware of the exact uses of the plants which suggest that they have lost the Ecological knowledgeof the plant use.

The popularity of use of leaves was attributed to community naturally being livestock keepers. Thus species like *Balanites pedicellaris, Balanites aegyptica, Ziziphus mauritiana, Vachellia tortilis* and *Tamarindus indica* are sources of the fodder for their animals especially during the dry season. Fruits are also known to be source of nourishment during wet and dry season e.g. *Balanites pedicellaris* and *Balanites aegyptiaca* fruits are boiled to reduce their bitterness during dry season and fed to children. Also fruits like *Meyna tetraphylla, Tamarindus indica, Ximenia americana,* and *Vangueria madagascariensis* were popular in this region.

Dependency on indigenous plant species necessitated the development of cultural practices to preserve the species. The harvesting of useful indigenous plant species from communal lands is regulated through observance of strict harvesting methods by all community members who collect the species to satisfy particular needs. Humans have shown tendency to managing plant resources according to their availability and value in households' subsistence (Leiper *et al.*, 2018). The conservation methods developed and used in the study included specific harvesting methods; making harvesting of some species a taboo or paying goat fines to the households for cuttingdown some trees such as *Balanites aegyptiaca* and *Vachellia tortilis* and control of the use of plant species by the local chief. Also the traditional medicinal plants, which may contribute greatly to trade in natural products in this century, are at risk due to habitat destruction and unsustainable rates of exploitation among other factors (Uchida *et al.*, 2018).

The current study confirms that there exist several plant species that are useful. The species are harvested for purposes such as food, fuel, and fodder for livestock, construction and manufacturing of household utensils. Majority of them were unable to identify the plant species and did not correctly identify the use of the plants as well as the plant parts used by the households. Indeed the identification of the conservation status of the local species was also poorly understood. The plants have been the source of livelihood and they are still valued for survival. Continuous use of the plant species is made possible by the methods developed to preserve the species. The species are sustained by the harvesting methods adopted by community members. Such mechanisms are culturally developed conservation systems known and practiced by community members.

Plants in Embobut Forest Reserve were most useful as fodder, medicine, firewood and food as well as for building. Plant foliage found many uses as livestock fodder, human food in form of vegetables and medicines for livestock and human. The leaves of *Basella alba*, *Amaranthus hybridus* and *Rumex bequaertii* were used as vegetable and the fruits of *Sizygium cordatum* and *Lantana camara* were edible fruits. Fodder plants included *Pycreus nitidus, Leersia hexandra, Floscopa glomerata, Rotalla tenella, Pennisetum schimperi* among others. Species of *Ajuga remota, Acmella caulirhiza, Carissa edulis, Galinsoga parviflora, Senna didymobotrya* and *Zehneria scabra* were used in traditional medicine. The use value index of the plants species was related to the abundance of the plant species. This study indicated that plant use was based on their abundance. The higher the use value, the higher the abundance. This was attributed to those used plants being conserved and harvested sustainably to offer continuous supply of resources to the community.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

There were 41 tree species, 60 shrub species, 7 liana species and 126 herbaceous species belonging to 11 life forms indicating low to moderate species numbers. Spatial variations in the plants species were significant ($P < 0.05$). Valley floor and escarpment had the highest abundance of trees shrubs respectively but diversity was highest in montane region for trees and escarpment for shrubs. . The lianas in the valley floor had the highest species diversity. The vast majority of the herbs belonged to the life form erect herbs which had 42 species and creepers with 21 species. Erect herbs, grasses, and creepers showed wide distribution where the valley floor had the highest herbaceous plant diversity.

Environmental variables were established that affected the distribution of plant species in a species-specific patterns. However, humidity, rainfall, wind speed, temperature and altitude exerted more control of abundance and diversity on several species of trees. Temperature, humidity, rainfall, altitude and wind speed were significant in controlling the distribution of majority of the shrubs positively while aspects and slope negatively. Also shrub diversity was significantly ($P < 0.05$) affected by all the seven environmental factors except aspect. Lianas species distribution was affected mainly by temperature, altitude humidity and wind speed, rainfall, slope and aspect while herbs owed their wide distribution to all environmental factors except aspect. Again the plant species were affected not by any single environmental factor but by a combination of several environmental factors that is; temperature, rainfall, wind speed, humidity, aspect, slope and altitude in species-specific trend.

There were a number of human activities reported in the study area of which grazing followed by logging, collection of firewood, uncontrolled burning and charcoal burning which were more frequent. Human activities affected the distribution of trees, shrubs, lianas and herbs in species-specific patterns but the most important activities were firewood, charcoal burning, path constructions, grass cutting and settlements which affected proportionately higher number of species. Collection of herbal medicine clearly affected the overall distribution of medicinal plants. The distribution in lianas species composition was affected mainly by artisanal mining, logging and collection of firewood affected the distribution of *Tinospora cordifolia* and *Asparagus racemosus*. There was significant positive influence of charcoal burning and cultivation affecting the distribution of creepers and erect herbs while uncontrolled burning, grazing, grass cutting, logging and collection herbal medicine affected the distribution of grasses, prostrate herbs and succulent herbs.

There were 208 plant species within the area based on assessment. There were 152 useful plants species. The use of roots for treatment was used by at least 67.2% of the households. This was an indication that roots could be harving higher concentration of active ingreadiets for treatment of diseases. The overharvesting harvesting of these plant roots could be impacting negatively to the composition, abundance and diversity of plant species of Embobut Forest Reserve. On the other hand the use of stem (48.6%), branches (43.7%) and leaf (21.6%) in management of disease was used by between 20 and 50% of the households. The use of the remaining parts of the plants vis: fruits (8.3%), bark (6.6%), bulb (5.7) and flowers (6.9%) were practiced by less than 10% of the households. The use value index of the plants species was related to the abundance of the plant species. Plants use was based on their abundance. The more use value the plants had conformed to higher abundance of the plants. This was an indication that the community gave priority to plant with multiple uses as opposed to those which did not directly benefit them.

6.2 Recommendations

The following recommendations are suggested

1. A strategy for management of Embobut Forest Reserve should focus on the multiple-use conservation approaches. Some of the areas within the forest showing signs of relatively little human impacts can be designated for strict conservation so that they may act as repositories of biodiversity and possibly as a source of forest genetic resources, alongside sustainable use of the already exploited forest. Conserving ecological systems, plant communities, and species provide a more ecologically integrated conservation strategy. Conservation, in order to be effective, must strive to balance the protection of countable objects of diversity and the use of natural processes, the balance which should entail a broad assortment of programs on a variety of spatial and organizational scales. Areas sought by this study to have been favoured environmental factors and have less human interference should act as repositories for plant species concervation of this region. Also those areas with high diversity of trees such as the highland forest and moorland should be protected and those plant species that are site specific for this area should be introduced where overharvested.

2. The species are harvested for purposes such as food, fuel, and fodder for livestock, construction and manufacturing of household utensils. Indeed the identification of the conservation status of the local species was also poorly understood. Continuous use of the plant species is made possible by the methods developed to preserve the species. The species are sustained by the harvesting methods adopted by community members. Such mechanisms are culturally developed conservation systems known and practiced by community members. Observations of the regulations on the harvesting of plant species uphold common allegiance to the chief of the community and Community Forest Asssociation (CFA).
3. Inhabitants of Embobut are encouraged to sustanably use the plants. For this reason, the inventory generated by this study ought to be printed and used to educate the younger generation about the varied types of plant resources and their uses. Priority should be given to those plants with multiple use to ease the pressure in their utilization. Additionally, the study has shown that integrating new scientific knowledge yield greater results in terms of sustainable utilization of the local flora. More planting of vegetation in terms of abundance should be encouraged for sustainable utilization of plant species in Embobut Forest Reserve

REFERENCES

Abebe, F.B. (2019). Ethnobotanical Studies of Medicinal Plants used to Treat Human and Livestock Ailments in Southern Nations, Nationalities and Peoples' Region, Ethiopia: A Systematic Review. *Journal of Plant Studies*. **8**: 1-9.

Abood, S.A., Lee, J.S.H., Burivalova, Z., Garcia-Ulloa, J. and Koh, L.P. (2015). Relative contributions of the logging, fiber, oil palm, and mining industries to forest loss in Indonesia. *Conservation Letters*. **8**: 58-67.

Aerts, R., Thijs, K.W., Lehouck, V., Beentje, H., Bytebier, B., Matthysen, E., Gulinck, H., Lens, L. and Muys, B. (2011). Woody plant communities of isolated Afromontane cloud forests in Taita Hills, Kenya. *Plant Ecology*. **212**: 639-649.

Agisho, H., Osie, M. and Lambore, T. (2014). Traditional medicinal plants utilization, management and threats in Hadiya Zone, Ethiopia. *Journal of Medicinal Plants*. **2**: 94-108.

Al-Aklabi, A., Al-Khulaidi, A.W., Hussain, A. and Al-Sagheer, N. (2016). Main vegetation types and plant species diversity along an altitudinal gradient of Al Baha region, Saudi Arabia. *Saudi Journal of Biological Sciences*. **23**: 687-697.

Aleixandre-Benavent, R., Aleixandre-Tudó, J.L., Castelló-Cogollos, L. and Aleixandre, J.L. (2017). Trends in scientific research on climate change in agriculture and forestry subject areas (2005–2014). *Journal of cleaner production*. **147**: 406-418.

Alroy, J. (2017). Effects of habitat disturbance on tropical forest biodiversity. *Proceedings of the National Academy of Sciences*. **114**: 6056-6061.

Alroy, J. (2018). Limits to species richness in terrestrial communities. *Ecology Letters*. **21**: 1781-1789.

Amzat, J. and Razum, O. (2018). *Traditional medicine in Africa, Towards a Sociology of Health Discourse in Africa*. Springer, Gewerbestrasse, Switzeland. pp. 79-91.

Andersen, K.M., Naylor, B.J., Endress, B.A. and Parks, C.G. (2015). Contrasting distribution patterns of invasive and naturalized non‐native species along environmental gradients in a semi‐arid montane ecosystem. *Applied Vegetation Science*. **18**: 683-693.

Apaza‐Quevedo, A., Lippok, D., Hensen, I., Schleuning, M. and Both, S. (2015). Elevation, topography, and edge effects drive functional composition of woody plant species in tropical montane forests. *Biotropica*. **47**: 449-458.

Argumedo-Espinoza, J., Ramírez, J.S., Díaz-Núñez, V., Pérez-Salicrup, D.R. and Delgado, M.E.S. (2018). *Diversity, Distribution, and Abundance of Woody Plants in a Dry Tropical Forest: Recommendations for Its Management*. in: A., O.-R. (Ed.), *Mexican Natural Resources Management and Biodiversity Conservation*. Springer, Gewerbestrasse, Switzerland. pp. 479-500.

Arias, M.E., Wittmann, F., Parolin, P., Murray-Hudson, M. and Cochrane, T.A. (2018). Interactions between flooding and upland disturbance drives species diversity in large river floodplains. *Hydrobiologia*. **814**: 5-17.

Asfaw, A.G. (2018). Woody Species Composition, Diversity and Vegetation Structure of Dry Afromontane Forest, Ethiopia. *Journal of Agriculture and Ecology Research International*. **16**: 1-20.

Awoke, H. and Mewded, B. (2019). Changes in woody species composition and structure of Denkoro dry evergreen Afromontane forest over 16 years (2001–2017), South Wollo, Ethiopia. *Forest Ecology and Management*. **441**: 71-79.

Aynekulu, E., Aerts, R., Denich, M., Negussie, A., Friis, I., Demissew, S. and Boehmer, H.J. (2016). Plant diversity and regeneration in a disturbed isolated dry Afromontane forest in northern Ethiopia. *Folia Geobotanica*. **51**: 115-127.

Báez, S. and Homeier, J. (2018). Functional traits determine tree growth and ecosystem productivity of a tropical montane forest: Insights from a long‐term nutrient manipulation experiment. *Global Change Biology*. **24**: 399-409.

Banda, K., Delgado-Salinas, A., Dexter, K.G., Linares-Palomino, R., Oliveira-Filho, A., Prado, D., Pullan, M., Quintana, C., Riina, R. and Rodríguez, G.M. (2016). Plant diversity patterns in neotropical dry forests and their conservation implications. *Science*. **353**: 1383-1387.

Bax, V. and Francesconi, W. (2018). Environmental predictors of forest change: An analysis of natural predisposition to deforestation in the tropical Andes region, Peru. *Applied Geography*. **91**: 99-110.

Belbin, L. (1995). A multivariate approach to the selection of biological reserves. *Biodiversity & Conservation*. **4**: 951-963.

Bilal, A.F. (2019). Distribution Patterns and Abundance of the Dura Andat, Agonoscelis pubescens (Thunb.), and other Pentatomids Across Habitat Patches in the Central Clay Plain of Sudan. *University of Khartoum Journal of Agricultural Sciences*. **19**: 1-10.

Blanco, J. and Carrière, S.M. (2016). Sharing local ecological knowledge as a human adaptation strategy to arid environments: Evidence from an ethnobotany survey in Morocco. *Journal of Arid Environments*. **127**: 30-43.

Bleher, B., Uster, D. and Bergsdorf, T. (2006). *Assessment of threat status and management effectiveness in Kakamega Forest, Kenya*. in: Hawksworth, D.L., Bull, A.T. (Eds.), *Forest diversity and management*. Springer, Dordrecht, The Netherlands. pp. 99-117.

Bogale, T., Datiko, D. and Belachew, S. (2017). Structure and natural regeneration status of woody plants of berbere afromontane moist forest, bale zone, South East Ethiopia; implication to biodiversity conservation. *Open Journal of Forestry*. **7**: 352-371.

Brambach, F., Leuschner, C., Tjoa, A. and Culmsee, H. (2017). Diversity, endemism, and composition of tropical mountain forest communities in Sulawesi, Indonesia, in relation to elevation and soil properties. *Perspectives in Plant Ecology, Evolution and Systematics*. **27**: 68-79.

Brandt, P., Hamunyela, E., Herold, M., De Bruin, S., Verbesselt, J. and Rufino, M.C. (2018). Sustainable intensification of dairy production can reduce forest disturbance in Kenyan montane forests. *Agriculture, Ecosystems & Environment*. **265**: 307-319.

Bürgi, M., Östlund, L. and Mladenoff, D.J. (2017). Legacy effects of human land use: ecosystems as time-lagged systems. *Ecosystems*. **20**: 94-103.

Callaghan, C., Major, R.E., Cornwell, W.K., Poore, A.G., Wilshire, J.H. and Lyons, M. (2019). Continental-scale urbanness predicts local-scale responses to urbanization. *Ecography*. **43**: 528–538.

Cárate‐Tandalla, D., Camenzind, T., Leuschner, C. and Homeier, J. (2018). Contrasting species responses to continued nitrogen and phosphorus addition in tropical montane forest tree seedlings. *Biotropica*. **50**: 234-245.

Caroline, M.S.M., elicit, e, T.L., Romain, N.J. and Bernard-Aloys, N. (2016). Comparison of plant communities between primary and secondary tropical forests of Mount Oku, Cameroon. *Journal of Ecology and The Natural Environment*. **8**: 163-174.

Casalini, A.I., Bouza, P.J. and Bisigato, A.J. (2019). Geomorphology, soil and vegetation patterns in an arid ecotone. *Catena*. **174**: 353-361.

Cavender-Bares, J. (2016). Diversity, distribution, and ecosystem services of the North American oaks. *International Oaks*. **27**: 37-48.

Chanthorn, W., Wiegand, T., Getzin, S., Brockelman, W.Y. and Nathalang, A. (2018). Spatial patterns of local species richness reveal importance of frugivores for tropical forest diversity. *Journal of Ecology*. **106**: 925-935.

Chaturvedi, R., Raghubanshi, A., Tomlinson, K. and Singh, J. (2017). Impacts of human disturbance in tropical dry forests increase with soil moisture stress. *Journal of Vegetation Science*. **28**: 997-1007.

Chebet, C., Odenyo, V.A. and Kipkorir, E.C. (2017). Modeling the impact of land use changes on river flows in Arror watershed, Elgeyo Marakwet County, Kenya. *Water Practice and Technology*. **12**: 344-353.

Chen, G., Powers, R.P., de Carvalho, L.M. and Mora, B. (2015). Spatiotemporal patterns of tropical deforestation and forest degradation in response to the operation of the Tucuruí hydroelectric dam in the Amazon basin. *Applied Geography*. **63**: 1-8.

Chen, S.-L., Yu, H., Luo, H.-M., Wu, Q., Li, C.-F. and Steinmetz, A. (2016). Conservation and sustainable use of medicinal plants: problems, progress, and prospects. *Chinese Medicine*. **11**: 1-12.

Chukwuma, E.C., Soladoye, M.O. and Feyisola, R.T. (2015). Traditional medicine and the future of medicinal Plants in Nigeria. *Journal of Medicinal Plants Studies*. **3**: 23-29.

Corlett, R.T. (2016). Plant diversity in a changing world: status, trends, and conservation needs. *Plant Diversity*. **38**: 10-16.

Cronin, J.T., Bhattarai, G.P., Allen, W.J. and Meyerson, L.A. (2015). Biogeography of a plant invasion: plant–herbivore interactions. *Ecology*. **96**: 1115-1127.

Cuni-Sanchez, A., Pfeifer, M., Marchant, R., Calders, K., Sørensen, C.L., Pompeu, P.V., Lewis, S.L. and Burgess, N.D. (2017). New insights on above ground biomass and forest attributes in tropical montane forests. *Forest Ecology and Management*. **399**: 235-246.

D'Amen, M., Mod, H.K., Gotelli, N.J. and Guisan, A. (2018). Disentangling biotic interactions, environmental filters, and dispersal limitation as drivers of species co ‐ occurrence. *Ecography*. **41**: 1233-1244.

Daoub, R.M., Elmubarak, A.H., Misran, M., Hassan, E.A. and Osman, M.E. (2018). Characterization and functional properties of some natural Acacia gums. *Journal of the Saudi Society of Agricultural Sciences*. **17**: 241-249.

Dar, A.K., ul Hassan, W., Lone, A.H., Haji, A., Manzoor, N. and Mir, A.I. (2017). Study to assess high demand and high commercial value medicinal plants of Jammu and Kashmir India-with special focus on routes of procurement and identification. *IJRDPL*. **6**: 2576-2585.

Davies, M.I. and Moore, H.L. (2016). Landscape, time and cultural resilience: a brief history of agriculture in Pokot and Marakwet, Kenya. *Journal of Eastern African Studies*. **10**: 67-87.

de la Riva, E.G., Lloret, F., Pérez-Ramos, I.M., Marañón, T., Saura-Mas, S., Díaz-Delgado, R. and Villar, R. (2017). The importance of functional diversity in the stability of Mediterranean shrubland communities after the impact of extreme climatic events. *Journal of Plant Ecology*. **10**: 281-293.

de la Riva, E.G., Pérez ‐ Ramos, I.M., Tosto, A., Navarro ‐ Fernández, C.M., Olmo, M., Marañón, T. and Villar, R. (2016). Disentangling the relative importance of species occurrence, abundance and intraspecific variability in community assembly: a trait ‐ based approach at the whole ‐ plant level in Mediterranean forests. *Oikos*. **125**: 354-363.

Deák, B., Valkó, O., Török, P., Kelemen, A., Bede, Á., Csathó, A.I. and Tóthmérész, B. (2018). Landscape and habitat filters jointly drive richness and abundance of specialist plants in terrestrial habitat islands. *Landscape Ecology*. **33**: 1117-1132.

Denzin, N.K. (2017). *The research act: A theoretical introduction to sociological methods*. Routledge.

Díaz-García, J.M., Pineda, E., López-Barrera, F. and Moreno, C.E. (2017). Amphibian species and functional diversity as indicators of restoration success in tropical montane forest. *Biodiversity and Conservation*. **26**: 2569-2589.

Dietz, J., Leuschner, C., Hölscher, D. and Kreilein, H. (2007). Vertical patterns and duration of surface wetness in an old-growth tropical montane forest, Indonesia. *Flora-Morphology, Distribution, Functional Ecology of Plants*. **202**: 111-117.

Droissart, V., Dauby, G., Hardy, O.J., Deblauwe, V., Harris, D.J., Janssens, S., Mackinder, B.A., Blach ‐ Overgaard, A., Sonké, B. and Sosef, M.S. (2018). Beyond trees: Biogeographical regionalization of tropical Africa. *Journal of Biogeography*. **45**: 1153-1167.

Dzerefos, C.M., Witkowski, E.T. and Kremer-Köhne, S. (2017). Aiming for the biodiversity target with the social welfare arrow: medicinal and other useful plants from a Critically Endangered grassland ecosystem in Limpopo

Province, South Africa. *International Journal of Sustainable Development & World Ecology*. **24**: 52-64.

Ehrlén, J. and Morris, W.F. (2015). Predicting changes in the distribution and abundance of species under environmental change. *Ecology Letters*. **18**: 303-314.

Farwig, N., Sajita, N., Schaab, G. and Böhning-Gaese, K. (2008). Human impact diminishes seedling species richness in Kakamega Forest, Kenya. *Basic and Applied Ecology*. **9**: 383-391.

Figueiredo, F.O., Zuquim, G., Tuomisto, H., Moulatlet, G.M., Balslev, H. and Costa, F.R. (2018). Beyond climate control on species range: The importance of soil data to predict distribution of Amazonian plant species. *Journal of Biogeography*. **45**: 190-200.

Fischer, F.M., Wright, A.J., Eisenhauer, N., Ebeling, A., Roscher, C., Wagg, C., Weigelt, A., Weisser, W.W. and Pillar, V.D. (2016). Plant species richness and functional traits affect community stability after a flood event. *Philosophical Transactions of the Royal Society B: Biological Sciences*. **371**: 20150276. http://dx.doi.org/10.1098/rstb.2015.0276.

Fisher, J., Arora, P. and Rhee, S. (2018). Conserving Tropical Forests: Can Sustainable Livelihoods Outperform Artisanal or Informal Mining? *Sustainability*. **10**: 2586. https://doi.org/10.3390/su10082586.

Fraser, L.H., Pither, J., Jentsch, A., Sternberg, M., Zobel, M., Askarizadeh, D., Bartha, S., Beierkuhnlein, C., Bennett, J.A. and Bittel, A. (2015). Worldwide evidence of a unimodal relationship between productivity and plant species richness. *Science*. **349**: 302-305.

Frisch, A., Rudolphi, J., Sheil, D., Caruso, A., Thor, G. and Gustafsson, L. (2015). Tree species composition predicts epiphytic lichen communities in an African montane rain forest. *Biotropica*. **47**: 542-549.

Fujiki, S., Nishio, S., Okada, K.-i., Nais, J. and Kitayama, K. (2017). Plant communities and ecosystem processes in a succession-altitude matrix after shifting cultivation in the tropical montane forest zone of northern Borneo. *Journal of Tropical Ecology*. **33**: 33-49.

Gadow, K.v., Zhang, G., Durrheim, G., Drew, D. and Seydack, A. (2016). Diversity and production in an Afromontane Forest. *Forest Ecosystems*. **3**: 15. doi:10.1186/s40663-016-0074-7.

Gaoue, O.G., Jiang, J., Ding, W., Agusto, F.B. and Lenhart, S. (2016). Optimal harvesting strategies for timber and non-timber forest products in tropical ecosystems. *Theoretical ecology*. **9**: 287-297.

Gillman, L.N., Wright, S.D., Cusens, J., McBride, P.D., Malhi, Y. and Whittaker, R.J. (2015). Latitude, productivity and species richness. *Global Ecology and Biogeography*. **24**: 107-117.

Goldammer, J.G. (2016). Fire Management in Tropical Forests. *Tropical Forestry Handbook*. **1**: 2659-2710.

Gonmadje, C., Doumenge, C., Sunderland, T. and McKey, D. (2019). Environmental filtering determines patterns of tree species composition in small mountains of Atlantic Central African forests. *Acta Oecologica*. **94**: 12-21.

González-M, R., García, H., Isaacs, P., Cuadros, H., López-Camacho, R., Rodríguez, N., Pérez, K., Mijares, F., Castaño-Naranjo, A. and Jurado, R. (2018). Disentangling the environmental heterogeneity, floristic distinctiveness and current threats of tropical dry forests in Colombia. *Environmental Research Letters*. **13**: e045007.

Gosselin, F. and Callois, J.-M. (2018). Relationships between human activity and biodiversity in Europe at the national scale: Spatial density of human activity as a core driver of biodiversity erosion. *Ecological Indicators*. **90**: 356-365.

Guillozet, K., Bliss, J.C. and Kelecha, T.S. (2015). Degradation in an Afromontane forest in highland Ethiopia, 1969–2010. *Small-scale Forestry*. **14**: 121-137.

Gwali, S., Okullo, P., Hafashimana, D. and Byabashaija, D.M. (2010). Taxonomic diversity, distinctness, and abundance of tree and shrub species in Kasagala forest reserve in Uganda: implications for management and conservation policy decisions. *Tropical Conservation Science*. **3**: 319-333.

Hamelin, R. and Innes, J.L. (2016). *Forest ecosystem health and vitality*. Routledge. New York, USA.

Hamilton, A.C. (2004). Medicinal plants, conservation and livelihoods. *Biodiversity & Conservation*. **13**: 1477-1517.

Hatfield, J.H., Harrison, M.L. and Banks-Leite, C. (2018). Functional diversity metrics: How they are affected by landscape change and how they represent ecosystem functioning in the tropics. *Current Landscape Ecology Reports*. **3**: 35-42.

Hilbe, J.M. (2007). STATISTICA 7: an overview. *The American Statistician*. **61**: 91-94.

Hill, L., Hector, A., Hemery, G., Smart, S., Tanadini, M. and Brown, N. (2017). Abundance distributions for tree species in Great Britain: A two ‐ stage approach to modeling abundance using species distribution modeling and random forest. *Ecology and Evolution*. **7**: 1043-1056.

Hitimana, J., Kiyiapi, J., Njunge, J. and Bargerei, R. (2010). Disturbance indicators and population decline of logged species in Mt. Elgon Forest, Kenya. *African Journal of Ecology*. **48**: 699-708.

Huang, Y., Chen, Y., Castro-Izaguirre, N., Baruffol, M., Brezzi, M., Lang, A., Li, Y., Härdtle, W., von Oheimb, G. and Yang, X. (2018). Impacts of species richness on productivity in a large-scale subtropical forest experiment. *Science*. **362**: 80-83.

Huang, Y., Ma, S., Wang, Y., Yan, R., Wang, S., Liu, N., Chen, B., Chen, J. and Liu, L. (2019). The role of traditional Chinese herbal medicines and bioactive ingredients on ion channels: a brief review and prospect. *CNS & Neurological Disorders-Drug Targets (Formerly Current Drug Targets-CNS & Neurological Disorders).*

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

Hutton, J., Patenaude, G., Revéret, J.-P. and Potvin, C. (2017). *The role of indigenous peoples in conservation actions: a case study of cultural differences and conservation priorities*, *Governing Global Biodiversity*. Routledge. pp. 159-176.

Ibanez, T., Keppel, G., Baider, C., Birkinshaw, C., Culmsee, H., Cordell, S., Florens, F.V., Franklin, J., Giardina, C.P. and Gillespie, T.W. (2018). Regional forcing explains local species diversity and turnover on tropical islands. *Global ecology and biogeography*. **27**: 474-486.

Irakiza, R., Vedaste, M., Elias, B., Nyirambangutse, B., Serge, N.J. and Marc, N. (2016). Assessment of traditional ecological knowledge and beliefs in the utilisation of important plant species: The case of Buhanga sacred forest, Rwanda. *Koedoe*. **58**: 1-11.

Jiang, H., Zhang, Y., Lü, E. and Wang, C. (2015). Archaeobotanical evidence of plant utilization in the ancient Turpan of Xinjiang, China: a case study at the Shengjindian cemetery. *Vegetation History and Archaeobotany*. **24**: 165-177.

Jost, L. (2006). Entropy and diversity. *Oikos*. **113**: 363-375.

Kandari, L.S., Negi, T., Thakur, A.K. and Yilma, E. (2015). Ethnobotanical and indigenous knowledge of important plants in East Hararghe, Eastern Ethiopia. *Journal of Mountain Science*. **12**: 1521-1533.

Kariuki, P.M., Onyango, C.M., Lukhoba, C.W. and Njoka, J.T. (2018). The Role of Indigenous Knowledge on Use and Conservation of Wild Medicinal Food Plants in Loita Sub-county, Narok County. *Asian Journal of Agricultural Extension, Economics & Sociology*. **28**: 1-9.

Kenya National Bureau of Statistics. (2010). *The 2009 Kenya population and housing census*. Kenya National Bureau of Statistics.

Keppel, G., Robinson, T.P., Wardell-Johnson, G.W., Yates, C.J., Van Niel, K.P., Byrne, M. and Schut, A.G. (2017). A low-altitude mountain range as an important refugium for two narrow endemics in the Southwest Australian Floristic Region biodiversity hotspot. *Annals of Botany*. **119**: 289-300.

Khan, W., Khan, S.M. and Ahmad, H. (2015). Altitudinal variation in plant species richness and diversity at Thandiani sub forests division, Abbottabad, Pakistan. *Journal of Biodiversity and Environmental Sciences*. **7**: 46-53.

Kibet, M. (2010). Evaluation of tree and shrub responses to soil moisture status and their potential for afforestation in the semi-arid rangelands of Makueni District, Kenya, Egerton University. Kenyatta University.

Kibet, S. (2011). Plant communities, species diversity, richness, and regeneration of a traditionally managed coastal forest, Kenya. *Forest Ecology and Management*. **261**: 949-957.

Kigen, G., Kamuren, Z., Njiru, E., Wanjohi, B. and Kipkore, W. (2019). Ethnomedical Survey of the Plants Used by Traditional Healers in Narok County, Kenya. *Evidence-Based Complementary and Alternative Medicine*: Volume 2019, Article ID 8976937, 8 pages https://doi.org/10.1155/2019/8976937.

Kimondo, J., Miaron, J., Mutai, P. and Njogu, P. (2015). Ethnobotanical survey of food and medicinal plants of the Ilkisonko Maasai community in Kenya. *Journal of Ethnopharmacology*. **175**: 463-469.

Kipkemoi, I. (2018). Spatio-temporal degradation detection and modeling future scenarios of embobut forest in Elgeyo Marakwet County, Kenya, Kenyatta University. Kenyatta University.

Kipkoech, S., Melly, D.K., Mwema, B.W., Mwachala, G., Musili, P.M., Hu, G. and Wang, Q. (2019). Conservation priorities and distribution patterns of vascular plant species along environmental gradients in Aberdare ranges forest. *PhytoKeys*. **131**: 91-101.

Kipkore, W., Wanjohi, B., Rono, H. and Kigen, G. (2014). A study of the medicinal plants used by the Marakwet Community in Kenya. *Journal of Ethnobiology and Ethnomedicine*. **10**: 24 (2014). https://doi.org/10.1186/1746-4269-10-24.

Kiringe, J.W. (2005). Ecological and anthropological threats to ethno-medicinal plant resources and their utilization in Maasai communal ranches in the Amboseli region of Kenya. *Ethnobotany Research and Applications*. **3**: 231-242.

Klaus, V.H., Kleinebecker, T., Busch, V., Fischer, M., Hölzel, N., Nowak, S., Prati, D., Schäfer, D., Schöning, I. and Schrumpf, M. (2018). Land use intensity, rather than plant species richness, affects the leaching risk of multiple nutrients from permanent grasslands. *Global Change Biology*. **24**: 2828-2840.

Knapp, S. and Vorontsova, M.S. (2016). A revision of the "African Non-Spiny" Clade of *Solanum* L. (*Solanum* sections *Afrosolanum* Bitter, *Benderianum* Bitter, *Lemurisolanum* Bitter, *Lyciosolanum* Bitter, *Macronesiotes* Bitter, and *Quadrangulare* Bitter: Solanaceae). *PhytoKeys*: 1–142.

Koenen, E.J., Clarkson, J.J., Pennington, T.D. and Chatrou, L.W. (2015). Recently evolved diversity and convergent radiations of rainforest mahoganies (Meliaceae) shed new light on the origins of rainforest hyperdiversity. *New Phytologist*. **207** 327–339.

Komonen, A. and Elo, M. (2017). Ecological response hides behind the species abundance distribution: Community response to low ‐ intensity disturbance in managed grasslands. *Ecology and evolution*. **7**: 8558-8566.

Kraft, N.J., Adler, P.B., Godoy, O., James, E.C., Fuller, S. and Levine, J.M. (2015). Community assembly, coexistence and the environmental filtering metaphor. *Functional Ecology*. **29**: 592-599.

Krupa, J., Sureshkumar, J., Silambarasan, R., Priyadarshini, K. and Ayyanar, M. (2018). Integration of traditional herbal medicines among the indigenous communities in Thiruvarur District of Tamil Nadu, India. *Journal of Ayurveda and integrative medicine*.

Kuosmanen, N., Marquer, L., Tallavaara, M., Molinari, C., Zhang, Y., Alenius, T., Edinborough, K., Pesonen, P., Reitalu, T. and Renssen, H. (2018). The role of climate, forest fires and human population size in Holocene vegetation dynamics in Fennoscandia. *Journal of Vegetation Science*. **29**: 382-392.

LaManna, J.A., Mangan, S.A., Alonso, A., Bourg, N.A., Brockelman, W.Y., Bunyavejchewin, S., Chang, L.-W., Chiang, J.-M., Chuyong, G.B. and Clay, K. (2017). Plant diversity increases with the strength of negative density dependence at the global scale. *Science*. **356**: 1389-1392.

Larsen, S. (2015). Threatened forest, threatened culture: a case study of subjectivities, nature and resistance in Embobut Forest, Lund University Lund University Centre for Sustainability Studies.

Laurance, W.F., Campbell, M.J., Alamgir, M. and Mahmoud, M.I. (2017). Road expansion and the fate of africa's tropical forests. *Frontiers in Ecology and Evolution*. **5**: 75-84.

Lebrija ‐ Trejos, E., Reich, P.B., Hernández, A. and Wright, S.J. (2016). Species with greater seed mass are more tolerant of conspecific neighbours: a key driver of early survival and future abundances in a tropical forest. *Ecology Letters*. **19**: 1071-1080.

Lei, K., Pan, H. and Lin, C. (2016). A landscape approach towards ecological restoration and sustainable development of mining areas. *Ecological Engineering*. **90**: 320-325.

Leiper, I., Zander, K.K., Robinson, C.J., Carwadine, J., Moggridge, B.J. and Garnett, S.T. (2018). Quantifying current and potential contributions of Australian indigenous peoples to threatened species management. *Conservation Biology*. **32**: 1038-1047.

Lézine, A.-M., Izumi, K., Kageyama, M. and Achoundong, G. (2019). A 90,000-year record of Afromontane forest responses to climate change. *Science*. **363**: 177-181.

Li, D., Xu, Y., Li, Y., Wang, J., Yin, X., Ye, X., Wang, A. and Wang, L. (2018). Sedimentary records of human activity and natural environmental evolution in sensitive ecosystems: A case study of a coral nature reserve in Dongshan Bay and a mangrove forest nature reserve in Zhangjiang River estuary, Southeast China. *Organic Geochemistry*. **121**: 22-35.

Lillo, E.P., Fernando, E.S. and Lillo, M.J.R. (2019). Plant diversity and structure of forest habitat types on Dinagat Island, Philippines. *Journal of Asia-Pacific Biodiversity*. **12**: 83-105.

Liu, H. and Lv, G. (2019). Biomass energy flow between species and species survival in fragmented landscapes. *Ecological Complexity*. **37**: 1-10.

Luck, G.W., Daily, G.C. and Ehrlich, P.R. (2003). Population diversity and ecosystem services. *Trends in Ecology and Evolution*. **18**: 331-336.

Lüttge, U. (2019). Functional Diversity of Photosynthesis, Plant-Species Diversity, and Habitat Diversity. *Progress in Botany*. **81**: 23-31.

MacFarlane, D.W., Kinzer, A.T. and Banks, J.E. (2015). Coupled human-natural regeneration of indigenous coastal dry forest in Kenya. *Forest Ecology and Management*. **354**: 149-159.

Magurran, A.E. and Henderson, P. (2018). More than the sum of the parts: annual partitioning within spatial guilds underpins community regulation. *Proceedings of the Royal Society B: Biological Sciences*. **285**: e20180659.

Mahmoud, S.H. and Gan, T.Y. (2018). Impact of anthropogenic climate change and human activities on environment and ecosystem services in arid regions. *Science of The Total Environment*. **633**: 1329-1344.

Makokha, J., Kerich, E. and Mkung, D. (2017). Effects of Forest Disturbance on Plant Species Composition and Forest Structure: A Case Study of Kapkanyar Power line in Cherangani Forest. *International Journal of Science and Research*. **6**: 1953-1957.

Malanson, G.P., Resler, L.M., Butler, D.R. and Fagre, D.B. (2019). Mountain plant communities: Uncertain sentinels? *Progress in Physical Geography: Earth and Environment*: 0309133319843873.

Mången, I.E., Karki, S., Prajapati, C., Yadav, R.K. and Shrestha, B.B. (2015). Facing north or south: Does slope aspect impact forest stand characteristics and soil properties in a semiarid trans-Himalayan Valley? *Journal of Arid Environments*. **121**: 112-123.

Marselis, S.M., Tang, H., Armston, J.D., Calders, K., Labrière, N. and Dubayah, R. (2018). Distinguishing vegetation types with airborne waveform lidar data in a tropical forest-savanna mosaic: A case study in Lopé National Park, Gabon. *Remote Sensing of Environment*. **216**: 626-634.

Matthew, D. (2014). Geoarchaeological assessment of the area around Tot, Marakwet. Cambridge University Press. University of Cambridge.

Maua, J.O., Tsingalia, M.H. and Cheboiwo, J. (2018). Species Diversity and Utilization of Non-Timber Forest Products (NTFPs) by Households Adjacent to South Nandi Forest, Kenya. *Species Diversity*. **8**: 23-32.

Maxwell, J.D., Rhodes, A.C. and Clair, S.B.S. (2019). Human altered disturbance patterns and forest succession: impacts of competition and ungulate herbivory. *Oecologia*. **189**: 1061-1070.

Mbuni, Y.M., Zhou, Y., Wang, S., Ngumbau, V.M., Musili, P.M., Mutie, F.M., Njoroge, B., Kirika, P.M., Mwachala, G. and Vivian, K. (2019). An annotated checklist of vascular plants of Cherangani Hills, Western Kenya. *PhytoKeys*. **120**: 1-124.

McGlinn, D.J., Xiao, X., May, F., Gotelli, N.J., Engel, T., Blowes, S.A., Knight, T.M., Purschke, O., Chase, J.M. and McGill, B.J. (2019). Measurement of Biodiversity (MoB): A method to separate the scale‐dependent effects of species abundance distribution, density, and aggregation on diversity change. *Methods in Ecology and Evolution*. **10**: 258-269.

Medley, K.E., Maingi, J.K., Maingi, K. and Henkin, M. (2019). Embedded histories and biogeographic interpretations of forest diversity at Mt. Kasigau, Kenya. *African Geographical Review*. **38**: 109-125.

Medley, K.E., Maingi, J.K. and Mutiti, C.M. (2017). *Conservation of woody plant diversity in Kenya*, *Biodiversity and conservation of woody plants*. Springer. pp. 273-290.

Medvecká, J., Zaliberová, M., Májeková, J., Senko, D. and Jarolímek, I. (2018). Role of infrastructure and other environmental factors affecting the distribution of alien plants in the Tatra Mts. *Folia Geobotanica*. **53**: 349-364.

Melly, D.K., Kipkoech, S., Muema, B.W., Kamau, P., Malombe, I., Hu, G. and Wang, Q.-F. (2020). An annotated checklist of the vascular flora of South and North Nandi Forests, Kenya. *PhytoKeys*. **155**: 87-123.

Metcalfe, H., Hassall, K.L., Boinot, S. and Storkey, J. (2019). The contribution of spatial mass effects to plant diversity in arable fields. *Journal of Applied Ecology*. **56**: 1560–1574.

Miyamoto, K., Wagai, R., Aiba, S.-i. and Nilus, R. (2016). Variation in the aboveground stand structure and fine-root biomass of Bornean heath (kerangas) forests in relation to altitude and soil nitrogen availability. *Trees*. **30**: 385-394.

Molnár, Z. and Berkes, F. (2018). Role of traditional ecological knowledge in linking cultural and natural capital in cultural landscapes. *Reconnecting Natural and Cultural Capital: Contributions from Science and Policy; Paracchini, ML, Zingari, PC, Blasi, C., Eds*: 183-193.

Moreira, E.F., Boscolo, D. and Viana, B.F. (2015). Spatial heterogeneity regulates plant-pollinator networks across multiple landscape scales. *PloS One*. **10**: e0123628.

Morgan, G.A., Leech, N.L., Gloeckner, G.W. and Barrett, K.C. (2004). *SPSS for introductory statistics: Use and interpretation*. Lwarence Erlbaum Association. New Jersey, USA.

Mota, G.S., Luz, G.R., Mota, N.M., Coutinho, E.S., Veloso, M.d.D.M., Fernandes, G.W. and Nunes, Y.R.F. (2018). Changes in species composition, vegetation structure, and life forms along an altitudinal gradient of rupestrian grasslands in south-eastern Brazil. *Flora*. **238**: 32-42.

Mouchet, M.A., Villéger, S., Mason, N.W. and Mouillot, D. (2010). Functional diversity measures: an overview of their redundancy and their ability to discriminate community assembly rules. *Functional Ecology*. **24**: 867-876.

Muhati, G.L., Olago, D. and Olaka, L. (2018). Participatory scenario development process in addressing potential impacts of anthropogenic activities on the ecosystem services of Mt. Marsabit forest, Kenya. *Global Ecology and Conservation*. **14**: 402-412.

Mukungu, N., Abuga, K., Okalebo, F., Ingwela, R. and Mwangi, J. (2016). Medicinal plants used for management of malaria among the Luhya community of Kakamega East sub-County, Kenya. *Journal of Ethnopharmacology*. **194**: 98-107.

Mullah, C.J.A., Klanderud, K., Totland, Ø. and Kigomo, B. (2014). Relationships between the density of two potential restoration tree species and plant species abundance and richness in a degraded A fromontane forest of K enya. *African Journal of Ecology*. **52**: 77-87.

Müller, J., Noss, R.F., Thorn, S., Bässler, C., Leverkus, A.B. and Lindenmayer, D. (2019). Increasing disturbance demands new policies to conserve intact forest. *Conservation Letters*. **12**: 12449-12457.

Mulugeta, Y., Bekele, T. and Kelbessa, E. (2015). Floristic Composition, Species Diversity and Vegetation Structure of Gera Moist Montane Forest, Jimma Zone of Oromia National Regional State, Southwest Ethiopia. *Ethiopian Journal of Biological Sciences*. **14**: 45-68.

Muriithi, F.K. (2016). Land use and land cover (LULC) changes in semi-arid sub-watersheds of Laikipia and Athi River basins, Kenya, as influenced by expanding intensive commercial horticulture. *Remote Sensing Applications: Society and Environment*. **3**: 73-88.

Mutiso, F.M., Mugo, M.J., Cheboiwo, J., Sang, F. and Tarus, G.K. (2015). Floristic composition, affinities and plant formations in tropical forests: A case study of

Mau forests in Kenya. *International Journal of Agriculture and Forestry*. **5**: 79-91.

Negi, V.S., Pathak, R., Sekar, K.C., Rawal, R., Bhatt, I., Nandi, S. and Dhyani, P. (2018). Traditional knowledge and biodiversity conservation: a case study from Byans Valley in Kailash Sacred Landscape, India. *Journal of Environmental Planning and Management*. **61**: 1722-1743.

Neto, M. (2015). Diversity of vascular epiphytes in two high altitude biotopes of the Brazilian Atlantic Forest. *Revista brasileira de botaÌ nica*. **38**: 295-310.

Neves, D.M., Dexter, K.G., Pennington, R.T., Valente, A.S., Bueno, M.L., Eisenlohr, P.V., Fontes, M.A., Miranda, P.L., Moreira, S.N. and Rezende, V.L. (2017). Dissecting a biodiversity hotspot: The importance of environmentally marginal habitats in the Atlantic Forest Domain of South America. *Diversity and Distributions*. **23**: 898-909.

Niu, Y., Yang, S., Zhou, J., Chu, B., Ma, S., Zhu, H. and Hua, L. (2019). Vegetation distribution along mountain environmental gradient predicts shifts in plant community response to climate change in alpine meadow on the Tibetan Plateau. *Science of the Total Environment*. **650**: 505-514.

Njue, N., Koech, E., Hitimana, J. and Sirmah, P. (2016). Influence of land use activities on riparian vegetation, soil and water quality: An indicator of biodiversity loss, South West Mau Forest, Kenya. *Open Journal of Forestry*. **6**: 373-284.

Njunge, J. and Mugo, J. (2011). Composition and succession of the woody flora of South Nandi Forest, Kenya. *Research Journal of Botany*. **6**: 112-121.

Nor, A.N.M., Corstanje, R., Harris, J.A. and Brewer, T. (2017). Impact of rapid urban expansion on green space structure. *Ecological Indicators*. **81**: 274-284.

Norberg, A., Abrego, N., Blanchet, F.G., Adler, F.R., Anderson, B.J., Anttila, J., Araújo, M.B., Dallas, T., Dunson, D. and Elith, J. (2019). A comprehensive evaluation of predictive performance of 33 species distribution models at species and community levels. *Ecological Monographs*. **32**: 1370-1389.

Odongo, E., Mungai, N., Mutai, P., Karumi, E., Mwangi, J. and Omale, J. (2018). Ethnobotanical survey of the medicinal plants used in Kakamega County, western Kenya. *Applied Medical Research*. **4**: 22–40.

Ojelel, S., Mucunguzi, P., Katuura, E., Kakudidi, E.K., Namaganda, M. and Kalema, J. (2019). Wild edible plants used by communities in and around selected forest reserves of Teso-Karamoja region, Uganda. *Journal of Ethnobiology and Ethnomedicine*. **15**: 3-11.

Oke, O.A. and Thompson, K.A. (2015). Distribution models for mountain plant species: the value of elevation. *Ecological Modelling*. **301**: 72-77.

Otieno, N.E. and Analo, C. (2012). Local indigenous knowledge about some medicinal plants in and around Kakamega forest in western Kenya. *F1000Research*. **1**: 1-16.

Oyugi, J.O., Brown, J.S. and Whelan, C.J. (2008). Effects of human disturbance on composition and structure of Brachystegia woodland in Arabuko‐Sokoke Forest, Kenya. *African Journal of Ecology*. **46**: 374-383.

Pasion, B.O., Roeder, M., Liu, J., Yasuda, M., Corlett, R.T., Slik, J.F. and Tomlinson, K.W. (2018). Trees represent community composition of other plant life-forms, but not their diversity, abundance or responses to fragmentation. *Scientific reports*. **8**: 11374.

Pelletier, J., Siampale, A., Legendre, P., Jantz, P., Laporte, N.T. and Goetz, S.J. (2017). Human and natural controls of the variation in aboveground tree biomass in African dry tropical forests. *Ecological Applications*. **27**: 1578-1593.

Pennington, R.T. and Lavin, M. (2016). The contrasting nature of woody plant species in different neotropical forest biomes reflects differences in ecological stability. *New Phytologist*. **210**: 25-37.

Pergl, J., van Kleunen, M., Hejda, M., Babu, C.R., Majumdar, S., Singh, P., Singh, S.P., Salamma, S., Rao, B.R.P. and Pyšek, P. (2018). Naturalized alien flora of the Indian states: biogeographic patterns, taxonomic structure and drivers of species richness. *Biological Invasions*. **20**: 1625-1638.

Phumthum, M., Srithi, K., Inta, A., Junsongduang, A., Tangjitman, K., Pongamornkul, W., Trisonthi, C. and Balslev, H. (2018). Ethnomedicinal plant diversity in Thailand. *Journal of Ethnopharmacology*. **214**: 90-98.

Pieroni, A., Nedelcheva, A. and Dogan, Y. (2015). Local knowledge of medicinal plants and wild food plants among Tatars and Romanians in Dobruja (South-East Romania). *Genetic Resources and Crop Evolution*. **62**: 605-620.

Pilgrim, S., Pretty, J., Adams, B., Berkes, F., de Athayde, S.F., Dudley, N., Hunn, E., Maffi, L., Milton, K. and Rapport, D. (2009). The intersections of biological diversity and cultural diversity: towards integration. *Conservation and Society*. **7**: 100-100.

Platts, P.J., Ahrends, A., Gereau, R.E., McClean, C.J., Lovett, J.C., Marshall, A.R., Pellikka, P.K., Mulligan, M., Fanning, E. and Marchant, R. (2010). Can distribution models help refine inventory‐based estimates of conservation priority? A case study in the Eastern Arc forests of Tanzania and Kenya. *Diversity and Distributions*. **16**: 628-642.

Pourrhamati, G., Mataji, A., Pourababei, H. and Salehi, A. (2018). Floristic composition and relationships between plant species abundance and soil properties in common hazel (*Corylus avellana*) mountainous forest of northern Iran. *Biodiversitas Journal of Biological Diversity*. **19**: 1835-1841.

Prada, C.M. and Stevenson, P.R. (2016). Plant composition associated with environmental gradients in tropical montane forests (Cueva de Los Guacharos National Park, Huila, Colombia). *Biotropica*. **48**: 568-576.

Prevedello, J.A., Almeida‐Gomes, M. and Lindenmayer, D.B. (2018). The importance of scattered trees for biodiversity conservation: A global meta‐analysis. *Journal of Applied Ecology*. **55**: 205-214.

Pulungan, M.A., Suzuki, S., Gavina, M.K.A., Tubay, J.M., Ito, H., Nii, M., Ichinose, G., Okabe, T., Ishida, A. and Shiyomi, M. (2019). Grazing enhances species diversity in grassland communities. *Scientific Reports*. **9**: 112-124.

Qian, H., Deng, T. and Sun, H. (2018). Global and regional tree species diversity. *Journal of Plant Ecology*. **12**: 210-215.

Quaresma, A.C., Piedade, M.T.F., Wittmann, F. and ter Steege, H. (2018). Species richness, composition, and spatial distribution of vascular epiphytes in Amazonian black-water floodplain forests. *Biodiversity and Conservation*. **27**: 1981-2002.

Queloz, V., Grünig, C.R., Sieber, T.N. and Holdenrieder, O. (2005). Monitoring the spatial and temporal dynamics of a community of the tree‐root endophyte *Phialocephala fortinii* sl. *New Phytologist*. **168**: 651-660.

Rabosky, D.L. and Hurlbert, A.H. (2015). Species richness at continental scales is dominated by ecological limits. *The American Naturalist*. **185**: 572-583.

Rahm, E. and Do, H.H. (2000). Data cleaning: Problems and current approaches. *IEEE Data Eng. Bull.* **23**: 3-13.

Rana, D., Bhatt, A. and Lal, B. (2019). Ethnobotanical knowledge among the semi-pastoral Gujjar tribe in the high altitude (Adhwari's) of Churah subdivision, Ddistrict Chamba, Western Himalaya. *Journal of Ethnobiology and Ethnomedicine*. **15**: 10-20.

Rathore, R. and Mathur, A. (2018). Entrepreneurship Development in Medicinal and Aromatic Plants: Prospects and Challenges. *International Journal of Economic Plants*. **5**: 32-35.

Razafindratsima, O.H., Brown, K.A., Carvalho, F., Johnson, S.E., Wright, P.C. and Dunham, A.E. (2018). Edge effects on components of diversity and above‐ground biomass in a tropical rainforest. *Journal of Applied Ecology*. **55**: 977-985.

Reese, G., Rosenmann, A. and Cameron, J.E. (2019). *The Psychology of Globalization: Identity, Ideology, and Action*. Academic Press.

Refuge, E.B., Forest, A. and Post, D. (2016). Floristic species composition and structure of a mid-elevation tropical montane evergreen forests (sholas) of the western ghats, southern India. *Tropical Ecology*. **57**: 533-543.

Reshad, M. and Alemayehu Beyene, M.M. (2019). Woody Species Richness and Diversity at Ades Dry Afromontane Forest of South Eastern Ethiopia. *American Journal of Agriculture and Forestry*. **7**: 44-52.

Rezende, V.L., Bueno, M.L., Eisenlohr, P.V. and Oliveira-Filho, A.T. (2018). Patterns of tree species variation across southern South America are shaped by environmental factors and historical processes. *Perspectives in Plant Ecology, Evolution and Systematics*. **34**: 10-16.

Ricklefs, R.E. and He, F. (2016). Region effects influence local tree species diversity. *Proceedings of the National Academy of Sciences*. **113**: 674-679.

Rongoei, P., Kipkemboi, J., Kariuki, S. and van Dam, A. (2014). Effects of water depth and livelihood activities on plant species composition and diversity in Nyando floodplain wetland, Kenya. *Wetlands Ecology and Management*. **22**: 177-189.

Rotich, B. (2019). Forest Conservation and Utilization in Embobut, Cherangani Hills, Kenya. *International Journal of Natural Resource Ecology and Management*. **4**: 7-14.

Rumpf, S.B., Hülber, K., Klonner, G., Moser, D., Schütz, M., Wessely, J., Willner, W., Zimmermann, N.E. and Dullinger, S. (2018). Range dynamics of mountain plants decrease with elevation. *Proceedings of the National Academy of Sciences*. **115**: 1848-1853.

Rutten, G., Ensslin, A., Hemp, A. and Fischer, M. (2015). Forest structure and composition of previously selectively logged and non-logged montane forests at Mt. Kilimanjaro. *Forest Ecology and Management*. **337**: 61-66.

Sahoo, U.K. and Rocky, P. (2015). Species composition and plant diversity as influenced by altitude and size of homegardens in Mizoram, North-East India. *International Journal of Ecology and Environmental Sciences*. **41**: 195-215.

Sainge, M.N., Lyonga, N.M., Mbatchou, G., Kenfack, D., Nchu, F. and Peterson, A.T. (2019). Vegetation, floristic composition and structure of a tropical montane forest in Cameroon. *Bothalia-African Biodiversity & Conservation*. **49**: 1-12.

Salako, K.V., Moreira, F., Gbedomon, R.C., Tovissodé, F., Assogbadjo, A.E. and Kakaï, R.L.G. (2018). Traditional knowledge and cultural importance of Borassus aethiopum Mart. in Benin: interacting effects of socio-demographic attributes and multi-scale abundance. *Journal of Ethnobiology and Ethnomedicine*. **14**: 36-44.

Sambaraju, K., DesRochers, P., Rioux, D., Boulanger, Y., Kulkarni, N., Verma, R.K., Pautasso, M., Pureswaran, D., Martel, V. and Hébert, C. (2016). *Forest ecosystem health and biotic disturbances: perspectives on indicators and management approaches, Ecological Forest Management Handbook*. ROUTLEDGE in association with GSE Research. pp. 459-515.

Sanoussi, F., Ahissou, H., Dansi, M., Hounkonnou, B., Agre, P. and Dansi, A. (2015). Ethnobotanical investigation of three traditional leafy vegetables [*Alternanthera sessilis* (L.) DC. *Bidens pilosa* L. *Launaea taraxacifolia* Willd.] widely consumed in southern and central Benin. *Journal of Biodiversity and Environmental Sciences*. **6**: 187-198.

Schäfer, E., Heiskanen, J., Heikinheimo, V. and Pellikka, P. (2016). Mapping tree species diversity of a tropical montane forest by unsupervised clustering of airborne imaging spectroscopy data. *Ecological indicators*. **64**: 49-58.

Schnitzer, S.A. (2018). Testing ecological theory with lianas. *New Phytologist*. **220**: 366-380.

Schultz, E. (2019). Population dynamics in a changing world: the consequences of environmental variation for species with complex life histories, Rice University. Houston, Texas.

Schweiger, A.K., Cavender-Bares, J., Townsend, P.A., Hobbie, S.E., Madritch, M.D., Wang, R., Tilman, D. and Gamon, J.A. (2018). Plant spectral diversity integrates functional and phylogenetic components of biodiversity and predicts ecosystem function. *Nature Ecology and Evolution*. **2**: 976-1003.

Sen, S. and Chakraborty, R. (2015). Toward the integration and advancement of herbal medicine: a focus on traditional Indian medicine. *Botanics: Targets and Therapy*. **5**: 33-44.

Seswa, F., Manohar, S. and Kitur, E. (2018). Current Floristic Composition and Growth Forms of Equatorial Rainforest, Kakamega County, Kenya. *International Journal of Agriculture and Forestry*. **8**: 70-76.

Seta, T., Demissew, S. and Woldu, Z. (2019). Floristic diversity and composition of the Biteyu forest in the Gurage mountain chain (Ethiopia): implications for forest conservation. *Journal of Forestry Research*. **30**: 319-335.

Shakya, A.K. (2016). Medicinal plants: future source of new drugs. *International Journal of Herbal Medicine*. **4**: 59-64.

Shelef, O., Weisberg, P.J. and Provenza, F.D. (2017). The value of native plants and local production in an era of global agriculture. *Frontiers in Plant Science*. **8**: 2069-2072.

Shiferaw, W., Lemenih, M. and Gole, T.W.M. (2018). Analysis of plant species diversity and forest structure in Arero dry Afromontane forest of Borena zone, South Ethiopia. *Tropical Plant Research*. **5**: 129-140.

Shiracko, N., Owuor, B.O., Gakuubi, M.M. and Wanzala, W. (2016). A survey of ethnobotany of the AbaWanga people in Kakamega county, western province of Kenya.

Shumi, G., Rodrigues, P., Schultner, J., Dorresteijn, I., Hanspach, J., Hylander, K., Senbeta, F. and Fischer, J. (2019). Conservation value of moist evergreen Afromontane forest sites with different management and history in southwestern Ethiopia. *Biological Conservation*. **232**: 117-126.

Silveira, D., Prieto, J.M., Freitas, M.M. and Mazzari, A.L. (2018). *Herbal Medicine and Public Healthcare: Current and Future Challenges*, *Natural Products as Source of Molecules with Therapeutic Potential*. Springer. pp. 495-515.

Slik, J.F., Arroyo-Rodríguez, V., Aiba, S.-I., Alvarez-Loayza, P., Alves, L.F., Ashton, P., Balvanera, P., Bastian, M.L., Bellingham, P.J. and Van Den Berg, E. (2015). An estimate of the number of tropical tree species. *Proceedings of the National Academy of Sciences*. **112**: 7472-7477.

Soriano-Redondo, A., Jones‐Todd, C.M., Bearhop, S., Hilton, G.M., Lock, L., Stanbury, A., Votier, S.C. and Illian, J.B. (2019). Understanding species distribution in dynamic populations: a new approach using spatio‐temporal point process models. *Ecography*. **42**: 1092–1102.

Sosef, M.S., Dauby, G., Blach-Overgaard, A., Van Der Burgt, X., Catarino, L., Damen, T., Deblauwe, V., Dessein, S., Dransfield, J. and Droissart, V. (2017). Exploring the floristic diversity of tropical Africa. *BMC Biology*. **15**: 15-22.

Specht, M.J., Pinto, S.R.R., Albuquerque, U.P., Tabarelli, M. and Melo, F.P. (2015). Burning biodiversity: Fuelwood harvesting causes forest degradation in human-dominated tropical landscapes. *Global Ecology and Conservation*. **3**: 200-209.

Srivastava, A.K. (2018). *Significance of medicinal plants in human life, Synthesis of Medicinal Agents from Plants*. Elsevier. pp. 1-24.

Srivastava, S., Dvivedi, A., Rai, S. and Shukla, R. (2016). Plant diversity in terai grassland vegetation: a landscape level assessment with special reference to north-eastern uttar pradesh, India. *International Journal of Biodiversity and Conservation*. **8**: 365-381.

Stagakis, S., Vanikiotis, T. and Sykioti, O. (2016). Estimating forest species abundance through linear unmixing of CHRIS/PROBA imagery. *ISPRS Journal of Photogrammetry and Remote Sensing*. **119**: 79-89.

Steinbauer, M.J., Grytnes, J.-A., Jurasinski, G., Kulonen, A., Lenoir, J., Pauli, H., Rixen, C., Winkler, M., Bardy-Durchhalter, M. and Barni, E. (2018). Accelerated increase in plant species richness on mountain summits is linked to warming. *Nature*. **556**: 231-241.

Swamynathan, B. (2013). Flowering And Fruiting Phenology Of Trees And Lianas In Tropical Dry Evergreen Forests On The Coromandel Coast Of Peninsular India, Pondicherry University. Puducherry, India.

Tang, C.Q. (2015). *The subtropical vegetation of southwestern China: plant distribution, diversity and ecology*. Springer.

Tashev, A.N., Vitkova, A.A. and Alexandrova, A.V. (2018). Floristic composition and current state of forest natural habitats in Natura 2000 protected site "Kamchia"(BG0000116). *Acta Zoologica Bulgarica*. **11**: 69-74.

Tekalign, M., Flasse, C., Frankl, A., Van Rompaey, A., Poesen, J., Nyssen, J. and Muys, B. (2018). Forest cover loss and recovery in an East African remnant forest area: Understanding its context and drivers for conservation and sustainable ecosystem service provision. *Applied Geography*. **98**: 133-142.

Ter Steege, H., de Oliveira, S.M., Pitman, N.C., Sabatier, D., Antonelli, A., Andino, J.E.G., Aymard, G.A. and Salomão, R.P. (2019). Towards a dynamic list of Amazonian tree species. *Scientific Reports*. **9**: 3501-3513.

Thiele, J., Kellner, S., Buchholz, S. and Schirmel, J. (2018). Connectivity or area: what drives plant species richness in habitat corridors? *Landscape ecology*. **33**: 173-181.

Thijs, K.W., Aerts, R., Musila, W., Siljander, M., Matthysen, E., Lens, L., Pellikka, P., Gulinck, H. and Muys, B. (2014). Potential tree species extinction, colonization and recruitment in Afromontane forest relicts. *Basic and Applied Ecology*. **15**: 288-296.

Tian, X. (2017). Ethnobotanical knowledge acquisition during daily chores: the firewood collection of pastoral Maasai girls in Southern Kenya. *Journal of Ethnobiology and Ethnomedicine*. **13**: 2-11.

Tikhonov, G., Abrego, N., Dunson, D. and Ovaskainen, O. (2017). Using joint species distribution models for evaluating how species‐to‐species associations depend on the environmental context. *Methods in Ecology and Evolution*. **8**: 443-452.

Tonteri, T., Salemaa, M., Rautio, P., Hallikainen, V., Korpela, L. and Merilä, P. (2016). Forest management regulates temporal change in the cover of boreal plant species. *Forest Ecology and Management*. **381**: 115-124.

Tormos, T., Van Looy, K., Kosuth, P., Villeneuve, B. and Souchon, Y. (2013). Catchment Scale Analysis of the Influence of Riparian Vegetation on River Ecological Integrity Using Earth Observation Data. *Earth Observation of Ecosystem Services*. **1**: 201-227.

Trumbore, S., Brando, P. and Hartmann, H. (2015). Forest health and global change. *Science*. **349**: 814-818.

Tugume, P., Kakudidi, E.K., Buyinza, M., Namaalwa, J., Kamatenesi, M., Mucunguzi, P. and Kalema, J. (2016). Ethnobotanical survey of medicinal plant species used by communities around Mabira Central Forest Reserve, Uganda. *Journal of Ethnobiology and Ethnomedicine*. **12**: 5-14.

Tura, G.B. and Reddy, P.R. (2015). Study of Vegetation Composition of Magada Forest, Borana Zone, Oromia, Ethiopia. *Universal Journal of Plant Science*. **3**: 87-96.

Turkington, R., Sharam, G. and Sinclair, A.R. (2015). Biodiversity and the dynamics of riverine forests in Serengeti. *Serengeti IV: Sustaining Biodiversity in a Coupled Human-Natural System*. **2**: 235.

Uchida, K., Koyanagi, T.F., Matsumura, T. and Koyama, A. (2018). Patterns of plant diversity loss and species turnover resulting from land abandonment and intensification in semi-natural grasslands. *Journal of Environmental Management*. **218**: 622-629.

Ulian, T., Sacandé, M., Hudson, A. and Mattana, E. (2017). Conservation of indigenous plants to support community livelihoods: the MGU–Useful Plants Project. *Journal of Environmental Planning and Management*. **60**: 668-683.

Ulrich, W., Kubota, Y., Kusumoto, B., Baselga, A., Tuomisto, H. and Gotelli, N.J. (2018). Species richness correlates of raw and standardized co ‐ occurrence metrics. *Global Ecology and Biogeography*. **27**: 395-399.

Valencia, R., Condit, R., Foster, R.B., Romoleroux, K., Villa Munoz, G., Svenning, J.-C., Magård, E., Bass, M., Losos, E. and Balslev, H. (2004). Yasuni forest dynamics plot, Ecuador. *Tropical Forest Diversity and Dynamism*. **11**: 609-620.

Van Andel, T., Van Onselen, S., Myren, B., Towns, A. and Quiroz, D. (2015). “The medicine from behind”: The frequent use of enemas in western African traditional medicine. *Journal of Ethnopharmacology*. **174**: 637-643.

Van Wyk, B.-E. and Wink, M. (2017). *Medicinal plants of the world*. CABI.

Vasisht, K., Sharma, N. and Karan, M. (2016). Current perspective in the international trade of medicinal plants material: an update. *Current Pharmaceutical Design*. **22**: 4288-4336.

Vellend, M., Baeten, L., Becker-Scarpitta, A., Boucher-Lalonde, V., McCune, J.L., Messier, J., Myers-Smith, I.H. and Sax, D.F. (2017). Plant biodiversity change across scales during the Anthropocene. *Annual Review of Plant Biology*. **68**: 563-586.

Wang, J., Lin, Y., Zhai, T., He, T., Qi, Y., Jin, Z. and Cai, Y. (2018a). The role of human activity in decreasing ecologically sound land use in C hina. *Land degradation & development*. **29**: 446-460.

Wang, J., Lin, Y., Zhai, T., He, T., Qi, Y., Jin, Z. and Cai, Y. (2018b). The role of human activity in decreasing ecologically sound land use in C hina. *Land degradation and Development*. **29**: 446-460.

Wehi, P.M. and Lord, J.M. (2017). Importance of including cultural practices in ecological restoration. *Conservation Biology*. **31**: 1109-1118.

Weinzettel, J., Vačkář, D. and Medková, H. (2018). Human footprint in biodiversity hotspots. *Frontiers in Ecology and the Environment*. **16**: 447-452.

Weiß, C.H. (2007). Statsoft, inc., tulsa, ok.: Statistica, version 8. *AStA Advances in Statistical Analysis*. **91**: 339-341.

Whitlock, C., Colombaroli, D., Conedera, M. and Tinner, W. (2018). Land‐use history as a guide for forest conservation and management. *Conservation Biology*. **32**: 84-97.

Wilson, S.J. and Rhemtulla, J.M. (2018). Small montane cloud forest fragments are important for conserving tree diversity in the Ecuadorian Andes. *Biotropica*. **50**: 586-597.

Winkelhuijzen, R. (2017). page: A makeshift house in Kapkok glade, inside Embobut forest. Picture by author. *development*. **23**: 1073-1084.

Wisz, M.S., Pottier, J., Kissling, W.D., Pellissier, L., Lenoir, J., Damgaard, C.F., Dormann, C.F., Forchhammer, M.C., Grytnes, J.A. and Guisan, A. (2013). The role of biotic interactions in shaping distributions and realised assemblages of species: implications for species distribution modelling. *Biological reviews*. **88**: 15-30.

Woldearegay, M., Woldu, Z. and Lulekal, E. (2018). Species diversity, population structure and regeneration status of woody plants in Yegof dry afromontane forest, Northeastern Ethiopia. *European Journal of Advanced Research in Biological and Life Sciences*. **6**: 20-34.

Xu, M., Ma, L., Jia, Y. and Liu, M. (2017). Integrating the effects of latitude and altitude on the spatial differentiation of plant community diversity in a mountainous ecosystem in China. *PloS one*. **12**: e0174231.

Yadeta, T., Veenendaal, E., Sykora, K., Tessema, Z.K. and Asefa, A. (2018). Effect of Vachellia tortilis on understory vegetation, herbaceous biomass and soil nutrients along a grazing gradient in a semi-arid African savanna. *Journal of forestry research*. **29**: 1601-1609.

Yang, M., Lu, Z., Fan, Z., Liu, X., Hens, L., De Wulf, R. and Ou, X. (2018). Distribution of non-native plant species along elevation gradients in a protected area in the eastern Himalayas, China. *Alpine Botany*. **128**: 169-178.

Zhang, L., Zhuang, H., Zhang, Y., Wang, L., Zhang, Y., Geng, Y., Gou, Y., Pei, S. and Wang, Y. (2018). Plants for health: An ethnobotanical 25-year repeat survey of traditional medicine sold in a major marketplace in North-west Yunnan, China. *Journal of Ethnopharmacology*. **224**: 119-125.

Zhang, M.-G., Slik, J.F. and Ma, K.-P. (2016). Using species distribution modeling to delineate the botanical richness patterns and phytogeographical regions of China. *Scientific reports*. **6**: 22400-22413.

Zhou, Y., Chen, S., Hu, G., Mwachala, G., Yan, X. and Wang, Q. (2018). Species richness and phylogenetic diversity of seed plants across vegetation zones of Mount Kenya, East Africa. *Ecology and Evolution*. **8**: 8930-8939.

Zhou, Y., Ochola, A.C., Njogu, A.W., Boru, B.H., Mwachala, G., Hu, G., Xin, H. and Wang, Q. (2019). The species richness pattern of vascular plants along a tropical elevational gradient and the test of elevational Rapoport's rule depend on different life‐forms and phytogeographic affinities. *Ecology and evolution*. **9**: 4495-4503.

Zizka, A., Thiombiano, A., Dressler, S., Nacoulma, B.M., Ouédraogo, A., Ouédraogo, I., Ouédraogo, O., Zizka, G., Hahn, K. and Schmidt, M. (2015). Traditional plant use in Burkina Faso (West Africa): a national-scale analysis with focus on traditional medicine. *Journal of Ethnobiology and Ethnomedicine*. **11**: 9-18.

Zobel, M. (2016). The species pool concept as a framework for studying patterns of plant diversity. *Journal of Vegetation Science*. **27**: 8-18.

APPENDICES

Appendix I: Overall plant species composition recorded in Embobut Forest Reserve

	Botanic name	**Common name**	**Local name**	**Habit**
Acanthaceae	*Acanthus eminens* C.B.Cl.	Bear's breeches	Lugumwo/Tegelde/ Tegilde	SH
	Asystasia mysorensis (Roth) T. Anders		Taltal	EH
	Barleria acanthoides Vahl.			SH
	Barleria argentea Rolf. f.			DSH
	Barleria eranthemoides R. Br.	Spiny Baleria		DSH
	Barleria grandcalyx Lindau			DSH
	Blephalis edulis (Forssk.) Pers.	Rohida tree	Kimarigat/Paraiya	SH
	Crabbea velutina S. Moore		Kitabcheptarbus	PH
	Crossandra subcaulis C.B. Clarke			PH
	Hypoestes aristata (Vahl) Sol. ex Roem. & Schult.	Ribbon bush	Tirkonio	EH
	Hypoestes forskaolii (Vahl) R.Br.	White ribbon bush	Tirkonwo	EH
	Hypoestes triflora (Forsk.) Roem & Schultes.	Pink Ribbon Bush	Seger	EH
	Justicia anagalloides (Nees)T.Anders	Willowleaf justicia	Kirongony	EH
	Justicia betonica L.	Shrimp plant		EH
	Justicia calyculata (Deflers) T. Anders	Willowleaf justicia	Kirongony	EH
	Justicia flava Vahl	Willowleaf justicia	Kirongony	EH
	Justicia striata (Klotsch.) Bullock.		Lelekwo/Tirkon	EH
	Megalochlamys revoluta (Lindau) Vollasen	Taltal		EH
	Mimulopsis alpina Chiov.			SH
	Ruellia patula Jacq.	Veld violet	Kipchunchun	EH
	Thurnbergia alata Bojer ex Sims	Blackeyed Susan	Chelolony/Cheposesimo/Ketpokipkon/ Nondoywo	CL
Amaranthaceae	*Achyranthes aspera* L.	Devil's horsewhip	Kipsirim	EH
	Achyranthes schinzii (Standl.) Cufod	Prickly chaff flower	Kipsirim	SH
	Aerva lanata (L.) Schultes	Mountain knotgrass	Cheborus Korelyo/Krelachean	EH
	Alternanthera pungens Kunth	Khakhi weed		CR
	Alternanthera sessilis (L.) DC.			CR
	Amaranthus hybridus L.	Slim amaranth	Kipkandiwa	EH
	Amaranthus spinosus L.	Spiny pigweed	Pangani	EH
	Cyathula cylindrica Moq.		Kimnangwe	EH
	Cyathula uncinulata (Schrad.) Schinz		Kimnangwe	EH
	Digera muricata (L.) Mart.	False amaranth	Cherekelat/Chesukut	EH
	Pupalia lappacea (L.) A.Juss.	Creeping Cock's Comb	Tanakit/Tikinit	CL
	Spinacea oleracea L.	Spinash	Spinash	EH
Amaryllidaceae	*Allium cepa* L.	Onion	Kitunguyon	SCH
	Scadoxus multiflorus (Martyn) Raf	Blood lily	Chebsar	EH
Anacardiaceae	*Lannea fulva* (Engl.) Engl.		Lolotwo/Lalat	TR

	Lannea schimperi Hochst. Ex A.Rich.		Morno/Lolotwo	TR
	Lannea schweinfurthii (Engl.) Engl	False Valley floor	Korot	TR
	Lannea triphylla (A.Rich.) Engl		Chemosong	TR
	Mangifera indica L.	Mango	Maembe	TR
	Ozoroa insignis Delile	Tar berry	Mutung'wa/Mutung'wo	TR
	Persea americana Mill.	Avocado	Avagado	TR
	Rhus natalensis Berhn. Ex Krauss.	Natal rhus	Sirian	TR
	Rhus vulgaris Meikle	Castor oil	Sirya	TR
	Sclerocarya birrea (A.Rich.) Hochst.	Valley floor tree	Ororwo/Oror	TR
Annonaceae	*Monanthotaxis buchananii* (Engl.) Verdc.	Buchanan's dwaba-berry	Murkuyo	L
Annonaceae	*Uvaria scheffleri* Diels	Common Gorse	Murkui/Murkuyo/Tomolokwo	L
Apiaceae	*Agrocharis incognita* (Denzin) Heyw & July.		Kipsigoi	EH
	Caucalis melanantha (Hochst.) Vatke	Wild parsley.		EH
	Centella asiatica (L.) Urban	Indian pennywort		CR
	Heteromorpha trifoliata (Wendl.) Eckl. & Zeyh.	Common parsley tree		TR
	Hydrocotyle ranuncloides L.f.	Floating Pennywort		CR
	Hydrocotyle sibthorpioides Lam	Lawn Pennywort	Sumboiyon	CR
	Peucedanum aculeolatum Engl.	Wild Parsley	Borio	EH
	Peucedanum linderi Norman			EH
	Tolilis arvensis (Huds.) Link	Spreading hedgeparsley		EH
Apocynaceae	*Adenium obesum* (Forssk.) Roem & Schult.	Desert Rose	Konowarany	SH
	Carallocarpus egigaeus (Rottler) C.B.Clarke.	Bryoms Telugu	Kilesan	CL
	Caralluma acutangula (Decne.) N.E.Br.		Mochontopokot	SCH
	Caralluma arachnoidea (Bally)M.G.Gilbert		Mochondorwani	SCH
	Carrisa edulis Vahl.	Simple-spined num-num	Legatetwa/Legetetwet	SH
	Edithcolea grandis N.E.Br.	Persian carpet flower		SCH
	Landolfia buchannanii (Hallier f.) Stapf	Apricot vine	Loloito	L
	Pentarrhinum abyssinicum Decne	African heartvine	Sinende	CL
	Periploca linearifolia Dill. A.Rich.	Silk vine	Sinendo/Sinondo	L
	Plumeria rubra L.	Red Frangipani	Kipsir	SH
	Rauvolfia caffra Sond.	Quinine tree		TR
	Saba comorensis (Bojer ex A.DC.) Pichon	Rubber vine	Ochon	L
Aquifoliaceae	*Ilex mitis* (L.) Radlk.	Cape Holly		TR
Araceae	*Stylochiton borumensis* N.E.Br.		Kitawi	SCH
Araliaceae	*Cussonia spicata* Thunb	Spiked cabbage tree	Cheliite/Jeleikta/Jeliita	TR
	Polyscias kikuyuensis Summerh	Parasol tree	Auoun/Oon	TR
	Schefflera abyssinica (Hochst. ex A.Rich.) Harms	Umbrella Tree		TR
	Schefflera volkensii (Harms) Harms	Cabbage tree	Tingwa/Tingwon/Tinwot	TR
Asclepiadaceae	*Calotropis procera* (Aiton) W.T. Aiton	Rubber bush	Kibou/Ararat	SH
	Leptadenia hastata (Pers.) Dechne		Kipchekin	L
	Orbea dummeri (N.E.Br.) Bruyns.	Carrion flowers	Chebo Kabarkebo	SCH

	Pergularia daemia (Forsk.) Chiov.	Trellis-vine	Kipchee	CL
Asparagaceae	*Agave sisalana* Perrine.	Sisal		SH
	Asparagus falcatus (L.) Druce	Sicklethorn	Kipsowor/Malut/Maltwo	SH
	Asparagus racemosus Willd.	Satavar	Kabungai	SH
	Dracaena ellenbeckiana Engl.			SH
	Dracaena fragrans (L.) Ker Gawl.	Cornstalk dracaena		SH
	Sansevieria cylindrica Bojer.	Spear sansevieria	Soroko	SH
	Sansevieria frequens Chahin.	African Dawn	Belgeiyo/Orak	SH
	Sansevieria robusta N.E. Brown	Snake Plant	Sarokot/Sarakot/Sorogat	SH
Asphodelaceae	*Aloe cheranganiensis* S.Carter &Brandham	First Aid Plant		SH
	Aloe kendongensis Reynolds		Cheletwa	SH
	Aloe secundiflora Engl.			SH
	Aloe tweediae Christian	Chinese aloe	Chalbat/Chalpat	SH
	Kniphofia thomsonii Baker	Thomson's red-hot poker		EH
Aspleniaceae	*Asplenium aethiopicum* (Burm.f.) Bech.	Egyptian spleenwort		FN
	Asplenium stuhlmanii Hieron.		Lobchon	FN
	Asplenium theciferum (Kunth) Mett.	Spleenwort		FN
Asteraceae	*Acanthospermum hispidum* DC.	Hispid starbur		EH
	Acmella caulirhiza Del.	Toothache plant	Kiputkut/Kibutkut	CR
	Ageratina adenophora (Spreng.) R.M King & H Robins	Sticky snakeroot		EH
	Ageratum conyzoides L.	Billygoat-weed	Chebarapbei	EH
	Artemisia afra Jacq ex Willd.	African wormwood	Sesimwa/Sesimua	SH
	Aspilia pluriseta Schweinf.		Lobchon	SH
	Berkheya spekeana Oliv.	Buffalo-tongue	Katabut	EH
	Bidens biternata L.	Yellow flowered blackjack		EH
	Bidens pilosa L.	Blackjack	Chepkondiwo/ Cheposiwach/ Kreilis/ Jepkondewo	EH
	Blumea mollis (D.Don) Merr.	Soft blumea		EH
	Bothriocline fusca (S. Moore) M. Gilbert.			SH
	Carduus chamaecephalus (Vatke) Oliv. & Hiern	Rosette Thistle	Kataabut	PH
	Carduus kikuyorum R.E.Fr.	Kikuyu thistle	Kipitat	EH
	Carduus nyassanus (S. Moore) R.E.Fr.	Thistles	Kibetete/Kataabut	EH
	Cirsium vulgare (Savi.) Ten		Tokoukowo	EH
	Conyza newii Oliv & Hiern	Horseweed	Kipnyagi/Kipkosum	SH
	Conyza pyrrhopappa A. Rich	Fleabane	Kirorio/Kiroria	SH
	Conyza stricta Willd.		Picheng'wo	EH
	Conyza sumatrensis (Retz.) E. Walker	Guernsey fleabane	Kantelwo/Krorion	EH
	Cotula abyssinica Sch.Bip. ex A.Rich	Buttonweed		PH
	Crassocephalum luteum (Humb.) Humb.	Fireweed		EH
	Crassocephalum montuosum (S.Moore) Milne-Redh.	Ragleaf	Jebojompir/ Chepochobir	EH
	Crassocephalum vitellinum (Benth.) S. Moore			EH
	Dicrocephala chrysanthemifolia (Blume) DC.	Japanese Anemone		EH

	Dicrocephala integrifolia (L.f.) O. Kuntze			EH
	Euryops brownei S. Moore	Golden daisy bush		SH
	Galinsoga parviflora Cav.	Gallant soldier	Jepkondewo/ Jepkondewa/ Chepkontewo	EH
	Gnaphalium unionis Oliv & Hiern.	Cudweed		EH
	Guizotia jacksonii (S.Moore) J.Baagøe	Sunflecks	Morkurwo	CR
	Guizotia scabra (Vis.) Chiov.	Sunflecks		EH
	Gynula scandens O.Hoffm.			EH
	Haplocarpha rueppellii (Sch. Bip) P. Beauv.			PH
	Helichrysum argyranthum O. Hoffm.		Kimamatia/Lalak	SH
	Helichrysum formosissimum (Sch. Bip) A.Rich	Everlasting-flower	Mauasos	SH
	Helichrysum forskahlii (J.F. Gmel.) Hilliard & Burtt.	Forskahl's everlasting		EH
	Helichrysum globosum Sch. Bip.		Mauayanta arap koko	EH
	Helichrysum glumaceum DC.		Kiptanguyuibo Kai	EH
	Helichrysum kilimanjari Oliv.		Kimarachan	EH
	Helichrysum maranguense O. Hoffm.			EH
	Helichrysum newii Oliv & Hiern.		Nyarilen	EH
	Helichrysum odoratissimum (L.) Less.			EH
	Hirpicium diffusum (O. Hoffm.) Roess		Chebarus	EH
	Kleinia odora (Forsk.) DC.	Cigar Plant	Koimot	SH
	Laggera crispata (Vahl) Hepper & J.R.I. Wood		Mama tebengwa	SH
	Laggera elatior R.E.Fr.		Mokotion	SH
	Launaea cornuta (Hochst. ex Oliv. & Hiern) C. Jeffrey	Bitter lettuce		EH
	Melanthera scandens (Schumach.) Roberty		Kisangwa	EH
	Microglossa densiflora Hook.f.		Kipongwony	SH
	Microglossa pyrifolia (Lam.) Kuntze	Elephant sticks		SH
	Mikaniopsis bambuseti (R.E.Fries) C.Jeffrey		Cheptegaa	L
	Osteospermum volkensii (O. Hoffm) Norl.	African daisy		EH
	Pseudognaphalium luteoalbum (L.) Hilliard & Burtt	Cudweed	Kirelach	EH
	Psiadia paniculata (DC.) Vatke.	Blink Stefaans	Konocho	SH
	Schkuhria pinnata (Lam.) Thell.	Feathery false threadleaf	Kipitkut	EH
	Senecio hadiensis Forssk.	Ragwort	Arta/Orta/Chepcherwitit	L
	Sigesbeckia orientalis L.	St. Paul's wort		EH
	Solanecio angulatus (Vahl.) C. Jeffrey		Kipsakach	L
	Solanecio manii (Hook. f.) C. Jeffrey		Tergekwa/Torkokwo	SH
	Sphaeranthus suaveolens (Forssk.) DC.	Hardheads		EH
	Sphaeranthus ukambensis Vatke & O. Hoffm.		Moiyon/	EH
	Stoebe kilimandscharica O.Hoffm		Chepsikara/ Chepsigaka/ Chemborowony	SH
	Tagetes minuta L.	Mexican Marigold	Nyesorek	EH
	Tridax procumbens L.	Coatbuttons		EH
	Vernonia amygdalina Delile	Bitter leaf	Kirorion/Krorion	SH
	Vernonia auriculifera Hiern		Tabang'wa/ Ononion	SH

	Vernonia brachycarlyx O. Hoffm.	Bittertea	Chebongwony	SH
	Vernonia galamensis (Cass.)Less.	Ironweed	Kiptumat	EH
	Vernonia hymenolepis A. Rich	Bitterleaf	Kiptamit	SH
	Xanthium strumarium L.	Rough cocklebur		SH
Balsaminaceae	*Impatiens meruensis* Gilg.	Snapweed	Gororot	EH
	Impatiens sodenii Engl. & Warb	Oliver's touch-me-not	Kibesiot	EH
	Impatiens tinctoria A. Rich	Balsam	Kibolio/Sarkilatyalakam	SH
Basellaceae	*Basella alba* L.	Vinespinash	Kiraita	CL
Begoniaceae	*Begonia* sp		Kibong	SH
Berberidaceae	*Berberis holstii* Engl.	Barberry	Kipsolwen/ Kipsoroin/ Kipsuruny	SH
Bignoniaceae	*Kigeria africana* (Lam.) Benth.	Sausage tree	Asupka	TR
Boraginaceae	*Cordia ovalis* R.Br. ex A.DC.	Sandpaper saucer-berry	Tembererwo	TR
	Cordia sinensis Lam.	Grey-leaved cordia	Adomoyon/ Atomoiyon	TR
	Cynoglossum aequinoctiale T.C.E. Fr.			EH
	Cynoglossum cheranganiense Verdc			EH
	Cynoglossum coeruleum Hochst. ex A.DC.			EH
	Ehretia cymosa Thonn.		Morori/Kabonbonet	SH
	Heliotropium steudneri Vatke.	Common heliotrope		EH
	Heliotropium zeylanicum (Burm. f.) Lam.		Sesukimaket	EH
Brassicaceae	*Brassica oleraceae var acephala* L.	Kales	Sukuma Wiki	EH
	Brassica oleraceae var capitata L.	Cabbage	Cabbage	EH
	Cardamine obliqua A. Rich	Bittercress		EH
	Erucastrum arabicum Fisch & Mey		Maayos	EH
	Farsetia stenoptera Hochs			EH
	Nasturtium officinale W.T. Aiton	Watercress		EH
	Sisymbrium officinale (L.) Scop.	Hedge mustard		EH
	Thlaspi alliaceum L.	Roadside pennycress	Makiruk	EH
Burseraceae	*Commiphora africana* (A.Rich.) Endl.	African myrr	Chotwa/Chutwa	TR
	Commiphora mildebraedii Engl.			TR
Cactaceae	*Opuntia monacantha* Haw	Drooping prickly pear		SH
Campanulaceae	*Lobelia aberdarica* R.E & T.C.E. Fries	Great Lobelia	Segekwa	SH
	Lobelia giberroa Hemsl.	Giant Lobelia	Chururur	SH
Canellaceae	*Warburgia ugandensis* Sprague	Ugandan greenheart	Sekwon/Sokwon/Sekwan	TR
Capparaceae	*Boscia angustifolia* A. Rich.	Rough-leaved shephards tree	Sekon	TR
	Boscia coriacea Pax.	Shepherd's-tree	Serekwo/Sorukwo	TR
	Boscia mossambicensis Klotzsch	Broad-leaved shepherds tree	Kakachan	SH
	Boscia coriacea Pax.	African ebony	Miskin/Mbiririan	SH
	Capparis cartilaginea Decne.	Caperbush	Chepteretwa/ Chepteretwo/ Kiptolokut	SH
	Capparis tomentosa Lam.	African caper	Kipsomborwo	SH
	Cleome gynandra L.	Stinkweed, Spiderwisp	Sachan/Sakarta	EH
	Crateva adansonii DC.	Garlic Pear	Kolowo	L

	Maerua crassifolia Forssk.	Atil	Miskin	SH
	Maerua decumbens (Brogn.) DC. Wolf	Blue-Leaved Spider Bush	Chebiliswo/ Chepuluswo/ Cheluswo	SH
Caprifoliaceae	*Scabiosa columbaria* L.	Dove pincushions		EH
Caricaceae	*Carica papaya* L.	Pawpaw		SH
Caryophyllaceae	*Cerastium afromontanum* T.C.E.Fr.,	Mouse -ear chickweed		EH
	Drymaria cordata (L.) Willd. Ex Roem & Schult.	Tropical chickweed		CR
	Stellaria media (L.) Vill.	Chickweed	Tabarar	CL
Celastraceae	*Elaeodendron buchananii* Loes. Loes		Eburwo	TR
	Maytenus senegalensis (Lam.) Exell	Spike thorn, Confetti tree	Tirkirwo/Terkorwa	SH
	Mystroxylon aethiopicum (Thunb.) Loes	Spoonwood	Kelyo/Kelwo	TR
Chenopodiaceae	*Chenopodium ambrosioides* L.	Mexican tea	Montrich	EH
	Chenopodium murale L.	Nettle-leaved Goosefoot	Chepokamor	EH
	Chenopodium opulifolium Koch & Ziz	Grey goosefoot	Montrich	EH
Clusiaceae	*Garcinia livingstonei* T. Anderson.	African mangosteen	Nolkwo/ Sakitayan nyosetoseretion	TR
Colchicaceae	*Gloriosa superba* L.	Tiger claw	Kimagugu	EH
Combretaceae	*Combretum apiculatum* Sond.	Red bushwillow	Leleiya/Lolotwo	TR
	Combretum molle R.Br. Ex G. Don.	Velvet bushwillow		TR
	Terminalia brownii Fresen.	Red pod terminalia	Koloswo/ Goloswa/ Groswo	TR
Commelinaceae	*Commelina africana* L.	Yellow commelina	Nenaitet	SCH
	Commelina benghalensis L.	Bengals dayflower	Leleito	SCH
	Commelina elgonensis Bullock		Neneste	SCH
	Commelina lanceolata R.Br.	Dayflower		SCH
	Commelina latifolia Hochst ex A. Rich.	Dayflower		SCH
Convolvulaceae	*Convolvulus alsinoides* (Linn.) Linn.	Slender dwarf morning glory		CR
	Dichondra repens J.R. & G. Forst.	Kidney weed		CR
	Ipomoea batatas (L.) Lam.	Sweet potatoes		CR
	Ipomoea ochracea (Lindl.) G. Don	Fence Morning-glory	Siliba	CL
	Ipomoea sinensis (Desr.) Choisy		Kipche	CL
	Ipomoea tenuirostris Choisy	Spiderleaf	Cheroyet	CL
Cornaceae	*Afrocrania volkensii* (Harms.) Hutch.	Dogwood	Mororwo/Sait/Sayit	TR
Crassulaceae	*Crassula alsinoides* (Hook.f.) Engl		Kapchepinin	SCH
	Crassula granvikii Mildbr.			SCH
	Crassula schimperi Fisch & Mey		Chepkimwa	SCH
	Kalanchoe crenata (Andrews) Haw	Neverdie	Cheposerwo	SCH
	Kalanchoe densiflora Rolfe		Barbany/ Kamuserwo/ Kamusorwo	SCH
	Kalanchoe lanceolata (Forsk.) Pers.	Narrow-leaved	Kiparpany	SCH
Cucurbitaceae	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	Wild melon	Watermelon	CL
	Coccinia grandis (L.) Voigt		Minjilwo	CL
	Commiphora mildbraedii Engl.		Marsian	TR
	Corallocarpus epigaeus (Rottl)C.B.Cl.	Bryoms Telugu		CL
	Cucumis aculeatus Cogn.	Jimsonseed	Minjilwo	CR

	Cucumis figarei Naud.	Gooseberry gourd	Hatia/ Kilatia/ Sigirgerwa	CR
	Cucurbita maxima Duchesne	Pumpkin	Chepololo	CL
	Lagenaria abyssinica (Hook.f.) C.Jeffrey	Calabash gourd	Kakachan	CL
	Lagenaria siceraria (Mollina) Standl.	Bottle gourd	Salingwa/Kipcheros	CL
	Momordica anigosantha Hook.f.	Bitter Melon	Chepkingung	CL
	Momordica foetida Schum. & Thonn	Bad smell melon	Cheseria/Jeseria	CL
	Momordica rostrata A. Zimm.		Kokocho	CL
	Zehneria scabra (L.f.) Sond	Mouse melon	Kipsasa/Kisangwa	CL
Cupressaceae	*Cupressus lusitanica* Miller	Mexican Cypress	Cypress	TR
	Juniperus procera Hochst. Ex Endl.	African pencil cedar		TR
Cyperaceae	*Carex elgonensis* Nelmes.		Chemoigut	SD
	Cyanotis caespitosa Kotschy & Peyr.	Howling jackass	Kipngásngás	SCH
	Cyanotis caespitosa Linn.	Umbrella sedge		SD
	Cyperus esculentus L.	Nutsedge		SD
	Cyperus niveus Retz	Nut Grass	Morkut	SD
	Cyperus rigidifolius Steud.	Gisha grass	Chemoigut/ Chemoikut/ Chemorgut	SD
	Isolepis fluitans (L.) R.Br.	Floating Club-rush	Kibungwach	SD
	Kyllinga bulbosa P.Beauv.		Kiptunduru	SD
	Pycreus elegantulus (Steud.) C.B. Clarke		Chemoigut	SD
	Pycreus nitidus (Lam.) J. Raynal.			SD
Dryopteridaceae	*Dryopteris inaequalis* (Schltdl.) Kuntze	Woodfern	Tulol/Lobchon	FN
Ebenaceae	*Diospyros abyssinica* Hiern.	Giant diospyros	Turotwo	TR
	Euclea divinorum Hiern.	Towerghwarrie	Uswo/Huswo	TR
	Euclea racemosa L.	Dune guarrie		TR
Ericaceae	*Blaeria filago* Alm & Th. Fries			EH
	Blepharis maderaspatensis (L.) Roth	Creeping blepharis	Kimbirwo	SH
	Erica arborea L.	Giant heath	Kololion	SH
	Erica whyteana Britten			EH
Ericaulaceae	*Eriocaulon schimperi* Engl.	Pipewort		SCH
Euphorbiaceae	*Acalypha fruticosa* Forsk	Birch leaved acalypha	Kembirwo/ Leleiywo/ Sakuyo	SH
	Acalypha volkensii Pax	False nettle	Sowiyon	SH
	Clutia abyssinica Jaub & Spach.	Large fruited lighting-bush	Kioswa/ Chekelel/ Sitaboin	SH
	Croton ciliatoglandulifer Ortega	Mexican croton	Kibichan	TR
	Croton dichogamus Pax.		Kerelwo/Krekereawo	SH
	Croton macrostachyus Hochst. ex Delile.	Broad-leaved croton	Taboswa/Taposwo	TR
	Croton megalocarpus Hutch.	Kenya croton		TR
	Euphorbia candelabrum Kotschy	Candelabra euphorbia	Kireswa/Kureswo	TR
	Euphorbia gossypina Pax			L
	Euphorbia heterochroma Pax.		Makatar/Arukus	SH
	Euphorbia prostrata Aiton	Prostrate spurge, Caustic plant		CR
	Euphorbia tirucalli L.	Naked Lady	Asubgwa	SH

	Macaranga kilimandscharica Pax		Kibgetoyoa	TR
	Manihot esculenta Crantz	Cassava	Moken	SH
	Neoboutonia macrocalyx Pax	Lace-leaf	Kibakwa	TR
	Phyllanthus boehmii Pax.			EH
	Phyllanthus fischeri Pax.		Senian	SH
	Phyllanthus ovalifolius Forssk.	Small fruited potato bush	Kembirwo	SH
	Ricinus communis L.	Castor-oil plant	Mania/Monwo	SH
	Tragia brevipes Pax	Inch plant	Gemelit/Kimelei ne mining	CL
Fabaceae	*Acacia brevispica* Harms.	Prickly thorn	Aiman/Kiptare/ Korniswa/ Parnyirit/ Korniswo	SH
	Acacia elatior Brenan	River acacia	Atat	TR
	Acacia gerrardii Benth.	Grey haired acacia	Chesamis	TR
	Acacia hockii De Willd.	White thorn acacia	Choror/Chuiya/Chuina	TR
	Acacia lahai (Steud. & Hochst ex) Benth.	Red thorn	Tilak/Tilatilil	TR
	Acacia mearnsii De Wild	Wattle tree	Mtikombun	TR
	Albizia anthelmintica (A.Rich) Brongn.	Goatweed	Kitang'wa/Kitong'wo	TR
	Albizia gummifera (J.F.Gmel.) C. A. Sm	Peacock flower	Set/Setyo	TR
	Alysicarpus glumaceus (Vahl) DC	Alyce clover		CR
	Arachis hypogaea L.	Peanut	Njuguu	EH
	Caesalpinia decapetala (Roth) Alston	Cat's claw	Kinangwa	SH
	Cajanus cajan (L.) Millsp.	Pigeon pea	Mbaazi	SH
	Chamaecrista mimosoides (Fresen) Wild & Drum.	Artillery plant	Karyaltere/ Mamaa Kipsinjiriu	PH
	Crotalaria anthyllopsis Taub ex Baker.f.	Rattlebox	Paraya	EH
	Crotalaria brevidens Benth	Ethiopian rattlebox		EH
	Crotalaria deserticola Bak.f.			EH
	Crotalaria incana L.	Woolly Rattlepod.	Kimiraa	EH
	Crotalaria lachnocarpoides Engl.	Rattlebox	Kipkurkur	EH
	Crotalaria polysperma Kotschy		Kimira/Kimilta	EH
	Desmodium repandum (Vahl) DC.	Orange Desmondium		CL
	Erythrina abyssinica Lam. ex DC.	Red-hot-poker tree, Lucky-bean tree	Gorgorwa	TR
	Faidherbia albida (Delile) A.Chev.	Apple-ring acacia, Winter thorn	Kokoja	TR
	Glycine wightii (Wight & Arn.) Verdc.	Perrenial Soybean		CL
	Indigofera ambelacensis Schweinf.		Sarkelat	SH
	Indigofera arrecta Hochst. ex A.Rich.	Bengal Indigo	Kiptolion	SH
	Indigofera atriceps Hook.f.		Sarkilat/Sarkelat	SH
	Indigofera homblei Baker f. & Martin	Indigo	Robwoni	SH
	Lonchocarpus eriocalyx Harms.	Broad lance-pod	Sikiroi	TR
	Parochetus communis D. Don	Shamrock Pea		CR
	Phaseolus vulgaris L.	Common bean		EH
	Rhynchosia minima (L.) DC.	Jumby-bean		CL
	Rhynchosia usambarensis Taub ex Desc	Jackal-berry		CL
	Senegalia mellifera (M. Vahl) S. & Ebinger	Common thorn tree	Barnyirit	L

	Senegalia senegal (L.) Britton.	Sudan gum arabic	Belel/Pilil/Monokwo	TR
	Senna didymobotrya (Fresen.) Irwin & Barneby	Candle bush	Senetwet/Senetwo	SH
	Senna italica Miller	Italian senna	Kipkurkurio/ Komongoi	SH
	Senna occidentalis (L.) Link.	Coffeeweed	Kipsengereu/ Kipsingirwo	SH
	Senna siamea (Lam.)Irwin et Barneby	Kassod tree/Blackwood cassia	Chakaranda	TR
	Tamarindus indica L.	Tamarind, Athel tree	Oron	TR
	Tephrosia pumila (Lam.) Pers.		Kipsinjiriu	SH
	Trifolium cryptopodium A.Rich.	Trefoil		CR
	Trifolium lugardii Bullock	Lugards clover		CR
	Trifolium semipilosum Fresen.	Kenya clover		CR
	Vachellia nilotica (L.) P.J.H. Hutler & Mabb	Scented thorn	Angapwo/ Ngapko/ Ngobgwa	TR
	Acacia nubica Benth.		Chesamis/Labeiywa	SH
	Acacia reficiens (Wawra) Kya & Boatwr.	False Umbrella Thorn	Ngowo	SH
	Vachellia seyal (Delile) P.J.H. Hurter	Red acacia	Rena/Reno	TR
	Vachellia tortilis (Forssk.) Galasso & Banfi	Israeli babool	Ses/Seswa	TR
	Vachellia xanthophloea Benth.	Fever tree	Reno	TR
	Vigna radiata (L.) R. Wilczek	Mungbean	Ndengu	EH
	Vigna unguiculata (L.) Walp	Blackeyed field pea	Kunden	EH
	Zornia glochidiata DC.		Tukesyon	CR
Flacourtiaceae	*Dovyalis abyssinica* (A. Rich.) Warb	Ceylon gooseberry	Mindililwo/ Bapchebilil/ Mintrilwo	SH
	Flacourtia indica (Burm. f.) Merr.	Governor's plum	Tongururwo/ Tungururwa/ Tingas	TR
Francoaceae	*Bersama abyssinica* Fresen.	Winged bersama	Kipsagas/ Kipset	TR
Gentiaceae	*Sebaea leiostyla* Gilg.			SCH
Geraniaceae	*Geranium arabicum* Forsk.	Storksbill		CR
	Pelargonium alchemilloides (L.) Aiton	Garden Geranium	Chemendilil	EH
Gunneraceae	*Gunnera perpensa* L.	River pumpkin		EH
Hamamelidaceae	*Trichocladus ellipticus Eckel & Zeyh*	White Witchhazei Shrub	Berkeiyo	TR
Hyacinthaceae	*Drimia altissima* (L.f.) Ker Gawl	Tall white Squill		SCH
	Drimia indica (Roxb.) Jessop	Indian squil.	Parangoya	SCH
Hypericaceae	*Hypericum revolutum* Vahl	Forest primrose	Kakau	TR
Iridaceae	*Dierama cupuliflorum* Klatt	Angel's Fishing Rod	Chebarap bei	EH
Juncaceae	*Juncus dregeanus i* Kunth.	Common rush	Torokwo	RS
Lamiaceae	*Achyrospermum schimperi* (Hochst. exBriq.) Perkins	Bush guarri	Cherarabei/ Setyon/ Chebujon	SH
	Becium obovatum (E.Mey. Ex Benth) N.E. Br.			DSH
	Clerodendrum johnstonii Oliv.	Tinderwoods	Chesakau/ Jesegao	SH
	Clinopodium abyssinicum (Benth.) Kuntze.	Basilweed		DSH
	Clinopodium uhligii (Guerke) Ryding		Kibararia/Ketpokurol	DSH
	Fuerstia africana T.C.E. Fries		Birirwa/Birirwo	DSH
	Hoslundia opposita Vahl.	Bird gooseberry	Sumboiwo/Sumbeiwo	SH
	Leonotis ocymifolia (Burm f.) Iwarsson	Minaret Flower, Lions Tail	Kipserere	SH
	Leucas aspera (Willd.) Link	Wild ocinum	Nechebgwa	EH

	Leucas calostachys Oliv.		Ng'eng'echwo/ Ng'echepwo	SH
	Leucas deflexa Hook. f.		Taltal	EH
	Leucas glabrata (Vahl.) R.Br.	Dainty Tumbleweed	Kipserere	EH
	Leucas martinicensis (Jacq.) Ait. f.	Bobbin weed	Chebokobil/Kipsereti	EH
	Micromeria biflora (D.Don) Benth	African wild savory	Torokwongwony	DSH
	Micromeria imbricata (Forsk) C. Chr.		Kibararia	DSH
	Nepeta azurea R. Br. ex Benth.	Catmint	Sachangok	SH
	Ocimum americanum L.	Hoary Basil	Rigerio/ Chebo Kabarkebo	SH
	Ocimum basilicum L.	Sweet basil	Kimumunya	SH
	Ocimum grantissimum L.	Wild basil	Jemasat/ Toiyoiya/ Chesimua/ Rerkon	SH
	Ocimum kilimandscharicum Guerke.	Camphor basil	Chebo Kabarkebo/ Chebuchentokor	SH
	Plectranthus barbatus Andrews.	Indian coleus	Ang'urwet	SH
	Plectranthus caninus Roth	Piss-off plant		EH
	Plectranthus kamerunensis Guerke		Lonwo	EH
	Plectranthus lactifolius (Vatke) Agnew	White spur flower	Simamat	EH
	Plectranthus laxiflorus Benth.	Citronella spur flower	Ngenchei	SH
	Plectranthus punctatus ssp. Punctatus (L.f.) L'Her.			EH
	Plectranthus sylvestris Gürke	Painted nettle		SH
	Pycnostachys meyeri Gürke ex Engl	Prayer plant		SH
	Rotheca myricoides (Hochst.)Steane & Mabb.	Butterfly Bush	Kapkerelwo	SH
	Salvia coccinea Buc'hoz ex Etl.	Tropical sage	Chekowo	EH
	Salvia merjamie Forssk.	Sage	Sakitia	EH
	Salvia nilotica Jacq.	African Sage		EH
	Satureja pseudosimensis Brenan	Savory	Chepkonuk	EH
	Stachys aculeolata Hook.f.			EH
	Tetradenia riparia (Hochst.) Codd	Nutmeg Bush	Olonwo/Lonwo	SH
Loganiaceae	*Strychnos henningsii* Gilg.	Red bitter berry	Chemoyu Kobil	SH
Loranthaceae	*Englerina woodfordioides* (Schweinf.) Balle.	Short-barred sapphire	Sagorgetia	P
	Oncocalyx fischeri (Engl.) M. Gilberty	Mistotle	Sorkorket nyepoturetwo	P
	Phragmanthera usuiensis (Oliv.) M.G. Gilbert	Mistotle	Sorkorket	P
	Plicosepalus curviflorus (Oliv.) Van Tiegn	Mistotle	Sokorket pomporton	P
Malvaceae	*Abutilon mauritianum* (Jacq.) Medic.	Velvet-leaf Indian mallow	Jeptula/Jeptur	SH
	Dombeya torrida (J.F. Gmel.)Bamps	Forest dombeya	Borowo	TR
	Grewia bicolor Juss	White raisin	Sitot/Sitet	TR
	Grewia similis K. Schum	African blackwood	Marsitet	SH
	Grewia tenax (Forsk.) Fiori.	Phalsa cherry	Konwo	TR
	Grewia villosa Willd.	Mallow raisin	Mokoyon/ Mongurwo/ Mwokirwo	SH
	Hibiscus diversifolius Jacq.	Embobut River Basin hibiscus		SH
	Hibiscus fuscus Garcke			SH
	Hibiscus meyeri Harv. Welw ex Baker	Lebombo hibiscus	Utanwo	SH
	*Hibiscus trionum*L.	bladder weed,		EH

	Malva verticillata L.	Marrow	Chepnyakwany/ Chepnyanche	SH
	Pavonia patens (Andrews) Chiov			SH
	Pavonia urens Cav.	Stinging pavonia	Motos/Matus	SH
	Sida cuneifolia Roxb	Common wireweed	Korkorio/Korkor	DSH
	Sida ovata Forssk.			DSH
	Triumfetta brachyceras K.Schum	Burr bush		SH
	Triumfetta rhomboidea Jacq.	Diamond burbark		EH
Marchantiaceae	*Marchantia polymorpha* L.	Common liverwort		LW
Meliaceae	Azadirachta indica A. Juss	Neem	Mwarubaine/ Mwarubaini	TR
	Ekebergia capensis Sparrm.	Cape ash	Korbut/Kerbut	TR
	Trichilia emetica Vahl.	Cape mahogany	Kurteswa	TR
Menispermaceae	*Cissampelos pareira* L.	Velvet leaf	Mating'wo	CL
	Stephania abyssinica (Oliv.) Diels			CL
	Tinospora cordifolia (Thunb.) Meirs	Heart-leaved moonseed	Kimugugu/Kimukuku	L
Molluginaceae	*Mollugo nudicaulis* Lam.	Nakedstem Carpetweed		PH
Monimiaceae	*Xymalos monospora* (Harv.) Baill	Lemonwood	Kiptassi	TR
Moraceae	*Ficus natalensis* Hochst.	Back-cloth fig	Simotwo	TR
	Ficus sycomorus L.	Faroh's tree	Mokongwo/Makany	TR
	Ficus thoningii Blume.		Simotwo/Poriotwo	TR
Musaceae	*Ensete ventricosum* (Welw.) Cheesman	Ethiopian banana	Sosurwa/Sosurwo	SH
	Musa paradisiaca L.	Plaintain	Ndizi	SH
Myricaceae	*Myrica salicifolia* Hochst ex A. Rich	Candleberry	Barsiginion/Chebyakwai	TR
Myrsinaceae	*Myrsine africana* L.	African boxwood	Segatet/ Sesimua/ Turesion	SH
Myrtaceae	*Psidium guajava* L.	Guava	Mapera	TR
	Eucalyptus saligna Sm.	Sydney blue gum	Blugum	TR
	Syzygium cordatum (Hochst.)	Water-berry tree	Reberwa/Reperuo	TR
	Syzygium guineense Wall.	Water pear	Lemeiwo/ Lomoiwo/ Lamai	TR
Nyctaginaceae	*Boerhavia coccinea* Mill.	Scarlet spiderling		EH
	Commicarpus grandiflorus (A. Rich) Standl	Cerise stars	Tanacit/Namgra	EH
Olacaceae	*Ximenia americana* L.	Yellow plum	Kinyotwo/Kunyat/Kunyotwo	TR
Oleaceae	*Jasminum abyssinicum* N.E.Br.	Forest jasmine	Kiptare/ Kiptora/ Kipkawa/ Chenamgoi	L
	Olea capensis L.	Black ironwood	Masat	TR
	Olea europaea L.	Olive tree	Yemit/Remit	TR
Opiliaceae	*Opilia amentacea* Roxb.	Fragrant opilia		L
Orchidaceae	*Ansellia africana* L.	Leopard orchid		EP
	Eulophia petersii Reichb.f.			EP
	Polystachya bennettiana Reichb.f.	Yellowspike Orchid		EP
Orobanchaceae	*Alectra parasitica* A. Rich.			P
	Alectra sessiliflora (Vahl) Kuntze.	Yellow witchweed		P
Oxalidaceae	*Biophytum abyssinicum* Steud ex A.Rich	Sensitive wood sorrel	Chebumbu/ Konuch/ Konuk	EH
	Oxalis corniculata L.	Yellow sorrel	Sikwatarit	CR

	Oxalis latifolia Kunth	Broadleaf sorrel	Kiririch	PH
	Oxalis obliquifolia Steud ex A. Rich	Oblique Sorrel		CR
Passifloraceae	*Adenia venenata* Forsk.	Prince's tree	Ken	L
Pedaliaceae	*Sesamum calycinum* Welw.	Wild simsim		EH
Penaeaceae	*Olinia rochetiana* A. Juss.	Hard Pear	Nerkwo/Nerkwa	TR
Phytolaccaceae	*Phytolacca dodecandra* L.	American Pokeweed	Kipsugotit	L
	Phytolacca octandra L.	Inkweed		EH
Piperaceae	*Peperomia abyssinica* Miq.			SCH
	Piper umbellatum L.	Wild pepper	Ketipmirut	SH
Pittosporaceae	*Pittosporum viridiflorum* Sims	Cheesewood	Chemnowo	TR
Plantaginaceae	*Plantago palmata* Hook. f.	Ribwort plaintain	Siriny	PH
	Veronica abyssinica Fresen.			CR
Poaceae	*Agrostis keniensis* Pilg.	Bentgrass	Namkwarat	G
	Aira caryophyllea L.	Silver hairgrass	Saratan	G
	Andropogon amethystinus Steud.	Beard grass		G
	Aristida adoensis Hochst. Ex A. Rich	Fendler threeawn	Solio/Solion	G
	Aristida adscensionis L.	Sixweeks threeawn	Kilalyaus	G
	Aristida kenyensis Henr.	Kenya needle grass		G
	Bothriochloa insculpta (A. Rich.) A. Camus	Sweet pitted grass		G
	Brachiaria decumbens Stapf.	Signal grass		G
	Bromus diandrus Roth.	Ripgut brome		G
	Bromus leptoclados Nees.	Brome grass		G
	Chloris pycnothrix Trin.	Finger grass	Mamaa Kilalya	G
	Cymbopogon pospichilii (K. Schum) C.E. Hubb	Barbed wire grass		G
	Cynodon dactylon (L.) Pers.	Bermuda grass		G
	Cynodon plectostachyus (K. Schum.) Pilger)	Giant star grass		G
	Cynodon transvaalensis Burtt Davy	African dogstooth grass		G
	Dactyloctenium aegyptium (L.) Willd.	Egyptian grass	Anyinya	G
	Digitaria scalarum (Schweinf.) Chiov	African couch grass	Cheroiyo	G
	Digitaria ternata (A. Rich.) Stapf.	Black-Seeded crabgrass	Mamaa Saratan	G
	Digitaria velutina (Forssk.) P. Beauv.	Velvet crabgrass	Saratan	G
	Ehrharta erecta Lam.	Panic veldgrass	Saratan	G
	Eleusine coracana Gaertn.	Finger millet	Matiya	G
	Eleusine jaegeri Pilg.	Goosegrass	Sekut/Sogut	G
	Enneapogon cenchroides (Roem. & Schult.) C.E.Hubb.	Nine-awned Grass		G
	Enteropogon macrostachyus (A. Rich) Benth	Bush rye		G
	Eragrostis cilianensis (All.) Lut.	Gray lovegrass	Sikicho	G
	Eragrostis tuneifolia (A. Rich.) Hochst. ex Steud	Elastic Grass		G
	Eragrostis minor Host.	Little lovegrass		G
	Ehrharta erecta Lam.			G
	Eriochloa fatmensis (Hochst. & Steud.) ClaytonEngl.			G

	Exotheca abyssinica A. Rich			G
	Harpachne schimperi A. Rich.	Tender lovegrass	Mamaa Kiptunguyuy	G
	Heteropogon contortus (L.) Roem & Schult.	Tanglehead	Kipkotot	G
	Hyparrhenia anamesa Clayton	Sesigo grass		G
	Loudetia simplex (Nees) C.E. Hubb	Common russet grass		G
	Melinis repens (Willd) Zizka	Natal red top	Kimatany	G
	Microchloa kunthii Desv	Sickle grass		G
	Oplismenus hirtellus (L.) P. Beauv.	basket grass	Sirat	G
	Panicum calvum Stapf.	Panicgrass	Sirat	G
	Panicum maximum Jacq.	Guinea grass	Cheboso	G
	Pennisetum clandestinum Hochst. ex Chiov	Fauntaingrass	Seretion	G
	Pennisetum pupureum Hochst. ex Chiov.	West African pennisetum	Nappier	G
	Pennisetum stramineum Peter	Crimson Fountaingrass	Kipkanerwa	G
	Phalaris arundinacea L.	Bunchgrass		G
	Poa leptoclada A. Rich.	Meadow-Grass	Kipsil	G
	Rhynchelytrum roseum (Nees) Stapf and C.E. Hubb.			G
	Schmidtia pappophoroides Steud. ex J.A.Schmidt	Sand quick		G
	Setaria pallide-fusca (Schumach.) Stapf. & C.E. Hubb.	Garden bristle grass		G
	Setaria plicatilis (Hochst.) Hack ex. Engl	Bigleaf bristlegrass	Ewarer	G
	Setaria pumila (Poir.) Roem & Schult.	Cattail grass		G
	*Setaria sphacelata (*Schumach.) M.B. Moss	Golden bristle grass	Kipcheiya	G
	Sorghum vulgare Pers.	Sudangrass	Mosong	EH
	Sporobolus festivus A. Rich.	Bird's broom	Chebo Kiptintis	G
	Sporobolus helvolus (Trin.) Dur. &Schinz	Giant dropseed		G
	Sporobolus pyramidalis P. Beauv.	Rat's tail grass		G
	Tetrapogon cenchriformis (A. Rich.) Clayton			G
	Themeda triandra Forsk.	Common Veld Grasses	Chebarapbei	G
	Tragus berteronianus Schult	Spike bur grass	Kipkantul	G
	Yushania alpina (K.Schum.) W.C. Lin	Bamboo	Tegan	SH
	Zea mays L.	Maize	Alpai	EH
Podocarpaceae	*Podocarpus gracilior (*Pilg.) C.N. Page	Weeping Podocarpus	Ben/Benet	TR
	Podocarpus latifolius (Thunn.) R.Br. ex Mirb.	Real yellowwood	Seseite	TR
Polygalaceae	*Polygala sphenoptera* Fres	Milkwort	Kisoiyo	DSH
Polygonaceae	*Oxygonum sinuatum* (Hochs. & Steud ex Meisn.) Dammer	Double Thorn	Kipkereti	EH
	Rumex acetosera L.	Red sorrel	Kibongbong	SCH
	Rumex bequaertii De Wild	Dock plant	Kisirirwa	SCH
	Rumex crispus L.	Yellow dock	Chepoasiririan	SCH
	Rumex usambarensis (Goldammer) Dammer	Red Rumex/Wood Dock	Kimintilil/Kibongbong	SH
Portulacaceae	*Portulaca commutata* M. Gilbert.	Purslane	Kitumeryo	SCH
	Portulaca kermesina N.E. Br.			SCH
	Portulaca oleracea L.	Common purslane, Pigweed	Chemorin/ Chemorinolakwa	SCH

	Portulaca quadrifida L.	Chickweed	KitumerioChepkit/ Kitanti	SCH
	Talinum portulacifolium (Forsk.) Schweinf	Fameflower		SH
Primulaceae	*Maesa lanceolata* Forsk.	False Assegai	Ribotio	TR
	Rapanea melanophloeos (L.) Mez	Cape beech	Sitotwa/Sitotwet/ Karabar	TR
Proteaceae	*Faurea saligna* Harv.	Beechwood	Siririto/Sirirte/ Maiyokwa/ Markwa	TR
	Grevillea robusta A.Cunn. Ex R.B.	Silky Oak	Grevillea	TR
Pteridaceae	Actiniopteris dimorpha P.C. Serm.	Ray fern	Kiptunguyuy	FN
	Cheilanthes hirta Sw.	Lip fern		FN
	Pellaea calomelanos (Sw.) Link	Hard Fern	Chenamkor	FN
	Pteris cotoptera Kuntze	Brake fern		FN
Putranjivaceae	*Drypetes gerrardii* Hutch.	Bastard White Ironwood	Sikit	TR
Ranunculaceae	*Clematis simensis* Fresen.	Pine hyacinth	Bisungwa/ Busungwo/ Pising/ Pisingwo	L
	Ranunculus multifidus Forsk.	African Buttercup	Baiwandab tarit	EH
	Thalictrum rhynchocarpum Dillon & A Rich	False maidenhair	Chebanyiny	EH
Rhamnaceae	*Berchemia discolor* (Kloztsch) Hemsl.	Brown ivory	Muchuk/Muchukwo	TR
	Rhamnus prinoides L. Her.	African Dogwood	Kosisit/Kasisit	SH
	Rhamnus staddo A. Rich	Buckthorn	Kipsur	SH
	Scutia myrtina (Burm. f.) Kurz	Cat-thorn	Tolgokwo/ Tigagowa/ Sumbeyiwa	L
	Ziziphus mauritiana Lam.	Indian plum, Jujube	Tilomwo/Tilam/Tirak	TR
	Ziziphus mucronata Willd.	Buffalo thorn	Nonoiwo/Nanai/Nonowo	TR
Rosaceae	*Alchemilla chryptantha* A. Rich.	Lady's mantle		CR
	Alchemilla ellenbeckii Engl.	Creeping lady's mantle		CR
	Alchemilla johnstonii Oliv.	Holotrichous lady's mantle	Aririyo	CR
	Alchemilla rothii Oliv.	Downy lady's mantle	Uptuburo/Kipsiriny	CR
	Cliffortia nitidula R.E. & T.C.E. Fries	Large-leaved Rice-bush	Chesegerkat/ Torokwongwony/ Sakitiantaseretion	SH
	Hagenia abyssinica Willd.	African redwood	Sewerwa	TR
	Prunus africana (Hook.f.) Kalkman	Red stinkwood		TR
	Rubus apetalus Poir	Sombre bramble		L
	Rubus pinnatus Willd.	Blackberry	Momon	L
	Rubus steudneri Schweinf.	Forest bramble	Momonwa	L
Rubiaceae	*Anthospermum herbaceum* L.f.			EH
	Canthium schimperianum A. Rich.		Cheptuiya/Komolwo	SH
	Conostomium quadrangulare (Rendle) Cufod.	Wild pentas		EH
	Galium aparine L.	Stickyweed	Nangwarat	CL
	Galium scioanum Chiov.		Chepkolei	CL
	Galium thunbergianum Eckyl & Zeyh.	Stickyweed	Kimnabai/Sinorion	CL
	Gardenia ternifolia Schumach & Thonn.	Large-leaved Transvaalgardenia	Mokilion	TR
	Gardenia volkensii K. Schum.	Common gardenia	Mokilion	TR
	Keetia gueinzii (Sond.) Brindson	Climbing Turkeyberry	Rotio	L
	Meyna tetraphylla (Schweinf. Ex Hiern) Robyns		Tilingwo/Tiliny	TR
	Mitracarpus scaber Zucc.	Girdlepod	Kiborusio	CR

	Oldenlandia monanthos (A. Rich.) Hiern			EH
	Pavetta abyssinica Fres.	Brides-bush	Jemokimnerkeny	SH
	Pentas longiflora Oliv.		Jepkole	EH
	Psychotria kirkii L.		Kabonbonot	SH
	Psydrax schimperiana (A.Rich.) Bridson		Jeptue	SH
	Richardia brasiliensis Gomes	Mexican clover	Samurta	CR
	Rubia cordifolia L.	Indian mander	Chebobet	CL
	Vangueria apiculata K. Schum.	Triangle-flowered wild-medlar	Tabirir/	SH
	Vangueria madagascariensis J.F.Gmel.	Tamarind-of-the-Indies	Komol/Komolwo	SH
	Vangueria volkensii K. Schum	Wild medlar	Tapirir	SH
Rutaceae	*Citrus aurantiifolia* (Christm.) Swingle	Lime	Ndimu	SH
	Citrus aurantium L.	Bitter orange	Marimau	SH
	Citrus sinensis (L.)Osbeck	Sweet orange	Machungwa/ Machungwayan	SH
	Clausena anisata (Willd.) Hook.f. ex Benth.	Horsewood	Chesagon/Cheboinoiywa	SH
	Harrisonia abyssinica Oliv.		Kapkerelwa	TR
	Teclea nobilis Delile.	Small fruited teclea	Kuriot	TR
	Teclea simplicifolia (Engl.) Verdc.	Small-fruited	Kuriot	TR
	Toddalia asiatica (L.) Lam.	Cockspur Orange	Kipkeres/Kipkutai	L
	Zanthoxylum chalybeum Engl.	Knot wood	Kochon/ Songoiywa/ Songururwa	TR
Salvadoraceae	*Dobera glabra* (Forssk.) Juss. ex Poir		Korosion	TR
	Salvadora persica L.	Toothbrush tree	Checha	TR
Santalaceae	*Osyris lanceolata* Hochst.& Steudel.	Sandlewood	Mormorwo	TR
	Viscum album L.		Sesukimaket	P
Sapindaceae	*Allophylus abyssinicus* (Hochst.) Radlk.	Forest velvet false-currant	Losin	TR
	Cardiospermum halicacabum L.	Heart-pea vine		L
	Dodonaea angustifolia L.f.	Sand olive, Hop bush	Tabilikwa/ Taplikwo/ Tabirirwa	SH
	Pappea capensis Eckyl & Zeyh.	Bushveld Cherry	Kibiryokwo/Piriokwo	TR
Sapotaceae	*Aningeria adolfi-friederici* (Engl.) Robyns & G.C Gilbert	Anigre	Saait/Seite	TR
Scrophulariaceae	*Buddleja polystachya* Fresen	Anfar tree	Gelelwa/Geletwa/Leleito	SH
	Cycnium herzfeldianum (Vatke) Engl.	Ink-flower	Sakiliantangwony	EH
	Diclis bambuseti R. E. Fries			CR
	Hebenstretia angolensis Rolfe			EH
	Verbascum brevipedicellatum (Engl.) Huber-Moranth	Velvet plant		EH
Solanaceae	*Cupsicum frutescens* L.	Chili pepper	Pilipili	DSH
	Datura stramonium L.	Jimson weed		EH
	Discopodium penninervum Hochst.			DSH
	Lycopersicon esculentum Mill.	Tomato	Nyanya	EH
	Nicotiana tabacum L.	Tobbaco	Timote	SH
	Physalis peruviana L.	Cape gooseberry	Cheptolon/Boni	EH
	Solanum aculeastrum Dunal	Apple of Sodom	Sikawa/Sikowo	SH
	Solanum aculeatissimum Jacq.	Dutch eggplant	Kaplobotwa	SH

	Solanum giganteum Jacq.	Healing-leaf tree	Kipkukai	SH
	Solanum incanum L.	Sodom apple	Kalopot/ Labotwa/ Jebokimnerkeny	SH
	Solanum mauense Bitter		Kalopotwo	SH
	Solanum nigrum L.	Black nightshade	Kisoyo/Kipongosi	EH
	Solanum renschii Vatke	Bitterapples	Ketbor	SH
	Solanum sessilistellatum Bitter			SH
	Solanum terminale Forssk.		Kisoyoborin	SH
	Solanum tuberosum L.	Irish potato	Potatoes	EH
	Withania somnifera (L.) Dunal	Winter cherry	Tarkukai/ Kipkogai/ Kwoleria	SH
Sterculiaceae	*Sterculia stenocarpa* H. Winkler.		Ililwo	TR
Stilbaceae	*Nuxia congesta* R.Br. ex Fresen.	Brittlewood	Chorwo	TR
Thymelaeaceae	*Gnidia glauca* (Fresen.) Gilg	Fish Poison Bush	Kiris	SH
	Struthiola thomsonii Oliv.			SH
Tiliaceae	*Corchorus tridens* L.	Wild jute	Arialeter	EH
Typhaceae	*Typha latifolia* L.	Common Cattail		RD
Urticaceae	*Didymodoxa caffra* (Thunb.) Friis & Wilmot-Dear			EH
	Girardinia diversifolia (Link) Friis	Himalayan nettle	Kisegere	EH
	Pilea johnstonii Oliv.			EH
	Urera hypselodendron (Hochst. Ex. A. Rich.) Wedd.	Scratch brush	Nyalya	L
	Urtica massaica Mildbr.	Maasai stinging nettle	Kimilei	EH
Verbenaceae	*Lantana camara* L.	Red-sage, Tickberry	Kipche	SH
	Lippia javanica (Burm f.) Spreng	Lemon Bush	Mwokio/ Kipkororon/ Kururu	SH
Violaceae	*Viola abyssinica* Oliv.	Violet	Puputya	CR
Vitaceae	*Ampelocissus africana* (Lour.) Merr.	Simple leaved wild grape	Kipsirim	SH
	Cissus cactiformis Gilg	Grape Ivy	Krorot	L
	Cissus quadrangularis L.	Devil'sbackbone	Krorot	L
	Cissus rotundifolia (Forsk.) Vahl	Venezuelan treebine	Kraras/ Kiroroswo/ Kroroswo	L
	Cyphostemma cyphopetalum (Fresen.)Desc. Ex Wild & R. Drum		Kibungwach/ Kipkawa/ Murutyo	CL
	Gomphocarpus phillipsiae (N.E.Br.) Goyder	Milkweed		EH
	Gomphrena celsioides Mart.	Bachelor’s button, Gomphrena weed	Kocheboi	CR
	Rhoicissus tridentata (L.f.)Wild & Drum	Bitter grape	Turotwo/ Torotwa/ Iwambora	L
Xylariaceae	*Engleromyces goetzei* Henn.	Baby’s bottom	Jeptekan	P
Zingiberaceae	*Zingiber officinale* Roscoe	Ginger	Tangauzi	RH
Zygophyllaceae	*Balanites aegyptiaca* (L.) Delile	Desert date	Ng' oswa/ Tuyunwa	TR
	Balanites pedicellaris (Welw) Mildbr & Schltr	Soap berry bush	Lomion	SH
	Tribulus terrestris L.	Caltrop	Kilesan/Kreswo	CR

CL- Climber, CR - Creeper, DSH - Dwarf shrub, EH - Erect herb, EP – Epiphyte, FN – Fern, G – Grass, L - Liana, LW – Liverwort, P – Parasite, PH - Prostrate herb, RD – Reed, RH - Rhizomatous herb, RS – Rushes, SCH - Succulent herb, SD - Sedge, SH – Shrub, TR –Tree

Appendix II: Herbaceous plant species abundance and their lifeforms in Embobut Forest Reserve

Habit	Species	Valle	Escarpme	Upland	Montan
Climber	*Cyphostemma cyphopetalum*	0	3	2	0
	Galium aparine L.	0	0	0	4
	Galium scioanum Chiov.	0	0	0	1
	Galium thunbergianum Eckyl & Zeyh.	0	0	0	8
	Glycine wightii (Wight & Arn.) Verdc.	0	4	0	0
	Rhynchosia minima (L.) DC.	0	7	3	0
	Rhynchosia usambarensis Taub ex Desc	0	4	0	0
	Total	**0**	**18**	**5**	**13**
Creeper	*Alchemilla ellenbeckii* Engl.	0	0	0	5
	Alchemilla rothii Oliv.	0	0	0	2
	Centella asiatica (L.) Urban	0	0	8	24
	Convolvulus alsinoides (Linn.) Linn.	1	0	0	0
	Dichondra repens J.R. & G. Forst.	0	0	2	7
	Diclis bambuseti Diclis bambuseti R. E. Fries	0	0	2	5
	Galium scioanum Chiov.	0	0	2	0
	Galium thunbergianum Eckyl & Zeyh.	0	0	0	1
	Oldenlandia monanthos (A. Rich.) Hiern	0	0	0	2
	Oxalis corniculata L.	0	2	9	4
	Parochetus communis D. Don	0	0	1	7
	Phyllanthus boehmii Pax.	0	0	0	10
	Pupalia lappacea (L.) A.Juss.	3	3	0	0
	Tribulus terrestris L.	3	0	0	0
	Trifolium cryptopodium A.Rich.	0	0	0	10
	Trifolium lugardii Bullock	0	0	0	1
	Trifolium semipilosum Fresen.	0	0	2	1
	Veronica abyssinica Fresen.	0	0	0	9
	Viola abyssinica Oliv.	0	0	7	0
	Total	**7**	**5**	**33**	**88**
Erect herb	*Achyranthes aspera* L.	0	0	2	2
	Agrocharis incognita (Denzin) Heyw & July.	0	2	0	6
	Aerva lanata (L.) Schultes	0	1	0	0
	Berkheya spekeana Oliv.	0	0	1	1
	Bidens pilosa L.	0	10	1	0
	Blaeria filago Alm & Th. Fries	0	0	0	4
	Blephalis edulis (Forssk.) Pers.	3	3	0	0
	Boerhavia coccinea Mill.	2	0	0	0
	Carduus kikuyorum R.E.Fr.	0	0	0	12
	Commicarpus grandiflorus (A. Rich) Standl	0	2	0	0
	Conostomium quadrangulare (Rendle) Cufod.	0	0	2	0
	Crotalaria incana L.	0	3	0	0
	Cyathula cylindrica Moq.	0	0	2	0
	Cynoglossum coeruleum Hochst. ex A.DC.	0	0	1	0
	Desmodium repandum (Vahl) DC.	0	0	2	0
	Didymodoxa caffra (Thunb.) Friis & Wilmot-Dear	0	0	0	2
	Galinsoga parviflora Cav.	0	5	1	0
	Geranium arabicum Forsk.	0	1	1	14
	Gnaphalium unionis Oliv & Hiern.	0	2	0	1
	Guizotia jacksonii (S.Moore) J.Baagøe	0	0	0	1
	Hebenstretia angolensis Rolfe	0	0	0	2
	Helichrysum kilimanjari Oliv.	0	0	0	2
	Hypoestes forskaolii (Vahl) R.Br.	12	23	0	0
	Hypoestes triflora (Forsk.) Roem & Schultes.	0	0	9	0
	Justicia flava Vahl	0	1	0	0
	Leucas calostachys Oliv.	0	2	0	0
	Leucas deflexa Hook. f.	0	0	1	0

	Leucas glabrata (Vahl.) R.Br.	0	4	0	0
	Leucas martinicensis (Jacq.) Ait. f.	1	1	0	0
	Micromeria biflora (D.Don) Benth	0	0	0	5
	Micromeria imbricata (Forsk) C. Chr.	0	0	1	14
	Oxygonum sinuatum (Hochs. & Steud ex Meisn.)	0	1	0	0
	Phyllanthus fischeri Pax.	1	1	0	0
	Plantago palmata Hook. f.	0	0	0	1
	Plectranthus kamerunensis Guerke	0	1	0	0
	Plectranthus laxiflorus Benth.	0	0	4	0
	Polygala sphenoptera Fres	0	4	0	0
	Rumex bequaertii De Wild	0	0	3	1
	Salvia nilotica Jacq	0	0	4	5
	Scabiosa columbaria L.	0	0	0	3
	Tagetes minuta L.	0	1	0	0
	Tolilis arvensis (Huds.) Link	0	1	1	0
	Tridax procumbens L.	0	1	0	0
	Urtica massaica Mildbr.	0	0	3	1
	Total	**19**	**70**	**39**	**77**
Grass	*Agrostis keniensis* Pilg.	0	1	0	11
	Aira caryophyllea L.	0	0	0	1
	Aristida adoensis Hochst. Ex A. Rich	0	3	0	0
	Aristida kenyensis Henr.	1	0	0	0
	Brachiaria decumbens Stapf.	1	0	0	0
	Cymbopogon pospichilii (K. Schum) C.E. Hubb	0	7	0	0
	Cynodon transvaalensis Burtt Davy	0	0	1	0
	Dactyloctenium aegyptium (L.) Willd.	1	4	0	0
	Digitaria scalarum (Schweinf.) Chiov	0	0	28	0
	Digitaria velutina (Forssk.) P. Beauv.	0	6	0	0
	Eleusine jaegeri Pilg.	0	0	0	1
	Enteropogon macrostachyus (A. Rich) Benth	1	0	0	0
	Eragrostis minor Host.	0	0	0	6
	Ehrharta erecta Lam	0	8	0	0
	Harpachne schimperi A. Rich.	0	1	0	0
	Heteropogon contortus (L.) Roem & Schult.	0	10	0	0
	Hyparrhenia anamesa Clayton	0	2	0	0
	Loudetia simplex (Nees) C.E. Hubb	0	4	0	0
	Panicum calvum Stapf	0	0	1	0
	Pennisetum clandestinum Hochst. ex Chiov	0	0	30	23
	Rhynchelytrum roseum (Nees) Stapf and C.E. Hubb.	0	1	0	0
	Setaria plicatilis (Hochst.) Hack ex. Engl	0	2	0	0
	Sporobolus pyramidalis P. Beauv.	0	2	0	0
	Total	**5**	**60**	**63**	**42**
Parasite	*Alectra sessiliflora* (Vahl) Kuntze	0	1	0	0
	Total	**0**	**1**	**0**	**0**
Prostrate herb	*Euphorbia prostrata* Aiton	1	0	0	0
	Cotula abyssinica Sch.Bip. ex A.Rich	0	0	0	2
	Oldenlandia monanthos (A. Rich.) Hiern	0	0	7	0
	Total	**1**	**0**	**7**	**2**
Pteridophyte	Actiniopteris dimorpha P.C. Serm.	0	1	0	0
	Asplenium aethiopicum (Burm.f.) Bech.	0	4	0	0
	Asplenium theciferum (Kunth) Mett.	0	0	2	0
	Dryopteris inaequalis (Schltdl.) Kuntze	0	2	1	0
	Pellaea calomelanos (Sw.) Link	0	1	0	0
	Total	**5**	**60**	**63**	**42**
Rhizomatous	*Drimia indica* (Roxb)Jessop	10	1	0	0
	Oxalis obliquifolia Steud ex A. Rich	0	4	0	0
	Total	**10**	**5**	**0**	**0**
Rosette herb	*Biophytum abyssinicum* Steud ex A.Rich	0	1	0	0
	Chamaecrista mimosoides (Fresen) Wild & Drum.	0	2	0	0
	Crabbea velutina S. Moore	4	0	0	0

	Crossandra subcaulis C.B. Clarke	0	3	0	0
	Total	**4**	**6**	**0**	**0**
Succulent herb	*Commelina africana* L.	8	3	4	0
	Commelina benghalensis L.	0	3	0	0
	Commelina latifolia Hochst ex A. Rich.	2	0	0	0
	Crassula granvikii Mildbr.	0	0	0	1
	Edithcolea grandis N.E.Br.	3	0	0	0
	Kalanchoe densiflora Rolfe	1	1	0	0
	Kalanchoe lanceolata (Forsk.) Pers.	4	1	0	3
	Portulaca commutata M. Gilbert.	0	0	0	1
	Portulaca kermesina N.E. Br.	6	1	0	0
	Portulaca oleracea L.	3	0	0	0
	Sebaea leiostyla Gilg.	0	0	0	1
	Total	**27**	**9**	**4**	**6**
Sedge	*Carex elgonensis* Nelmes.	0	0	0	5
	Cyperus esculentus L.	1	0	0	1
	Cyperus rigidifolius Steud.	0	0	12	4
	Isolepis fluitans (L.) R.Br.	0	0	0	1
	Kyllinga bulbosa P.Beauv.	0	0	2	0
	Pycreus elegantulus (Steud.) C.B. Clarke	0	0	0	4
	Pycreus nitidus (Lam.) J. Raynal.	0	0	1	0
	Total	**1**	**0**	**15**	**15**
	Grand Total	**73**	**173**	**166**	**243**

Appendix III: Local identification, scientific name and common names of plant species used in Embobut Forest Reserve

Local Name checklist	Scientific_Name	Common_Name
Cheporus (Chebarus/Jeporus)	*Justicia flava* Vahl	Yellow justicea
Lukumwo (Lugumwo/Tolgoto)	*Acanthus eminens* C.B.Cl.	Bear's breeches
Tirkonio (Tolkonwo)	*Hypoestes forskaolii* (Vahl) R.Br.	White ribbon bush
Chalbatwo (Chalpat/Chalpat/Jalpat)	*Aloe tweediae* Christian	Chinese aloe
Kipangani (Pangani)	*Amaranthus spinosus* L.	Spiny pigweed
Kipsirim	*Achyranthes aspera* L.	Devil's horsewhip
Arolwo (Orolwo/Oror)	*Sclerocarya birrea* (A.Rich.) Hochst.	Valley floor tree
Loloito (Lolotwo)	*Lannea fulva* (Engl.) Engl.	
Morno	*Lannea schweinfurthii* (Engl.) Engl	False Valley floor
Mutung'wo (Mutung'wa)	*Ozoroa insignis* Delile	Tar berry
Siria (Sirian/Sirya)	*Rhus natalensis* Berhn. Ex Krauss.	Natal rhus
Murkui	*Uvaria scheffleri* Diels	Common Gorse
Murkuywo	*Monanthotaxis buchananii* (Engl.) Verdc.	Buchanan's dwaba-berry
Borio (Porion/Porii)	*Peucedanum aculeolatum* Engl.	Wild Parsley
Kibou (Ararat)	*Calotropis procera* (Aiton) W.T. Aiton	Rubber bush
Konowarany	*Adenium obesum* (Forssk.) Roem & Schult.	Desert Rose
Legatet (Legatetwa/Legatetwet/Legatetwo)	*Carrisa edulis* Vahl.	Simple-spined num-num
Ochon	*Saba comorensis* (Bojer ex A.DC.) Ochon	Rubber vine
Sinondo (Sinonto)	*Periploca linearifolia* Dill. A.Rich.	Silk vine
Cheliita (Cheliite/Jeliita)	*Cussonia spicata* Thunb	Spiked cabbage tree
Oon	*Polyscias kikuyuensis* Summerh	Parasol tree
Tingwon (Tingwa/Tinwo/Tinwon)	*Schefflera volkensii* (Harms) Harms	Cabbage tree
Kipchor (Kipjo)	*Pergularia daemia* (Forsk.) Chiov.	Trellis-vine
Malut (Maltwo)	*Asparagus falcatus* (L.) Druce	Sickle thorn
Lobchon	*Asplenium stuhlmanii* Hieron.	
Arta (Orta)	*Senecio hadiensis Forssk.*	Ragwort
Chemamaran (Jemamaran)	*Ageratina adenophora* (Spreng.) King & H.	Crofton weed
Cheposiwoch	*Bidens pilosa L.*	Blackjack
Chepteka (Cheptekaa)	*Mikaniopsis bambuseti (*R.E. Fries) C. Jeffrey	
Jepkondewo (Jepkondewa/Chepkontewo)	*Galinsoga parviflora* Cav.	Gallant soldier
Jepojompir	*Crassocephalum montuosum* (S. Moore)	Rag leaf
Katabut	*Berkheya spekeana* Oliv.	Buffalo-tongue
Kipcho	*Launaea cornuta* (Hochst. ex Oliv. & Hiern)	Bitter lettuce
Kipitkut	*Schkuhria pinnata* (Lam.) Thell.	Feathery false thread leaf
Kiputkut	*Acmella caulirhiza* Del.	Toothache plant
Kirelachan (Kirelach)	*Pseudognaphalium luteoalbum (L.) Hilliard &*	Cudweed
Kirorion	*Vernonia amygdalina* Delile	Bitter leaf
Kiroryo	*Conyza pyrrhopappa* A. Rich	Fleabane
Konocho	*Psiadia paniculata* (DC.) Vatke.	Blink Stefaans
Mauanta Arap Koko	*Helichrysum globosum* Sch. Bip.	
Moiyon	*Sphaeranthus ukambensis* Vatke & O. Hoffm.	
Sesimwo (Sesimwa)	*Artemisia afra* Jacq ex Willd.	African wormwood
Tobongwo (Tabangwa)	*Vernonia auriculifera* Hiern	
Yelgekwa (Tolkokwo)	*Solanecio manii* (Hook. f.) C. Jeffrey	
Kiraita	*Basella alba* L.	Vine spinach
Kipsolwen	*Berberis holstii* Engl.	Barberry
Kirotion (Rotion)	*Kigeria africana* (Lam.) Benth.	Sausage tree
Adomeiyon	*Cordia sinensis* Lam.	Grey-leaved cordia
Chutwa	*Commiphora africana* (A.Rich.) Endl.	African Myrr
Marsian	*Commiphora mildebraedii*	
Sekekwa (Segekwa)	*Lobelia giberroa* Hemsl.	Giant Lobelia

Sekwon (Sekwan/Sokwon)	*Warburgia ugandensis* Sprague	Ugandan greenheart
Chebilis (Chebiliswo)	*Maerua decumbens* (Brogn.) DC. Wolf	Blue-Leaved Spider Bush
Kolowo	*Crateva adansonii* DC.	Garlic pear
Miskin	*Cadaba farinosa* Forssk.	African ebony
Sachan (Sakar)	*Cleome gynandra* L.	Stink weed/Spider wisp
Sekon	*Boscia angustifolia* A. Rich.	Rough-leaved shepherds
Sorukwo (Serekwo/Sorukwa)	*Boscia coriacea* Pax.	Shepherd's-tree
Eburwo	*Elaeodendron buchananii* Loes. Loes	
Kelwo (Kelyo)	*Mystroxylon aethiopicum* (Thunb.) Loes	Spoon wood
Montrich	*Chenopodium opulifolium* Koch & Ziz	Grey goosefoot
Nonwo	*Garcinia livingstonei* T. Anderson.	African mango steen
Koloswo (Kileswa/Goloswa/Groswo)	*Terminalia brownii* Fresen.	Red pod terminalia
Siliba	*Ipomoea sinensis* (Desr.) Choisy	
Sait (Sayit/Sakarta)	*Afrocrania volkensii* (Harms.) Hutch.	Dogwood
Kamuserwo	*Kalanchoe crenata* (Andrews) Haw	Neverdie
Kamusorwo	*Kalanchoe densiflora* Rolfe	
Kapchebinin	*Crassula alsinoides* (Hook.f.) Engl	
Kiparpany	*Kalanchoe lanceolata* (Forsk.) Pers.	Narrow-leaved
Cheseria (Jeserya)	*Momordica foetida* Schum. & Thonn	Bad smell melon
Kisangwa	*Zehneria scabra* (L.f.) Sond	Mouse melon
Kokocha	*Momordica rostrata* A. Zimm.	
Silangwa	*Lagenaria siceraria* (Mollina) Standl.	Bottle gourd
Torokwo	*Juniperus procera* Hochst. Ex Endl.	African pencil cedar
Jemoikut (Chemoigut)	*Cyperus rigidifolius* Steud.	Gisha grass
Moikut (Morkut)	*Cyperus esculentus* L.	Nutsedge
Tilol (Tulol)	*Dryopteris inaequalis* (Schltdl.) Kuntze	Wood fern
Huswo (Uswo)	*Euclea divinorum* Hiern.	Towerghwarrie
Arukus	*Euphorbia heterochroma* Pax.	
Kibichan (Kipichan)	*Croton ciliatoglandulifer* Ortega	Mexican croton
Kioswo	*Clutia abyssinica* Jaub & Spach.	Large fruited lighting-bush
Kireswo	*Euphorbia candelabrum* Kotschy	Candelabra euphorbia
Leleiya (Leleywo)	*Acalypha fruticosa* Forsk	Birch leaved acalypha
Monwo	*Ricinus communis* L.	Castor-oil plant
Sowiyon	*Acalypha volkensii Pax.*	False nettle
Taposwa/Toboswo)	*Croton macrostachyus* Hochst. ex Delile.	Broad-leaved croton
Aron (Knapp and Vorontsova)	*Tamarindus indica L.*	Tamarind, Athel tree
Atat	*Acacia elatior* Brenan	River acacia
Bilil (Belel/Pilil)	*Senegalia senegal* (L.) Britton.(Acacia	Sudan gum arabic
Chesamis	*Acacia gerrardii* Benth. (nubica)	Grey haired acacia
Churur (Jurur)/Sikiroi	*Lonchocarpus eriocalyx* Harms.	
Kapkerelwo	*Harrisonia abyssinica* Oliv.	
Kimilta	*Crotalaria polysperma* Kotschy	
Kipsingiriu (Kipsinjiriu)	*Tephrosia pumila* (Lam.) Pers.	
Kitongwo (Kitangwa)	*Albizia anthelmintica* (A.Rich)	Goat weed
Kokoja	*Faidherbia albida* (Delile) A.Chev.	Apple-ring acacia, Winter
Korniswo (Korniswa/Parnyirit)	*Acacia brevispica* Harms.	Prickly thorn
Labeiywa	*Acacia nubica (Benth.) Kyal & Boatwr.*	
Ngapko (Ngopko)	*Vachellia nilotica* (L.) P.J.H. Hutler & Mabb	Scented thorn
Rena	*Vachellia seyal* (Delile) P.J.H. Hurter	Red acacia
Sarkelat	*Indigofera arrecta* Hochst. ex A.Rich.	Bengal Indigo
Sarkilat	*Indigofera atriceps* Hook.f.	
Ses	*Vachellia tortilis (Forssk.)* Galasso & Banfi	Israeli babool
Setyo	*Albizia gummifera (*J.F.Gmel.) C. A. Sm	Peacock flower
Tilak	*Acacia lahai* (Steud. & Hochst ex) Benth.	Red thorn
Mindirilwo (Mintrilwo)	*Dovyalis abyssinica* (A. Rich.) Warb	Ceylon gooseberry

Ting'as (Ting'oswa/Tongururwo/Tungururwa)	*Flacourtia indica* (Burm. f.) Merr.	Governor's plum
Berkeiyo	*Trichocladus ellipticus* Eckel & Zeyh	White Witchhazei Shrub
Ang'urwo (Ang'uur/Ang'urwet/Ong'urwo)	*Plectranthus barbatus* Andrews.	Indian coleus
Birirwo (Birirwa/Birirwo)	*Fuerstia africana* T.C.E. Fries	
Chebobet (Chepobet)	*Rotheca myricoides* (Hochst.)Steane & Mabb.	Butterfly Bush
Chesakau	*Clerodendrum johnstonii* Oliv.	Tinder woods
Kipchekin	*Leptadenia hastata* (Pers.) Dechne	
Lonwo	*Plectranthus kamerunensis* Guerke	
Ng'eng'echwo	*Leucas calostachys* Oliv.	
Olonwo	*Tetradenia riparia* (Hochst.) Codd	Nutmeg Bush
Sakition	*Salvia merjamie* Forssk.	Sage
Simamat	*Plectranthus laxiflorus* Benth.	Citronella spur flower
Torokwong'wony	*Clinopodium abyssinicum* (Benth.) Kuntze.	Basil weed
Chorwo (Jorwo)	*Nuxia congesta* R.Br. ex Fresen.	Brittle wood
Jeptekan	*Engleromyces goetzei* Henn.	Baby's bottom
Sokorket Tendwo	*Englerina woodfordioides (Schweinf.) Balle.*	Short-barred sapphire
Sokorkor Topongwo	*Oncocalyx fischeri* (Engl.) M. Gilberty	Mistotle
Borowo	*Dombeya torrida* (J.F. Gmel.)Bamps	Forest dombeya
Chepnyakwany (Chepnyanche)	*Malva verticillata* L.	Marrow
Jeptur (Jeptula)	*Abutilon mauritianum* (Jacq.) Medic.	Velvet-leaf Indian mallow
Korkorwo (Korkorio/Korkor)	*Sida cuneifolia* Roxb	Common wire weed
Marsitet	*Grewia similis K. Schum*	African black wood
Mokoyon	*Grewia villosa* Willd.	Mallow raisin
Sitet (Sitot)	*Grewia bicolor* Juss	White raisin
Korbu (Korbut)	*Ekebergia capensis* Sparrm.	Cape ash
Kimukuku (Kimugugu)	*Tinospora cordifolia* (Thunb.) Meirs	Heart-leaved moonseed
Kiptasi	*Xymalos monospora (*Harv.) Baill	Lemonwood
Boriotwo (Poriotwo)	*Ficus thoningii Blume.*	
Mokong'wo	*Ficus sycomorus* L.	Faroh's tree
Simotwo	*Ficus natalensis* Hochst.	Back-cloth fig
Sosurwo (Sosurwa)	*Ensete ventricosum* (Welw.) Cheesman	Ethiopian banana
Mborion (Mboryo/Ribotio)	*Maesa lanceolata* Forsk.	False Assegai
Turesho (Turesion)	*Myrsine africana* L.	African boxwood
Lemeiwo (Lemeiywa/Lomoiwo)	*Syzygium guineense* Wall.	Water pear
Mapera	*Psidium guajava* L.	Guava
Reperuo	*Syzygium cordatum* (Hochst.)	Water-berry tree
Kinyotwo	*Ximenia americana* L.	Yellow plum
Kiptora (Kiptoro)	*Jasminum abyssinicum N.E.Br.*	Forest jasmine
Masat	*Olea capensis* L.	Black ironwood
Yemit/Remit	*Olea europaea* L.	Olive tree
Nelkwo (Nerkwo)	*Olinia rochetiana* A. Juss.	Hard Pear
Kirirish	*Oxalis latifolia* Kunth	Broadleaf sorrel
Konuk (Konuch)	*Biophytum abyssinicum* Steud ex A. Rich	Sensitive wood sorrel
Chemnowo (Chemnoa/Jepnowo)	*Pittosporum viridiflorum* Sims	Cheesewood
Kipkanerwa	*Pennisetum stramineum*	Crimson fountain grass
Sarkut (Sekut)	*Eleusine jaegeri* Pilg.	Goose grass
Seretion (Seretyo)	*Pennisetum clandestinum* Hochst. ex Chiov	Fauntain grass
Tegaa (Tekaa/Tekan)	*Yushania alpina* (K.Schum.) W.C. Lin	Bamboo
Ben/Benet	*Podocarpus gracilior* (Pilg.) C.N. Page	Weeping Podocarpus
Kisoiyo	*Polygala sphenoptera* Fres	Milkwort
Chepoasiriran	*Rumex crispus* L.	Yellow dock
Kimintril	*Rumex usambarensis* (Goldammer) Dammer	Red rumex/Wood dock
Sitotwo (Sitotwa)	*Rapanea melanophloeos* (L.) Mez	Cape beech
Sirirto (Sirirte)	*Faurea saligna*	Beech wood
Busungwo (Pisingwo/Pising/Pisimwo)	*Clematis simensis* Fresen.	Pine hyacinth

Asisit (Kosisit/Kasisit)	*Rhamnus prinoides* L. Her.	African Dogwood
Muchukwo (Muchuk)	*Berchemia discolor* (Kloztsch) Hemsl.	Brown ivory
Nonoiwo (Nonowo)	*Ziziphus mucronata* Willd.	Buffalo thorn
Tilomwo	*Ziziphus mauritiana* Lam.	Indian plum (Jujube
Tolgokwo (Tolgokwa)	*Scutia myrtina* (Burm. f.) Kurz	Cat-thorn
Torotwa (Turotwo)	*Rhoicissus tridentata* (L.f.)Wild & Drum	Bitter grape (ebony)
Aririyo	*Alchemilla ellenbeckii* Engl.	Creeping lady's mantle
Kipsiriny (Kipsuruny)	*Alchemilla rothii* Oliv.	Downy lady's mantle
Momon	*Rubus pinnatus* Willd.	Blackberry
Momonwo	*Rubus steudneri* Schweinf.	Forest bramble
Soworwo (Sewerwa)	*Hagenia abyssinica* Willd.	African redwood
Tendwo (Tentwo)	*Prunus africana* (Hook.f.) Kalkman	Red stinkwood
Jepkore	*Pentas longiflora* Oliv.	
Komolwo	*Vangueria madagascariensis* J.F. Gmel.	Tamarind-of-the-Indies
Komolwo	*Canthium schimperianum* A. Rich.	
Mokilion	*Gardenia ternifolia* Schumach & Thonn.	Large-leaved Transvaal
Tapirir (Tapirirwo)	*Vangueria apiculata* K. Schum.	Triangle-flowered wild-
Tilam	*Keetia gueinzii* (Sond.) Brindson	Climbing Turkey berry
Tilingwo (Tiliny)	*Meyna tetraphylla* (Schweinf. Ex Hiern)	
Kipkaras (Kipkeres)	*Toddalia asiatica* (L.) Lam.	Cockspur Orange
Songoror (Songururwa/Songururwa)	*Zanthoxylum chalybeum* Engl.	Knot wood
Chekowo	*Salvadora persica* L.	Toothbrush tree
Korosion	*Dobera glabra* (Forssk.) Juss. ex Poir	
Mormorwo	*Osyris lanceolata*	Sandle wood
Kibiryokwo/Piriokwo	*Pappea capensis* Eckyl & Zeyh.	Bushveld Cherry
Losin	*Allophylus abyssinicus (Hochst.) Radlk.*	Forest velvet false-currant
Tabirikwa	*Dodonaea angustifolia L.f.*	Sand olive (Hop bush)
Cheptolong (Jeptolong)	*Physalis peruviana* L.	Cape gooseberry
Kalobotwo	*Solanum incanum* L.	Sodom apple
Kalopotwo (Kalopot)	*Solanum mauense* Bitter	
Kaplobotwo (Kaplopot/Kaplopotwo)	*Solanum aculeatissimum* Jacq.	Dutch eggplant
Kipkukai (Kipkutai)	*Solanum giganteum* Jacq.	Healing-leaf tree
Kisoyo (Sujaa)	*Solanum nigrum* L.	Black nightshade
Kisoyoborin	*Solanum terminale* Forssk.	
Sikowo (Sikawa)	*Solanum aculeastrum* Dunal	Apple of Sodom
Tarkukai	*Withania somnifera* (L.) Dunal	Winter cherry
Ililwo	*Sterculia stenocarpa* H. Winkler.	
Kiris	*Gnidia glauca* (Fresen.) Gilg	Fish Poison Bush
Kimelei	*Urtica massaica* Mildbr.	Maasai stinging nettle
Nyalya (Nyalian)	*Urera hypselodendron* (Hochst. Ex. A. Rich.)	
Chepking'ung (Jepking'ung/Kipking'ung)	*Momordica anigosantha* Hook.f.	Bitter Melon
Kibungwach/Murtio	*Cyphostemma cyphopetalum* (Fresen.)Desc. Ex Wild & R. Drum	
Kriris (Kraras/Kroroswo)	*Cissus rotundifolia* (Forsk.) Vahl	Venezuelan treebine
Krorot	*Cissus quadrangularis* L.	Devil's backbone
Kilesan (Kreswo)	*Tribulus terrestris* L.	Caltrop
Lomion	*Balanites pedicellaris* (Welw) Mildbr & Schltr	Soap berry bush
Tuyunwo	*Balanites aegyptiaca* (L.) Delile	Desert date

Appendix IV: Local identification, scientific name and common names of the identified medicinal plant species in Embobut Forest Reserve

Local Name checklist	Scientific_Name	Common name
Tilak	***Acacia lahai*** (Steud. & Hochst ex) Benth.	Red thorn
Lugumwo/Tegelde/Tegilde	*Acanthus eminens* C.B.Cl.	Bear's breeches
Kipsirim	*Achyranthes aspera* L.	Devil's horsewhip
Kiputkut/Kibutkut	*Acmella caulirhiza* Del.	Toothache plant
Sait/Sayit/Morowo	*Afrocrania volkensii* (Harms.) Hutch.	Dogwood
Kitong'wo/Kitang'wa	*Albizia gummifera* (J.F.Gmel.) C. A. Sm	Goatweed
Chalbat/Chalpat	*Aloe tweediae* Christian	Chinese aloe
Pangani	*Amaranthus spinosus* L.	Spiny pigweed
Sesimwa/Sesimua	*Artemisia afra* Jacq ex Willd.	African wormwood
Malut/Maltwo/Kipsowor	*Asparagus falcatus* (L.) Druce	Sicklethorn
Kiraita	*Basella alba* L.	Vinespinash
Kipsolwen/Kipsoroin/Kipsuruny	*Berberis holstii* Engl.	Barberry
Katabut	*Berkheya spekeana* Oliv.	Buffalo-tongue
Chepkondiwo/Cheposiwach/Kreilis Jenkondewo/Jenkondewo	*Bidens pilosa* L.	Blackjack
Konuch/Konuk	*Bi Biophytum abyssinicum* Steud ex A.Rich *ophytum abyssinicum*	
Sorukwo/Serekwo	*Boscia coriacea* Pax.	
Ararat/Kibou	*Calotropis procera* (Aiton) W.T. Aiton	Rubber bush
Cheptuiya/Komolwo	*Canthium schimperianum* A. Rich.	
Legatetwa	*Carrisa edulis* Vahl.	Simple-spined num-num
Montrich	*Chenopodium ambrosioides* L.	Mexican tea
Montrich	*Chenopodium opulifolium* Koch & Ziz	Grey goosefoot
Busungwo/Pisingwo/Pising	*Clematis simensis* Fresen.	Pine hyacinth
Sachan/Sakarta	*Cleome gynandra* L.	Stinkweed/Spiderwisp
Torokwo-ngwony/Kibararia	*Clinopodium abyssinicum* (Benth.) Kuntze.	Basilweed
Kioswa/Sitab oin/Chekelel	*Clutia abyssinica* Jaub & Spach.	Large fruited lighting-bush
Kolowo	*Crateva adansonii* DC.	
Kimilta/Kimira	*Crotalaria polysperma* Kotschy	
Kibichan	*Croton ciliatoglandulifer* Ortega	Mexican croton
Taposwo/Taboswa	*Croton macrostachyus* Hochst. ex Delile.	Broad-leaved croton
Jeleikta/Jeliita/Cheliite	*Cussonia spicata* Thunb	Spiked cabbage tree
Morkut	*Cyperus esculentus* L.	Nutsedge
Kibungwach/Murutyo	*Cyphostemma cyphopetalum* (Fresen.)Desc. Ex Wild & R. Drum	
Korosion	*Dobera glabra*	
Tabilikwa/Taplikwo	*Dovyalis abyssinica* (A. Rich.) Warb	Sand olive/Hop bush
Borowo	*Dombeya torrida* (J.F. Gmel.)Bamps	Forest dombeya
Mindililwo/Mintrilwo	*Dovyalis abyssinica* (A. Rich.) Warb	Ceylon gooseberry
Lobchon/Turol	*Dryopteris inaequalis* (Schltdl.) Kuntze	

Sagorgetia	*Englerina woodfordioides* (Schweinf.) Balle.	Short-barred sapphire
Jeptekan	*Engleromyces goetzei*	Baby's bottom
Sosurwo/Sosurwa	*Ensete ventricosum* (Welw.) Cheesman	Ethiopian banana
Jeptuiya/Uswo	*Euclea divinorum* Hiern.	Towerghwarrie
Kureswo/Kireswa	*Euphorbia candelabrum* Kotschy	Candelabra euphorbia
Kokoja	*Faidherbia albida* (Delile) A.Chev.	Apple-ring acacia, Winter thorn
Sirirto/Maiyokwa/Markwa	*Faurea saligna* Harv.	Beechwood
Simotwo	*Ficus natalensis* Hochst.	Back-cloth fig
Poriotwo	*Ficus thoningii* Blume.	
Tingas/Tongururwo/Tungururwa	*Flacourtia indica* (Burm. f.) Merr.	Governor's plum
Nolkwo	*Garcinia livingstonei* T. Anderson.	African mangosteen
Mokilion	*Gardenia ternifolia* Schumach & Thonn.	Large-leaved Transvaalgardenia
Sewerwa/Soworwo	*Hagenia abyssinica* Willd.	African redwood
Kapkerelwa	*Harrisonia abyssinica* Oliv.	
Tirgonio/Tirkonio	*Hypoestes forskaolii* (Vahl) R.Br.	White ribbon bush
Kiptolion	*Indigofera arrecta* Hochst. ex A.Rich.	Bengal Indigo
Sarkelat/Sarkilat	*Indigofera atriceps* Hook.f.	
Kiptora/Kipkawa	*Jasminum abyssinicum* N.E.Br.	
Torokwo	*Juniperus procera* Hochst. Ex Endl.	African pencil cedar
Cheporus/Tirkonio	*Justicia flava* Vahl	Yellow justicea
Kamuserwo	*Kalanchoe crenata* (Andrews) Haw	Neverdie
Rotio/Rotion	*Kigeria africana* (Lam.) Benth.	Sausage tree
Loloito/Lolotwo	*Lannea fulva* (Engl.) Engl.	
Morno	*Lannea schweinfurthii* (Engl.) Engl	False marula
Sikiroi/Chururur	*Lonchocarpus eriocalyx* Harms.	
Mborio/Ribotio	*Maesa lanceolata* Forsk.	False Assegai
Chepkingung	*Momordica anigosantha* Hook.f.	Bitter Melon
Cheseria/Jeseria	*Momordica foetida* Schum. & Thonn	French concombre sauvage
Segatet	*Myrsine africana* L.	African boxwood
Chorwo	*Nuxia congesta* R.Br. ex Fresen.	Brittlewood
Remit/Yemit	*Olea europaea* L.	Olive tree
Mutung'wa/Mutung'wo	*Ozoroa insignis* Delile	Tar berry
Kipchee	*Pergularia daemia* (Forsk.) Chiov.	Trellis-vine
Sinendo/Sinondo	*Periploca linearifolia* Dill. A.Rich.	Silk vine
Borio	*Peucedanum aculeolatum* Engl.	Wild Parsley
Chemnowo	*Pittosporum viridiflorum* Sims	Cheesewood
Ang'urwet/Ang'uur	*Plectranthus barbatus* Andrews.	Indian coleus
Ben/Benet	*Podocarpus gracilior (*Pilg.) C.N. Page	Weeping Podocarpus
Tendwo/Tondwo//Tendwet	*Prunus africana* (Hook.f.) Kalkman	Red stinkwood

Sitotwet/Karabar	*Rapanea melanophloeos* (L.) Mez	Cape beech
Kosisit/Kasisit	*Rhamnus prinoides* L. Her.	African Dogwood
Sirian	*Rhus natalensis* Berhn. Ex Krauss.	Natal rhus
Monwo/Mania	*Ricinus communis* L.	Castor-oil plant
Chebobet	*Rotheca myricoides* (Hochst.)Steane & Mabb.	Butterfly Bush
Momonwa	*Rubus steudneri* Schweinf.	Forest bramble
Chekowo/Checha	*Salvadora persica* L.	Toothbrush tree
Tinwot/Tingwa/Tingwon	*Schefflera volkensii* (Harms) Harms	Cabbage tree
Kipitkut	*Schkuhria pinnata* (Lam.) Thell.	Feathery false threadleaf
Tigagowa	*Scutia myrtina* (Burm. f.) Kurz	Cat-thorn
Korkor/Korkorio	*Sida cuneifolia* Roxb	Common wireweed
Lemeiwo/Lomoiwo	*Syzygium guineense* Wall.	Water pear
Labotwa/Jebokimnerkeny	*Solanum incanum* L.	Sodom apple
Sikawa/Sikowo	*Solanum aculeastrum* Dunal	Apple of Sodom
Kalopotwo	*Solanum mauense* Bitter	
Kisoyo/Kipongosi	*Solanum nigrum* L.	Black nightshade
Kisoyoborin	*Solanum terminale* Forssk.	
Oron	*Tamarindus indica* L.	Tamarind/Athel tree
Koloswo/Goloswa/Groswo	*Terminalia brownii* Fresen.	
Kipkeres/Kipkutai	*Toddalia asiatica* (L.) Lam.	Cockspur Orange
Kilesan/Kreswo	*Tribulus terrestris* L.	Caltrop
Kimilei	*Urtica massaica* Mildbr.	Maasai stinging nettle
Ngapko/Ngobgwa/Angapwo	*Vachellia nilotica* (L.) P.J.H. Hutler & Mabb	Scented thorn
Labeiywa/Chesamis	*Acacia nubica* Benth.	
Reno/Rena	*Vachellia seyal* (Delile) P.J.H. Hurter	Red acacia
Krorion/Kirorion	*Vernonia amygdalina* Delile	Bitter leaf
Ononion/Tabang'wa	*Vernonia auriculifera* Hiern	
Sekwon/Sokwon/Sekwan	*Warburgia ugandensis* Sprague	Ugandan greenheart
Tarkukai/Kipkogai/Kwoleria	*Withania somnifera* (L.) Dunal	Winter cherry
Tegan/Tegaa	*Yushania alpina* (K.Schum.) W.C. Lin	Bamboo
Songoiywa/Songururwa	*Zanthoxylum chalybeum* Engl.	Knot wood
Cheserya/Kisangwa	*Zehneria scabra* (L.f.) Sond	Mouse melon
Tilomwo/Tirak/Tilam	*Ziziphus mauritiana* Lam.	Indian plum/Jujube

Appendix V: The plants commonly used and their UVI in the Embobut Forest Reserve

Species checklist	Fen	Pol	Cha	Fod	Orn	Fru	Fir	Hon	Nec	Rop	Tim	Veg	Uses	UVI
Acacia brevispica Harms	√			√		√	√						4	0.31
Acacia elatior Brenan	√	√	√	√		√	√		√		√		8	0.63
Acacia gerrardii Benth.	√	√	√	√			√		√				6	0.47
Acacia hockii De Willd.	√	√	√	√		√	√		√				7	0.55
Acacia lahai (Steud. & Hochst ex) Benth.	√	√	√	√		√	√						6	0.47
Acacia nubica Benth.	√	√	√	√		√	√		√				7	0.55
Acanthus eminens C.B.Cl.	√			√			√						3	0.24
Afrocrania volkensii (Harms.) Hutch.	√	√	√	√			√				√		6	0.47
*Albizia gummifera (*J.F.Gmel.) C. A. Sm	√	√	√	√		√	√				√		7	0.55
Allophylus abyssinicus (Hochst.) Radlk.	√	√	√	√		√	√		√		√		8	0.63
Aloe cheranganiensis S.Carter &Brandham	√			√	√								3	0.24
Aloe tweediae Christian	√			√	√								3	0.24
Amaranthus spinosus L.												√	1	0.08
Artemisia afra Jacq ex Willd.	√			√			√						3	0.24
Asparagus falcatus (L.) Druce	√					√							2	0.16
Balanites aegyptiaca (L.) Delile	√	√	√	√		√	√				√	√	8	0.63
Basella alba L.	√			√						√		√	4	0.31
Berberis holstii Engl.	√		√	√	√		√						5	0.39
Berchemia discolor (Kloztsch) Hemsl	√	√	√	√		√	√						6	0.47
Boscia angustifolia A. Rich.	√	√	√				√						4	0.31
Boscia coriacea Pax.	√	√	√				√						4	0.31
Canthium schimperianum A. Rich.				√		√	√						3	0.24
Carrisa edulis Vahl.	√		√	√		√	√		√				6	0.47
Chenopodium ambrosioides L.				√								√	2	0.16
Chenopodium opulifolium Koch & Ziz				√								√	2	0.16
Cissus rotundifolia (Forsk.) Vahl	√			√						√			3	0.24
Clematis simensis Fresen.	√			√	√		√			√			5	0.39
Cleome gynandra L.				√								√	2	0.16
Clerodendrum johnstonii Oliv.	√			√			√						3	0.24
Clutia abyssinica Jaub & Spach.				√			√			√			3	0.24
Combretum apiculatum Sond.	√	√	√	√			√				√		6	0.47
Commiphora africana (A.Rich.) Engl.	√	√		√				√					4	0.31
Commiphora mildebraedi Endl.				√				√					2	0.16

Cordia sinensis Lam.	√	√	√	√			√						5	0.39
Crateva adansonii DC.				√		√	√						3	0.24
Crotalaria polysperma Kotschy				√								√	2	0.16
Croton ciliatoglandulifer Ortega	√	√	√	√			√						5	0.39
Croton dichogamus Pax.	√		√				√						3	0.24
Croton macrostachyus Hochst. ex Delile.	√	√	√	√			√	√	√		√		8	0.63
				√		√						√	3	0.24
Cussonia spicata Thunb	√		√	√	√		√						5	0.39
Cyperus esculentus L.				√			√						2	0.16
Cyphostemma cyphopetalum (Fresen.)Desc. Ex Wild & R. Drum	√			√						√			3	0.24
Digera muricata (L.) Mart.				√								√	2	0.16
Diospyros abyssinica Hiern	√	√	√	√		√	√				√		7	0.55
Dobera glabra (Forssk.) Juss. ex Poir	√	√	√				√						4	0.31
Dodonaea angustifolia L.f.	√			√			√						3	0.24
Dombeya torrida (J.F. Gmel.)Bamps	√	√	√	√	√		√		√	√	√		9	0.71
Dovyalis abyssinica (A. Rich.) Warb	√		√	√		√	√				√		6	0.47
Dryopteris inaequalis (Schltdl.) Kuntze													0	0.00
Ekebergia capensis Sparrm.	√	√	√	√		√	√				√		7	0.55
Elaeodendron buchananii Loes. Loes	√	√	√	√			√				√		6	0.47
Ensete ventricosum (Welw.) Cheesman			√	√	√	√		√		√			6	0.47
Euclea divinorum Hiern.	√	√	√	√		√	√						6	0.47
Euphorbia candelabrum Kotschy	√			√	√		√						4	0.31
Faidherbia albida (Delile) A.Chev.	√	√		√		√	√						5	0.39
Faurea saligna Harv.	√	√	√	√			√				√		6	0.47
Ficus natalensis Hochst.	√		√	√	√	√	√				√		7	0.55
Ficus sycomorus L.						√					√		2	0.16
Ficus thoningii Blume.	√	√			√	√					√		5	0.39
Flacourtia indica (Burm. f.) Merr.	√	√	√	√		√	√						6	0.47
Garcinia livingstonei T. Anderson.	√	√	√	√		√	√				√		7	0.55
Gardenia ternifolia Schumach & Thonn.	√	√	√	√		√	√						6	0.47
Gnidia glauca (Fresen.) Gilg	√		√	√			√						4	0.31
Grewia bicolor Juss	√	√	√				√			√			5	0.39
Grewia villosa Willd.	√		√	√		√	√						5	0.39
Hagenia abyssinica Willd.	√	√	√	√	√		√		√		√		8	0.63
Harrisonia abyssinica Oliv.	√	√	√			√	√						5	0.39

Indigofera arrecta Hochst. ex A.Rich.				√			√						2	0.16
Indigofera atriceps Hook.f.				√			√						2	0.16
Jasminum abyssinicum N.E.Br.	√		√				√						3	0.24
Juniperus procera Hochst. ex Endl.	√	√	√	√	√		√				√		7	0.55
Keetia gueinzii (Sond.) Brindson		√		√		√					√		4	0.31
Kigeria africana (Lam.) Benth.		√	√	√	√	√	√						6	0.47
Lagenaria abyssinica (Hook.f.) C.Jeffrey	√			√						√			3	0.24
Lannea fulva (Engl.) Engl.	√	√	√	√			√			√			6	0.47
Lannea schimperi Hochst. Ex A.Rich.	√	√	√	√		√	√			√			7	0.55
Lannea schweinfurthii (Engl.) Engl	√	√	√	√		√	√	√		√			8	0.63
Leptadenia hastata (Pers.) Dechne				√				√				√	3	0.24
Lonchocarpus eriocalyx Harms.	√	√	√	√			√			√	√	√	8	0.63
Maerua decumbens (Brogn.) DC. Wolf				√			√						2	0.16
Maesa lanceolata Forssk.	√	√	√	√			√						5	0.39
Meyna tetraphylla (Schweinf. ex Hiern) Robyns	√	√	√	√		√	√						6	0.47
Mikaniopsis bambuseti (R.E.Fries) C.Jeffrey	√			√		√				√			4	0.31
Momordica anigosantha Hook.f.	√			√						√			3	0.24
Momordica foetida Schum. & Thonn	√	√		√		√				√			5	0.39
Monanthotaxis buchananii (Engl.) Verdc.				√		√	√						3	0.24
Myrica salicifolia Hochst ex A. Rich		√	√	√			√				√		5	0.39
Musa paradisiaca L.	√	√	√	√			√				√		6	0.47
Neoboutonia macrocalyx Pax	√	√	√	√			√	√			√		7	0.55
Nuxia congesta R.Br. ex Fresen.	√	√	√	√			√	√	√		√		8	0.63
Olea capensis L.	√	√	√	√	√	√	√		√		√		9	0.71
Olea europaea L.	√	√	√	√	√	√	√		√		√		9	0.71
Olinia rochetiana Juss.	√	√	√	√			√		√		√		7	0.55
Osyris lanceolata Hochst. & Steud.Hochst. & Steud.			√	√			√						3	0.24
Ozoroa insignis Delile	√	√	√	√		√	√				√		7	0.55
Pappea capensis Eckl. & Zeyh.	√	√	√	√		√	√				√		7	0.55
Pergularia daemia (Forsk.) Chiov.	√			√						√			3	0.24
Periploca linearifolia Dill. A.Rich.	√			√						√			3	0.24
Peucedanum aculeolatum Engl.				√								√	2	0.16
Physalis peruviana L.				√		√						√	3	0.24
Pittosporum viridiflorum Sims		√	√	√		√	√						5	0.39
Plectranthus barbatus Andrews.	√			√			√						3	0.24

Podocarpus gracilior (Pilg.) C.N. Page	√	√	√	√			√	√		√	√		8	0.63
Polyscias kikuyuensis Summerh	√	√	√	√			√	√					6	0.47
Prunus africana (Hook.f.) Kalkman	√	√	√	√	√	√	√		√		√		9	0.71
Psidium guajava L.			√		√	√	√		√		√		6	0.47
Rapanea melanophloeos (L.) Mez	√	√	√	√			√		√		√		7	0.55
Rhamnus prinoides L. Her.	√	√	√	√			√		√		√		7	0.55
Rhus natalensis Berhn. Ex Krauss.	√	√	√	√		√	√						6	0.47
Ricinus communis L.						√	√						2	0.16
Rubus pinnatus Willd.				√		√							2	0.16
Saba comorensis (Bojer ex A.DC.) Pichon				√		√							2	0.16
Salvadora persica L.	√	√	√	√			√						5	0.39
Schefflera volkensii (Harms) Harms	√	√	√	√	√		√				√		7	0.55
Sclerocarya birrea (A.Rich.) Hochst.	√	√	√	√	√	√	√	√			√		9	0.71
Scutia myrtina (Burm. f.) Kurz	√			√		√	√	√					5	0.39
Senecio hadiensis Forssk.	√			√									2	0.16
Senegalia mellifera (M. Vahl) S. & Ebinger	√			√			√						3	0.24
Senegalia senegal (L.) Britton.	√	√	√	√		√	√	√	√				8	0.63
Solanum aculeastrum Dunal	√			√	√	√	√		√				6	0.47
Solanum incanum L.				√		√	√					√	4	0.31
Solanum nigrum L.				√		√	√					√	4	0.31
Sphaeranthus ukambensis Vatke & O.Hoffm.				√									1	0.08
Sterculia stenocarpa H. Winkler.				√		√	√						3	0.24
Syzygium cordatum (Hochst.)		√	√	√		√	√	√	√		√		8	0.63
Syzygium guineense Wall.	√	√		√	√	√	√		√		√		8	0.63
Tamarindus indica L.	√	√	√	√		√	√		√		√		8	0.63
Teclea nobilis Delile.				√			√		√		√		4	0.31
Terminalia brownii Fresen.	√	√		√	√		√				√		6	0.47
Tetradenia riparia (Hochst.) Codd							√						1	0.08
Toddalia asiatica (L.) Lam.	√	√		√			√						4	0.31
Urera hypselodendron (Hochst. ex A.Rich.) Wedd.	√	√		√		√	√						5	0.39
Urtica massaica Mildbr.	√	√	√	√		√	√				√		7	0.55
Uvaria scheffleri Diels	√	√	√	√			√						5	0.39
Vachellia nilotica (L.) P.J.H. Hutler & Mabb	√	√	√	√		√	√						6	0.47
Vachellia seyal (Delile) P.J.H. Hurter	√			√			√		√				4	0.31

Vachellia tortilis (Forssk.) Galasso & Banfi	√	√	√	√			√	√	√	√		8	0.63
Vachellia xanthophloea Benth.	√	√	√	√		√	√			√		7	0.55
Vangueria madagascariensis J.F.Gmel	√		√	√			√					4	0.31
Vernonia amygdalina Delile	√	√	√	√		√	√			√		7	0.55
Vernonia auriculifera Hiern	√			√								2	0.16
Warburgia ugandensis Sprague	√			√	√			√				4	0.31
Ximenia americana L.											√	1	0.08
Xymalos monospora (Harv.) Baill.	√			√			√					3	0.24
Yushania alpina (K.Schum.) W.C. Linn	√				√	√						3	0.24
Zanthoxylum chalybeum Engl.	√	√	√	√		√	√	√		√	√	9	0.71
Zehneria scabra (Linn. f.) Sond.	√			√					√		√	4	0.31
Ziziphus mauritiana Lam.	√		√	√			√	√				5	0.39
Ziziphus mucronata Willd.	√	√	√	√		√	√					6	0.47

Key:
Fen = Fencing; Pol = Poles; Cha = Charcoal; Fo =Food; Orn = Ornamental; Fru = Fruits; Fir = Firewood; Hon = Honey; Nec = Nectar; Rop = Ropes; Tim = Timber; Veg = Vegetables

Appendix VI: Similarity report

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