

**IMPACT OF CLIMATE VARIABILITY ON SELECTED KIPSIGIS SACRED
PLANT SPECIES IN BELGUT DIVISION, KERICHO COUNTY, KENYA**

By

CHEPKORIR ENNETH (B.Ed., Home. Econ)

N50/CE/26009/2011

**A Thesis Submitted in Partial Fulfillment of the Requirements for the Award of
the Degree of Master of Environmental Studies (Climate Change and
Sustainability) in the School of Environmental Studies of Kenyatta University**

OCTOBER 2015

DECLARATION

Student's Declaration

This is my original work and has not been presented for a degree in any other university or for any other academic award.

SIGNATURE..... DATE.....

CHEPKORIR ENNETH (B.Ed., Home Economics)

N50/CE/26009/2011

Supervisors' Declaration

We confirm that the work reported in this thesis was carried out by the candidate under our supervision.

SIGNATURE..... DATE.....

Dr. James K. A. Koske

Department of Environmental Education

Kenyatta University

SIGNATURE..... DATE.....

Dr. Richard Kerich

Department of Environmental Education

Kenyatta University

DEDICATION

I dedicate this study to my beloved husband Robert Kirui, and our children Ryan, Lianne and Andrey for enduring loneliness and emotional constraints while I furthered my education.

ACKNOWLEDGEMENT

Foremost, I am thankful to the Almighty God for His love and blessings. I am greatly indebted to my supervisors, Dr. James Koske and Dr. Richard Kerich both of the School of Environmental Studies, Kenyatta University for their scholarly advice and guidance. I am similarly appreciative of the assistance and cooperation accorded by the Chief and the residence of Kabianga location for granting me permission to undertake my data collection in their area.

To my incredible family members; parents Mr. and Mrs. Ng'eno and Mr. and Mrs. Mibei for their inspiration and for embodying the spirit of hard work as a key to success in life, to my brothers and sisters, I say thank you for supporting me in various ways during the time of this study. There are many friends, colleagues and workmates whom I have not mentioned individually, kindly accept my appreciation for the role you played towards the successful completion of this study.

TABLE OF CONTENTS

DECLARATION	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF PLATES	ix
ABBREVIATIONS AND ACRONYMS	x
ABSTRACT.....	xi
CHAPTER ONE: INTRODUCTION.....	1
1.1 Background Information	1
1.2 Statement of the Problem	2
1.3 Research Questions	2
1.4 Research Objectives	3
1.5 Justification	3
1.6 Conceptual Framework	4
1.7 Definition of Terms	6
CHAPTER TWO: LITERATURE REVIEW	8
2.1 Global Overview of the Importance of Biodiversity.....	8
2.2 Drivers and Pressures of Climate Change.....	11
2.3 Effect of Climate Change on Energy and Biodiversity.....	16
2.4 Health and Biodiversity.....	19
2.5 Interactions Between Biodiversity and Culture.....	22
2.6 Religious Status of Kipsigis of Kericho County	26
2.7. Description of the Plant Species.....	28
2.8. Climate Variability and Effects on the Kalenjin Community	30
2.9. Factors affecting the diversity and occurrence of plants species.....	30
CHAPTER THREE: METHODOLOGY	32
3.1 Area of Study.....	32
3.2 Temperature and Rainfall patterns	32
3.3 Geology and Soils	32
3.4 Topography and Drainage	34
3.5 Population Distribution and Economic Activities.....	34

3.6	Sampling Procedure	34
3.7	Research Instruments	35
3.8	Research Design and Methods of Collecting Data.....	36
3.9	Administration of Research Instruments.....	36
3.10	Data Analysis	37
CHAPTER FOUR: RESULTS AND DISCUSSION		38
4.1	Respondents' Interview Response Rate	38
4.2	Respondents' Age and Gender Profiles.....	39
4.3	Climate Variability in Kericho County between 1980 and 2012	40
4.3.1	<i>Temperature trend of Kericho between 1980 and 2012</i>	40
4.3.2	<i>Rainfall trend of Kericho between 1980 to 2012.....</i>	43
4.4	Respondents' View on Rainfall and Temperature Variability	45
4.4.1	<i>Respondence Views on the Importance of the Plants</i>	45
4.4.2	<i>Vernonia auriculifera.....</i>	45
4.4.3	<i>Croton macrostachyus</i>	47
4.4.4	<i>Periploca linearifolia.....</i>	49
4.5	Responses on Effects of Climate Variability on the Plant Species	53
4.6	Visual assessment of land cover of selected plants.....	56
4.9	Importance and distribution of the plants.....	59
CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS		68
5.1	Summary of the study.....	68
5.2	Conclusions	68
5.2.1	<i>Temperature and Rainfall Variability in the Kipsigis area of Kericho ...</i>	68
5.2.2	<i>Abundance of V. auriculifera, C. macrostachyus and P. linearifolia to the Kipsigis community.....</i>	69
5.2.3	<i>Temperature and rainfall effects on occurrence of V. auriculifera, C. macrostachyus and P. linearifolia</i>	69
5.3	Recommendations for further research.....	69
REFERENCES		71
APPENDICES		82
Appendix 1: Introductory Letter		82
Appendix 2: Questionnaire		83
Appendix 3: Occurrence, Abundance and GPS location of the plant species.....		89

LIST OF TABLES

Table 4.1: Summary of questionnaires issued and received per sub location	38
Table 4.2 : Respondents' age and gender profiles.....	40
Table 4.3 : Descriptive statistics on uses of <i>V. auriculifera</i>	47
Table 4.4 : Descriptive statistics on uses of <i>C. macrostachyus</i>	48
Table 4.5 : Descriptive statistics on uses of <i>P. linearifolia</i>	50
Table 4.6 : Male verses Female respondents' on uses of <i>V. auriculifera</i> , <i>C.</i> <i>macrostachyus</i> and <i>P.linearifolia</i>	51
Table 4.7 : Raw statistics on effects of rainfall and temperature.....	53
Table 4.8 : Percentages illustrating effects of rainfall and temperature	54
Table 4.9: Relative abundance of the selected plants	57
Table 4.10. Table of estimate plant distribution per sub location.....	58

LIST OF FIGURES

Figure 1.1: Conceptual Framework.....	5
Figure 4.1: Percentages of duly filled and received questionnaires.....	39
Figure 4.2: Annual average temperature variability in Kericho during the period 1980-2012.....	41
Figure 4.3: Graph of temperature deviation from mean	42
Figure 4.4: Graph illustrating annual average rainfall of Kericho 1980 to 2012.....	43
Figure 4.5: Graph of rainfall deviation from mean.....	44

LIST OF PLATES

Plate 3.1: A map of Belgut Constituency in Kericho County	33
Plate 4.1: Young <i>V. auriculifera</i> plant.	46
Plate 4.2: <i>C. macrostachyus</i> plant in a homestead.....	48
Plate 4.3: <i>P.linearifolia</i> ,	49
Plate 4.4: <i>V. auriculifera</i> along roadside of Kibingei-Kabianga road	59
Plate 4.5: <i>P.linearifolia</i> creeping <i>G.robusta</i>	60
Plate 4.6: <i>P.linearifolia</i> climbing a wild plant.....	61
Plate 4.7: <i>C. macrostachyus</i> and <i>V. auriculifera</i> forming part of a live fence.....	62
Plate 4.8: Sinendet Towers, in Kericho town,	63
Plate 4.9: Kaptebengwo Secondary school	64
Plate 4.10: Kaptebeswet Secondary school	65
Plate 4.11: Plant distribution (occurrence and abundance) map.....	66

ABBREVIATIONS AND ACRONYMS

AGC:	Africa Gospel Church
AIC:	Africa Inland Church
AIDS:	Acquired Immune Deficiency Syndrome
BAP	Biodiversity Action Plan
BMU:	Bundesministerium fur Umwelt
CBD	Convention on Biological Diversity
CITES	Convention for International Treaties on Endangered Species
ESA:	Endangered Species Act
GPS:	Global Positioning System
ICSU:	International Council for Science Unions
IPCC:	International Panel On Climate Change
IAASTD:	International Assessment of Agricultural Knowledge Science And Technology
IUCN:	International Union for Conservation of Nature
IZA:	International Zeolite Association
KNBS:	Kenya National Bureau of Statistics
MAB:	Man and the Biosphere
NBSAP:	National Biodiversity Strategy and Action Plan
MDGS:	Millennium Development Goals
MEAR:	Millennium Ecosystem Assessment Report
MENR:	Ministry of Environment and Natural Resources
OECD:	Organization for Economic Cooperation Development
RBA:	Relative Bioavailability
SDA:	Seventh - day Adventist
SCBD:	Secretariat of the Convention on Biological Diversity
SPSS:	Statistical Packages for Social Sciences
UNESCO:	United Nations Educational, Scientific and Cultural Organization
WEHAB:	Water Energy Health Agriculture and Biodiversity
WSSD:	World Summit on Sustainable Development
WRI:	World Resource Institute

ABSTRACT

Indigenous plant species have salient socio-cultural significance among many peoples of Africa. In Kenya, certain plant species are important for ceremonial functions such as marriage and rites of passage. Among the Kalenjin, over 100 species are important for such functions. However, the species are relatively under threat in their occurrence and abundance due to climate variations and impacts of development. The purpose of this study was to examine the impact of climate change on the occurrence and abundance of three selected plant species namely (*Croton macrostachyus* Hochst. ex Delile, 1847, *Periploca linearifolia* Linnaeus, 1753 and *Vernonia auriculifera* Linnaeus, 1847. *Croton macrostachyus*); that are culturally significant among the Kipsigis of Belgut Division in Kericho County. The selected plants were commonly used to construct a prayer altar “mabwaita”. Specifically the study intended to relate climate variability to the culturally-important tree species’ occurrence and abundance. Three hundred and ninety five households were randomly selected from rural farms in Belgut Division, Kabianga location. Questionnaires were administered to the heads of the households about the perceived impacts of climate variability on the plant species. The questionnaires included the Likert type scale on which the respondents expressed their beliefs about species occurrence and abundance in relation to climate variability. Focused group discussions on the occurrence and abundance of the species were held with key informants from the area, visual assessment of the land cover of the selected plant species were also made to estimate the species occurrence and abundance. Other relevant information was obtained from secondary sources such as that of rainfall and temperature data from 1980 to 2012 was obtained from Kericho meteorological department. The data obtained was statistically analyzed by use of SPSS and results discussed and presented in tables, charts and graphs. Respondents who reported that rainfall and temperature patterns have varied significantly over time represents 92.7% while those that responded that there has not been any change represents 7.3%. The difference between the two categories of respondents was significant ($\chi^2=218.5$, $p=0.000$). The responses were tested by adopting statistical significance of $p\leq 0.05$. From the study it was found that rainfall and temperature variability have affected the three sacred plant species under study, but the most affected of all is *P. linearifolia* followed by *V. auriculifera* and the least affected is *C. macrostachyus*. However apart from climate variability human activities have also affected the plants occurrence and abundance. Recommendation made for further study include; Farmers to practice agroforestry (growing of trees alongside crops). Farmers should also establish forests within their farms. This will increase evapotranspiration and create more carbon sinks hence maintaining an ideal temperature and rainfall for vegetation. The community should be encouraged to domesticate the plants, especially *P. linearifolia*. Riparian strip should be left undisturbed to allow natural vegetation to grow. These will include *C. macrostachyus*, *V. auriculifera* and *P. linearifolia* and others. Exotic trees (i.e *eucalyptus ssp*) along the riparian strip should be cut down. Farming along the strip should also be discouraged. Researchers to find out ways in which occurrence and abundance of *C. macrostachyus*, *V. auriculifera* and *P. linearifolia* can be enhanced.

CHAPTER ONE: INTRODUCTION

1.1 Background Information

Human societies everywhere have depended on biodiversity for cultural identity, spirituality, inspirations, aesthetic enjoyment and recreation. Culture can also play a key role in the conservation and sustainable use of biodiversity which affects both material and non-material human welfare. According to World Resource Institute, (2005). Both the continued loss of biodiversity and disruption of cultural integrity represent obstacles towards the development of the Millennium Development Goals (MDGs) (WRI, Over the past two decades, there has been growing recognition of the relevance of culture and cultural diversity for the conservation of biodiversity and for sustainable development (Berkes and Folke 1998, Borrini-Feyerabend *et al.*, 2004, Oviedo *et al.*, 2000, Posey 1999, Skutnabb-Kangas *et al.*, 2003, UNDP, 2004, UNEP and UNESCO 2003). In each society, culture is influenced by locally specific relationships between people and the environment, resulting in varied values, knowledge and practices related to biodiversity (Selin, 2003).

Cultural knowledge and practices have often contributed specific strategies for the sustainable use and management of biodiversity (Carlson and Maffi, 2004). The diversity of cultures that have developed globally provide vast array of responses to different ecosystems, and to variation and change in environmental conditions within them. This cultural diversity forms an essential part of the global pool of resources available to address the conservation of biodiversity (ICSU, 2002, UNESCO, 2000). However, cultural diversity is being rapidly lost, in parallel to biological diversity, and largely in response to the same drivers (Harmon, 2002; Maffi, 2001). Taking linguistic diversity as an indicator of cultural diversity, over 50 per cent of the world's 6,000 languages are currently endangered (UNESCO, 2001), and it has been speculated that up to 90 per cent of existing languages may not survive beyond 2100 (Krauss, 1992).

According to many cultural and religious belief systems, human beings should be good stewards of the Earth's organisms. Many people agree that we should preserve biodiversity for aesthetic reasons. Almost everyone enjoys contact with wild living

things. Time spent with other living things renews our sense of connection with nature and our appreciation of the world as a living system (Holt, 2000). With loss of languages comes the loss of cultural values, knowledge, innovations and practices, including those related to biodiversity (Zent and López-Zent, 2004).

1.2 Statement of the Problem

Environmental conditions play a key role in defining the functions and distribution of plants, in combination with other factors. Changes in long term environmental conditions that can be collectively referred to as climate change are known to have had enormous impacts on plant diversity patterns in the past, and are seen as having significant current impacts (Sahney *et al.*, 2010). Changing climatic variables relevant to the functions and distribution of plants include increasing global temperatures and altered precipitation patterns among others (Steffen *et al.*, 2005). Although these climate variability is experienced globally with consequences on functions and distribution of plants, it is important to carry out specific studies to determine their effects on plant diversity patterns in specific areas. Kericho area in South Rift region of Kenya has also experienced changing climatic variables as indicated by data from Kericho meteorological department 2012, with varying effects. However, no significant studies have been carried out to determine the extent of rainfall and temperature variation effects on the occurrence and abundance of *Vernonia auriculifera*, *Croton macrostachyus* and *Periploca linearifolia* and their sufficiency for their utilization by the Kipsigis ethnic community as sacred plants for their cultural activities.

1.3 Research Questions

- a) How have rainfall and temperature varied significantly from 1980 to 2012, in Kericho?
- b) Does the Kipsigis community find *Vernonia auriculifera*, *Croton macrostachyus* and *Periploca linearifolia* sufficient in occurrence and abundance as their sacred plants?
- c) Is the occurrence and abundance of *Vernonia auriculifera*, *Croton macrostachyus* and *Periploca linearifolia* related to climate variability?

1.4 Research Objectives

The overriding objective for this study was to relate climate variability on the occurrence and abundance of culturally important plants species. The specific objectives are:

- a) To examine whether rainfall and temperature patterns have varied significantly from the years 1980 to 2012 in Kericho County.
- b) To assess if the Kipsigis community find *V. auriculifera*, *C. macrostachyus* and *P. linearifolia* sufficient in occurrence and abundance as their sacred plants.
- c) To determine if the occurrence and abundance of *V. auriculifera*, *C. macrostachyus* and *P. linearifolia* is related to climate variability.

1.5 Justification

Biodiversity loss continues because the values of biodiversity are insufficiently recognized by political and market systems. In part this is due to the costs of biodiversity loss not being borne solely by those responsible for its loss. An added complexity is that the global nature of many biodiversity values results in the impact of biodiversity loss being felt far beyond national boundaries (UNESCO, 2000). Incorporating local and traditional knowledge in policy decisions and on-the-ground action calls for mainstreaming the links between biodiversity and culture into social and sectoral plans and policies (UNESCO, 2000).

The Kipsigis community, like other indigenous peoples in Africa, is being impacted by large scale drought (Heine *et al.*, 2008). The change in climate can be linked to global warming and human activities in the overall change of weather patterns (Heine *et al.*, 2008). For the Kipsigis community to remain a cultural group, they need to maintain their cultural traditions and practices (Heine *et al.*, 2008) by use of cultural elements which are the sacred plants. Unfortunately these elements are currently under threat due to climate change. There is need therefore for the conservation of biodiversity for a sustainable development and maintenance of cultural practices and traditions.

1.6 Conceptual Framework

A conceptual framework is used in research to outline possible courses of action or to present a preferred approach to an idea or thought. Conceptual frameworks (theoretical frameworks) are a type of intermediate theory that attempt to connect to all aspects of inquiry (such as problem definition, purpose, literature review, methodology, data collection and analysis) (Patricia and Hassan, 2006).

The conceptual frame illustrated in Figure 1.1, summarizes the importance of a sustainable biodiversity to mankind. The biodiversity is important because of practical uses such as; medicinal value, cultural uses, carpentry, as source of firewood, ecosystem preservation and aesthetic reasons. Some of the plant species that are important to mankind include *V. auriculifera*, *P. linearifolia* and *C. macrostachyus*.

The same biodiversity has been threatened by adverse climate variability such as erratic rainfall, temperature patterns and destruction of habitat. A sustainable biodiversity can be attained by educating the society on the importance of biodiversity to the community, laws, agreements and protection of the entire ecosystem for example the Endangered Species Act and Biodiversity treaty can be adopted in order to attain a sustainable biodiversity.

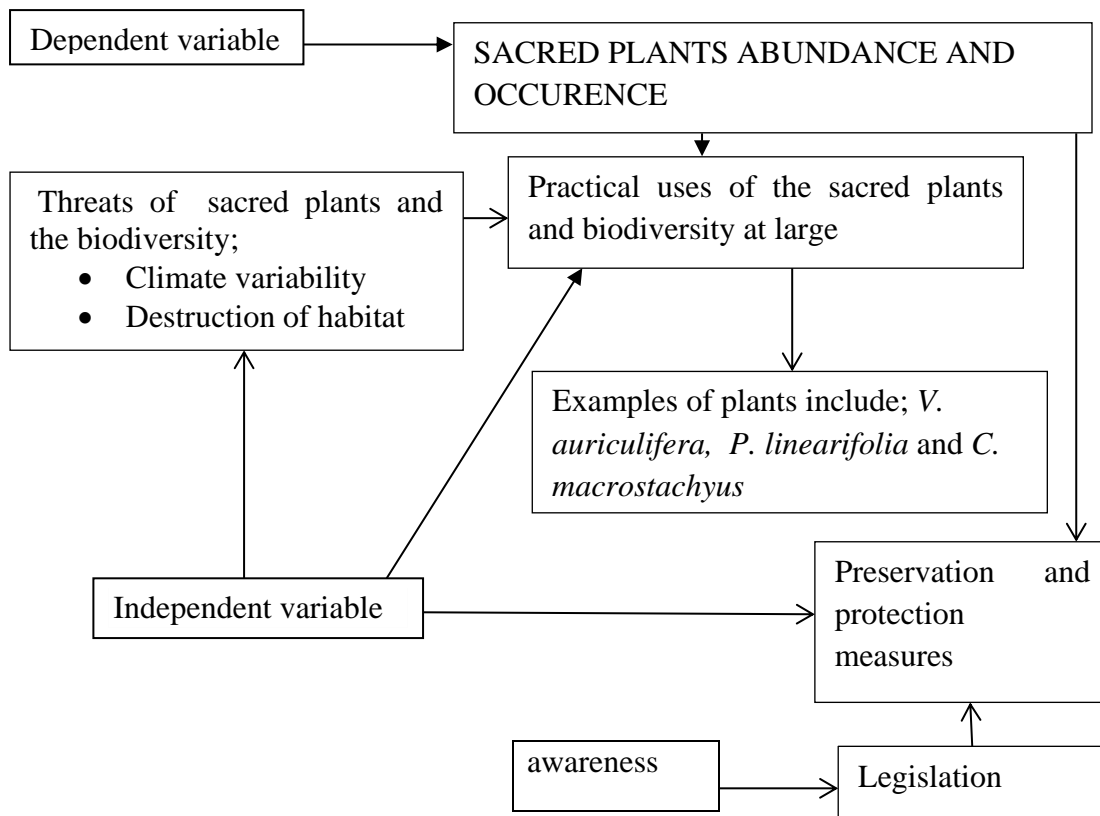


Figure 1.1: Conceptual Framework

In this conceptual framework sacred plants is the dependent variable and the independent variables include; occurrence and abundance, conservation measures, the uses of sacred plants and biodiversity and threats to it, such as climate variability. The changes in the biodiversity are caused by the effects of the independent variables such as varying rainfall patterns; changes in temperature, habitat destruction, the practical uses of the sacred plants which include; medicinal value, cultural, carpentry, source of firewood, ecosystem preservation and aesthetic reasons.

The same biodiversity can be conserved and protected by enforcing laws and agreements and protection of the entire ecosystem such as the endangered species act. The Endangered Species Act (ESA) of 1973 is the prime piece of legislation protecting species from extinction. It mandates a continually updated list of threatened species - those that are declining in number - as well as endangered species - those actually facing near-term extinction. Once a species is listed, the ESA mandates a recovery plan to help that species return to a healthy population level (CITES, 2013).

Biodiversity action plan (BAP) can also be embraced, it is an internationally recognized program addressing threatened species and habitats and is designed to protect and restore biological systems. The original impetus for these plans derives from the 1992 Convention on Biological Diversity (CBD) (CITES, 2013).

1.7 Definition of Terms

“Assis”	This is the main name for the one deity in Kalenjin.
“Assista”	The sun, the celestial body, which gives light and heat to the earth. It symbolizes God’s presence among the Kalenjin.
“Biodiversity”	It is the abundance and variety of species in the world or in the area
“Choorwet”	The cabbage tree; also known as the friendship tree; it signifies safety used in the construction of the Mabwaita.
“Climate factors”	The resulting factors of climate variability for instance, drought and floods.
“Emityoot”	Its common name is Black ironwood or East African olive, scientific name is <i>Olea capensis</i> ; Swahili name is loliondo or mushargi, signifies durability used in the construction of mabwaita.
“Kokweet”	Community.
“Kisaap mabwaita”	Bringing to life or restoring the prayer altar.
“Mabwai”	The term used by the Kipsigis for the family altar or prayer tree which was positioned east of the door as one exited from the door.
“Mumeek”	A term used for various ceremonies connected with oathing; plural form of “mumyaat”. To do something impossibly disgusting.
“Ng’eeetunoteet”	The coming out ceremony after initiation and circumcision.
“Non climatic factors”	Factors not directly resulting from climate variability.
“Sinendeet”	A vine with milky sap, used for sacred purposes.
“Tebeng’wet”	A branch from this tree could be used in “mumeek” oathing; a leaf from this plant could be tossed for “kewireen sogoot” (to place a death wish curse on someone.)

- “Tebesweet”** A tree which signifies life and fertility; used in erecting *mabwaita*.
- “Tegeryoot”** Person whose next older brother or sister died before his or she was born or who was an only living child.
- “Tiseet-aap emet”** Sprinkling of the land for cleansing involved the healing or sweetening of the harvest of a poor quality of millet.

CHAPTER TWO: LITERATURE REVIEW

2.1 Global Overview of the Importance of Biodiversity

Ecosystems vary greatly in size and composition, ranging from a small community of microbes in a drop of water, to the entire Amazon rain forest. The very existence of people, and that of the millions of species with which the planet is shared, is dependent on the health of our ecosystems. People are putting increasing strain on the world's terrestrial and aquatic ecosystems. Despite the importance of ecosystems, they are being modified in extent and composition by people at an unprecedented rate, with little understanding of the implications this will have in terms of their ability to function and provide services in the future (Millenium Assesment, 2005). For more than half of the world's 14 biomes, 20–50 per cent of their surface areas have already been converted to croplands (Olson *et al.*, 2001).

Tropical dry broadleaf forests have undergone the most rapid conversion since 1950, followed by temperate grasslands, flooded grasslands and savannahs. Approximately 50 per cent of inland water habitats are speculated to have been transformed for human use during the twentieth century (Finlayson and D'Cruz, 2005). Some 60 per cent of the world's major rivers have been fragmented by dams and diversions (Revenga *et al.*, 2000), reducing biodiversity as a result of flooding of habitats, disruption of flow patterns, isolation of animal populations and blocking of migration routes.

River systems are also being significantly affected by water withdrawals, leaving some major rivers nearly or completely dry. In the marine realm, particularly threatened ecosystems include coral reefs and seamounts. All available evidence points to a sixth major extinction event currently underway. Unlike the previous five events, which were due to natural disasters and planetary change the current loss of biodiversity is mainly due to human activities. The current rapid rates of habitat and landscape changes and modifications, increased rates of species extinction, and the reduction in genetic variability due to population declines, are having impacts on natural processes and on the needs of people. The details of many of these impacts remain uncertain, but their major negative influences can be foreseen and avoided or mitigated (Revenga *et al.*, 2000).

The fragmentation of ecosystems is increasingly affecting species, particularly migratory species that need a contiguous network of sites for their migratory journeys, species that rely on particular microhabitats and those that require multiple types of habitats during different life cycle stages. Although about 2 million species have been described, the total number of species ranges between 5 and 30 million (IUCN, 2006, May, 1992). Much of this uncertainty relates to the most species-rich groups such as invertebrates.

Current documented rates of extinction are estimated to be roughly 100 times higher than typical rates in the fossil record (Millenium Assesment, 2005). Although conservation success in the recovery of several threatened species has been noted (IUCN, 2006), and a few species that were presumed extinct have been rediscovered (Baillie *et al.*, 2004), it is feasible that extinction rates will increase to the order of 1 000–10 000 times background rates over the coming decades (Millenium Assesment, 2005).

Fewer than 10 per cent of the world's described species have thus far been assessed to determine their conservation status. Of these, over 16 000 species have been identified as threatened with extinction. Of the major vertebrate groups that have been comprehensively assessed, over 30 per cent of amphibians, 23 per cent of mammals and 12 per cent of birds are threatened (IUCN, 2006).

To understand trends in extinction risk, the conservation status of an entire species group must be assessed at regular intervals. Currently, this information is only available for birds and amphibians, both of which indicate a continuing increase in the risk of extinction from the 1980s to 2004 (Baillie *et al.*, 2004, Butchart *et al.*, 2005, IUCN, 2006).

The threat status of species is not evenly distributed. Tropical moist forests contain by far the highest number of threatened species, followed by tropical dry forests, montane grasslands and dry shrub lands. The distributions of threatened species in freshwater habitats is poorly known, but regional assessments from the United States, the Mediterranean Basin and elsewhere indicate that freshwater species are, in general, at much greater risk of extinction than terrestrial taxa (Smith and Darwall, 2006, Stein *et al.*, 2000).

Genetic diversity provides the basis for adaptation, allowing living organisms to respond to natural selection, and adapt to their environment. Genes therefore play a strong role in the resilience of biodiversity to global changes, such as climate change or novel diseases. Genes also provide direct benefits to people, such as the genetic material needed for improving yield and disease resistance of crops or for developing medicines and other products. Over the past two decades, many of the world's most important agricultural crops have lost genetic diversity due to changes in agricultural practices (Heal *et al.*, 2002).

The continued loss of genetic diversity of such crops may have major implications on food security. The amount or rate of loss of genetic diversity is poorly known, but inferences can be made from documented extinctions and population declines, which suggest that substantial genetic loss is occurring (IUCN, 2006).

Global responses to curb biodiversity loss In 2002, parties to the Convention on Biological Diversity (CBD) committed themselves to actions to “achieve, by 2010, a significant reduction of the current rate of biodiversity loss at the global, regional and national levels as a contribution to poverty alleviation and to the benefit of all life on earth” (Decision VI/26, CBD Strategic Plan). Setting this target has helped to highlight the need for improved biodiversity indicators, capable of measuring trends in a range of aspects of global biodiversity. It has also helped to galvanize the scientific community to try to develop indicators capable of measuring trends in the various aspects or levels of biodiversity (SCBD, 2006).

In addition to ensuring the effective management of protected areas, emphasis will increasingly need to be placed on the conservation of biodiversity outside protected areas, and in conjunction with other land uses if the rate of loss of biodiversity is to be reduced. The establishment of new policies and processes at all scales, the re-emergence of sustainable agricultural practices, the further development of collaboration among sectors, including corporate partnerships between conservation organizations and extractive industries, and the mainstreaming of biodiversity issues into all areas of decision making, will all contribute to a more secure future for biodiversity, and for sustainable development. Over the last 20 years environmental issues have increasingly been recognized as important in the development sector at a global scale. The commitment by parties to the CBD to achieve a significant reduction

in the rate of biodiversity loss by 2010 as a contribution to poverty alleviation and the benefit of all life on Earth, the endorsement by the 2002 Johannesburg World Summit on Sustainable Development (WSSD) of the CBD's 2010 target, and the incorporation of the 2010 biodiversity target into the Millennium (SCBD, 2006).

Development Goals as a new target under Goal 7 on environmental sustainability are some examples. A framework for action was proposed at WSSD to implement sustainable development policies, which covered five key areas (water, energy, health, agriculture and biodiversity), This "WEHAB" framework provided a focus, and confirmed the recognition of biodiversity as a key component of the sustainable development agenda.

2.2 Drivers and Pressures of Climate Change

Currently, population growth and patterns of consumption, which lead to increased demand for ecosystem services and energy, are the most important drivers affecting biodiversity. These drivers result in pressures that have direct impacts on ecosystems, species and genetic resources. Human activities cause changes in both the living and non-living components of ecosystems and these pressures have increased dramatically over the past few decades. Drivers and pressures seldom act in isolation. They tend to interact in synergistic ways, and their impacts on biodiversity are more than the sum of the effects of the individual drivers and pressures themselves (Millenium Assesment, 2005). Additionally, the interaction shows considerable regional variation. Drivers and pressures act at different temporal and spatial scales.

Virtually all of the factors leading to the accelerating loss of biodiversity are linked to the development of and increasing demand for energy by society. Of particular importance are the high levels of per capita energy use in the developed world, and the potential growth in energy use in the large emerging economies. The rapid increase in demand for energy has profound impacts on biodiversity at two levels (Guruswamy and McNeely, 1998; Wilson, 2002): impacts from the production and distribution of energy, and those resulting from the use of energy. Exploration for hydrocarbons, pipeline construction, uranium and coal mining, hydroelectric dam construction, harvesting for fuel wood and, increasingly, biofuel plantations can all lead to significant biodiversity loss, both on land and at sea. The widespread

anthropogenic changes to the environment have altered patterns of human disease, and increased pressures on human well-being. The loss of genetic diversity, overcrowding and habitat fragmentation all increase susceptibility to disease outbreaks (Lafferty and Gerber, 2002).

Some ecosystem changes create new habitat niches for disease vectors, for example, increasing the risk of malaria in Africa and the Amazon Basin (Vittor *et al.*, 2006). Trends in biodiversity over the next few decades will largely depend on human actions, especially those relating to land-use changes, energy production and conservation. These actions will, in turn, be affected by various factors including advances in our understanding of ecosystem services, development of viable alternatives to natural resources (especially fossil fuels), and the emphasis placed on the environment and conservation by developed and developing country governments alike. Efforts made to predict the prospects for species-level biodiversity have indicated that extinctions are likely to continue at a pace well above the background rate, with as many as 3.5 per cent of the world's birds (BirdLife International 2000), and perhaps a greater proportion of amphibians and freshwater fish, being lost or committed to extinction by the middle of the century.

Climate change is likely to play an increasing role in driving changes in biodiversity, with species' distributions and relative abundances shifting as their preferred climates move towards the poles and higher altitudes, leaving those endemic to polar and high mountain regions most at risk. Biodiversity is closely linked to livelihood security, agriculture, energy, health and culture, the five themes. Of these themes, agriculture (in terms of food security) and energy were explicitly considered in the Brundtland Commission report, and with a focus on water and health, tie together the WEHAB framework for action arising from WSSD (SCBD, 2006).

Biodiversity contributes directly and indirectly to livelihood security (Millennium Assessment, 2005). Functioning ecosystems are crucial buffers against extreme climate events, and act as carbon sinks and filters for water-borne and airborne pollutants. For example, the frequency of shallow landslides appears to be strongly related to vegetation cover, as roots play an important role in slope stability, and can give the soil mechanical support at shallow depth. In coastal areas, mangroves and other wetlands are particularly effective in providing shoreline stability, reducing

erosion, trapping sediments and toxins. The clustering of climate-related and biological risks will also contribute to impacts on human well-being through events such as heat waves and crop failures. Meeting global food needs poses increasing challenges, and will require either intensification or extensification to increase agricultural productivity (Tillman *et al.*, 2002).

Intensified systems tend to be dominated by only a few varieties. This approach is usually associated with higher levels of inputs, including technology, agrochemicals, energy and water use. The latter three, at least, have serious negative impacts on biodiversity. Extensification relies on lower inputs, and generally on more land being used, often through habitat conversion. In many parts of the world, agricultural extensification involves converting more land for the cultivation of major commodities such as soybeans (Latin America and the Caribbean), oil palm and rubber (Asia and the Pacific), and coffee (Africa, Latin America and Asia), and it is exacerbated by the emergence of new markets for export. In Brazil, for example, the area of land used for growing soybeans (most of which are exported to China) grew from 117 000 km² in 1994 to 210 000 km² in 2003. This was driven by a 52 per cent increase in world consumption of soybeans and soybean products (USDA, 2004), and these figures continue to rise dramatically. A major agricultural biotechnology innovation during the past two decades is the use of “transgenic” or living modified organisms (LMOs) to provide new attributes in different crops and breeds (FAO, 2004; IAASTD, 2007).

The technology is very young, and major investments are being made to enhance its contributions to human well-being and business stability. Research on LMOs has focused mainly on mitigating the impacts of pests and diseases, and there is evidence of reduced needs for pesticides and herbicides in some crops, such as cotton and maize, through genetic modification (FAO, 2004). The global production of genetically modified crops (mainly maize, soybean and cotton) was estimated to cover more than 900 000 km² in 2005 (James, 2003).

The use of LMOs is, as for many new technologies, highly controversial, specifically in relation to the uncertain impacts on ecosystems (through escape and naturalization in the landscape), human health and social structures. There are concerns about how its introduction will affect poor people, whose livelihoods depend primarily on

traditional low input agricultural practices. Increased research, monitoring and regulation are needed to ensure these negative impacts are avoided as this technology is developed. The Cartagena Protocol on Biosafety was negotiated and adopted under the CBD to develop a global framework for managing and regulating LMOs (FAO, 2004, Kormos, 2000).

More recently, increasing attention is being given to the existing and potential impacts of climate change on agriculture. Issues include the timing of growth, flowering and maturing of crops, and the impacts of (and on) pollinators, water resources and the distribution of rainfall. There are also issues of changes in market structures, yields for different crops and strains, and the impacts of extreme weather events on traditional methods and livelihoods (Stige *et al.*, 2005). Models show that in some areas, specifically where low temperature is a growth-limiting factor, agricultural productivity may increase with climate change. In other areas, where water and heat are limiting factors, productivity may be severely curtailed (IPCC, 2007).

Changes in production practices and loss of diversity in agro-ecosystems can undermine the ecosystem services necessary to sustain agriculture. For example, pollinator diversity and numbers are affected by habitat fragmentation (Aizen and Feinsinger, 1994; Aizen *et al.*, 2002), agricultural practices (Kremen *et al.*, 2002; Partap, 2002), the land-use matrix surrounding agricultural areas (De Marco and Coelho, 2004; Klein *et al.*, 2003) and other land-use changes (Joshi *et al.*, 2004). Although some of the crops that supply a significant proportion of the world's major staples do not require animal pollination (such as rice and maize), the decline of pollinators has long-term consequences for those crop species that serve as crucial sources of micronutrients and minerals (such as fruit trees and vegetables) in many parts of the world. Genetic erosion, loss of local populations of species, and loss of cultural traditions are often intimately intertwined. While rates of genetic erosion are poorly known, they generally accompany the transition from traditional to commercially developed varieties (FAO, 1998).

In crop and livestock production systems throughout the developing world, genetic erosion reduces smallholder farmer options for mitigating impacts of environmental change and reducing vulnerability, especially in marginal habitats or agricultural systems that are predisposed to extreme weather conditions (such as arid and semi-

arid lands of Africa and India). Implications for agricultural technologies and policy Methodological and technological innovation Since the Brundtland Commission report, agricultural research and development has made major advances in integrating conservation and development to mitigate loss of biodiversity, reverse land degradation and foster environmental sustainability. Much remains to be done to create the appropriate enabling environment in many countries, rich and poor alike, especially in eliminating anti-conservation regulations and inappropriate agricultural production subsidies. A particular area of advancement is the use of innovative agricultural practices to enhance production while conserving native biodiversity (Collins and Qualset, 1999; McNeely and Scherr, 2001; McNeely and Scherr, 2003, Pretty, 2002).

Efforts to foster biodiversity-friendly practices by integrating trees on farms (agroforestry), conservation agriculture, organic agriculture and integrated pest management are all contributing towards the sustainability of production landscapes. Agroforestry, for example, has emerged as a major opportunity for achieving biodiversity conservation and sustainability in production landscapes (Buck *et al.*, 1999; McNeely, 2004; Schroth *et al.*, 2004), through three major pathways: reducing pressure on natural forests, providing habitat for native plant and animal species and serving as an effective land use in fragmented landscapes. Integrated land management approaches are also helping to enhance ecosystem resilience through participatory processes that engage and empower farmers, strengthen local institutions and create options for value-added income generation. These approaches offer significant prospects for restoring degraded lands to enhance habitat connectivity and ecosystem processes. In the tropical forest margins, where slash-and-burn farming is a major cause of deforestation, knowledge of land-use dynamics has helped to identify practical options that are profitable for small-scale farmers and at the same time environmentally sustainable (Palm *et al.*, 2005).

However, a major challenge to wide-scale implementation of these approaches is the lack of appropriate policy frameworks that align rural and agricultural policies with the protection of biodiversity and ecosystem services. Without such links, the value of integrated natural resource management (Sayer and Campbell, 2004) and ecoagriculture (McNeely and Scherr, 2003) innovations will remain marginal in

ensuring the long-term viability of biodiversity. Very substantial collections of plant genetic resources for food and agriculture are now maintained Agriculture in a rain forest in Ghana, growing cassava and fruits such as bananas and papayas.

2.3 Effect of Climate Change on Energy and Biodiversity

Demand for energy is projected to grow at least 53 per cent by 2030 (IEA, 2006). Energy from biomass and waste is projected to supply about 10 per cent of global demand until 2030 However, this assumes that adequate fossil fuels will be available to address the majority of the increase in demand, and some have suggested this may not be realistic (Campbell, 2005). Energy-related carbon dioxide emissions are expected to increase slightly faster than energy use by 2030. Energy use has impacts at local, national and global levels. Pollution from burning fossil fuels, and the associated effects of acid rain have been a problem for European and North American forests, lakes and soils, although the impacts on biodiversity have not been as significant or widespread as cautioned in the Brundtland Commission report.

While emission controls in Europe and North America led to a reversal of acidification trends, there is now a risk of acidification in other areas of the world, particularly Asia. Desertification in the Sahel and elsewhere in sub-Saharan Africa has been linked in part to fuel demand from biomass (Goldemberg and Johansen, 2004). Indirect effects of energy use include both overexploitation of natural resources and greatly facilitated spread of invasive alien species through global trade, both made possible through cheap and easily-available energy for transport.

The impacts noted above are relatively localized and small in comparison to the potential impacts of climate change, which results largely from energy use As a result of climate change, species ranges and behavior are changing with consequences for human well-being, including changing patterns of human disease distribution, and increased opportunities for invasive alien species. Species most likely to be affected include those that already are rare or threatened, migratory species, polar species, genetically impoverished species, peripheral populations and specialized species, including those restricted to alpine areas and islands. Some amphibian species extinctions have already been linked with climate change (Ron *et al.*, 2003; Pounds *et*

al., 2006), and a recent global study estimated that 15–37 per cent of regional endemic species could be committed to extinction by 2050 (Thomas *et al.*, 2004 b).

Nuclear Combustible renewables, waste, geothermal and solar/wind/other Natural Gas Coal and coal products Crude, natural gas liquids and feed stocks have caused increase in global temperature. Climate change is also having impacts at ecosystem scales. By the year 2000, 27 per cent of the world's coral reefs had been degraded in part by increased water temperatures, with the largest single cause being the climate-related coral bleaching event of 1998. For some reefs recovery is already being reported (Wilkinson, 2002). Mediterranean-type ecosystems found in the Mediterranean basin, California, Chile, South Africa and Western Australia are expected to be strongly affected by climate change (Lavorel, 1998, Sala *et al.*, 2000). Few energy sources are completely biodiversity neutral, and energy choices need to be made with an understanding of the trade-offs involved in any specific situation, and the subsequent impacts on biodiversity and human well-being. Biodiversity management is emerging as a key tool for the mitigation of and adaptation to the impacts of climate change – from avoided deforestation to biodiversity offsets – while contributing to the conservation of a wide range of ecosystem services.

Biodiversity-based energy sources include both traditional biomass and modern biofuels. Ecosystems provide relatively inexpensive and accessible sources of traditional biomass energy, and therefore have a vital role to play in supporting poor populations. If these resources are threatened, as is the case in some countries with extreme deforestation, poverty reduction will be an even greater challenge. Use of fuelwood can cause deforestation, but demand for fuelwood can also encourage tree planting, as occurs, for example, in Kenya, Mali and several other developing countries (Barnes *et al.*, 2002)

Current actions to address the impacts of climate change can be both beneficial and harmful to biodiversity. For example, some carbon sequestration programmes, designed to mitigate impacts of greenhouse gases, can lead to adverse impacts on biodiversity through the establishment of monoculture forestry on areas of otherwise high biodiversity value. Avoiding deforestation, primarily through forest conservation projects, is an adaptation strategy that may be beneficial, with multiple benefits for climate change mitigation, forest biodiversity conservation, reducing desertification

and enhancing livelihoods. It must be recognized that some “leakage” in the form of emissions resulting from those conservation efforts can occur (Aukland *et al.*, 2003).

Climate change will also affect current biodiversity conservation strategies (Bomhard and Midgley, 2005). For example, shifts from one climate zone to another could occur in about half of the world’s protected areas (Halpin, 1997), with the effects more pronounced in those at higher latitudes and altitudes. Some protected area boundaries will need to be flexible if they are to continue to achieve their conservation goals. The impacts of energy production and use on biodiversity have been addressed as a by-product of several policy responses in the past few decades. Examples include Germany’s effort to reduce subsidies in the energy and transport sectors, promoting increases in the proportion of organic farming and reducing nitrogen use in agriculture (BMU, 1997; OECD, 2001).

However, responses have not been comprehensive, coordinated or universal. Commitments, including shared plans of action, have been made in various fora, but implementation has proved to be extremely challenging, due both to problems of securing required finance and lack of political will or vision. Global climate change and associated disturbances, particularly when coupled with human population growth and accelerating rates of resource use, will bring losses in biological diversity. Air pollution (including acid rain) has led to damage to forests in southern China amounting to US\$14 billion/year. Losses from air pollution impacts on agriculture are also substantial, amounting to US\$4.7 billion in Germany, US\$2.7 billion in Poland and US\$1.5 billion in Sweden (Myers and Kent, 2001).

The direct impact of oil spills on aquatic and marine ecosystems are widely reported. The most infamous case is the Exxon Valdez, which ran aground in 1989, spilling 37 000 tonnes of crude oil into Alaska’s Prince William Sound (ITOPF, 2006). Impacts also come through the development of oil fields and their associated infrastructure, and human activities in remote areas that are valuable for conserving biodiversity (such as Alaska’s Arctic National Wildlife Refuge that may be threatened by proposed oil development). Changes in distribution of and loss of natural resources that support livelihoods. Respiratory disease due to poor air quality. Decreased amount of land available for food crops or other needs due to greatly expanded use of land to produce biofuels, such as sugar cane or fast-growing trees, resulting in

possible natural habitat conversion to agriculture, and intensification of formerly extensively developed or fallow land. Can contribute chemical pollutants into the atmosphere that affect biodiversity (Pimentel *et al.*, 1994).

Burning crop residues as a fuel also removes essential soil nutrients, reducing soil organic matter and the water-holding capacity of the soil. Ensuring access to energy while maintaining biodiversity and vital ecosystem services will require an integrated multi-sectoral approach that includes: an ecosystem approach to management of biodiversity and natural resources that ensures inclusion of lessons learned in ongoing management of natural resources affected by energy production and use; a major shift in environmental governance to incorporate policies and incentives promoting energy production and use that mainstreams action to address biodiversity concerns, especially with respect to climate change; and increasing partnership with the private sector, including extractive industries and the financial sector, to promote energy programmes that internalize the full costs on biodiversity and livelihoods.

2.4 Health and Biodiversity

Biodiversity change affects human health although there is limited understanding of the consequences of many specific changes in biodiversity for health and the incidence of disease in people and other species, the conceptual links between broader environmental changes and human health are well understood. Emerging diseases resulting from the destruction and fragmentation of tropical forests and other ecosystems, wildlife-human disease linkages (for example, Lyme disease, West Nile virus and avian influenza), the many known and as yet undiscovered pharmaceutical products found in nature, the contribution of ecosystem services to human health and the increasing recognition of the impacts of endocrine disrupters on both animal and human health, all underline the links between biodiversity and human health (Chivian 2002; Osofsky *et al.*, 2005).

About 1 billion people live a subsistence lifestyle, and loss of ecosystem productivity (for example through loss of soil fertility, drought or overfishing) can rapidly lead to malnutrition, stunted childhood growth and development, and increased susceptibility to other diseases. There is a profound global nutritional imbalance, with a billion overnourished (mainly rich) people and a similar number undernourished (mainly poor

people). Historically, this imbalance has been driven primarily by social and economic factors, but ecological factors will probably play an increasingly important role in the future. Some 70 per cent of infectious diseases originate in animals, and conservation issues are central to their epidemiology.

Increased risks of infectious disease spread and crossover can result from land-use changes, many forms of intensive animal production, invasive alien species and the international wildlife trade. Climate change is expanding the range and activity level of disease vectors, particularly insect-borne vectors. The recent international scares over Sudden Acute Respiratory Syndrome (SARS) and avian influenza have brought a dramatic new dimension to the global health debate. Along with biodiversity changes, there are a number of other factors that are increasing the exposure to and risk of disease. An increasing human population provides an increased number of hosts for disease agents; climate change raises temperatures, altering the wider distribution of disease vectors, such as mosquitoes; drug resistance to conventional treatments is increasing; and continuing poverty and malnutrition make many people more susceptible to disease. Recent experiences with West Nile virus, hantavirus, avian influenza and tuberculosis provide evidence that disease causing micro-organisms are rapidly adapting to changing circumstances, and emerging or increasing rates of infectious diseases are the result (Ayele *et al.*, 2004; Campbell *et al.*, 2002; Harvell *et al.*, 2002; Zeier *et al.*, 2005).

However, changes to ecosystems and their services, especially freshwater sources, food-producing systems and climatic stability, have been responsible for significant adverse impacts on human health in the past 20 years, predominantly in poor countries. Wealthy communities are often able to avoid the effects of local ecosystem degradation by migration, substitution or by appropriation of resources from less-affected regions.

Biodiversity is also the source for many cures. In 2002–2003, 80 per cent of new chemicals introduced globally as drugs could be traced to or were inspired by natural products. Profits from such developments can be enormous. For example, a compound derived from a sea sponge to treat herpes was estimated to be worth US\$50–100 million annually, and estimates of the value of anti-cancer agents from marine organisms are up to US\$1 billion a year (UNEP, 2006a).

Traditional medicines, mainly derived from plants, are a mainstay of primary health care for a significant proportion of the population in developing countries. It is speculated that some 80 per cent of people in developing countries rely on traditional medicines, mostly derived from plants, and more than half of the most frequently prescribed drugs in developed countries are derived from natural sources. Loss of biodiversity may decrease our options for new treatments in the future. WHO has identified 20 000 species of medicinal plants for screening, and there are many more species whose medicinal values are only just being discovered, or may prove important in the future. The value of the global herbal medicine market was estimated at roughly US\$43 billion in 2001 (WHO, 2001).

The capacity of ecosystems to remove wastes from the environment is being degraded, due to increased loading of wastes and degradation of ecosystems, leading to local and sometimes global waste accumulation (Millenium Assessement, 2005). Examples include the accumulation of particles and gases in the air, and of microbial contaminants, inorganic chemicals, heavy metals, radioisotopes and persistent organic pollutants in water, soil and food. Such wastes have a wide range of negative health impacts.

Access to ecosystem services is not equitably distributed, and far from optimal from a population health perspective. Essential resources, such as shelter, nutritious food, clean water and energy supplies, are top priorities in effective health policies. Where ill health is directly or indirectly a result of excessive consumption of ecosystem services, substantial reductions in consumption would have major health benefits, and simultaneously reduce pressure on ecosystems (WHO, 2005). For example, in rich countries, harmful effects of ecosystem changes on human health, direct health impacts “ecosystem-mediated” health impacts and Indirect.

Deferred, and displaced health impacts floods, heat waves, water shortage, landslides, exposure to pollutants altered infectious disease risk, reduced food fields (malnutrition, stunting), depletion of natural medicines, mental health (personal, community), impacts of aesthetic/cultural impoverishment diverse health consequences of livelihood loss, population displacement (including slum dwelling), conflict, inappropriate adaptation and mitigation urbanization and its impacts damage to coastal reefs and ecosystems wetlands loss and damage loss of species and genetic

resources land degradation and desertification forest clearance and land cover change freshwater depletion and contamination where overconsumption is causing increasing health impacts, the reduced consumption of animal products and refined carbohydrates would have significant benefits for both human health and for ecosystems globally (WHO, 2005).

Integration of national agricultural and food security policies with the economic, social and environmental goals of sustainable development could be achieved, in part, by ensuring that the environmental and social costs of production and consumption are reflected more fully in the price of food and water.

Responses that mitigate the impacts of ecosystem changes on human health often involve policies and actions outside the health sector. Action to mitigate impacts of climate change will require cooperation across multiple sectors. However, the health sector bears responsibility for communicating the health impacts of ecosystem changes, and of effective and innovative interventions. Where there are trade-offs, such as between mitigation of negative health impacts and economic growth in other sectors, it is important that the health consequences are well understood, so that they can be included when setting priorities and determining trade-offs.

2.5 Interactions Between Biodiversity and Culture

Over the past two decades, there has been growing recognition of the relevance of culture and cultural diversity for the conservation of biodiversity and for sustainable development, as made explicit during the WSSD in 2002 (UNDP, 2004, UNEP and UNESCO, 2003). In each society, culture is influenced by locally specific relationships between people and the environment, resulting in varied values, knowledge and practices related to biodiversity (Selin, 2003).

Cultural knowledge and practices have often contributed specific strategies for the sustainable use and management of biodiversity (Anderson and Posey, 1989; Carlson and Maffi 2004; Meilleur1994). The diversity of cultures that have developed globally provides a vast array of responses to different ecosystems, and to variation and change in environmental conditions within them. This cultural diversity forms an essential part of the global pool of resources available to address the conservation of biodiversity (ICSU, 2002; UNESCO, 2000). However, cultural diversity is being

rapidly lost, in parallel to biological diversity, and largely in response to the same drivers (Harmon, 2002; Maffi, 2001).

In addition to the importance of culture for the conservation and sustainable use of biodiversity, human societies everywhere are themselves dependent on biodiversity for their livelihoods, as well as for cultural identity, spirituality, inspiration, aesthetic enjoyment and recreation (Millenium Assesment, 2005). Loss of biodiversity thus affects both material and non-material human well-being.

Although societies in industrialized countries may be further removed from the immediate impacts of biodiversity loss, they are nevertheless adversely affected by loss or decline in ecosystem services. Certain categories of people are especially vulnerable to drastic environmental and social change. They include the poor, women, children and youth, rural communities, and indigenous and tribal peoples. The latter constitute the majority of the world's cultural diversity (Posey, 1999). Correlations have been identified between the respective geographic distributions of cultural and biological globally and regionally (Stepp *et al*; 2005).

While correlations are evident at the global level, the identification of any causal links between biodiversity and cultural diversity requires research at the local level. Empirical evidence that supports the interrelationships between cultures and biodiversity includes: anthropogenic creation and maintenance of biodiverse landscapes through traditional low-impact resource management practices (Baleé, 1993; Posey, 1998; Zent, 1998); large contribution of traditional farmers to the global stock of plant crop varieties and animal breeds (Oldfield and Alcorn, 1987; Thrupp 1998); customary beliefs and behaviours that contribute directly or indirectly to biodiversity conservation, such as sustainable resource extraction techniques, sacred groves, ritual regulation of resource harvests and buffer zone maintenance (Moock and Rhoades, 1992; Posey 1999); and dependence of socio-cultural integrity and survival of local communities on access to and tenure of traditional territories, habitats and resources, which also importantly affect food security (Maffi, 2001).

These findings point to significant ecological and societal implications of the increasing threats to the world's cultural diversity. Global social and economic change is driving the loss of biodiversity, and disrupting local ways of life by promoting

cultural assimilation and homogenization. Cultural change, such as loss of cultural and spiritual values, languages, and traditional knowledge and practices, is a driver that can cause increasing pressures on biodiversity, including overharvesting, widespread land-use conversion, overuse of fertilizers, reliance on monocultures that replace wild foods and traditional cultivars, and the increase and spread of invasive alien species that displace native species (Millenium Assesment, 2005). In turn, these pressures impact human well-being. The disruption of cultural integrity also impedes the attainment of the Millennium Development Goals (MDGs) Impact on vulnerable groups dependent on local resources Relevance to MDGs. Local food insecurity due to reduction of traditional varieties of crops and access to wild foods (IUCN, 1997)

The biodiversity of planet Earth is the total variability of life forms (Chapman, 2009). Global biodiversity is affected by extinction and speciation. The background extinction rate varies among taxa but it is estimated that there is approximately one extinction per million species years, Biodiversity has grown and shrunk in earth's past due to (presumably) abiotic factors such as extinction events caused by geologically rapid changes in climate (Sahney *et al.*, 2010)

Human societies everywhere have depended on biodiversity for cultural identity, spirituality, inspirations, aesthetic enjoyment and recreation. Culture can also play a key role in the conservation and sustainable use of biodiversity which affects both material and non-material human welfare. Both the continued loss of biodiversity and disruption of cultural integrity represent obstacles toward the achievement of the Millennium Development Goals (MDGs) (WRI, 2005). Cultural ecosystem services are being increasingly recognized as key determinants of human well-being including; the maintenance of cultural traditions, cultural identity and spirituality. Among the wide range of other benefits from biodiversity is the production of energy from biomass and fossil fuels. Such use of biodiversity has brought tremendous benefit to many people, but has also had some significant negative knock-on effects in the human-induced climate changes and habitat conversion (WRI, 2005).

The populations of developing countries worldwide continue to rely heavily on traditional medicine as their primary source of health care. Ethno botanical studies carried out throughout Africa confirm that indigenous plants are the main constituents

of traditional African medicines (Mann *et al.*, 2008). More than 80% of the population of developing countries relies on traditional medicines. The importance of the role of medicinal plants in the health care delivery is very enormous; particularly for the respiratory diseases (Chigora *et al.*, 2007)

Kenya is rich in biodiversity even though a comprehensive inventory has not been done. According to National Biodiversity Strategy and Action Plan (NBSAP) MENR (2000), the country has 35,000 known species of animals, plants and microorganisms. These biological resources provide services such as food, industrial inputs, pulpwood, firewood, construction materials, medicines and ecosystem functions or aesthetics. The main challenge faced in biodiversity utilization in Kenya is that the population does not understand non-direct value hence the uncoordinated utilization and management of these resources.

Biodiversity is rich in living and non-living natural resources which are important sources of food, water, medicinal plants, fuel wood, materials for building and handcrafts in Kenya (Terer *et al.*, 2004). Sacred groves are special forest areas imbued with super natural powers and commonly comprise sites for rituals, initiation and other social functions and ceremonies (Posey, 1998).

Both UNESCO-MAB biosphere reserve concept (UNESCO, 1996) and the World Heritage Convention (UNESCO, 1972) clearly recognize the importance of sacred sites and place them into the context of sustainable development. UNESCO continues to play a leading role in expanding human capacity to conserve and benefit from biodiversity through protection of sacred sites. The (United Nations Millennium Declaration, 2000) called for Respect for Nature as one of the fundamental values for humanity. The Declaration urges: prudence must be shown in the management of all living species and natural resources in accordance with the precepts of sustainable development.

Medicinal herbs have been ignored during some ages and even dismissed in others. All human beings need some help for their many diseases and this help presently comes from nature, from simple herbs. These humble plants that were almost forgotten hide the best medicines that nature may offer for mankind's health (Roger, 2000).

2.6 Religious Status of Kipsigis of Kericho County

Kericho inhabitants are mostly Christians, the most widespread church being the African Gospel Church. The other churches present in the county include AIC, SDA, Catholic, Anglican Church, Full Gospel Church and a host of independent churches (KNBS, 2009). Traditional Kalenjin beliefs are monotheistic, with a belief in a single Deity called “*Assis*” (symbolized by the sun). The Kipsigis believed that *Assista* was near where *Assis* lived. *Assis* was the power of light of the sun. *Assis* was believed to have the power to see and hear everyone wherever he was. He was considered to be kind; he gave food, rain, health and all good things people enjoyed. *Assis* was thought as being universal; and wherever the sun shone, *Assis* was also there. He was believed to communicate through signs. The stomach of a person was considered to be the center of life and of his feelings because it could not be opened to find out the wishes of *Assis*, nor the feelings of the person (Burnette and Gerald, 1996). *Mabwaita* was the term used by the Kipsigis for the family altar or prayer tree which was positioned to the east of the house. The *Mabwaita* might be considered a temporary object in that it could fall into disrepair and needed to have new branches added from time to time. At the same time it was a very important place of worship for the Kipsigis family. The *Mabwaita* may be compared to a cubicle for prayer near the house, or like a church. There the father would pray for the family members as they faced the rising sun in the east so its rays could shine on them. The father would pour milk on the ground at the base of the *mabwaita* at this time (Burnette and Gerald, 1996). The spirits of dead ancestors were also an important part of Kalenjin religion, as was a practice of sacrifice to the spirits. Modern Kalenjin are almost exclusively Christians, with some Muslims. Even so, many blend their old beliefs with the new ones

The process of putting together a *Mabwaita* was called *kisooop mabwaita* which meant bringing to life the prayer tree. It also meant using the right kinds of branches. The branches from among these trees and shrubs were used in putting together a *mabwaita*: (*choorweet, mangweita, tebeswet, lebeekwet, emityoot, kosisiityet, sapteet, and sinendet*) to bind the branches together (Burnette and Gerald, 1996). *Tebeswet* signified life; *sinendet* was a symbol of blessing and was only used for clean and holy things. A *Mabwaita* once built could be renewed for other needs if it had fallen into disrepair. This was done by adding branches and tying new vine around it; it could

become large. Years ago large “trees” were put together, but these days if one is needed, only a few branches are put together.

The various branches used at a home depended somewhat on what was available in geographic location plus historical family preferences. Not all of the trees and shrubs grew everywhere. Branches from thorny bushes were not used. When the father died, the *mabwaita* was taken away. An elderly man in the community would take the branches and discard them in the nearby bushes. When the new house was built about a year later a new *mabwaita* was erected also. An elderly member of the same clan as the deceased man would be called to erect the new *mabwaita*. If the ceremony was going to take place to bless the new house, people would hurry the work and finish the building on time. The *mabwaita* was the center of all home ceremonies and one was put together or repaired when there was a need. Some of these needs are stated below (Burnette and Gerald, 1996).

During birth a ram sacrifice at *mabwaita* was done to cleanse a mother who had given birth to twins. A year after birth the mother’s hair was cut at the *mabwaita* and put into the branches. A sacrifice was done for a girl initiate who was found out to be pregnant; the first sacrifice was made once it was found out that she was pregnant and the second sacrifice of a goat or sheep was made after the birth of the baby, this was a cleansing ceremony. Both sacrifices were done at *mabwaita*. The extraction of two lower permanent teeth was done during childhood at the west of *mabwaita* and the extracted teeth thrown at the east of *mabwaita*. A child between ten and fifteen years of age faced the east at the *mabwaita* in the morning as his or her earlobes were pierced in preparation for stretching. A ceremony was also done to a sickling/ill child where fresh milk was sprinkled on a goat and on the baby’s head and a prayer made for the child; this was also done at *mabwaita*. A ceremony was done at *mabwaita* to a *tegeryoot* (a person whose next older brother or sister died before his or she was born or who was an only living child) in a family. The evening before the initiate was circumcised, a crowd gathered at the home; a fire was lit at the *mabwaita*. The night - was spent singing and dancing. Female relatives garlanded by *sinendet* creepers circled at the *mabwaita*.

When a father of a young man talked to the father of the girl about marriage arrangements, they talked at the *mabwaita*. During the night of marriage, the bride

and her attendant arrived at the groom's home, the groom and his best man, on hearing her bell, went out and waited at the *mabwaita* where the fire has been lit. The four walked around *mabwaita* twice then entered the house for blessing then go to encircle *mabwaita* again twice, to make a total of four, then when back to the house to undergo other ceremonies.

Following a death, the person who carried a corpse to the spot or burial or disposal was considered unclean. A sacrifice for cleansing was offered at the *mabwaita* at this home. When the father died, the *mabwaita* was taken away. An elderly man in the community would take the branches and discard them in the nearby bushes. When the new house was built about a year later a new *mabwaita* was erected also. An elderly member of the same clan as the deceased man would be called to erect the new *mabwaita*. If the ceremony was going to take place to bless the new house, people would hurry the work and finish the building on time. Cleansing of a murderer was also done at *mabwaita*.

A small version of *mabwaita* was built in the millet field at the time of weeding. A prayer was offered for good crops and an offering of sweet- smelling sacred vines was burned, and beer was made and drunk. After the first millet had been harvested each *kookweet* (community) conducted its harvest celebration. A small *mabwaita* was erected in the field of the leading elder of the community. Each woman brought a small basket of newly harvested millet and marched around the *mabwaita* three times with it. Men were present and enjoyed the feast which followed and but they did not march around the *mabwaita*. *Tiseet-aap emet*, (sprinkling of the land) for cleansing involved the healing or sweetening of the harvest of a poor quality of millet. The women constructed a *mabwaita* at the river where the ceremony was performed. Each woman marched around it with some of the unpalatable millet in a goat bag in her back. After harvesting was completed a ceremony was observed. A large *mabwaita* was put up and a pure white goat was led around it by the local priest. The priest also asked *Asiis* for blessings. Cattle were sprinkled with beer for blessing.

2.7. Description of the Plant Species

The Kipsigis community uses many plant species for their cultural activities, three of these plants have been selected, these are; *Croton macrostachyus* Hochst. ex Delile,

1847 , *Periploca linearifolia* Linnaeus, 1753 and *Vernonia auriculifera* Linnaeus, 1847. *Croton macrostachyus* whose common name is the broad leaved croton, is called 'tebeswet' by the Kipsigis. According to Battiscombe (1926), it is a small spreading tree widely distributed throughout a colony at an altitude of 1219.2-1980.2 meters, occasionally attaining timber dimensions when growing in forest localities of heavy rainfall. Leaves are light green, ovate, up to 4 inches in length or longer and hairy on both surfaces. The flowers are produced in drooping racemes; 5-7 inches long. When it flowers, the plant resembles lime trees in that honey drips on the ground from flowers. (Applied research, Kericho 2012) explains that it is a woody plant of medium height, moderately soft and perishable hence not good for timber but is good for firewood. A decoction from the roots is used to treat malaria. The plant is also used by the Kipsigis to erect family altar (*mabwaita*) during ceremonial functions and to symbolize fertility of a land and life (Burnette and Gerald, 1996).

V. auriculifera is called 'tebeng'wet' by the Kipsigis. In Kenya, the Maasai community uses the stems and leaves in hut-construction and the Kipsigis use these materials to make platforms in hut-roofs for grain storage. In Kenya, the leaves are also used for wrapping plant drugs to be roasted and used as a poultice while in Uganda the leaves are used as a substitute for toilet paper. The stems are also burnt as fuel, In Rwanda and DR Congo, the leaves and young twigs are eaten by domestic animals (Isawumi, 2008). The stems, leaves and flowers yield a dye: green colored without mordant or with alum, and golden colored with chrome. *V. auriculifera* is left to grow or sometimes planted as a fallow plant to improve the soil or as a shade-providing nurse tree, In Ethiopia it is said that when the plant flowers it is time to sow millet, In Kenya *V. auriculifera* is used in traditional medicine (Isawumi, 2008), a branch from these tree could be used in *mumeek* (oathing); a leaf from these plant could be tossed for *kewiren sogoot* (to place a death wish curse on someone) (Burnette and Gerald, 1996).

P. linearifolia is called 'sinendet' by the Kipsigis community. It is a climbing herb with very large root stock, dark green in color with narrow and smooth leaves with smooth margins; the leaves are linear up to 3 inches in length and the stems are wiry (Battiscombe, 1926). It is a terrestrial plant common in Kikuyu and Kamba Counties. Latex is said to be collected from the roots by Akamba, and a mixture made from it

and then given to cows to increase supply of milk. The stems are used as a tying material by Kikuyus (found in places that experience medium amounts of rainfall). The plant is sacred to the Kipsigis community and it is used during important ceremonies for example; weddings and initiation ceremonies. According to (Burnette and Gerald 1995, 1996) a *mabwaita* was started by first sticking a large branch into the ground. Then other branches would be added and tied to it. *Sinendet*, a creeper with milky sap and narrow leaves was used to tie the branches together. *Sinendet* was used often in ceremonies. It was a symbol of blessing and was used only for clean and holy things. For example, it could not be used for tying the grass used to thatch the roof of a house or other buildings.

2.8. Climate Variability and Effects on the Kalenjin Community

The Kalenjin rely mainly on animal husbandry but drought has been the largest factor that has led to environmental degradation. Like other indigenous peoples in Africa being affected by large scale drought, the change in climate can be linked to global warming and factors caused by human beings in the overall change of weather patterns. Maintaining access to clean perennial water sources is a key issue effecting Kalenjin indigenous people as well as maintaining cultural traditions and practices in the face of rapidly modernizing global world (Heine *et al.*, 2008).

2.9. Factors affecting the diversity and occurrence of plants species

An introduced, alien, exotic, non-indigenous, or non-native species, or simply an introduction, is a species living outside its native distributional range, which has arrived there by human activity, either deliberate or accidental. Non-native species can have various effects on the local ecosystem. Introduced species that have a negative effect on a local ecosystem are also known as invasive species. Not all non-native species are considered invasive. Some have no negative effect and can, in fact, be beneficial as an alternative to pesticides in agriculture for example. In some instances the potential for being beneficial or detrimental in the long run remains unknown (Dov Sax, 2008).

According to Kevin and Lewis (1994), Human introduction of new plant species accidentally or intensively into a new area can have both positive and negative effects.

Plants that invade an area may be more successful than indigenous flora; they can begin to dominate a region which may be advantageous. Human introduction of animals to a region may have devastating effects on its vegetation, with rapid growth of world's population; many societies have been demanding more from earth's resources and affecting its land surface. In more recent times humans have destroyed enormous tract vegetation, excavated large areas of land and greatly modified the landscape. As humans take up more space and deplete more resources we destroy the habitat of other species.

As explained by (Hsiao, 1973) drought have profound effects on growth of plants. Mechanisms underlying the responses of plants to water stress may be divided into the following categories: Reduction of water potential, decrease of cell turgor pressure, concentration of small molecules and macromolecules as volume decrease with reduced turgor. (Ilker *et al.*, 1979) describe that some plants of tropical origin are injured when temperature drops above freezing but low enough to cause damage to tissues, cells or organs of the plant. Acid rain is also considered to be the major culprit in the destructions of millions of trees (Kevin and Lewis, 1994).

Acid precipitation is highly acidic precipitation (rain, sleet or snow) that results from burning of fossil fuels. When fossil fuels are burned, they release oxides of sulfur and nitrogen as by-products. The oxides combine with water in the atmosphere to form sulfuric acid and nitric acid, which fall as precipitate. Acid precipitation can kill living things; it can even destroy the entire ecosystem. Forest ecosystems are also affected by acid precipitation. Trees, like other organisms, can tolerate only specific pH ranges. If the water they take up through their roots is too acidic, they will die (Holt, 2000).

Important aspects of climate are temperature and precipitation; these two aspects determine what types of organisms are able to live in a region. With increased averages in temperatures in low latitudes, vegetation/ farming shifts to higher and cooler latitudes (Holt, 2000). Despite the critical need for more effective conservation and sustainable use, the loss of biodiversity continues, and in many areas it is currently increasing in magnitude (WRI, 2005).

CHAPTER THREE: METHODOLOGY

3.1 Area of Study

The Study was undertaken at Belgut Division of Kericho County, which borders the following counties: Nandi to the North, Nakuru to the East, Bomet to the South and Kisumu County to the West. Kericho County covers an area of about 2,469 km² (World Atlas, 1997). It lies at an altitude of 2096m above sea level and this area is an Agro-Ecological Zone 1 (KENBS, 2009). The area of study (which is Kabianga location of Belgut division) extends from 53°16'48.89"E, 0°18'12.53"S North to 35°2'25.89"E, 0°19'11.55"S North and 35°2'25.89" E 0°28'15.08S South to 35°16'48.65"E 0°28'14.74S South (GPS Google earth accessed on September 22, 2014) Belgut Division has five locations and the study was undertaken in one of the locations which is Kabianga Location. Kabianga location is made up of eight sub locations (see Plate 3.1)

3.2 Temperature and Rainfall patterns

Kericho county temperatures, range from a minimum of 10°C in the upper zone to a maximum of 27°C in the lower zone. The rainfall distribution is bi-modal. The average rainfall ranges between 1,200 mm and 2,200mm per annum split into long rains received in April to June and short rains in September to November with no distinct mark between the long and short rain seasons. Soils are mainly of volcanic origin exhibiting high fertility which is also declining due to many years of cropping and high rainfall which leaches soil nutrients underground. (Jaetzold *et al.*, 2009).

3.3 Geology and Soils

Intermediate and basic volcanic rocks (phonolites) underlie most of the area. The central part, which is the largest part of the district, is occupied by volcanic footbridge landscape. Here we find soil unit RBA of moderate fertility. In the eastern part of the district group, soils occur with generally high fertility (Jaetzold *et al.*, 2009).

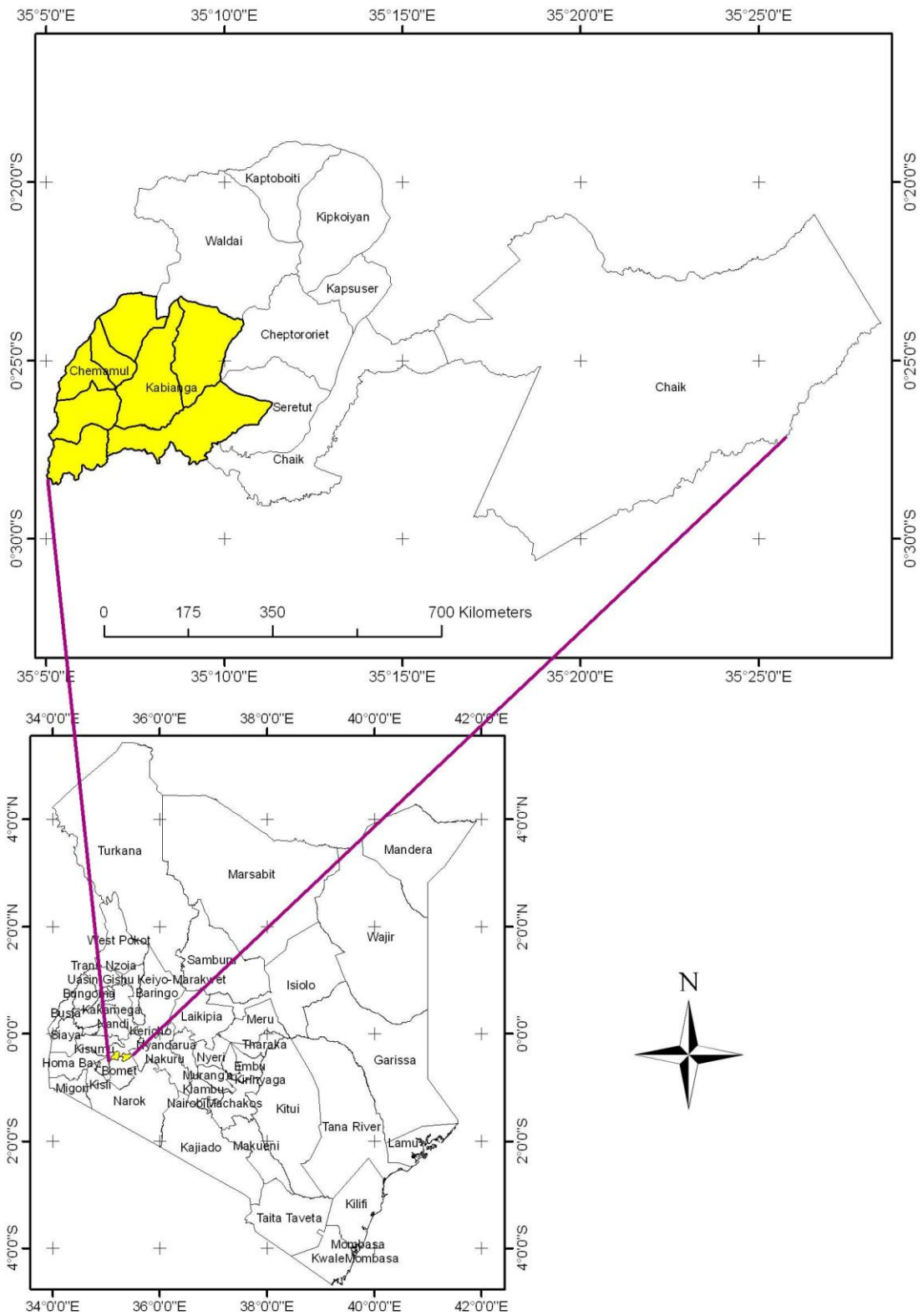


Plate 3.1: A map of Belgut Constituency in Kericho County

(Retrieved 10th June 2014, Adapted

from: <http://www.flickr.com/photos/albertkenyaniinima/7837213078/>

3.4 Topography and Drainage

The major part of the Kericho groups of districts exhibits undulating to rolling topography that gives way to flatter terrain in the south. The overall slope of the land is towards the west, consequently drainage is also in that direction, at least in the eastern part, cutting deep valleys (except in the southern part) (Jaetzold *et al.*, 2009).

3.5 Population Distribution and Economic Activities

The population of Kericho County is about 758,339 with a population density of 306 people per Km² (KNBS, 2009) and the study area has a population of 35,091. It is made up of eight sub-locations namely; Mobego, Kiptome, Kapkitony, Chebirirbei, Koiwalelach, Kapcheluch, Chemamul and Kabianga (KNBS, 2009). The main economic activities/industries are: tea growing and processing, dairy farming, horticulture and floriculture, wheat farming, fish farming and commercial businesses. Agricultural products include: maize, beans, potatoes, vegetables, tea and coffee (Kenya Decides, 2013)

3.6 Sampling Procedure

A non-probability sampling technique namely, purposive sampling was used in this study. According to Patton (cited in McMillian & Schumacher, 1993) purposive sampling is selecting information-rich cases for an in-depth study. The sample for this study comprised heads of families from the rural set-up of Belgut Division. Purposive sampling is undertaken to increase the utility of information obtained from small samples. Information rich participants were chosen because they were likely to be knowledgeable and informative about the phenomena under investigation (McMillian & Schumacher, 1993). A formula was also adapted to obtain an ideal sample size where the information rich participants were selected from. Yamane (1967) provides a simplified formula to calculate sample sizes. This formula was used to calculate the sample size where the information rich participants were selected from.

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size, and e is the level of precision which is (0.05). To obtain a sample size letters are substituted with values; the total population of the division was 35091, therefore;

$$N = 35091$$

n = Sample size

e = level of precision

$$n = \frac{35091}{1 + 35091(.05)^2}$$

$$n = 395$$

From the formula the actual sample size of this study was 395. After the issuance of the questionnaires, three hundred responses were duly filled, returned and analysed. The analysed number of responses represented 76% of the issued questionnaires. The results and interpretations are discussed in chapter four.

3.7 Research Instruments

Structured questionnaires were used to collect data from heads of families. Both qualitative and quantitative data were collected using closed-ended questions (Appendix 2). Data collected from heads of families include temperature and rainfall changes, knowledge and information on effects of rainfall and temperature changes to the selected sacred plants, perception on climate change phenomenon and uses of the selected sacred plants.

The Questionnaire was divided into two sections. The first section consisted of questions targeted at collecting respondents' profile data while section two consisted of specific questions seeking responses to the research questions. Responses involved selection from a list or rating / scaling using five point scales. When designing a rating scale, a researcher must specify the number of points on the scale (Likert, 1932). Rating scale most often uses 5 points. When responding to a Likert questionnaire item, respondents specified their level of agreement or disagreement on a symmetric agrees- disagree scale for a series of statements. Thus, the range captured the intensity of their feelings for a given item (Burns *et al.*, 2008). The use of

structured questionnaires to collect data from heads was considered most convenient due to the need to get as many responses as possible while being cognizant to keep the time taken to fill it as short as possible.

Semi-structured interviews were also used to collect data; the rationale for using semi structured interview method during data collection was informed by the need to obtain high response rate and in-depth data for the study.

3.8 Research Design and Methods of Collecting Data

These included primary and secondary data. Primary data was obtained by use of a structured questionnaire which contained closed-ended and a few open-ended questions. Because of illiteracy level of some climate variability witnesses, oral administration of questionnaires was also used. Secondary data was obtained from published works including books, relevant reports, newspapers, journals and internet. Additionally, primary data was obtained from the field through observation, measurement and recording of the available selected plant species and the information obtained from the respondents.

The abundances of plant species was measured by plant cover, i.e. the relative area covered by different plant species in a small plot (Coker and Coker, 1992, Grant, 1993). The most common way to measure plant cover in herbal plant communities is to make a visual assessment of the relative area covered by the different species in a small plot. The visually assessed cover of a plant species is then recorded as a continuous variable (Braun-Blanquet, 1964).

3.9 Administration of Research Instruments

Data collection was undertaken in the month of January and February 2014 and was spread throughout all the days of the week to ensure that a wide range of participants from diverse backgrounds was included. A total of 395 questionnaires were distributed. Prior to data collection a pilot study was undertaken in order to test the research instruments and also familiarize with modes of instrument administration. Heads of households were targeted and requested to fill the questionnaire since it was expected that they would have been exposed to Kipsigis culture and climate variability. In conditions where heads were unavailable to fill the questionnaires, their

wives were requested to fill them. All respondents filled the questionnaires on their own with the research assistants providing clarifications where necessary as well as cross checking the accuracy and completeness of the responses. On average it took about 10-15 minutes for the respondents to complete filling the questionnaires and this was within guidelines on designing (Moore *et al.*, 2009).

3.10 Data Analysis

The questionnaires were examined to ensure they were completed and consistently filled. The response questions were numerically coded and responses stored on computer spreadsheet software, MS Excel, under assigned variable names. Descriptive statistics namely, means, and percentages were used to analyze the data. Comparisons of categorical data were done using Chi-Square Test. Correlations were used to determine degree of associations between two linearly related variables such as relationship between climate variability and plant occurrence and abundance. A five point Likert-type scale was used to measure respondents' perception of the roles of *C. macrostachyus*, *P. linearifolia* and *V. auriculifera* in the community. A five point Likert-type scale was also used to assess respondents' agreement or disagreement with situational characteristics weather in Belgut Division. Statistical Package for Social Sciences (SPSS) was used to conduct these analyses.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Respondents' Interview Response Rate

The study was done in eight sub locations of Belgut Division; namely Mobego, Kiptome, Kapkitony, Chebirirbei, Koiwalelach, Kapcheluch, Chemamul and Kabianga. A Summary of questionnaires issued and received per sub location is shown in Table 4.1 below;

Table 4.1: Summary of questionnaires issued and received per sub location

SUBLOCATION	ISSUED QUESTIONNAIRES	DULY FILLED QUESTIONNAIRES
MOBEGO	49	38
KIPTOME	49	39
KAPKITONY	49	37
CHEBIRIRBEI	49	36
KAPCHELUCH	49	37
CHEMAMUL	49	38
KABIANGA	51	37
KOIWALELACH	50	38
UNACCOUNTED FOR	0	95
TOTAL	395	395

From the summary in (Table 4.1), three hundred and ninety five questionnaires were issued to the eight sub locations. The questionnaires were divided fairly amongst the eight sub locations and six sub locations was issued with forty nine questionnaires each, while two sublocations were issued with fifty and fifty one questionnaires respectively. This was done to obtain the maximum number of respondents per sub-location and also to prevent some sub locations from dominating in responding, this therefore ensured that fairness was observed. Out of the three hundred and ninety five issued questionnaires, three hundred were dully filled and returned. From Mobego sub location 38 questionnaires were well filled and returned, Kiptome 39, Kapkitony 37, Chebirirbei 36, Kapcheluch 37, Chemamul 38, Kabianga 37, and Koiwalelach 38. (Figure 4.1).

From the table (Table 4.1), 95 questionnaires representing 24% cannot be accounted for. Some of them were not well filled while others were not returned by the respondents on instances where respondents were given questionnaires in the morning and were to be collected in the afternoon, the field assistants could miss to find the respondent in the afternoon. Only three hundred were considered for data analysis.

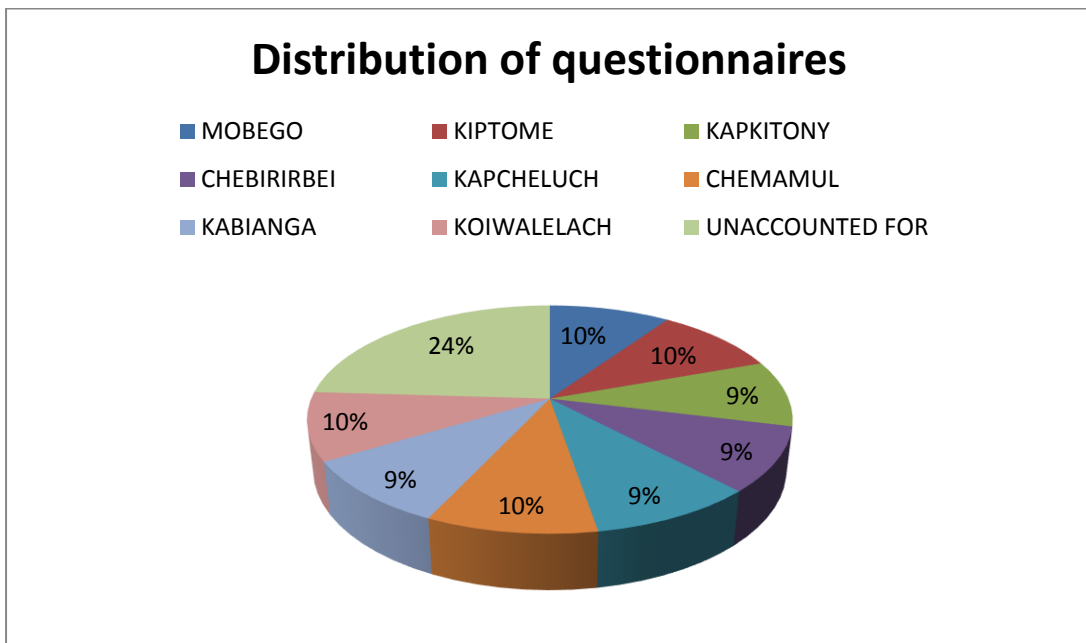


Figure 4.1: Percentages of duly filled and received questionnaires

4.2 Respondents' Age and Gender Profiles

Among the three hundred respondents, 169 were males and 131 were females, representing 56.3% and 43.7% respectively, as shown in (Table 4.2). The difference between male and female respondents was significant ($\chi^2=4.813$, $p=0.028$). Majority of the respondents representing (44%) were aged 50 years and above while those aged between 20 – 29 and 30-39 years accounted for 12% each (Table 4.2). The older respondents were a major target for this study because they had more knowledge on the Kipsigis culture and activities; they are the 'information rich' respondents. Criterion Sampling was also employed after the ideal sample size 395 was obtained; this involves searching for cases or individuals who meet a certain criterion, person or place or situation that has the largest potential for advancing your understanding (Lisa, 2008).

Table 4.2 : Respondents' Age and Gender Profiles

Number of respondents				
Age group	Male	Female	Total	(%)
20-29	17	20	37	12
30-39	20	15	35	12
40-49	49	47	96	32
50 -59	50	20	70	23.3
60-69	25	17	42	14
70 and above	8	12	20	6.7
Total	169	131	300	100
%Totals	56.3	43.7	100	

4.3 Climate Variability in Kericho County between 1980 and 2012

The examination of climate variability in the study area was necessary before assessing its relationship to plants species occurrence. Rainfall and temperature were considered most appropriate indicators of climate variability for this analysis as they are the most widely studied elements of climate globally. To achieve this analysis, the researcher obtained meteorological data on temperature and precipitation for Kericho County for the period 1980-2012 from the Kericho Meteorological Department.

4.3.1 Temperature trend of Kericho between 1980 and 2012

Using the computed monthly average temperatures based on monthly minimum and maximum temperature data obtained from Kericho Meteorological Department, the researcher performed a series of analyses to study temperature trends in Kericho. Five years moving an average of the area was calculated and the results revealed that Kericho is slowly warming.

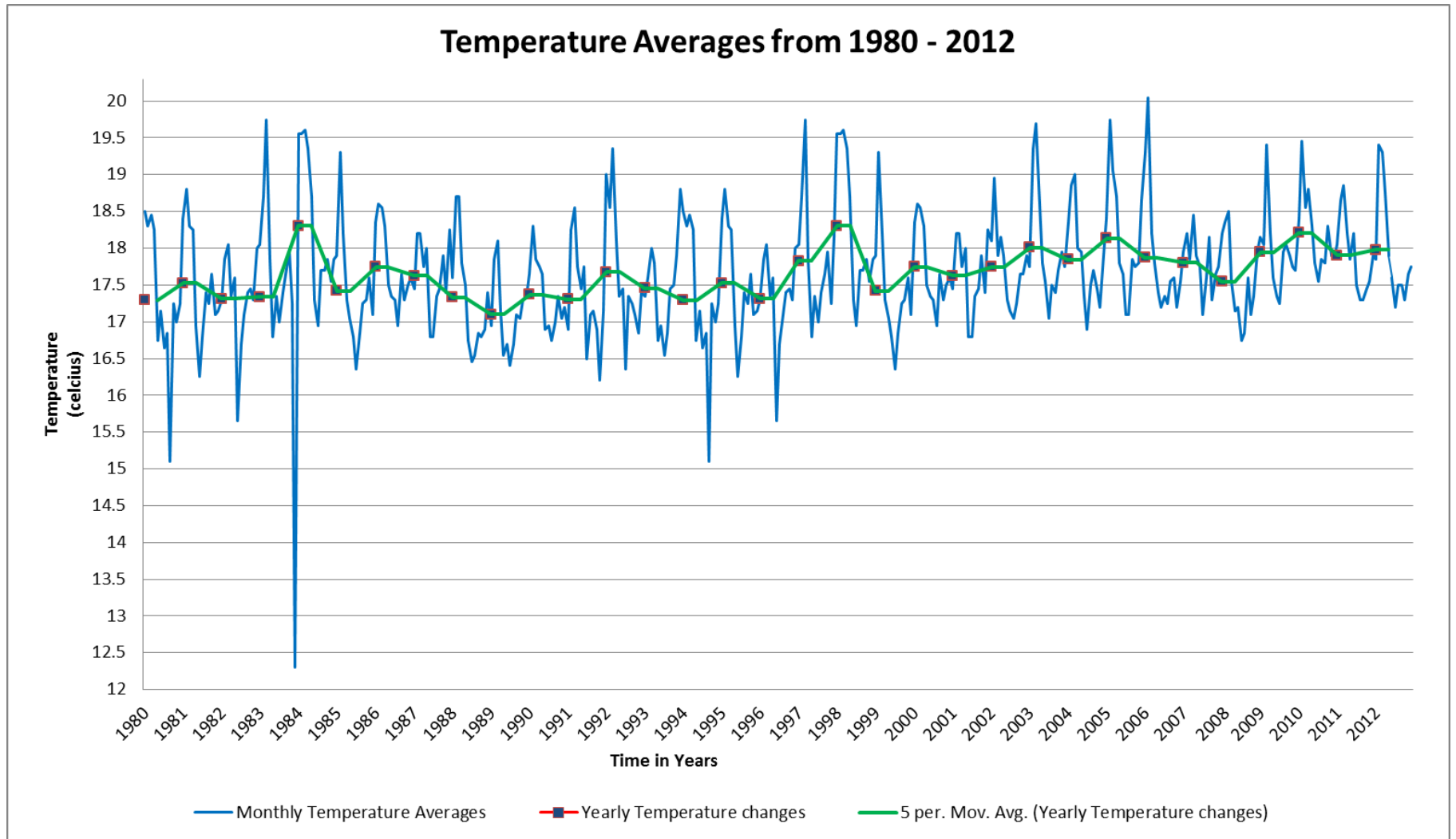


Figure 4.2: Annual average temperature variability in Kericho during the period 1980-2012

The average monthly temperature recorded in Kericho during the 33 years period under analysis was 17.662 °C. An analysis of annual average monthly temperature trend for this period revealed that temperatures rose from 17.292 °C in 1980 to 19.975 °C in 2012, but with significant annual variability as reflected in the significant differences in the means of the years that recorded temperatures below long term mean and those that recorded temperatures above the long term mean as illustrated in Figure 4.3. Temperatures for the years 1980 to 1983 remained below average; a sharp increase from 17.3375 °C in 1983 to 18.304 °C in 1984 was recorded, and in 1985 temperature above average was also recorded.

From 1987 to 1996 temperatures below average were recorded. 1997 and 1998 recorded an increase in monthly average temperature to 17.825 °C and 18.3041 respectively from 17.3125 in 1996, followed by decline back to 17.41 °C in 1999 and another sharp increase to 17.745 °C in 2000. In 2001 decline to 17.629 was recorded. The subsequent 5 years witnessed a temperature increase up to 17.870 °C in 2006. A sharp decline in temperature was recorded again in 2007, but this was not sustained in the subsequent years as temperatures remained above the 33 years mean temperature from 17.804 °C in 2007 to 17.975 °C in 2012.

A five years moving average analysis of temperatures across the three decades revealed that temperatures in Kericho has increased by 0.68 during the 33 years period.

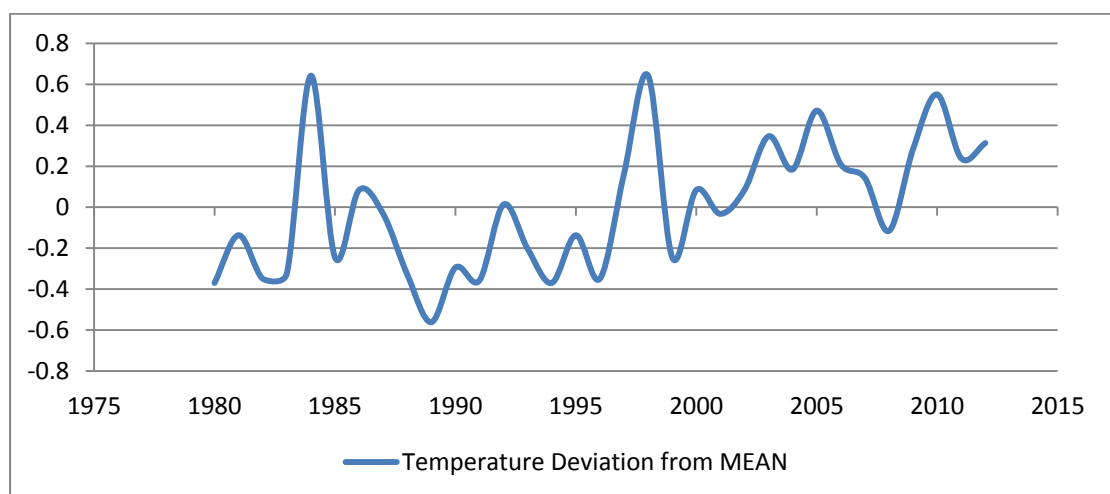


Figure 4.3: Graph of temperature deviation from mean

4.3.2 Rainfall trend of Kericho between 1980 to 2012

Precipitation is another key indicator of climate change just like temperature. An analysis of annual precipitation amounts recorded in Kericho for the period 1980-2012 revealed that rainfall amount in the area is slowly decreasing, but with yearly variability as illustrated in Fig. 4.4. by the linear representation of annual average rainfall.

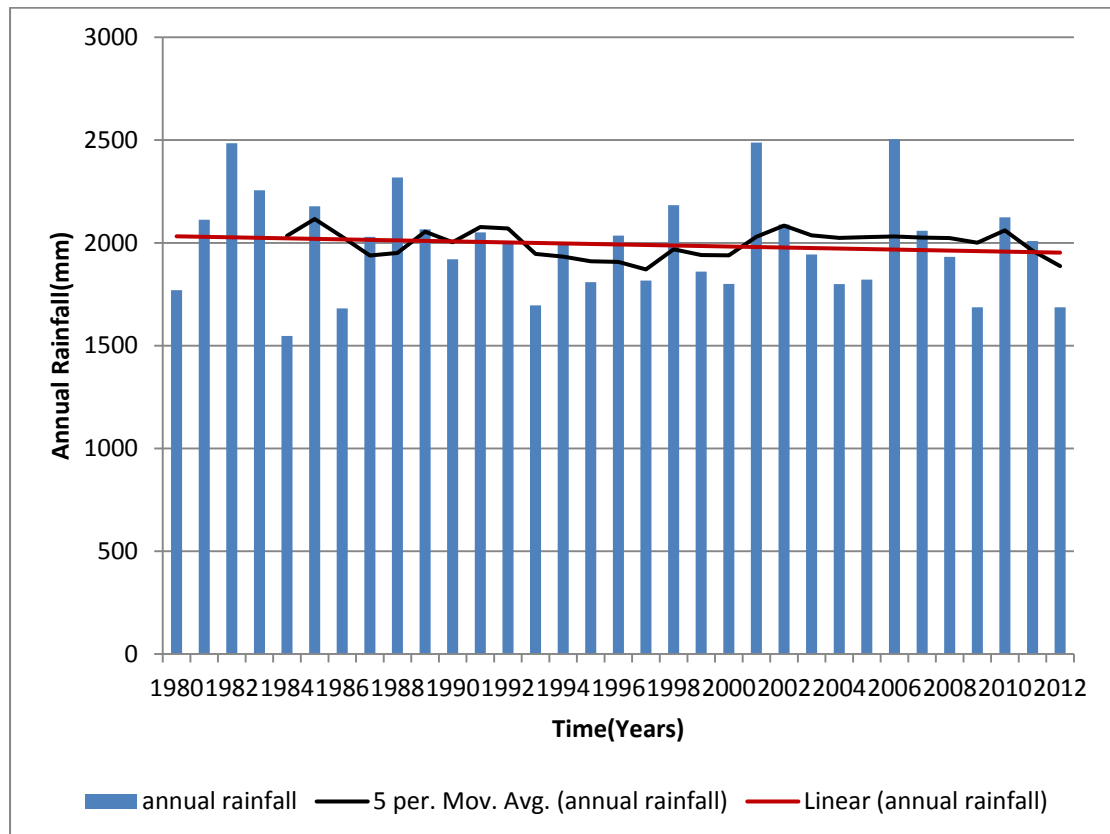


Figure 4.4: Graph illustrating annual average rainfall of Kericho 1980 to 2012

An average annual precipitation amount of 1992.53 mm was recorded in the area in the 33 years. The lowest annual precipitation amount of 1547.4 mm was recorded in 1984 while the highest amount of 2504.3mm was recorded in 2006. Annual precipitation amounts increased from 1770.1 mm in 1980 to 2484.6 mm in 1982. The subsequent years recorded a decrease in precipitation 1983 and 1984 which recorded 2256 and 1547.4 respectively. This was followed by a sharp increase to 2178 mm in 1985 and a decline to 1681.4 in 1986. After which annual precipitation amounts increased to 2029.5mm in 1987 and 2318.1mm in 1988. This increase was not sustained in the subsequent years as 1989 recorded a low precipitation amount of 2065.5mm and in 1990 it recorded 1920.2mm, increment in precipitation amounts to

2051.2mm in 1991 and a slight drop of 53.8 mm in 1992, then a drastic decline to 1695.7mm in 1993.

Annual precipitation increased to 1999.3 mm in 1994 and a decrease to 1808.6 mm in 1995. 1996 annual precipitation recorded was 2035.6 mm followed by a decline to 1816.5 in 1997. A noticeable increment of 367 mm in precipitation was witnessed in 1998 compared to 1997. A steady decline was then recorded from 1998 to 2000, but this was followed by a sharp increase to 2487.6 mm in 2001 and a subsequent sharp decline from the year 2002 to 2004. The years 2005 and 2006 recorded an increase in precipitation up to 2504.3 mm in 2006, but the subsequent years recorded low annual precipitation up to 1686.3 mm in 2009. In 2010 there was an increase to 2124.1 mm, followed by a decline in the remaining years to 1686.3 in 2012.

Precipitation irregularities characteristic of climate variability were clearly depicted when the data was computed and a graph plotted to illustrate the extent of deviation from the mean of rainfall in 33 years. Fig 4.5.

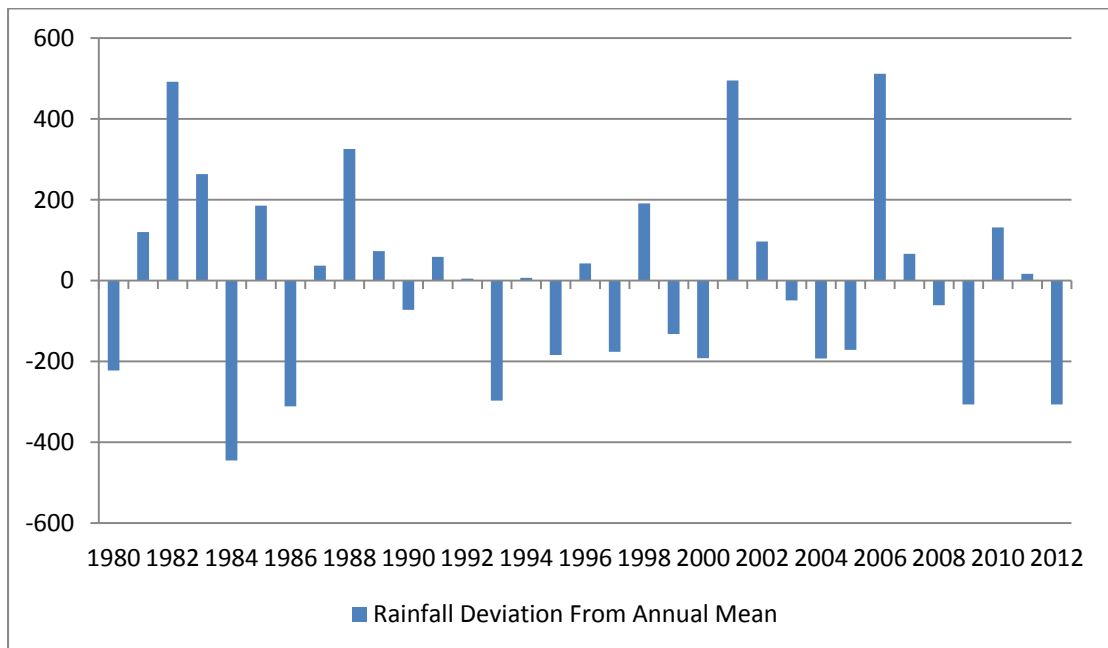


Figure 4.5: Graph of rainfall deviation from mean

From Fig 4.5, the annual rainfall of 18 years (1980,1981, 1982, 1983, 1985,1987,1988, 1989, 1991, 1992, 1994, 1996, 1998, 2001, 2002, 2006, 2007, 2010 and 2011) is above the mean of the years under study while in 15 years

(1980,1984,1986,1990,1993,1995,1997,1999,2000,2003, 2004, 2005, 2008,2009 and 2012) the annual rainfall is below the mean.

4.4 Respondents' View on Rainfall and Temperature Variability

There were 278 respondents who reported that rainfall and temperature patterns have varied significantly over time while 22 respondents reported that rainfall and temperature has not varied, representing 92.7% and 7.3% respectively. The difference between the two categories of respondents was significant ($\chi^2=218.5$, $p=0.000$).

According to data from Kericho meteorological department, temperature has varied over the years as shown in (Figure 4.2) and rainfall has also varied as shown in (Figure 4.4). The highest mean temperature recorded between the years 1980-2012 is 18.704⁰C in the month of February, while the lowest mean temperature recorded over the same period is 16.906⁰C recorded in the month of July. February is a month when droughts are experienced in Kericho and day time temperatures are high, while July is a month when short rains are about to begin and the area is chilly from June to early August.

4.4.1 Response Views on the Importance of the Plants

The three plant species under study included *V. auriculifera*, *C. macrostachyus* and *P. linearifolia* which according to the Kipsigis community are very important for various reasons. The importance of each plant to the community is discussed in detail in the (Tables 4.3, 4.4 and 4.5 below).

4.4.2 *Vernonia auriculifera*

Respondents were asked to rate, on a five-point scale, the importance of *V. auriculifera* plant on five categories which are of value to the Kipsigis community. These categories are: Medicinal, ceremonial, aesthetic, symbolic and domestic. Mean responses and the proportion (in counts and percentage) of all respondents in each scale are reported in (Table 4.3). The item “domestic” was reported by 45 % of the respondents as a most important and a 3.3% rating was captured as least important. On the other hand “for aesthetic reasons” received the lowest rating with 3.7 % of the respondents ranking it as the most significant and 80.7 % as least important. It is one of the basic plants used to construct the Kipsigis altar (Mabwaita).

Ceremonially, it is used to build shelter for initiates where they spent one month of training while undergoing the rites of passage. It also symbolizes fertility of land as a place where these plants grow in large numbers is said to be fertile. Domestically, *V. auriculifera* is used to construct houses, it is used as a source of fuel (firewood), used to wrap vegetables and medicinal herbs. The broad leaves of *V. auriculifera* are spread on the ground when slaughtering an animal such as a cow, goat or sheep. There is no part of this plant that is edible, but the plant is used in association with foods. Isawumi (2008), points out that in Kenya, the leaves of *V. auriculifera* have important functions as they are utilized for wrapping plant drugs for roasting and are also used as a poultice. The findings from the respondents concur with Isawumi's findings that the plant has valuable domestic functions.



Plate 4.1: Young *V. auriculifera* plant, plate taken during the study on 14th January 2014 at a farm in Belgut division.

Table 4.3 : Descriptive statistics on uses of *V. auriculifera*

Plant use	MS	SD	Importance scores (in counts and %)									
			1	%	2	%	3	%	4	%	5	%
Medicinal	4.17	1.01	21	7	18	6	37	12.3	103	34.3	121	40.3
Ceremonial	3.95	1.18	29	9.7	11	3.7	27	9	137	45.7	96	32
Aesthetic	3.87	1.19	242	80.7	16	5.3	11	3.7	20	6.7	11	3.7
Symbolic	3.42	1.43	59	19.7	20	6.7	26	8.7	125	41.7	70	23.3
Domestic	1.47	1.08	10	3.3	16	5.3	23	7.7	116	38.7	135	45

Notes: N-300, MS- Mean Score, SD- Standard deviation, 1-Least Important, 2

- A little important, 3 - Moderately important, 4 - Fairly important, 5- Most important. Scores for each scale (1 to 5) are in counts and percentages.

4.4.3 *Croton macrostachyus*

Respondents were asked to rate, on a five-point scale, the importance of *C. macrostachyus* for medicinal, ceremonial, aesthetic, symbolic and domestic purposes. Mean responses and the proportion (in counts and percentage) of all respondents in each scale are reported in (Table 4.4). The item “domestic” was reported by 53.7 % of the respondents as most important and 2% ranked it as least important. The function “ceremonial” received a rating of 57.3 % from respondents who reported it as important. On the other hand “for aesthetic reasons” obtained the lowest importance rating with 3.3 % of the respondents rating it as the most important and 79.7 % as least important. It is one of the basic plants used to construct the Kipsigis altar (*mabwaita*), it symbolizes fertility of land, and it also signifies life. Where these plants are found in large numbers is said to be fertile. An extract from the roots of *C. macrostachyus* is also used by traditional medicine men to treat malaria. Domestically, *C. macrostachyus* is used to construct houses, used as a source of fuel (firewood), combusted partially to make charcoal and also used to make furniture.



Plate 4.2: *C. macrostachyus* plant at a homestead in Kabianga subdivision, 17th January 2014.

Table 4.4 : Descriptive statistics on uses of *Croton macrostachyus*

Plant use	MS	SD	Importance scores (in counts and %)									
			1	%	2	%	3	%	4	%	5	%
Medicinal	4.34	0.89	13	4.3	14	4.7	40	13.3	97	32.3	136	45.3
Ceremonial	4.1	1.08	36	12	15	5	42	14	172	57.3	35	11.7
Aesthetic	3.52	1.14	239	79.7	24	8	9	3	18	6	10	3.3
Symbolic	3.39	1.42	59	19.7	21	7	32	10.7	121	40.3	67	22.3
Domestic	1.45	1.04	2	0.7	20	6.7	13	4.3	104	34.7	161	53.7

Notes: N - 300, MS - Mean Score, SD - Standard deviation, 1- Least Important, 2-A little important, 3 - Moderately important, 4 - Fairly important, 5 Most important. Scores for each scale (1 to 5) are in counts and percentages.

4.4.4 *Periploca linearifolia*

Respondents were asked to rate, on a five-point scale, the importance of *P. linearifolia* in the five categories enumerated early as medicinal, ceremonial, aesthetic, symbolic and domestic. Mean responses and the proportion (in counts and percentage) of all respondents in each scale are reported in (Table 4.5). The item “ceremonial” was reported by 60 % of the respondents as most important and 3.3 % rated it as least important. On the other hand “domestic” received the lowest importance rating with 13 % of the respondents rating it as the most important and 68.3 % as least important. Some of the respondents explained that *P. linearifolia* can be burnt and ashes obtained used for treating infertility. It is also used during important ceremonial activities for example traditional marriages to bind the bride and the groom as sign of permanent union after being made husband and wife. *P. linearifolia* is also used to tie the sacred plants together utilized for construction of an altar (*mabwaita*). *Mabwaita* is a term used by the Kipsigis for the family altar or prayer tree which was positioned to the east of the house as one exited from the door (Burnette and Gerald, 1996).

It is a holy place where agreements / covenants were made and whatever agreements that were enacted were irreversible and if they were to be reversed, they would only be revoked at the altar.



Plate 4.3: *P. linearifolia*, 20th January 2014

Table 4.5 Descriptive statistics on uses of *Periploca linearifolia*

Plant use	MS	SD	Importance scores (in counts & %)									
			1	%	2	%	3	%	4	%	5	%
Medicinal	4.29	1.07	14	4.7	12	4	25	8.3	96	32	153	51
Ceremonial	4.21	1.07	10	3.3	16	5.3	31	10.3	63	21	180	60
Aesthetic	3.45	1.67	150	50	24	8	25	8.3	39	13	62	20.7
Symbolic	2.46	1.66	83	27.7	10	3.3	17	5.7	68	23	122	40.7
Domestic	1.89	1.47	205	68.3	20	6.7	16	5.3	20	7	39	13

Notes: N-300, MS - Mean Score, SD- Standard deviation, 1- Least Important, 2 – A little important, 3 - Moderately important, 4 - Fairly important, 5 - Most important. Scores for each scale (1 to 5) are in counts and percentages.

Table 4.6 : Male versus Female respondents' on uses of *V. auriculifera*, *C. macrostachyus* and *P.linearifolia*

Uses	Rating	<i>V. auriculifera</i>		<i>C. macrostachyus</i>		<i>P. linearifolia</i>	
		Male	Female	Male	Female	Male	Female
Medicinal	Least Important	15	6	9	4	7	7
	A little Important	12	6	7	7	10	2
	Moderately Important	25	12	24	16	15	10
	Fairly Important	63	40	61	36	52	44
	Very Important	54	67	68	68	85	68
Ceremonial	Least Important	18	11	17	19	7	3
	A little Important	8	3	9	6	8	8
	Moderately Important	12	15	23	19	18	13
	Fairly Important	79	58	98	74	32	31
	Very Important	52	44	22	13	104	76
Aesthetic	Least Important	131	111	140	99	90	60
	A little Important	9	7	8	16	16	8
	Moderately Important	7	4	5	4	15	10
	Fairly Important	15	5	10	8	19	20
	Very Important	7	4	6	4	29	33
Symbolic	Least Important	38	21	45	14	60	23
	A little Important	11	9	16	5	3	7
	Moderately Important	20	6	12	20	11	6
	Fairly Important	58	67	60	61	34	34
	Very Important	42	28	36	31	61	61
Domestic	Least Important	7	3	0	2	112	93
	A little Important	11	5	16	4	16	4
	Moderately Important	11	12	7	6	9	7
	Fairly Important	67	49	61	43	8	12
	Very Important	73	62	85	76	24	15

From the summary (Table 4.6) more females (67) rate *V. auriculifera* as most important as a medicinal plant compared to males (54), representing 51 % of female respondents and 32% of male respondents respectively. This is more of the women in the study area are said to be medicine women compared to medicine men.

More males (104) than females (76) representing 61.5 % of male respondents and 58 % of female respondents rated *P. linearifolia* as very important for use during ceremonial functions. This could be because men officiate most of the cultural activities of the Kipsigis community as its elders. Examples of such activities include initiation ceremonies, traditional marriages, cleansing and offering of sacrifices to *Assis* (Sun) God of the ancient Kalenjin). During initiation, for example, at the *Mabwaita* girls were sprayed with wine by *poiyooot-aap tum* (the priest who officiated at the ceremony), a similar ceremony was performed for boys at their time of coming out from initiation. Each boy initiate handed his stick to the elder who knelt at the *mabwaita* (Burnette and Gerald, 1996). *P. linearifolia* is very essential for use during construction of the Kipsigis family altar (*mabwaita* in Kipsigis). The evening before the initiate was circumcised, a crowd gathered at the home; a fire was lit at the *mabwaita*. The night was spent singing and dancing. Female relatives garlanded by *sinendeet* creepers circled the *mabwaita*. (Burnette and Gerald, 1996).

More than 50% of both male and female respondents rated *V. auriculifera* and *C. macrostachyus* as very important for use domestically for example in the construction of houses, as a source of fuel (firewood), while the leaves of *V. auriculifera* were laid on the ground when slaughtering an animal, wrapping herbal medicine and vegetables. This is because both men and women take part in various domestic activities, for examples community men build houses slaughter animals and also collect herbal medicine, while the women collect firewood, vegetables and herbal medicine. Both men and women therefore make use of the plant species, it is commonly used to substitute toilet paper.

4.5 Responses on Effects of Climate Variability on the Plant Species

Table 4.7 summarizes responses on the effects of temperature and rainfall variability on the occurrence of *V. auriculifera*, *C. macrostachyus* and *P. linearifolia*. 177 respondents agree that *V. auriculifera* occurrence has been affected by rainfall variability while 123 believe that rainfall variability has not affected its occurrence. 184 of the respondents agree the temperature has also affected its occurrence while 116 respondents disagree with the same. 112 respondents agree that its occurrence is sufficient for use but 188 disagree with the same idea. A few of the respondents who explained that the plant species are sufficiently available are those who live near big rivers. These people obtain the plants close to river banks, areas where water is adequate throughout the year, while those that explained that they are not sufficiently available state that the useful parts of the plant i.e. broad leaves of *Vernonia auriculifera* were available a better part of the year but not of good size some months of the year as they are required.

Table 4.7 : Raw statistics on effects of Rainfall and Temperature

Plant species	Rainfall has affected occurrence		Temperature has affected occurrence		Sufficiently abundant	
	YES	NO	YES	NO	YES	NO
<i>V. auriculifera</i>	177	123	184	116	112	188
<i>C. macrostachyus</i>	182	118	188	112	109	191
<i>P. linearifolia</i>	288	12	226	74	68	232

C. macrostachyus is responded by 182 heads that it has been affected by rainfall variability while 118 respondents feel that it has not been affected by the same factor. 188 respondents felt that temperature has affected its occurrence while 112 respondents did not agree with the same. 109 respondents agreed that *C. macrostachyus* are in sufficient quantities for use by the Kipsigis community but a larger no of 191 disagreed with the same. A larger percentage agree that both temperature and rainfall variability affect their occurrence in sufficient in that, the

useful parts of the plant are not readily obtainable during some months of the year when needed. While those that argue that they are neither affected by rainfall variability nor temperature explain that these plants are readily available when needed. They also explained that this plant species regenerates faster after a disturbance and especially when there is availability of water.

P. linearifolia is observed to be a plant with wide variations in responses, where 288 respondents agree that the plant species has been affected by rainfall variations and only 12 respondents contradict the view. 226 on the other side believed that temperature has affected its occurrence while 74 respondents felt that temperature has no effect on its occurrence. 68 respondents reported that *P. linearifolia* is sufficiently available for use but a larger number of 232 respondents felt that the plant is currently insufficient for use by the Kipsigis community. This is so because this plant takes a longer time to regenerate after a climatic destruction has occurred it also takes time to flower and fruit so that if a disaster occurs during flowering stage the plant will be adversely affected. *P. linearifolia* is also difficult to grow/ be domesticated.

Table 4.8 : Percentages illustrating effects of rainfall and temperature

Effects of Rainfall and Temperature						
Plant species	Rainfall has affected occurrence		Temperature has affected occurrence		Sufficiently abundance	
	Yes(%)	No(%)	Yes(%)	No(%)	Yes(%)	No(%)
<i>Vernonia auriculifera</i>	59	41	61	39	37	63
<i>Croton macrostachyus</i>	61	39	63	37	36	64
<i>Periploca linearifolia</i>	96	4	75	25	23	77

From the findings of this study 59% of respondents agree that the occurrence and abundance of *V. auriculifera* has been affected by changes in rainfall while 41% do not agree with the opinion. This concurs with assertion that water supply is critical for plant growth; it plays a key role in determining the distribution of plants (Mackey, 2007).

On the other hand 61% of the respondents agree that temperature changes have affected the occurrence of *V. auriculifera* while 39% disagree with the opinion. A higher percentage also agree with the opinion that rainfall has affected the occurrence of *C. macrostachyus* at 61%, while 39% of the respondents believe that rainfall changes have had no effect on the occurrence of the plant species. From (Table 4.8) 63% of the respondents' believe that temperature changes have had tremendous effects on the occurrence of *C. macrostachyus*, while 27% are against the opinion. Again this is in line with scholarly research that increases in temperature raises the rate of many physiological processes such as photosynthesis in plants to an upper limit. Extreme temperatures can be harmful when beyond the physiological limits of plants (Mackey., 2007).

From the (Table 4.8) 96% of the respondents strongly agree that rainfall changes have affected the occurrence of *P. linearifolia* while a mere 4% do not agree with the opinion, 75% of the sample size also agree with the opinion that temperature changes have affected the occurrence of *P. linearifolia*.

From the findings illustrated in (Table 4.8) 37 %, 36 % and 23 % agree with the opinion that *V. auriculifera*, *C. macrostachyus* and *P. linearifolia* respectively are sufficiently available for use by the Kipsigis community of Belgut division. On the other hand 63%, 64% and 77% of the respondents strongly disagree with the opinion that *V. auriculifera*, *C. macrostachyus* and *P. linearifolia* are not sufficiently available for use by the Kipsigis community of Belgut Division. This observation tends to concur with the earlier report that rainfall and temperature changes have tremendous effects on the occurrence and abundance of these three Kipsigis sacred plants under study.

The respondents explained that heavy and prolonged rainfalls that are experienced lately may be interfering with flowering of the plants by shedding the flowers and also by providing chilling periods for seeds that should be germinating hence seeds undergo prolonged periods of dormancy. Some respondents suggested that prolonged droughts may have also interfered with the biological systems that plants undergo during their growth. Scholarly opinions show that changing climatic variables relevant to the function and distribution of plants which include CO₂ concentration, increasing global temperatures, altered precipitation pattern and changes in 'extreme'

weather events such as cyclones, fires or storms have significant effects on plant (Steffen and Canadell, 2005). Because individual plants and therefore species can only function physiologically and successfully complete their lifecycle under specific environmental conditions (ideally within a subset of these), changes to climate are likely to have significant impacts on plants from the level of the individual right through to the level of the ecosystem or biome (Steffen and Canadell, 2005).

4.6 Visual assessment of land cover of selected plants

Visual assessment of the land cover of the selected plant species was made and the results are summarized on the tables preceding. The GPS location of the plants was also taken and the summary table is found in the Appendix 5. Some respondents have domesticated the plants especially *Croton macrostachyus*, this is because it is commonly used as source of fuel and source of timber for construction. *Periploca linearifolia* has also been domesticated by some community members because it is commonly used during ceremonies such as weddings, initiations, graduations and other good ceremonies. Respondents obtain the plants from undisturbed bushes especially near rivers and other wet areas, live fences and along roads. Some community members get *Periploca linearifolia* from hill tops, this is because hill tops have a lower temperature compared to low land areas. *Vernonia auriculifera* is not commonly domesticated but found in almost similar conditions as *Croton macrostachyus*

Table 4.9: Relative abundance of the selected plants

PLANT SPECIES ABUNDANCE		NUMBER OF HH	NUMBER OF HH (%)
TEBENGWET (<i>Vernonia auriculifera</i>)	Not present (0)	0	0
	Least abundant (1)	16	5.3
	Relativley abundant(2)	46	15.3
	More abundant (3)	19	6.3
	Most abundant (≥ 3)	219	73.1
TEBESWET (<i>Croton macrostachyus</i>)	Not present (0)	1	0.3
	Least abundant (1)	0	0
	Relativley abundant (2)	0	0
	More abundant (3)	0	0
	Most abundant (≥ 3)	299	99.7
SINENDET (<i>Periploca linearifolia</i>)	Not present (0)	86	28.7
	Least abundant (1)	49	16.3
	Relativley abundant (2)	63	21
	More abundant (3)	67	22.3
	Most abundant (≥ 3)	35	11.7

NOTE: HH represents household,(0) the plant was not present,(1) one plant was present,(2) two plants present, (3) three plants present and (≥ 3) represent more than three plants were present in a homestead

The table 4.9 illustrates the relative abundance of the selected sacred plants for use by the community. The abundance of the plant species under study from visual assessment of the plant cover revealed that they varied. *V. auriculifera* was least abundant in 16 homesteads,relatively abundant in 46 homesteads,more abundant in 19 homesteads and most abundant in 219 homesteads that was used as sample for the study. *C. macrostachyus* was not present in only one homestead and found to be most abundant in the 299 homesteads. *P. linearifolia* plant species was not present in 86

homesteads, least abundant in 49 homesteads, relatively abundant in 63 homesteads, more abundant in 67 homesteads and was found to be most abundant in only 35 homesteads. From the summary it is clear that the most abundant plant species and for use by the community is *C.macrostachyus* which seems to be available for use through out the year, followed by *V. auriculifera* and the most affected plant is *P. linearifolia*.

Table 4.10. Table of estimate plant distribution per sub location

Village	Tebeng'wet (<i>V. auriculifera</i>)		Sinendet (<i>P. linearifolia</i>)		Tebeswet (<i>C. macrostachyus</i>)	
	Occurrence	Abundance	Occurrence	Abundance	Occurrence	Abundance
	(+)	(no of plants)	(+)	(no of plants)	(+)	(no of plants)
Kabianga	37	129	26	69	37	148
Chemamul	38	135	23	43	38	152
Koiwalelach	38	135	23	43	38	152
Chebiribei	39	143	25	44	39	156
Kapcheluch	37	125	26	69	37	148
Kapkitony	37	124	33	93	37	144
Kiptome	39	127	34	94	39	156
Mobego	38	131	26	62	38	152

(+) indicates occurrence of the plants per household

Visual assessment of plant cover to estimate the number of plants per sub location is summarized in Table 4.10, where in more than 37 house holds of the eight sublocations an estimate of more than 120 *Vernonia auriculifera* occurred and more than 140 *Croton macrostachyus* plants occurred in all the sublocations. *Periploca linearifolia* on the other hand occurred in less than 34 house holds where an estimate of not more than 93 plants were recorded.

4.9 Importance and distribution of the plants



Plate 4.4: *V. auriculifera* along the roadside of Kibingei – Kabianga road, Jan 2014

From the research it was found out that, the plant species under study are concentrated along the fences on the roadsides. The photograph in figure 4.9 illustrates *Vernonia auriculifera* forming part of a live fence along Kibingei- Kabianga road.



Plate 4.5: *P. linearifolia* creeping *G. robusta* at Kiptome sub location, 15th Feb 2014.

P. linearifolia is a climbing plant and can be seen in Figure 4.10 growing in association with other woody plants that can offer it support. Here the plant grows and obtains support from *G. robusta* which is a woody plant. *P. linearifolia* is also found in bushy undisturbed places and along live fences.



Plate 4.6: *P. linearifolia* climbing wild plants at Koiwalelach sub location, Feb, 2014

A young *p. linearifolia* is growing in association with wild plants along a live fence. Mature *P. linearifolia* are rare to get now days unlike before, as reported by the resource persons.



Plate 4.6: *C. macrostachvus* and *V. auriculifera* forming part of a live fence at Kapkitony sub location. Jan 2014

In figure 4.12 *V. auriculifera* and *C. macrostachvus* can be observed here where it forms part of a live and undisturbed fence of a grazing field.



Plate 4.7: Sinendet Towers, in Kericho town, named after the sacred plant *P. linearifolia*, photograph taken on February 2014

A group of about 15000 Kipsigis people from Kericho came together to form an investment group in 1970 with an aim of buying shares from tea estates, the group adapted the name sinendet. The group collected Kenya shillings 1000 per member but were not successful in buying the shares immediately. In 1979 the members contributed more money and bought Mau tea estate which was later called Tilya tea estate where the income of the group improved and they later built a tea factory called Tilya tea factory with an aim of processing their tea. The investment continued to grow and in 2006 they bought a plot in Kericho town and erected Sinendet towers building. The members of the Sinendet group remain to be the shareholders of the investment.

The building has rooms that have been rented out as banks, hotels Doctor's consultation rooms and various offices.

The group adapted the name Sinendet because the plant species *P. linearifolia* is greatly valued among the Kipsigis and the plant is used in all important ceremonies of the community except in bad occasions such as meetings where one is being cursed. In such functions the *P. linearifolia* plant species is not used.



Plate 4.9: Kaptebengwo Secondary named after *V. auriculifera* sacred plant. February 2014.

This is a sign post of a mixed day secondary school located in Sigowet Constituency. The school was established in 2013 to cater for the class eight leavers from primary schools around the area, for instance Chemegong primary, Marumbasi and Kamaget primary schools. The school was initially called Chemegong Secondary but the name was later changed to Kaptebengwo Secondary school because it is established in a village called Kaptebengwo. The village was named after *V. auriculifera* plant. The villagers claim that the plant species was found in large numbers in that village before, which is the reason for the name.



Plate 4.8: Kaptebeswet Secondary school named after *Croton macrostachyus* sacred plant, March, 2014.

The photograph in figure 4.15 is a gate of Kaptebeswet Secondary School located in Anamoi constituency, 3 kilometers from Kericho town along Kericho-Kisumu road. The school was established in 1985 to cater for standard eight leavers from the surrounding community, the school is a mixed day school. The school was given the name Kaptebeswet because the plant species grew in large numbers in the area.

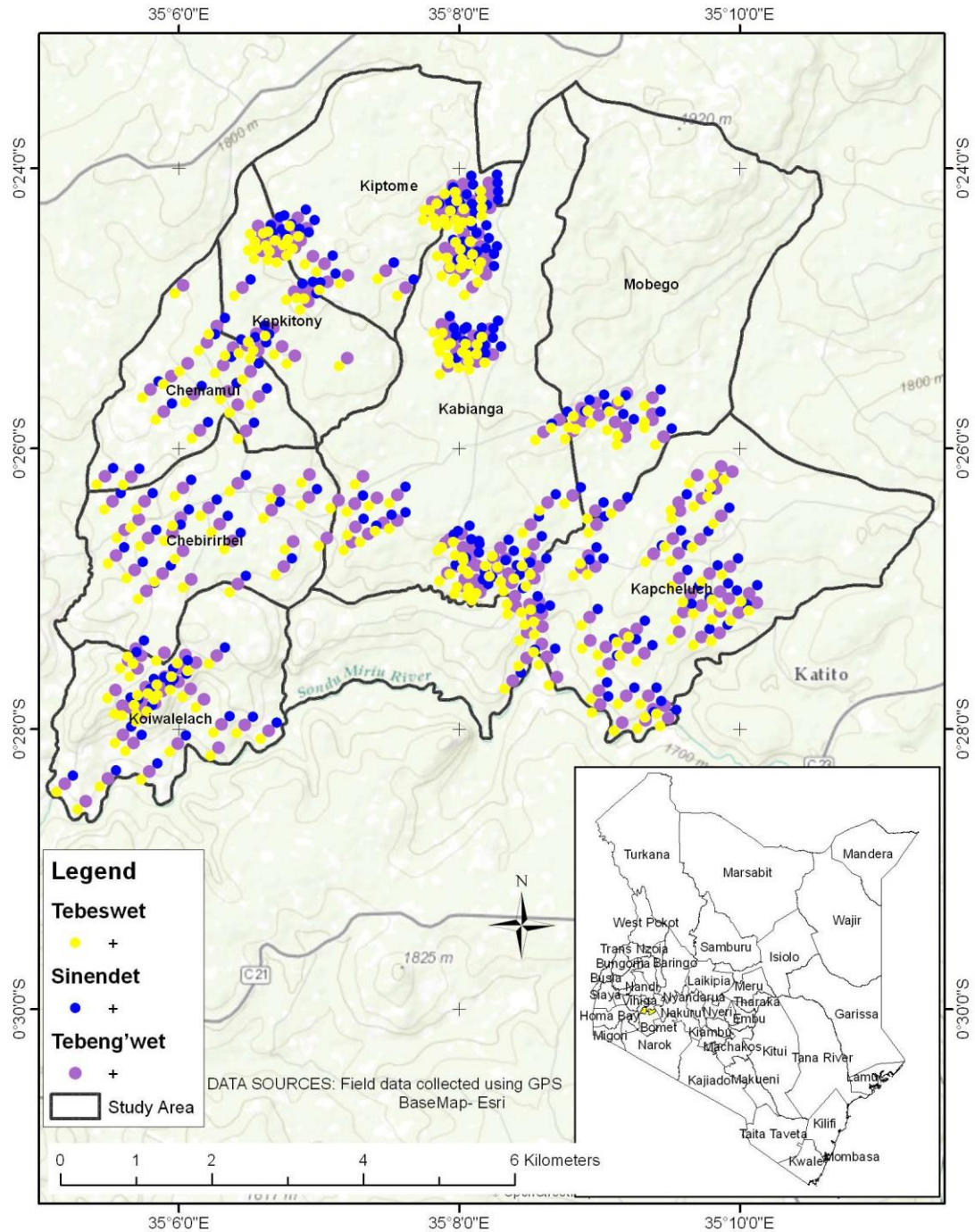


Plate 4.9: Plant distribution (occurrence and abundance) map

The plant distribution in the map above has been arrived at, using the GPS location of the plants as illustrated in appendix 3 and summary data in Table 4.10. (a dot represents an estimate of ten plants). The population items in the map are represented by dots in the key. The colours used (purple, blue and yellow) are their flower colours. *C. macrostachyus* plants cover most part of the area represented by yellow

dots, followed by *V. auriculifera* plants represented by purple dots. The less abundant plants are *P. linearifolia* species represented by the blue dots. *C. macrostachyus* and *V. auriculifera* are more concentrated at the boundary of Koiwalelach sub location, along the river bank of Sondu-Miriu River. The riparian strip where there is adequate water availability could be favouring growth of these plants. In other areas away from the river bank *C. macrostachyus* plants are evenly distributed in undisturbed farms and fences of homesteads, while *V. auriculifera* are concentrated along roadsides and live fences. *C. macrostachyus* are also found along the live fences, roadsides and along riparian strips. *P. linearifolia* does well in the west ward sides of small hills. At Kapkitony sub location, *C. macrostachyus* and *V. auriculifera* are more populated because most farms are fenced with Mauritius thorns *Caesalpinia decapitela*, (live fences) instead of barbed wire. This encourages the growth of these plants because of little disturbance.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the study

From the study it was found that rainfall and temperature variability have affected the three sacred plant species under study, but the most affected of all is *Periploca linearifolia* followed by *Vernonia auriculifera* and the least affected is *Croton macrostachyus*. The respondents also agreed that apart from rainfall and temperature variability, human activities such as domestic use of the plants have also affected their abundance though not as much as climate variability has.

5.2 Conclusions

5.2.1 *Temperature and Rainfall Variability in the Kipsigis area of Kericho*

From the research study that was conducted in Belgut Division there were 278 respondents who agreed that rainfall and temperature has varied significantly over time, while 22 of the respondents were against the notion that rainfall and temperature has varied.

Most of the respondents explained that rainfall patterns have tremendously changed over time. The older respondents above the age of fifty explained that for long periods between 1960s and 1980s, weather patterns in the eight sub locations of Belgut Division in Kericho County inhabited by the Kipsigis people were predictable. Long rains were expected between the month of February and May and that was the time when planting season would begin. Short rains were expected in the month of July and August, this was the time when people/farmers planted biannual plants because between the months of December and January drought was experienced, so people would need to store enough food for their families.

Currently, rainfall patterns have varied where rainy seasons are prolonged and rain has intensified while temperatures have become very low during this period. Drought periods have also been extended and temperature during this period has been very high during the day and low during the night.

According to data for a ten year period from Kericho meteorological department, temperature has varied as shown in (Figure 4.2 and appendix 3) and rainfall has also

varied as shown in (Figure 4.3 and appendix III). The highest mean temperature recorded between the years 1980-2012 was 18.704⁰C in the month of February, while the lowest mean temperature being 16.906⁰C was recorded in the month of July.

5.2.2 Abundance of *V. auriculifera*, *C. macrostachyus* and *P. linearifolia* to the Kipsigis community.

From the presentation in (Table 4.9) 63% of respondents reported that *Vernonia auriculifera* is not sufficiently available for use by the Kipsigis community inhabiting the eight sub locations that were under study. 64% reported that *croton macrostachyus* is also not sufficiently available for use as a cultural plant. A higher percentage (77%) reported that *Periploca linearifolia* is not sufficiently available for use as a cultural plant.

5.2.3 Temperature and rainfall effects on occurrence of *V. auriculifera*, *C. macrostachyus* and *P. linearifolia*

From the report illustrated in (Table 4.9) 59 % and 61% of the respondents concurred that rainfall and temperature variability respectively have affected the occurrence of *Vernonia auriculifera*. *Croton macrostachyus* have also been affected by changes in rainfall and temperature as reported by 61% and 63% respectively. The most affected plant amongst the three sacred plants was *Periploca linearifolia*, where 96% and 75% of the respondents reported that rainfall and temperature respectively have affected its occurrence and abundance and suggested need for further studies to identify appropriate measures to tame the declining trend.

5.3 Recommendations for further research

The following recommendations were made during the study;

- a) The government should encourage farmers to practice agroforestry (growing of trees alongside crops). Farmers should also establish forests within their farms. This will increase evapotranspiration and create more carbon sinks hence maintaining an ideal temperature and rainfall for vegetation.

- b) The community should be encouraged to domesticate the plants, especially *Periploca linearifolia* because it is commonly used in most ceremonies and also takes a longer time to regenerate after disturbance. Riparian strip should be left undisturbed to allow natural vegetation to grow. These will include *Croton macrostachyus*, *Vernonia auriculifera* and *Periploca linearifolia*. Exotic trees (i.e. *eucalyptus ssp*) along the riparian strip should be cut down. Farming along the strip should also be discouraged.
- c) Researchers to find out ways in which occurrence and abundance of *Croton macrostachyus*, *Vernonia auriculifera* and *Periploca linearifolia* can be enhanced.

REFERENCES

- Aizen, M. A., Ashworth L. and Galetto, L. (2002). Reproductive success in fragmented habitats: do compatibility systems and pollination specialization matter? *In Journal of Vegetation Science* 13(6):885-892
- Aizen, M. A. and Feinsinger, P. (1994). *Forest Fragmentation, Pollination, and Plant Reproduction in a Chaco Dry Forest, Argentina*. *In Ecology* 75(2):330-351
- Anderson, A. and Posey, D. (1989). *Management of a sub-tropical scrub savanna of the Gorotire Kayapo of Brazil*. *In Advances in Economic Botany* 7:159-173
- Aukland, L, Costal, P. M. and Brown. S. (2003). A conceptual framework and its application for addressing leakage: the case of avoided deforestation. *In Climate Policy* 3(2):123-136
- Ayele, W.Y., Neill, S.D., Zinsstag, J., Weiss, M.G. and Pavlik, I. (2004). Bovine tuberculosis; an old disease but a new threat to Africa. *In The International Journal of Tuberculosis and Lung Disease* 8:924-937
- Baillie, J.E.M., Hilton-Taylor, C. and Stuart, S.N. (2004). *2004 IUCN Red List of Threatened Species. A Global Species Assessment*. World Conservation Union (IUCN), Gland and Cambridge http://www.iucn.org/themes/ssc/red_list_2004/main_EN.htm (last accessed 8 May 2007)
- Baleé, W. (1993). *Indigenous Transformation of Amazonian Forests*. *In L'Homme* 126-128:231-254
- Barnes, D.F., Krutilla, K. and Hyde, W. (2002). *The Urban Energy Transition? Energy, Poverty, and the Environment*. The World Bank, Washington, DC
- Battiscombe, E. (1926). *Trees and shrubs of Kenya colony*. A descriptive catalog of some of the common trees and woody plants of Kenya colony. (pp. 1, 51,139) Nairobi: Government Printers.
- Berkes, F. & Folke, C. (eds.) (1998). *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge: Cambridge University Press.
- Best, J.W. & Kahn, J.V. (2006). *Research in Education*. 10th Ed. Boston: Pearson Education Inc.
- BirdLife International (2000). *Threatened Birds of the World*. Lynx Edicions and BirdLife International, Barcelona and Cambridge
- BMU (1997). *Sustainable Germany – towards an environmentally sound development*. Federal Environmental Agency of Germany <http://www.umweltdaten.de/publikationen/fpdf-l/2537.pdf> (last accessed 8 May 2007)

- Bomhard, B. and Midgley, G. (2005). *Securing Protected Areas in the Face of Global Change: Lessons Learned from the South African Cape Floristic Region*. A Report by the Ecosystems, Protected Areas, and People Project. IUCN, Bangkok and SANBI, Cape Town <http://www.iucn.org/themes/wcpa/pubs/pdfs/pasclimatechange.pdf> (last accessed 30 June 2007)
- Borrini-Feyerabend, G., MacDonald, K. & Maffi, L. (eds.) (2004). History, Culture and Conservation. In *Policy Matters* 13 Special Issue.
- Boyce, J. (2002). *Market Research in practice*. Sydney: McGraw-Hill
- Buck, L.E., Lassoie, J.P. and Fernandes, E.C.M. (eds.) (1999). *Agroforestry in Sustainable Agricultural Systems*. CRC Press LLC, Boca Raton, FL
- Burnette C. Fish & Gerald W. Fish (1995, 1996). *The Kalenjin Heritage. Traditional Religious and Social Practices*. Kenwide Media Ltd, Nairobi, Kenya. ISBN 0-962-04066-5
- Burns, Alvin; Burns, Ronald (2008). *Basic Marketing Research* (Second Ed.). New Jersey: Pearson Education. p. 245. ISBN 978-0-13-205958-9
- Butchart, S.H.M., Stattersfield, A.J., Baillie, J., Bennun, L.A., Stuart, S.N., Akcakaya, H.R., Hilton-Taylor, C. and Mace, G.M. (2005) *Using Red List Indices to measure progress towards the 2010 target and beyond*. In Philosophical Transactions of the Royal Society B 360:255–268 (Portal). Université Catholique de Louvain, Brussels
- Campbell, C J. (2005). *Oil Crisis*. Multi Science Publishing Co. Ltd., Essex
- Campbell, G.L., Martin, A.A., Lanciotti, R.S., and Gubler, D.J. (2002). *West Nile Virus*. A review. In *The Lancet Infectious Diseases* 2:519-529
- Carlson, T.J.S. & Maffi, L. (eds.) (2004). *Ethnobotany and Conservation of Biocultural Diversity. Advances in Economic Botany Series* Vol. 15. Bronx, New York: New York Botanical Garden Press.
- Chapman, A. D. (2009). *Numbers of Living Species in Australia and the World* (PDF) (2nd ed.). Canberra: Australian Biological Resources Study. pp. 1–80. ISBN 978 0 642 56861 8.
- Chigora, P., Masocha, R., & Mutenheri, F. (2007). *The role of indigenous medicinal knowledge (IMK) in the treatment of ailments in rural Zimbabwe: The case of Mutirikwi Communal Lands*. *Journal of Sustainable Development for Africa* 9, 26–43.
- Chivian, E. (2002). *Biodiversity: Its Importance to Human Health*. Center for Health and the Global Environment, Cambridge, MA

- Collins, W.W. and Qualset, C.Q. (eds.) (1999). *Biodiversity in Agroecosystems* . CRC Press, Boca Raton, FL
- Coker, Kent A., & Coker, P. (1992). *Vegetation Description and Analysis – A Practical Approach*. New York: John Wiley & Sons.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (2013). Retrieved June 10, 2014
- De Marco, P. and F. M. Coelho (2004). Services performed by the ecosystem: forest remnants influence agricultural cultures' pollination and production. *In Biodiversity and Conservation* 13(7):1245-1255
- Dov Sax, (Aug 2008). [The Proceedings of the National Academy of Sciences](#)
- FAO (1998). *The State of the World's Plant Genetic Resources for Food and Agriculture*. Food and Agriculture Organization of the United Nations, Rome
- FAO (2004). *The State of the World's Fisheries and Aquaculture 2004* . Food and Agriculture Organization of the United Nations, Rome
- Finlayson, C.M. & D'Cruz, R. (CLAs) (2005). Inland Water Systems (Chapter 20). In *Ecosystems and Human Well-being: Current Status and Trends*. Millennium Ecosystem Assessment. Washington, DC: Island Press.
- Goldemberg, J. and Johansson, T. B. (2004). *World Energy Assessment*. Overview: 2004 update. United Nations Development Programme and United Nations Department of Economic and Social Affairs, New York, NY
- Google Maps (2013). Belgut Map. Retrieved 20th March 2013
from: <http://www.flickr.com/photos/albertkenyaniinima/7837213078/>
- Grant, S. A. (1993). *Resource description: Vegetation and sward components*. In A. Davies, R. D. Baker, S. A. Grant, & A. S. Laidlaw (Eds.), *Sward measurement handbook (2nd ed., pp. 69–98)*. Reading, British Grassland Society.
- Guruswamy, L.D. and McNeely, J.A. (eds.) (1998). *Protection of Global Biodiversity: Converging Strategies*. Duke University Press, Durham and London
- Halpin, P.N. (1997). *Global climate change and natural-area protection: management responses and research directions*. In *Ecological Applications* 7:828-843
- Harmon, D. (2002). In Light of Our Differences: *How Diversity in Nature and Culture Makes Us Human*. Smithsonian Institution Press, Washington, DC
- Harvell, C.D., Mitchel, C.E., Ward, J.R., Altizer, S., Dobson, A.P., Ostfeld, R.S. and Samuel, M.D. (2002). Climate warming and disease risks for terrestrial and marine biota. *In Science* 296(5576):2158-62

- Heal G., Dasgupta, P., Walker, B., Ehrlich, P., Levin, S., Daily, G., Maler, K.G., Arrow, K., Kautsky, N., Lubchenco, J., Schneider, S., and Starrett, D. (2002). *Genetic Diversity and Interdependent Crop Choices in Agriculture*. Beijer Discussion Paper 170. The Beijer Institute, The Royal Swedish Academy of Sciences, Stockholm
- Heine, Bend & Derek, Nurse. (2008) *A linguistic Geography of Africa*. (Cambridge Approaches to Language contact). Cambridge University Press.
- Holt, R.W., (2000). *Environmental science; biodiversity at risk*. South Capital of Texas Highway, Austin, Texas 78746. (pp. 258).
- IAASTD (2007). *The International Assessment of Agricultural Science and Technology for Development* . <http://www.agassessment.org> (last accessed 8 May 2007)
- IEA (2006). *World Energy Outlook 2006*. International Energy Agency, Paris
- ICSU (2002). *Science and Traditional Knowledge* . Report from the ICSU Study Group on Science and Traditional Knowledge http://www.icsu.org/Gestion/img/ICSU_DOC_DOWNLOAD/220_DD_FILE_Traitional_Knowledge_report.pdf (last accessed 30 June 2007)
- IPCC (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability* . Working Group II Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Cambridge University Press, Cambridge
- IТОPF (2006). *Summaries of major tanker spills from 1967 to the present day*. <http://www.itopf.com/casehistories.html#exxonvaldez> (last accessed 30 June 2007)
- IUCN (2006). *2006 IUCN Red List of Threatened Species*. <http://www.iucnredlist.org/> (last accessed 30 June 2007)
- IUCN (1997). *Indigenous Peoples and Sustainability*. Cases and Actions , IUCN Inter-Commission Task Force on Indigenous Peoples. International Books, Utrecht
- Ilker, R., R.W. Breidenbach, & J. M. Lyons. (1979). *Sequences of ultrastructure changes in tomato cotyledons during short periods of chilling*. (Pp.97-113) Academic New York.
- Isawumi, M.A., (2008). *The status of generic revision in the African Vernoniae (Asteraceae)*. *Compositae Newsletter* 46, 27–48
- ICSU (2002). *Science and Traditional Knowledge*. Report from the ICSU Study Group on Science and Traditional Knowledge (Accessed 30th February 2013) <http://www.icsu.org/Gestion/img/>

- IUCN (1997). *Indigenous Peoples and Sustainability. Cases and Actions*, IUCN Inter-Commission Task Force on Indigenous Peoples. International Books, Utrecht
- IUCN (2006). 2006 IUCN *Red List of Threatened Species*. <http://www.iucnredlist.org/> (last accessed 30 June 2007)
- Jaetzold, R., Helmut, S., & Chris, S., (2009) *Farm management handbook of Kenya*, atlas of agro - ecological zones, soils and fertilizing by group of districts in Southern rift valley -subpart b1a Kericho County, (vol. ii).
- Jachak, S. M., Saklani, A., & Gautam, R. (2007). Indian Medicinal plants as a source of antimycobacterial agents. *Journal of Ethnopharmacology* 110, 200–223.
- James, C. (2003). Preview: *Global status of commercialized transgenic crops*. Briefs No. 30. International Service for the Acquisition of Agri-biotech Applications (ISAAA). Ithaca, NY
- Johnson, B. & Christensen, L. (2004). *Educational Research Quantitative, Qualitative and Mixed Approaches*. 2nd Ed. Boston: Pearson Education Inc.
- Joshi, S. R., Ahmad, F. and Gurung, M.B. (2004). *Status of Apis laboriosa populations in Kaski district, western Nepal*. In *Journal of Apicultural Research* 43(4):176-180
- Kenya Decides retrieved on 12th April, 2013, Kenya population situation analysis, <http://kenyadecides.co.ke/county/kericho/>
- Kenya National Bureau of Statistics, (2009). *Population and Housing census Highlight*. Republic of Kenya.
- Kevin, P. & Lewis, A. O. (1994). *An introduction to global environmental issues*, (pp. 250,251).
- Klein, A. M., Steffan-Dewenter, I. and Tschardtke, T. (2003). Pollination of *Coffea canephora* in relation to local and regional agroforestry management. In *Journal of Applied Ecology* 40:837-845
- Kormos, C. and Hughes, L. (2000). *Regulating Genetically Modified Organisms: Striking a Balance between Progress and Safety*. Advances in Applied Biodiversity Science, Number 1. Conservation International, Washington, DC
- Krauss, M. (1992). *The world's languages in crisis*. In *Language*, University of Alaska, Fairbanks 68:4-10
- Kremen, C., Williams, N. M. and Thorp, R.W. (2002). *Crop pollination from native bees at risk from agricultural intensification*. In *Proceedings of the National Academy of Sciences* 99(26):16812-16816

- Krauss, M. (1992). The world's languages in crisis. In *Language* 68, 4-10
- Lafferty, K. D. and Gerber, L. (2002). Good medicine for conservation biology: The intersection of epidemiology and conservation theory. In *Conservation Biology* 16:593-604
- Lavorel, S. (1998). Mediterranean terrestrial ecosystems: research priorities on global change effects. In *Global Ecology and Biogeography* 7:157-166
- Lisa M. Given (Ed.) (2008). *The Sage Encyclopedia of Qualitative Research Methods*. Sage: Thousand Oaks, CA, Vol.2, pp.697-698
- Maffi, L. (ed.) (2001). *On Biocultural Diversity: Linking Language, Knowledge, and the Environment*. Smithsonian Institution Press, Washington, DC
- Mann, A., Amupitan, J. O., Oyewale, A.O., Okogun, J.I., Ibrahim, K., Oladosu, P., Lawson, I., Olajide, L., & Nnamdi, A. (2008). Evaluation of *in-vitro* antimycobacterial activity of Nigerian plants used for treatment of respiratory diseases. *African Journal of Biotechnology* 7, 1630–1636.
- Malhotra, N.K. & Birks, D.F. (2004). *Marketing Research: An applied orientation*. 4th Ed. Essex, England: Prentice-Hall.
- McMillan, J. H. & Schumacher, S. (1993). *Research in Education A Conceptual Introduction*. New York: Harper Collins College Publishers.
- McNeely, J.A. and Scherr, S.J. (2001). *Common Ground, Common Future: How Ecoagriculture Can Help Feed the World and Save Wild Biodiversity*. World Conservation Union and Future Harvest, Washington, DC
- McNeely, J.A. and Scherr, S.J. (2003). *Ecoagriculture: Strategies to Feed the World and Save Wild Biodiversity*. Island Press, Washington, DC
- McNeely, J.A. (2004). *Nature vs. Nurture: managing relationships between forests, agroforestry and wild biodiversity*. In *Agroforestry Systems* 61:155-165
- Meilleur, B. (1994). *In Search of "Keystone Societies."* In Etkin, N.L. (ed.) *Eating on the Wild Side: The Pharmacologic, Ecologic, and Social Implications of Using Noncultigens*. University of Arizona Press, Tucson, AZ
- Millenium Assesment (2005). *Ecosystems and Human well-being: Biodiversity Synthesis. Millennium Ecosystem Assessment*. World Resources Institute, Washington, DC
- Ministry Of Environment and Natural Resources (2000). *The Kenya National Biodiversity and Strategy Plan*. Nairobi, Kenya: The National Environment Secretariat
- Moock, J. and Rhoades, R. (1992). *Diversity, Farmer Knowledge and Sustainability*. Cornell University Press, Ithaca, NY Mora, C., Andr  fou  t, S., Costello, M.J.,

- Kranenburg, C., Rollo, A., Veron, J., Gaston, K. J., Myers, R. A. (2006). Coral Reefs and the Global Network of Marine Protected Areas. In *Science* 312:1750-1751
- Moore, S.A., Crilley, G., Darcy, S., Griffin, T., Taplin, R., Tonge, J., Wegner, A., and Smith, A. (2009). *Designing and testing a park-based visitor survey*. Gold Coast, Queensland. CRC for Sustainable Tourism Pty Ltd.
- Myers, N. and Kent. J. (2001). *Perverse Subsidies: How Tax Dollars Can Undercut the Environment and Economy*. Island Press, Washington, DC
- Nergard, C.S., Diallo, D., Michaelsen, T.E., Malterud, K.A., Kiyohara, H., Matsumoto, T., Yamada, H., & Paulsen B., S. (2004). Isolation, partial characterization and immunomodulating activities of polysaccharides from *Vernonia kotschyana* Bip.exWalp. *J. Ethnopharmacol.*, 91, 141-152.
- OECD (2001). *Environmental Performance Reviews Germany*. Organisation for Economic Co-operation and Development, Paris
- Oldfield, M.L. and Alcorn, J. (1987). Conservation of Traditional Agroecosystems. In *BioScience* 37(3):199-208
- Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., D'Amico, J.A., Itoua, I., Strand, H.E., Morrison, J.C., Loucks, C.J., Allnutt, T.F., Ricketts, T.H., Kura, Y., Lamoreux, J.F., Wettengel, W.W., Hedao, P. and Kassem, K.R. (2001). *Terrestrial ecoregions of the world: a new map of life on earth*. In *BioScience* 51:933-8
- Osofsky, S. A., Kock, R. A., Kock, M.D., Kalema-Zikusoka, G., Grahn, R., Leyland, T. and Karesh, W. B. (2005). *Building support for protected areas using a "one health" perspective*. In McNeely, J. A. (ed.) *Friends for Life: New Partners in Support of Protected Areas*. World Conservation Union, Gland
- Oviedo, G., Maffi, L. and Larsen, P. B. (2000). *Indigenous and Traditional Peoples of the World and Ecoregion Conservation: An Integrated Approach to Conserving the World's Biological and Cultural Diversity*. World Wide Fund for Nature and Terralingua, Gland
- Palm, C.A., Vosti, S.A., Sanchez, P.A. and Ericksen, P.J. (eds.) (2005). *Slash-and-Burn Agriculture: The Search for Alternatives*. Columbia University Press, New York, NY
- Pamplona, R. (2000) *Encyclopedia of medicinal plants*. Education and health library.
- Patricia, M. Shields, & Tajalli, H. (2006), "Intermediate Theory: The Missing Link in Successful Student Scholarship," *Journal of Public Affairs Education* 12(3): 313-334. Retrieved on 10th February 2013 <https://digital.library.txstate.edu/handle/10877/3967>

- Partap, U. (2002). *Cash crop farming in the Himalayas: the importance of pollinator management and managed pollination*. Biodiversity and the Ecosystem Approach in Agriculture. Forestry and Fisheries, Food and Agriculture Organization of the United Nations, Rome
- Pimentel, D., Rodrigues, G., Wang, T., Abrams, R., Goldberg, K., Staecker, H., Ma, E., Brueckner, L., Trovato, L., Chow, C., Govindarajulu, U. and Boerke, S. (1994). *Renewable energy: economic and environmental issues*. In *BioScience* 44:536-547
- Posey, D. A., (1998). *Cultural and Spiritual Values of Biodiversity*. London: Intermediate Technology Publications.
- Posey, D. A. (ed.) (1999). *Cultural and Spiritual Values of Biodiversity*. London and Nairobi: Intermediate Technology Publications and United Nations Environment Programme.
- Pounds, J.A., Bustamante, M. R., Coloma, L. A., Consuegra, J. A., Fogden, M. P. L., Foster, P. N., La Marca, E., Masters, K. L., Merino-Viteri, A., Puschendorf, R., Ron, S. R., Sa´nchez-Azofeifa, G. A., Still, C. J. and Young, B. E. (2006). *Widespread amphibian extinctions from epidemic disease driven by global warming*. In *Nature* 469:161-167
- Pretty, J. (2002). *Agri-Culture: Reconnecting People, Land and Nature* . Earthscan, London
- Readers Digest Association Far East Limited. (1997). *Illustrated Atlas of the world*. (pp. 204). Readers Digest Association Limited.
- Revenga, C., Brunner, J., Henninger, N., Kassem, K. and Payne, R. (2000). *Pilot Analysis of Global Ecosystems: Freshwater Systems*. World Resources Institute, Washington, DC
- Ron, S. R., Duellman, W. E., Coloma, L. A. and Bustamante, M.R. (2003). *Population declines of the Jambato toad *Atelopus ignescens* (Anura:Bufonidae) in the Andes of Ecuador*. In *J. Herpetol* 37:116-126
- Sahney, S., Benton, M.J & Falcon-Lang, H. J. (2010). “*Rainforest collapse triggered Pennsylvanian tetrapod diversification in Euramerica*” Retrieved on 22/10/2013 from <http://geology.geoscienceworld.org/cgi/content/abstract/38/12/1079> (PDF)
- Sala, O.E., Chapin, F.S. and Armesto, J.J. (2000). *Global biodiversity scenarios for the year 2100*. In *Science* 287:1770–1774
- Sayer, J. and Campbell, B. (2004). *The Science of Sustainable Development: Local Livelihoods and the Global Environment*. Cambridge University Press, Cambridge.
- SCBD (2006). *Global Biodiversity Outlook 2*. Secretariat of the Convention on Biological Diversity, Montreal

- Schroth, G., Da Fonseca, G.A.B., Harvey, C.A., Gascon, C., Vasconcelos, H.L. and Izac, A-M. (2004). *Agroforestry and Biodiversity Conservation in Tropical Landscapes*. Island Press, Washington, DC
- Selin, H. (ed.) (2003). *Nature Across Cultures: Views of Nature and the Environment in Non-Western Cultures*. Dordrecht: Kluwer Academic Publishers.
- Skutnabb-Kangas, T., Maffi, L. & Harmon, D. (2003). *Sharing a World of Difference: The Earth's Linguistic, Cultural, and Biological Diversity*. Paris: United Nations Educational, Scientific and Cultural Organization.
- Smith, K. and Darwall, W. (compilers) 2006. *The Status and Distribution of Freshwater Fish Endemic to the Mediterranean Basin*. World Conservation Union, Gland and Cambridge
- Steffen, W. & Canadell, P. (2005) 'Carbon Dioxide Fertilization And Climate Change Policy.' 33pp. Australian Greenhouse Office. Canberra: Department Of Environment and Heritage.
- Stein, B.A., Kutner, L.S. and Adams, J.S. (2000). *Precious Heritage: The Status of Biodiversity in the United States*. Oxford University Press, New York, NY
- Stepp, J. R., Castaneda, H. and Cervone, S. (2005). *Mountains and biocultural diversity*. In *Mountain Research and Development* 25(3):223-227
- Stige, L.C., Stave, J., Chan Kung-Sik, Ciannelli, L., Pettoelli, N., Glantz, M., Herren, H.R. and Stenseth, N.C. (2005). *The effect of climate variation on agro-pastoral production in Africa*. In *Proceedings of the National Academy of Sciences* 103(9):3049-3053
- Tabuti, J.R.S., Kukunda, C.B. & Waako, P.J. (2010). Medicinal practitioners in the treatment of tuberculosis and related ailments in Uganda. *Journal of Ethnopharmacology* 127, 130–136.
- Terer, T., G.G. Ndiritu, & N.N. Gichuki, (2004). Socio-economic Values and Traditional Strategies of Managing Wetlands Resources in Lower Tana River, Kenya. *Hydrobiologia* 527, 3-14.
- The Kalenjin Tribe in Kenya. Retrieved on 20th August 2012. From www.kenya-advisory.com/kalenjin-tribe.html
- Thrupp, L.A. (1998). *Cultivating Diversity*. World Resources Institute, Washington, DC
- Tillman, D., Cassman, K.G., Matson, P.A., Naylor, R. and Polasky, S. (2002). *Agricultural sustainability and intensive production practices*. In *Nature* 418:671-677

- Thomas, C.D., Cameron, A., Green, R.A., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., de Siquera, M.F., Grainger, A., Hannah, L., Hughes, L., Huntley, B., van Jaarsveld, A.S., Midgley, G.F., Miles, L., Ortega-Huerta, M.A., Townsend Peterson, A., Phillips, O.L. and Williams, S.E. (2004b). *Extinction risk from climate change*. In *Nature* 427:145-8
- UNDP. (2004). *Human Development Report 2004: Cultural Liberty in Today's Diverse World*. New York, NY. United Nations Development Programme.
- UNESCO. (1972) *Report of the Convention Concerning the Protection of the World's Cultural and Natural Heritage*. Paris: UNESCO.
- UNESCO. (1996). *Biosphere Reserves: the Servile Strategy and the Statutory Framework of the World Network*. Paris: UNESCO.
- UNESCO. (2000). *Science for the Twenty-First Century: A New Commitment*. World Conference on Science, United Nations Educational, Scientific and Cultural Organization, Paris.
- UNEP (2006a). *Marine and coastal ecosystems and human well-being: A synthesis report based on the findings of the Millennium Ecosystem Assessment*. DEW/0785/NA. United Nations Environment Programme, Nairobi
- UNEP & UNESCO. (3rd September 2002) World summit on sustainable development, *Cultural diversity and biodiversity for sustainable development*.
- UNEP and UNESCO (2003). *Cultural Diversity and Biodiversity for Sustainable Development*. United Nations Environment Programme, Nairobi
- UNESCO (2000). *Science for the Twenty-First Century: A New Commitment*. World Conference on Science, United Nations Educational, Scientific and Cultural Organization, Paris
- UNESCO (2001). *Atlas of the World's Languages in Danger of Disappearing*. United Nations Educational, Scientific and Cultural Organization Publishing, Paris
- Vittor, A.Y., Gilman, R.H., Tielsch, J., Glass, G.E., Shields, T.M., Sanchez-Lozano W, Pinedo, V.V. and Patz, J.A. (corresponding author) (2006). *The effects of deforestation on the human-biting rate of Anopheles darlingi, the primary vector of falciparum malaria in the Peruvian Amazon*. In *American Journal of Tropical Medicine and Hygiene* 74:3-11
- WHO (2001). *Herbs For Health, But How Safe Are They?* In WHO News. Bulletin of the World Health Organization 79(7):691
- WHO (2005). *Ecosystems and Human Well-being: Health Synthesis*. Millennium Ecosystem Assessment. World Resources Institute, Washington, DC
- Wilkinson, C. (2002). *Coral bleaching and mortality – The 1998 event 4 years later and bleaching to 2002*. In Wilkinson, C. (ed). *Status of coral reefs of the world: 2002*. Australian Institute of Marine Science

<http://www.aims.gov.au/pages/research/coral-bleaching/scr2002/scr-00.html>
(last accessed 8 May 2007)

- Wilson, E.O. (2002). *The Future of Life*. Alfred A. Knopf, New York, NY
- Wood, S., Sebastian, K. and Scherr, S.J. (2000). *Pilot Analysis of Global Ecosystems: Agroecosystems*. Report Prepared for the Millennium Assessment of the State of the World's Ecosystems. International Food Policy Research Institute and World Resources Institute, Washington, DC
- WRI. (2005). *Ecosystems and Human well-being: Biodiversity Synthesis*. Millennium Ecosystem Assessment Report. Washington, DC: World Resources Institute.
- Yamane, Taro. (1967) *Statistics: An Introductory Analysis*, 2nd Ed., New York: Harper and Row.
- Zeier, M., Handermann, M., Bahr, U., Rensch, B., Muller, S., Kehm, R., Muranyi, W. and Darai, G. (2005). New ecological aspects of hantavirus infection: a change of a paradigm and a challenge of prevention – a review. *In Virus Genes* 30(2):157-80
- Zent, E.L. (1998). *A Creative Perspective of Environmental Impacts by Native Amazonian Human Populations*. In *Interciencia* 23(4):232-240
- Zent, S. and Lopez-Zent, E. (2004). *Ethnobotanical Convergence, Divergence, and Change among the Hoti of the Venezuelan Guayana*. In Carlson, T.J.S. and Maffi, L. (eds.) (2004)

APPENDICES

Appendix 1: Introductory Letter

Chepkorir Enneth

P.O BOX 194-20200,

KERICHO.

Dear Sir/Madam,

I am a student at Kenyatta University taking a Master of Environmental Studies, Climate Change and Sustainability. I am conducting a research on the title “**Impact of climate variability on the selected sacred Kipsigis plant species in Belgut Division Kericho County, Kenya**”. I have selected you as a participant in this study. You are pleased informed that the information you will give here will be used for the sole purpose of the study. The researcher understands the ethics of research and the sensitivity of the information that will be collected. I therefore request you not to put any information that could reveal your identity such as your name or any other personal information.

Yours sincerely

Chepkorir Enneth

Appendix 2: Questionnaire

Questionnaire for Head of the household

Date _____

Questionnaire Ref No. _____

Please answer the following questions as objectively as possible as per the instructions on each section. Your personal details are not required.

Section 1: Demographic Information

Please answer by ticking (✓) in the bracket against your preferred choice

1. Gender: Male [] Female []

2. a) What is your religion

SDA []

AGC []

AIC []

FGCK []

CATHOLIC []

(Or church where respondents do not attend any of the above)

.....

b) Give frequency of church attendance per week: (circle where appropriate)

i) Daily (3)

ii) Once a week (2)

iii) Rarely (1)

iv) Not at all (0)

Other.....

3. Give your age (years) or Year of birth

.....

4. Highest level of education

a) None []

b) Primary []

c) Secondary []

d) University []

Other.....

5. a) Housing: Temporary []

Semi-permanent []

Permanent []

Section 2: Effects of climate variability on the selected sacred plant species

6. a) Have rainfall and temperature varied significantly between (1980-2012)? Yes [] No []

b) Tick if appropriate (**SD for Strongly Disagree, D for Disagree, U for Undecided, A for Agree and SA for Strongly Agree**)

Statement	SD	D	U	A	SA
1).Temperature has been moderate					
2). Temperature has been very high					
3). Temperature has been low					
4).Temperature has been fluctuating over the years					

c) Tick if appropriate

Statement	SD	D	U	A	SA
1).Rainfall has been moderate					
2).Rainfall has been very high					
3).Rainfall has been low					
4).Rainfall has been fluctuating over the years					

7. What is the importance of this plant species in your community?

i) *Vernonia auriculifera* (**Tebeng'wet**)

USES	Part of the plant	Least Important... Most Important				
		1	2	3	4	5
Medicinal						
Ceremonial						
For aesthetic reasons						
Symbolic						
Domestic use, i.e. for firewood, house construction etc.						

b) Have rainfall patterns affected the occurrence of *Vernonia auriculifera* (Tebeng'wet)

Yes [] No []

c) Have temperature patterns affected the occurrence of *Vernonia auriculifera* (Tebeng'wet)

Yes [] No []

d) Does the Kipsigis community find the following sufficient in occurrence

Vernonia auriculifera, tebeng'wet, Yes [] No []

e) What else has affected the occurrence of *Vernonia auriculifera*, tebeng'wet? Please tick [✓] a number that best reflect the extent of the effect.

ACTIVITY	A moderate				
	Not at all....	Disagree...	A great deal		
Clearing of land for settlement	1	2	3	4	5
Clearing of land for agriculture					
Interruption of cultural integrity					
Introduction of alien species					

ii) *Croton macrostachyus* (Tebeswet)

USES	Part of the plant	Least Important... Most Important				
		1	2	3	4	5
Medicinal						
Ceremonial						
For aesthetic reasons						
Symbolic						
Domestic use, i.e. for firewood, house construction etc.						

b) Have rainfall patterns affected the occurrence of *Croton macrostachyus* (Tebeswet)

Yes [] No []

c) Have temperature patterns affected the occurrence of *Croton macrostachyus* (Tebeswet)

Yes [] No []

d) Does the Kipsigis community find the following sufficient in occurrence

Croton macrostachyus (tebeswet)

Yes [] No []

e) What else has affected the occurrence of *Croton macrostachyus*, tebeswet? Please tick

[√] a number that best reflect the extent of the effect.

ACTIVITY	A moderate				
	Not at all...	Disagree...	A great deal		
Clearing of land for settlement	1	2	3	4	5
Clearing of land for agriculture					
Interruption of cultural integrity					
Introduction of alien species					

iii) *Periploca linearifolia* (Sinendet)

USES	Part of the plant	Least Important... Most Important				
		1	2	3	4	5
Medicinal						
Ceremonial						
For aesthetic reasons						
Symbolic						
Domestic use, i.e. for firewood, house construction etc.						

b) Have rainfall pattern affected the occurrence of *Periploca linearifolia* (sinendet)

Yes [] No []

c) Have temperature pattern affected the occurrence of *Periploca linearifolia* (sinendet)

Yes [] No []

d) Does the Kipsigis community find the following sufficient in abundance

Periploca linearifolia, sinendet

Yes [] No []

- e) What else has affected the occurrence of *Periploca linearifolia*, (sinendet)? Please tick [√] a number that best reflect the extent of the effect.

ACTIVITY	A moderate				
	Not at all...	Disagree....	A great deal		
Clearing of land for settlement	1	2	3	4	5
Clearing of land for agriculture					
Interruption of cultural integrity					
Introduction of alien species					

8. a). What environmental conservation measures were practiced in the community in the past years? Please answer by ticking (√) against your preferred choice, (SA) for Strongly Agree, (A) for Agree, (U) for Undecided (D) for Disagree and (SD) for Strongly Disagree.

MEASURE	SA	A	U	D	SD
Placement of taboos on cutting of certain plants					
Restriction on harvest to certain seasons and certain people					
Areas with sacred plants were restricted to some people					
Some plants were made sacred so that most households planted them					

- b) Are there some practices that have been abandoned ?Yes[],No []

- c) If yes, which are these practices and why have they been abandoned?

PRACTICES THAT HAVE BEEN ABANDONED	Place one tick or more
Placement of taboos on cutting certain plants	
Restriction on harvest to certain seasons	
Restriction on harvest to certain people	
Areas with sacred plants were restricted to some people	
Some plants were made sacred so that most households planted them	

d) What is the reason for abandonment of the practice above

REASONS	Place one tick or more
Adoption of western culture	
Introduction of alien species	
Disruption of cultural integrity	

9. What measures can be put in place to mitigate climate variability that impacts on the selected species? Please tick [✓] the number that best represents the importance of each suggested measure.

MEASURE	Least important<.....>Most important				
	1	2	3	4	5
Formation of environmental clubs in schools to enlighten the young generation on the importance of biodiversity.					
Creation of special reserve for the Kipsigis sacred plants					
Use of modern ways of seed propagation to improve survival of the plant species.					
Educate the people on clean and renewable energy which produces less greenhouse gas emission					

Thank you very much for your cooperation.

Appendix 3: Occurrence, Abundance and GPS location of the plant species

HH	Tebeng'wet (<i>Vernonia auriculifera</i>)			Sinendet (<i>Periploca linearifolia</i>)			Tebeswet (<i>Croton macrostachyus</i>)		
	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS
	(+/-)	(no of plants)		(+/-)	(no of plants)		(+/-)	(no of plants)	
1	+	>3	35° 8'17.40"E, 0°26'44.98"S	+	2	35° 8'17.40"E, 0°26'44.98"S	+	>3	35° 8'17.40"E, 0°26'44.98"S
2	+	3	35° 8'15.86"E, 0°26'39.77"S	+	1	35° 8'15.86"E, 0°26'39.77"S	+	>3	35° 8'15.86"E, 0°26'39.77"S
3	+	>3	35° 8'10.79"E, 0°26'39.23"S	-	0	35° 8'10.79"E, 0°26'39.23"S	+	>3	35° 8'10.79"E, 0°26'39.23"S
4	+	>3	35° 8'9.97"E, 0°26'42.21"S	-	0	35° 8'9.97"E, 0°26'42.21"S	+	>3	35° 8'9.97"E, 0°26'42.21"S
5	+	>3	35° 8'14.98"E, 0°26'43.03"S	+	2	35° 8'14.98"E, 0°26'43.03"S	+	>3	35° 8'14.98"E, 0°26'43.03"S
6	+	>3	35° 8'19.03"E, 0°26'41.88"S	+	1	35° 8'19.03"E, 0°26'41.88"S	+	>3	35° 8'19.03"E, 0°26'41.88"S
7	+	>3	35° 8'15.85"E, 0°26'33.45"S	-	0	35° 8'15.85"E, 0°26'33.45"S	+	>3	35° 8'15.85"E, 0°26'33.45"S
8	+	>3	35° 8'22.96"E, 0°26'30.14"S	-	0	35° 8'22.96"E, 0°26'30.14"S	+	>3	35° 8'22.96"E, 0°26'30.14"S
9	+	>3	35° 8'13.34"E, 0°26'31.38"S	+	0	35° 8'13.34"E, 0°26'31.38"S	+	>3	35° 8'13.34"E, 0°26'31.38"S
10	+	3	35° 8'13.41"E, 0°26'26.40"S	+	1	35° 8'13.41"E, 0°26'26.40"S	+	>3	35° 8'13.41"E, 0°26'26.40"S
11	+	>3	35° 8'7.77"E, 0°26'33.64"S	+	2	35° 8'7.77"E, 0°26'33.64"S	+	>3	35° 8'7.77"E, 0°26'33.64"S
12	+	>3	35° 8'3.39"E, 0°26'36.82"S	+	3	35° 8'3.39"E, 0°26'36.82"S	+	>3	35° 8'3.39"E, 0°26'36.82"S
13	+	>3	35° 8'13.55"E, 0°26'27.74"S	+	3	35° 8'13.55"E, 0°26'27.74"S	+	>3	35° 8'13.55"E, 0°26'27.74"S
14	+	>3	35° 8'10.02"E, 0°26'25.73"S	+	2	35° 8'10.02"E, 0°26'25.73"S	+	>3	35° 8'10.02"E, 0°26'25.73"S
15	+	2	35° 8'9.25"E, 0°26'20.07"S	+	3	35° 8'9.25"E, 0°26'20.07"S	+	>3	35° 8'9.25"E, 0°26'20.07"S
16	+	>3	35° 8'4.44"E, 0°26'22.31"S	+	0	35° 8'4.44"E, 0°26'22.31"S	+	>3	35° 8'4.44"E, 0°26'22.31"S
17	+	2	35° 8'2.57"E, 0°26'23.79"S	+	0	35° 8'2.57"E, 0°26'23.79"S	+	>3	35° 8'2.57"E, 0°26'23.79"S
18	+	>3	35° 8'26.14"E, 0°26'25.91"S	+	3	35° 8'26.14"E, 0°26'25.91"S	+	>3	35° 8'26.14"E, 0°26'25.91"S
19	+	3	35° 8'24.73"E, 0°26'34.77"S	+	>3	35° 8'24.73"E, 0°26'34.77"S	+	>3	35° 8'24.73"E, 0°26'34.77"S
20	+	>3	35° 8'28.22"E, 0°26'30.73"S	+	0	35° 8'28.22"E, 0°26'30.73"S	+	>3	35° 8'28.22"E, 0°26'30.73"S
21	+	>3	35° 8'29.44"E, 0°26'36.99"S	+	>3	35° 8'29.44"E, 0°26'36.99"S	+	>3	35° 8'29.44"E, 0°26'36.99"S
22	+	2	35° 8'30.72"E, 0°26'41.02"S	+	>3	35° 8'30.72"E, 0°26'41.02"S	+	>3	35° 8'30.72"E, 0°26'41.02"S
23	+	>3	35° 8'35.27"E, 0°26'35.73"S	+	>3	35° 8'35.27"E, 0°26'35.73"S	+	>3	35° 8'35.27"E, 0°26'35.73"S
24	+	>3	35° 8'40.56"E, 0°26'39.05"S	-	0	35° 8'40.56"E, 0°26'39.05"S	+	>3	35° 8'40.56"E, 0°26'39.05"S
25	+	>3	35° 8'32.23"E, 0°26'46.69"S	+	3	35° 8'32.23"E, 0°26'46.69"S	+	>3	35° 8'32.23"E, 0°26'46.69"S
26	+	>3	35° 8'42.43"E, 0°26'49.05"S	-	0	35° 8'42.43"E, 0°26'49.05"S	+	>3	35° 8'42.43"E, 0°26'49.05"S
27	+	2	35° 8'38.50"E, 0°26'50.18"S	+	1	35° 8'38.50"E, 0°26'50.18"S	+	>3	35° 8'38.50"E, 0°26'50.18"S
28	+	2	35° 8'32.59"E, 0°26'51.04"S	-	0	35° 8'32.59"E, 0°26'51.04"S	+	>3	35° 8'32.59"E, 0°26'51.04"S
29	+	>3	35° 8'39.76"E, 0°26'55.45"S	+	3	35° 8'39.76"E, 0°26'55.45"S	+	>3	35° 8'39.76"E, 0°26'55.45"S

HH	Tebeng'wet (<i>Vernonia auriculifera</i>)			Sinendet (<i>Periploca linearifolia</i>)			Tebeswet (<i>Croton macrostachyus</i>)		
	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS
	(+/-)	(no of plants)		(+/-)	(no of plants)		(+/-)	(no of plants)	
30	+	3	35° 8'43.67"E, 0°26'54.12"S	+	3	35° 8'43.67"E, 0°26'54.12"S	+	>3	35° 8'43.67"E, 0°26'54.12"S
31	+	>3	35° 8'48.61"E, 0°26'49.42"S	+	2	35° 8'48.61"E, 0°26'49.42"S	+	>3	35° 8'48.61"E, 0°26'49.42"S
32	+	>3	35° 8'49.90"E, 0°26'39.85"S	+	3	35° 8'49.90"E, 0°26'39.85"S	+	>3	35° 8'49.90"E, 0°26'39.85"S
33	+	2	35° 8'52.97"E, 0°26'34.72"S	+	3	35° 8'52.97"E, 0°26'34.72"S	+	>3	35° 8'52.97"E, 0°26'34.72"S
34	+	>3	35° 8'55.81"E, 0°26'39.41"S	+	2	35° 8'55.81"E, 0°26'39.41"S	+	>3	35° 8'55.81"E, 0°26'39.41"S
35	+	3	35° 8'42.18"E, 0°26'33.98"S	+	>3	35° 8'42.18"E, 0°26'33.98"S	+	>3	35° 8'42.18"E, 0°26'33.98"S
36	+	>3	35° 8'27.28"E, 0°27'5.64"S	+	3	35° 8'27.28"E, 0°27'5.64"S	+	>3	35° 8'27.28"E, 0°27'5.64"S
37	+	2	35° 8'21.66"E, 0°27'9.60"S	+	3	35° 8'21.66"E, 0°27'9.60"S	+	>3	35° 8'21.66"E, 0°27'9.60"S
38	+	2	35° 6'30.72"E, 0°24'59.72"S	+	3	35° 6'30.72"E, 0°24'59.72"S	+	>3	35° 6'30.72"E, 0°24'59.72"S
39	+	>3	35° 6'20.94"E, 0°25'5.75"S	+	2	35° 6'20.94"E, 0°25'5.75"S	+	>3	35° 6'20.94"E, 0°25'5.75"S
40	+	>3	35° 6'31.48"E, 0°25'6.88"S	+	1	35° 6'31.48"E, 0°25'6.88"S	+	>3	35° 6'31.48"E, 0°25'6.88"S
41	+	>3	35° 6'38.07"E, 0°24'57.11"S	—	0	35° 6'38.07"E, 0°24'57.11"S	+	>3	35° 6'38.07"E, 0°24'57.11"S
42	+	2	35° 6'32.08"E, 0°24'52.94"S	—	0	35° 6'32.08"E, 0°24'52.94"S	+	>3	35° 6'32.08"E, 0°24'52.94"S
43	+	>3	35° 6'22.34"E, 0°24'51.49"S	—	0	35° 6'22.34"E, 0°24'51.49"S	+	>3	35° 6'22.34"E, 0°24'51.49"S
44	+	3	35° 6'13.95"E, 0°24'56.33"S	+	2	35° 6'13.95"E, 0°24'56.33"S	+	>3	35° 6'13.95"E, 0°24'56.33"S
45	+	>3	35° 6'9.54"E, 0°25'3.32"S	+	3	35° 6'9.54"E, 0°25'3.32"S	+	>3	35° 6'9.54"E, 0°25'3.32"S
46	+	>3	35° 6'16.52"E, 0°25'13.08"S	+	2	35° 6'16.52"E, 0°25'13.08"S	+	>3	35° 6'16.52"E, 0°25'13.08"S
47	+	>3	35° 6'28.27"E, 0°25'15.90"S	+	2	35° 6'28.27"E, 0°25'15.90"S	+	>3	35° 6'28.27"E, 0°25'15.90"S
48	+	>3	35° 6'27.90"E, 0°24'51.99"S	+	1	35° 6'27.90"E, 0°24'51.99"S	+	>3	35° 6'27.90"E, 0°24'51.99"S
49	+	>3	35° 6'25.39"E, 0°24'54.72"S	+	1	35° 6'25.39"E, 0°24'54.72"S	+	>3	35° 6'25.39"E, 0°24'54.72"S
50	+	>3	35° 6'36.18"E, 0°24'49.92"S	—	0	35° 6'36.18"E, 0°24'49.92"S	+	>3	35° 6'36.18"E, 0°24'49.92"S
51	+	>3	35° 6'43.82"E, 0°24'53.63"S	—	0	35° 6'43.82"E, 0°24'53.63"S	+	>3	35° 6'43.82"E, 0°24'53.63"S
52	+	>3	5° 6'42.33"E, 0°24'55.95"S	—	0	5° 6'42.33"E, 0°24'55.95"S	+	>3	5° 6'42.33"E, 0°24'55.95"S
53	+	2	35° 6'41.80"E, 0°25'5.19"S	—	0	35° 6'41.80"E, 0°25'5.19"S	+	>3	35° 6'41.80"E, 0°25'5.19"S
54	+	2	35° 5'59.40"E, 0°24'38.88"S	—	0	35° 5'59.40"E, 0°24'38.88"S	+	>3	35° 5'59.40"E, 0°24'38.88"S
55	+	>3	35° 6'37.01"E, 0°24'22.54"S	+	1	35° 6'37.01"E, 0°24'22.54"S	+	>3	35° 6'37.01"E, 0°24'22.54"S
56	+	3	35° 7'0.10"E, 0°24'29.87"S	+	2	35° 7'0.10"E, 0°24'29.87"S	+	>3	35° 7'0.10"E, 0°24'29.87"S
57	+	>3	35° 6'31.69"E, 0°25'26.52"S	+	1	35° 6'31.69"E, 0°25'26.52"S	+	>3	35° 6'31.69"E, 0°25'26.52"S
58	+	>3	35° 6'18.93"E, 0°25'24.27"S	+	1	35° 6'18.93"E, 0°25'24.27"S	+	>3	35° 6'18.93"E, 0°25'24.27"S
59	+	2	35° 6'22.72"E, 0°25'29.99"S	—	0	35° 6'22.72"E, 0°25'29.99"S	+	>3	35° 6'22.72"E, 0°25'29.99"S
60	+	2	35° 6'3.96"E, 0°25'25.58"S	+	1	35° 6'3.96"E, 0°25'25.58"S	+	>3	35° 6'3.96"E, 0°25'25.58"S
61	+	>3	35° 6'1.51"E, 0°25'12.33"S	—	0	35° 6'1.51"E, 0°25'12.33"S	+	>3	35° 6'1.51"E, 0°25'12.33"S
62	+	3	35° 5'54.32"E, 0°25'17.89"S	—	0	35° 5'54.32"E, 0°25'17.89"S	+	>3	35° 5'54.32"E, 0°25'17.89"S
63	+	3	35° 5'45.35"E, 0°25'23.70"S	+	1	35° 5'45.35"E, 0°25'23.70"S	+	>3	35° 5'45.35"E, 0°25'23.70"S

HH	Tebeng'wet (<i>Vernonia auriculifera</i>)			Sinendet (<i>Periploca linearifolia</i>)			Tebeswet (<i>Croton macrostachyus</i>)		
	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS
	(+/-)	(no of plants)		(+/-)	(no of plants)		(+/-)	(no of plants)	
64	+	>3	35° 5'51.21"E, 0°25'32.98"S	+	1	35° 5'51.21"E, 0°25'32.98"S	+	>3	35° 5'51.21"E, 0°25'32.98"S
65	+	>3	35° 6'6.75"E, 0°25'41.14"S	+	2	35° 6'6.75"E, 0°25'41.14"S	+	>3	35° 6'6.75"E, 0°25'41.14"S
66	+	>3	35° 6'26.27"E, 0°25'41.36"S	+	2	35° 6'26.27"E, 0°25'41.36"S	+	>3	35° 6'26.27"E, 0°25'41.36"S
67	+	>3	35° 7'9.64"E, 0°25'10.06"S	-	0	35° 7'9.64"E, 0°25'10.06"S	+	>3	35° 7'9.64"E, 0°25'10.06"S
68	+	>3	35° 7'11.02"E, 0°25'1.82"S	+	3	35° 7'11.02"E, 0°25'1.82"S	+	>3	35° 7'11.02"E, 0°25'1.82"S
69	+	3	35° 6'32.87"E, 0°25'3.28"S	+	3	35° 6'32.87"E, 0°25'3.28"S	+	>3	35° 6'32.87"E, 0°25'3.28"S
70	+	>3	35° 6'26.89"E, 0°25'4.71"S	+	2	35° 6'26.89"E, 0°25'4.71"S	+	>3	35° 6'26.89"E, 0°25'4.71"S
71	+	>3	35° 6'47.21"E, 0°25'9.14"S	-	0	35° 6'47.21"E, 0°25'9.14"S	+	>3	35° 6'47.21"E, 0°25'9.14"S
72	+	>3	35° 7'26.13"E, 0°24'32.81"S	+	3	35° 7'26.13"E, 0°24'32.81"S	+	>3	35° 7'26.13"E, 0°24'32.81"S
73	+	>3	35° 7'28.91"E, 0°24'45.73"S	+	3	35° 7'28.91"E, 0°24'45.73"S	+	>3	35° 7'28.91"E, 0°24'45.73"S
74	+	>3	35° 7'22.51"E, 0°24'53.41"S	-	0	35° 7'22.51"E, 0°24'53.41"S	+	>3	35° 7'22.51"E, 0°24'53.41"S
75	+	>3	35° 7'25.39"E, 0°25'2.38"S	-	0	35° 7'25.39"E, 0°25'2.38"S	+	>3	35° 7'25.39"E, 0°25'2.38"S
76	+	2	35° 5'28.63"E, 0°27'48.49"S	-	0	35° 5'28.63"E, 0°27'48.49"S	+	>3	35° 5'28.63"E, 0°27'48.49"S
77	+	>3	35° 5'15.20"E, 0°27'46.56"S	-	0	35° 5'15.20"E, 0°27'46.56"S	+	>3	35° 5'15.20"E, 0°27'46.56"S
78	+	2	35° 5'24.71"E, 0°27'41.56"S	+	1	35° 5'24.71"E, 0°27'41.56"S	+	>3	35° 5'24.71"E, 0°27'41.56"S
79	+	>3	35° 5'21.12"E, 0°27'33.56"S	-	0	35° 5'21.12"E, 0°27'33.56"S	+	>3	35° 5'21.12"E, 0°27'33.56"S
80	+	>3	35° 5'17.16"E, 0°27'30.05"S	+	2	35° 5'17.16"E, 0°27'30.05"S	+	>3	35° 5'17.16"E, 0°27'30.05"S
81	+	1	35° 5'20.50"E, 0°27'24.97"S	+	1	35° 5'20.50"E, 0°27'24.97"S	+	>3	35° 5'20.50"E, 0°27'24.97"S
82	+	>3	35° 5'22.57"E, 0°27'28.00"S	-	0	35° 5'22.57"E, 0°27'28.00"S	+	>3	35° 5'22.57"E, 0°27'28.00"S
83	+	>3	35° 5'27.93"E, 0°27'26.88"S	+	2	35° 5'27.93"E, 0°27'26.88"S	+	>3	35° 5'27.93"E, 0°27'26.88"S
84	+	>3	35° 5'28.85"E, 0°27'29.74"S	+	3	35° 5'28.85"E, 0°27'29.74"S	+	>3	35° 5'28.85"E, 0°27'29.74"S
85	+	>3	35° 5'32.56"E, 0°27'30.91"S	+	2	35° 5'32.56"E, 0°27'30.91"S	+	>3	35° 5'32.56"E, 0°27'30.91"S
86	+	>3	35° 5'32.68"E, 0°27'26.76"S	-	0	35° 5'32.68"E, 0°27'26.76"S	+	>3	35° 5'32.68"E, 0°27'26.76"S
87	+	2	35° 5'34.74"E, 0°27'34.06"S	+	3	35° 5'34.74"E, 0°27'34.06"S	+	>3	35° 5'34.74"E, 0°27'34.06"S
88	+	>3	35° 5'29.14"E, 0°27'32.73"S	+	3	35° 5'29.14"E, 0°27'32.73"S	+	>3	35° 5'29.14"E, 0°27'32.73"S
89	+	>3	35° 5'36.81"E, 0°27'27.48"S	-	0	35° 5'36.81"E, 0°27'27.48"S	+	>3	35° 5'36.81"E, 0°27'27.48"S
90	+	2	35° 5'41.52"E, 0°27'27.90"S	-	0	35° 5'41.52"E, 0°27'27.90"S	+	>3	35° 5'41.52"E, 0°27'27.90"S
91	+	>3	35° 5'46.22"E, 0°27'30.99"S	-	0	35° 5'46.22"E, 0°27'30.99"S	+	>3	35° 5'46.22"E, 0°27'30.99"S
92	+	>3	35° 5'41.75"E, 0°27'35.31"S	-	0	35° 5'41.75"E, 0°27'35.31"S	+	>3	35° 5'41.75"E, 0°27'35.31"S
93	+	>3	35° 5'39.17"E, 0°27'33.55"S	+	1	35° 5'39.17"E, 0°27'33.55"S	+	>3	35° 5'39.17"E, 0°27'33.55"S
94	+	>3	35° 5'40.24"E, 0°27'36.46"S	-	0	35° 5'40.24"E, 0°27'36.46"S	+	>3	35° 5'40.24"E, 0°27'36.46"S
95	+	>3	35° 5'32.93"E, 0°27'37.09"S	+	2	35° 5'32.93"E, 0°27'37.09"S	+	>3	35° 5'32.93"E, 0°27'37.09"S
96	+	>3	35° 5'55.03"E, 0°27'28.06"S	+	1	35° 5'55.03"E, 0°27'28.06"S	+	>3	35° 5'55.03"E, 0°27'28.06"S
97	+	>3	35° 5'38.62"E, 0°27'39.29"S	+	0	35° 5'38.62"E, 0°27'39.29"S	+	>3	35° 5'38.62"E, 0°27'39.29"S

HH	Tebeng'wet (<i>Vernonia auriculifera</i>)			Sinendet (<i>Periploca linearifolia</i>)			Tebeswet (<i>Croton macrostachyus</i>)		
	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS
	(+/-)	(no of plants)		(+/-)	(no of plants)		(+/-)	(no of plants)	
98	+	>3	35° 5'33.02"E, 0°27'41.61"S	+	2	35° 5'33.02"E, 0°27'41.61"S	+	>3	35° 5'33.02"E, 0°27'41.61"S
99	+	2	35° 5'29.15"E, 0°27'40.80"S	+	1	35° 5'29.15"E, 0°27'40.80"S	+	>3	35° 5'29.15"E, 0°27'40.80"S
100	+	>3	35° 5'31.55", 0°27'43.35"S	+	2	35° 5'31.55", 0°27'43.35"S	+	>3	35° 5'31.55", 0°27'43.35"S
101	+	>3	35° 5'23.11"E, 0°27'45.65"S	+	2	35° 5'23.11"E, 0°27'45.65"S	+	>3	35° 5'23.11"E, 0°27'45.65"S
102	+	>3	35° 5'23.98"E,0°27'49.77"S	-	0	35° 5'23.98"E,0°27'49.77"S	+	>3	35° 5'23.98"E,0°27'49.77"S
103	+	>3	35° 5'17.94"E, 0°27'50.13"S	+	3	35° 5'17.94"E, 0°27'50.13"S	+	>3	35° 5'17.94"E, 0°27'50.13"S
104	+	>3	35° 5'23.80"E, 0°27'52.70"S	+	2	35° 5'23.80"E, 0°27'52.70"S	+	>3	35° 5'23.80"E, 0°27'52.70"S
105	+	>3	35° 5'14.68"E, 0°27'49.45"S	+	3	35° 5'14.68"E, 0°27'49.45"S	+	>3	35° 5'14.68"E, 0°27'49.45"S
106	+	>3	35° 5'15.03"E, 0°28'1.90"S	+	1	35° 5'15.03"E, 0°28'1.90"S	+	>3	35° 5'15.03"E, 0°28'1.90"S
107	+	>3	35° 5'13.00"E, 0°28'5.51"S	+	1	35° 5'13.00"E, 0°28'5.51"S	+	>3	35° 5'13.00"E, 0°28'5.51"S
108	+	>3	35° 5'14.54"E, 0°28'8.11"S	+	2	35° 5'14.54"E, 0°28'8.11"S	+	>3	35° 5'14.54"E, 0°28'8.11"S
109	+	>3	35° 5'10.34"E, 0°28'9.75"S	+	2	35° 5'10.34"E, 0°28'9.75"S	+	>3	35° 5'10.34"E, 0°28'9.75"S
110	+	>3	35° 5'8.29"E, 0°28'14.46"S	-	0	35° 5'8.29"E, 0°28'14.46"S	+	>3	35° 5'8.29"E, 0°28'14.46"S
111	+	>3	35° 6'24.26"E, 0°26'10.03"S	+	3	35° 6'24.26"E, 0°26'10.03"S	+	>3	35° 6'24.26"E, 0°26'10.03"S
112	+	>3	35° 6'18.47"E, 0°26'10.90"S	+	2	35° 6'18.47"E, 0°26'10.90"S	+	>3	35° 6'18.47"E, 0°26'10.90"S
113	+	>3	35° 6'24.37"E, 0°25'59.05"S	+	3	35° 6'24.37"E, 0°25'59.05"S	+	>3	35° 6'24.37"E, 0°25'59.05"S
114	+	>3	35° 6'15.68"E, 0°26'0.37"S	-	0	35° 6'15.68"E, 0°26'0.37"S	+	>3	35° 6'15.68"E, 0°26'0.37"S
115	+	>3	35° 6'11.95"E, 0°26'15.85"S	+	3	35° 6'11.95"E, 0°26'15.85"S	+	>3	35° 6'11.95"E, 0°26'15.85"S
116	+	>3	35° 6'5.00"E, 0°26'19.25"S	-	0	35° 6'5.00"E, 0°26'19.25"S	+	>3	35° 6'5.00"E, 0°26'19.25"S
117	+	3	35° 6'6.50"E, 0°26'12.83"S	+	2	35° 6'6.50"E, 0°26'12.83"S	+	>3	35° 6'6.50"E, 0°26'12.83"S
118	+	>3	35° 6'6.12"E, 0°26'2.72"S	+	1	35° 6'6.12"E, 0°26'2.72"S	+	>3	35° 6'6.12"E, 0°26'2.72"S
119	+	2	35° 6'6.12"E, 0°26'2.72"S	-	0	35° 6'6.12"E, 0°26'2.72"S	+	>3	35° 6'6.12"E, 0°26'2.72"S
120	+	>3	35° 5'54.20"E, 0°26'17.38"S	-	0	35° 5'54.20"E, 0°26'17.38"S	+	>3	35° 5'54.20"E, 0°26'17.38"S
121	+	2	35° 5'59.18"E, 0°26'1.38"S	-	0	35° 5'59.18"E, 0°26'1.38"S	+	>3	35° 5'59.18"E, 0°26'1.38"S
122	+	>3	35° 5'39.71"E, 0°26'18.93"S	-	0	35° 5'39.71"E, 0°26'18.93"S	+	>3	35° 5'39.71"E, 0°26'18.93"S
123	+	>3	35° 5'35.85"E, 0°26'29.67"S	+	1	35° 5'35.85"E, 0°26'29.67"S	+	>3	35° 5'35.85"E, 0°26'29.67"S
124	+	>3	35° 5'16.19"E, 0°26'37.10"S	+	1	35° 5'16.19"E, 0°26'37.10"S	+	>3	35° 5'16.19"E, 0°26'37.10"S
125	+	>3	35° 5'8.33"E, 0°26'11.58"S	+	1	35° 5'8.33"E, 0°26'11.58"S	+	>3	35° 5'8.33"E, 0°26'11.58"S
126	+	>3	35° 4'56.02"E, 0°26'35.24"S	-	0	35° 4'56.02"E, 0°26'35.24"S	+	>3	35° 4'56.02"E, 0°26'35.24"S
127	+	>3	35° 4'52.60"E, 0°26'22.84"S	-	0	35° 4'52.60"E, 0°26'22.84"S	+	>3	35° 4'52.60"E, 0°26'22.84"S
128	+	>3	35° 5'30.63"E, 0°26'5.61"S	+	2	35° 5'30.63"E, 0°26'5.61"S	+	>3	35° 5'30.63"E, 0°26'5.61"S
129	+	2	35° 5'16.17"E, 0°25'54.12"S	+	2	35° 5'16.17"E, 0°25'54.12"S	+	>3	35° 5'16.17"E, 0°25'54.12"S
130	+	2	35° 4'52.71"E, 0°25'56.04"S	+	3	35° 4'52.71"E, 0°25'56.04"S	+	>3	35° 4'52.71"E, 0°25'56.04"S
131	+	>3	35° 4'33.81"E, 0°26'9.55"S	-	0	35° 4'33.81"E, 0°26'9.55"S	+	>3	35° 4'33.81"E, 0°26'9.55"S

HH	Tebeng'wet (<i>Vernonia auriculifera</i>)			Sinendet (<i>Periploca linearifolia</i>)			Tebeswet (<i>Croton macrostachyus</i>)		
	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS
	(+/-)	(no of plants)		(+/-)	(no of plants)		(+/-)	(no of plants)	
132	+	>3	35° 4'36.95"E, 0°26'40.23"S	+	3	35° 4'36.95"E, 0°26'40.23"S	+	>3	35° 4'36.95"E, 0°26'40.23"S
133	+	>3	35° 4'43.90"E, 0°26'32.80"S	+	2	35° 4'43.90"E, 0°26'32.80"S	+	>3	35° 4'43.90"E, 0°26'32.80"S
134	+	>3	35° 4'31.95"E, 0°26'31.13"S	+	1	35° 4'31.95"E, 0°26'31.13"S	+	>3	35° 4'31.95"E, 0°26'31.13"S
135	+	>3	35° 4'24.02"E, 0°26'24.99"S	+	2	35° 4'24.02"E, 0°26'24.99"S	+	>3	35° 4'24.02"E, 0°26'24.99"S
136	+	>3	35° 4'37.60"E, 0°26'17.56"S	+	0	35° 4'37.60"E, 0°26'17.56"S	+	>3	35° 4'37.60"E, 0°26'17.56"S
137	+	>3	35° 4'27.79"E, 0°26'13.91"S	-	0	35° 4'27.79"E, 0°26'13.91"S	+	>3	35° 4'27.79"E, 0°26'13.91"S
138	+	>3	35° 4'22.53"E, 0°26'1.87"S	+	1	35° 4'22.53"E, 0°26'1.87"S	+	>3	35° 4'22.53"E, 0°26'1.87"S
139	+	>3	35° 4'36.08"E, 0°26'1.35"S	+	1	35° 4'36.08"E, 0°26'1.35"S	+	>3	35° 4'36.08"E, 0°26'1.35"S
140	+	>3	35° 4'51.62"E, 0°26'8.63"S	+	1	35° 4'51.62"E, 0°26'8.63"S	+	>3	35° 4'51.62"E, 0°26'8.63"S
141	+	>3	35° 5'33.85"E, 0°25'56.94"S	-	0	35° 5'33.85"E, 0°25'56.94"S	+	>3	35° 5'33.85"E, 0°25'56.94"S
142	+	>3	35° 5'46.82"E, 0°25'50.31"S	-	0	35° 5'46.82"E, 0°25'50.31"S	+	>3	35° 5'46.82"E, 0°25'50.31"S
143	+	>3	35° 6'9.66"E, 0°25'51.15"S	-	0	35° 6'9.66"E, 0°25'51.15"S	+	>3	35° 6'9.66"E, 0°25'51.15"S
144	+	>3	35° 4'30.53"E, 0°25'51.29"S	+	1	35° 4'30.53"E, 0°25'51.29"S	+	>3	35° 4'30.53"E, 0°25'51.29"S
145	+	>3	35° 4'48.10"E, 0°26'15.29"S	+	2	35° 4'48.10"E, 0°26'15.29"S	+	>3	35° 4'48.10"E, 0°26'15.29"S
146	+	2	35° 5'46.53"E, 0°26'0.10"S	+	2	35° 5'46.53"E, 0°26'0.10"S	+	>3	35° 5'46.53"E, 0°26'0.10"S
147	+	>3	35° 5'13.87"E, 0°26'18.79"S	+	2	35° 5'13.87"E, 0°26'18.79"S	+	>3	35° 5'13.87"E, 0°26'18.79"S
148	+	2	35° 5'3.54"E, 0°26'4.62"S	+	1	35° 5'3.54"E, 0°26'4.62"S	+	>3	35° 5'3.54"E, 0°26'4.62"S
149	+	>3	35° 4'19.35"E, 0°25'51.11"S	+	1	35° 4'19.35"E, 0°25'51.11"S	+	>3	35° 4'19.35"E, 0°25'51.11"S
150	+	>3	35° 9'12.05"E, 0°27'5.01"S	+	1	35° 9'12.05"E, 0°27'5.01"S	+	>3	35° 9'12.05"E, 0°27'5.01"S
151	+	2	35° 9'17.01"E, 0°27'9.81"S	+	3	35° 9'17.01"E, 0°27'9.81"S	+	>3	35° 9'17.01"E, 0°27'9.81"S
152	+	>3	35° 9'24.70"E, 0°27'7.02"S	+	>3	35° 9'24.70"E, 0°27'7.02"S	+	>3	35° 9'24.70"E, 0°27'7.02"S
153	+	>3	35° 9'20.45"E, 0°27'2.27"S	+	1	35° 9'20.45"E, 0°27'2.27"S	+	>3	35° 9'20.45"E, 0°27'2.27"S
154	+	1	0°26'58.16"S, 35° 9'25.99"E	+	>3	0°26'58.16"S, 35° 9'25.99"E	+	>3	0°26'58.16"S, 35° 9'25.99"E
155	+	>3	35° 9'32.90"E, 0°27'1.27"S	+	3	35° 9'32.90"E, 0°27'1.27"S	+	>3	35° 9'32.90"E, 0°27'1.27"S
156	+	>3	35° 9'36.54"E, 0°27'4.02"S	+	>3	35° 9'36.54"E, 0°27'4.02"S	+	>3	35° 9'36.54"E, 0°27'4.02"S
157	+	>3	35° 9'28.33"E, 0°26'53.34"S	+	2	35° 9'28.33"E, 0°26'53.34"S	+	>3	35° 9'28.33"E, 0°26'53.34"S
158	+	1	35° 9'32.90"E, 0°27'9.70"S	-	0	35° 9'32.90"E, 0°27'9.70"S	+	>3	35° 9'32.90"E, 0°27'9.70"S
159	+	>3	35° 9'15.41"E, 0°26'55.41"S	+	3	35° 9'15.41"E, 0°26'55.41"S	+	>3	35° 9'15.41"E, 0°26'55.41"S
160	+	>3	35° 9'8.76"E, 0°26'54.40"S	+	3	35° 9'8.76"E, 0°26'54.40"S	+	>3	35° 9'8.76"E, 0°26'54.40"S
161	+	3	35° 9'3.67"E, 0°26'56.83"S	-	0	35° 9'3.67"E, 0°26'56.83"S	+	>3	35° 9'3.67"E, 0°26'56.83"S
162	+	>3	35° 9'15.34"E, 0°27'18.36"S	-	0	35° 9'15.34"E, 0°27'18.36"S	+	>3	35° 9'15.34"E, 0°27'18.36"S
163	+	>3	35° 9'45.30"E, 0°27'1.78"S	+	1	35° 9'45.30"E, 0°27'1.78"S	+	>3	35° 9'45.30"E, 0°27'1.78"S
164	+	2	35° 9'5.08"E, 0°27'2.50"S	+	2	35° 9'5.08"E, 0°27'2.50"S	+	>3	35° 9'5.08"E, 0°27'2.50"S
165	+	>3	35° 8'56.68"E, 0°27'9.51"S	+	2	35° 8'56.68"E, 0°27'9.51"S	+	>3	35° 8'56.68"E, 0°27'9.51"S

HH	Tebeng'wet (<i>Vernonia auriculifera</i>)			Sinendet (<i>Periploca linearifolia</i>)			Tebeswet (<i>Croton macrostachyus</i>)		
	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS
	(+/-)	(no of plants)		(+/-)	(no of plants)		(+/-)	(no of plants)	
166	+	>3	35° 8'52.41"E, 0°27'20.93"S	+	2	35° 8'52.41"E, 0°27'20.93"S	+	>3	35° 8'52.41"E, 0°27'20.93"S
167	+	2	35° 9'4.34"E, 0°27'23.12"S	+	3	35° 9'4.34"E, 0°27'23.12"S	+	>3	35° 9'4.34"E, 0°27'23.12"S
168	+	>3	35° 9'24.71"E, 0°27'20.47"S	+	>3	35° 9'24.71"E, 0°27'20.47"S	+	>3	35° 9'24.71"E, 0°27'20.47"S
169	+	>3	35° 9'15.77"E, 0°27'28.87"S	+	1	35° 9'15.77"E, 0°27'28.87"S	+	>3	35° 9'15.77"E, 0°27'28.87"S
170	+	>3	35° 9'12.41"E, 0°27'33.56"S	+	>3	35° 9'12.41"E, 0°27'33.56"S	+	>3	35° 9'12.41"E, 0°27'33.56"S
171	+	1	35° 9'22.22"E, 0°27'32.66"S	+	3	35° 9'22.22"E, 0°27'32.66"S	+	>3	35° 9'22.22"E, 0°27'32.66"S
172	+	>3	35° 9'13.78"E, 0°27'23.12"S	+	>3	35° 9'13.78"E, 0°27'23.12"S	+	>3	35° 9'13.78"E, 0°27'23.12"S
173	+	>3	35° 9'32.43"E, 0°27'18.78"S	+	2	35° 9'32.43"E, 0°27'18.78"S	+	>3	35° 9'32.43"E, 0°27'18.78"S
174	+	>3	35° 9'48.55"E, 0°27'5.79"S	—	0	35° 9'48.55"E, 0°27'5.79"S	+	>3	35° 9'48.55"E, 0°27'5.79"S
175	+	>3	35° 9'40.81"E, 0°27'10.24"S	+	3	35° 9'40.81"E, 0°27'10.24"S	+	>3	35° 9'40.81"E, 0°27'10.24"S
176	+	2	35° 9'37.49"E, 0°27'15.03"S	+	3	35° 9'37.49"E, 0°27'15.03"S	+	>3	35° 9'37.49"E, 0°27'15.03"S
177	+	>3	35° 9'20.59"E, 0°27'27.52"S	—	0	35° 9'20.59"E, 0°27'27.52"S	+	>3	35° 9'20.59"E, 0°27'27.52"S
178	+	>3	35° 9'2.47"E, 0°27'34.52"S	—	0	35° 9'2.47"E, 0°27'34.52"S	+	>3	35° 9'2.47"E, 0°27'34.52"S
179	+	>3	35° 8'52.95"E, 0°27'26.91"S	+	2	35° 8'52.95"E, 0°27'26.91"S	+	>3	35° 8'52.95"E, 0°27'26.91"S
180	+	2	35° 8'47.56"E, 0°27'14.34"S	—	0	35° 8'47.56"E, 0°27'14.34"S	+	>3	35° 8'47.56"E, 0°27'14.34"S
181	+	>3	35° 8'43.72"E, 0°27'7.17"S	—	0	35° 8'43.72"E, 0°27'7.17"S	+	>3	35° 8'43.72"E, 0°27'7.17"S
182	+	3	35° 8'48.69"E, 0°26'59.45"S	—	0	35° 8'48.69"E, 0°26'59.45"S	+	>3	35° 8'48.69"E, 0°26'59.45"S
183	+	>3	35° 8'38.17"E, 0°27'7.85"S	+	1	35° 8'38.17"E, 0°27'7.85"S	+	>3	35° 8'38.17"E, 0°27'7.85"S
184	+	>3	35° 8'37.40"E, 0°27'2.10"S	—	0	35° 8'37.40"E, 0°27'2.10"S	+	>3	35° 8'37.40"E, 0°27'2.10"S
185	+	2	35° 8'43.91"E, 0°26'59.67"S	—	0	35° 8'43.91"E, 0°26'59.67"S	+	>3	35° 8'43.91"E, 0°26'59.67"S
186	+	>3	35° 8'55.44"E, 0°27'2.34"S	+	>3	35° 8'55.44"E, 0°27'2.34"S	+	>3	35° 8'55.44"E, 0°27'2.34"S
187	+	>3	35° 7'14.68"E, 0°24'57.03"S	+	3	35° 7'14.68"E, 0°24'57.03"S	+	>3	35° 7'14.68"E, 0°24'57.03"S
188	+	>3	35° 7'18.81"E, 0°24'59.07"S	+	>3	35° 7'18.81"E, 0°24'59.07"S	+	>3	35° 7'18.81"E, 0°24'59.07"S
189	+	>3	35° 7'14.44"E, 0°24'54.66"S	+	>3	35° 7'14.44"E, 0°24'54.66"S	+	>3	35° 7'14.44"E, 0°24'54.66"S
190	+	>3	35° 7'10.90"E, 0°24'52.01"S	+	3	35° 7'10.90"E, 0°24'52.01"S	+	>3	35° 7'10.90"E, 0°24'52.01"S
191	+	1	35° 7'23.09"E, 0°24'56.40"S	+	>3	35° 7'23.09"E, 0°24'56.40"S	+	>3	35° 7'23.09"E, 0°24'56.40"S
192	+	>3	35° 7'15.48"E, 0°24'48.71"S	+	3	35° 7'15.48"E, 0°24'48.71"S	+	>3	35° 7'15.48"E, 0°24'48.71"S
193	+	1	35° 7'24.68"E, 0°25'3.19"S	+	3	35° 7'24.68"E, 0°25'3.19"S	+	>3	35° 7'24.68"E, 0°25'3.19"S
194	+	>3	35° 7'29.14"E, 0°25'3.74"S	+	2	35° 7'29.14"E, 0°25'3.74"S	+	>3	35° 7'29.14"E, 0°25'3.74"S
195	+	>3	35° 7'23.39"E, 0°24'59.82"S	+	3	35° 7'23.39"E, 0°24'59.82"S	+	>3	35° 7'23.39"E, 0°24'59.82"S
196	+	>3	35° 7'30.15"E, 0°24'56.79"S	+	>3	35° 7'30.15"E, 0°24'56.79"S	+	>3	35° 7'30.15"E, 0°24'56.79"S
197	+	2	35° 7'26.66"E, 0°24'53.01"S	+	2	35° 7'26.66"E, 0°24'53.01"S	+	>3	35° 7'26.66"E, 0°24'53.01"S
198	+	>3	35° 7'20.66"E, 0°24'52.24"S	+	>3	35° 7'20.66"E, 0°24'52.24"S	+	>3	35° 7'20.66"E, 0°24'52.24"S
199	+	>3	35° 7'26.96"E, 0°24'49.19"S	+	>3	35° 7'26.96"E, 0°24'49.19"S	+	>3	35° 7'26.96"E, 0°24'49.19"S

HH	Tebeng'wet (<i>Vernonia auriculifera</i>)			Sinendet (<i>Periploca linearifolia</i>)			Tebeswet (<i>Croton macrostachyus</i>)		
	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS
	(+/-)	(no of plants)		(+/-)	(no of plants)		(+/-)	(no of plants)	
200	+	2	35° 7'21.98"E, 0°24'48.88"S	+	>3	35° 7'21.98"E, 0°24'48.88"S	+	>3	35° 7'21.98"E, 0°24'48.88"S
201	+	>3	35° 7'12.05"E, 0°24'44.12"S	-	0	35° 7'12.05"E, 0°24'44.12"S	+	>3	35° 7'12.05"E, 0°24'44.12"S
202	+	>3	35° 7'8.19"E, 0°24'43.97"S	+	2	35° 7'8.19"E, 0°24'43.97"S	+	>3	35° 7'8.19"E, 0°24'43.97"S
203	+	3	35° 7'10.02"E, 0°24'34.66"S	-	0	35° 7'10.02"E, 0°24'34.66"S	+	>3	35° 7'10.02"E, 0°24'34.66"S
204	+	>3	35° 7'26.13"E, 0°24'32.81"S	+	2	35° 7'26.13"E, 0°24'32.81"S	+	>3	35° 7'26.13"E, 0°24'32.81"S
205	+	>3	35° 7'28.91"E, 0°24'45.73"S	+	3	35° 7'28.91"E, 0°24'45.73"S	+	>3	35° 7'28.91"E, 0°24'45.73"S
206	+	3	35° 6'52.99"E, 0°24'45.98"S	+	0	35° 6'52.99"E, 0°24'45.98"S	+	>3	35° 6'52.99"E, 0°24'45.98"S
207	+	>3	35° 6'54.82"E, 0°24'41.13"S	+	3	35° 6'54.82"E, 0°24'41.13"S	+	>3	35° 6'54.82"E, 0°24'41.13"S
208	+	>3	35° 7'1.20"E, 0°24'37.38"S	+	3	35° 7'1.20"E, 0°24'37.38"S	+	>3	35° 7'1.20"E, 0°24'37.38"S
209	+	>3	35° 6'51.40"E, 0°24'40.90"S	+	2	35° 6'51.40"E, 0°24'40.90"S	+	>3	35° 6'51.40"E, 0°24'40.90"S
210	+	2	35° 6'46.98"E, 0°24'41.83"S	+	2	35° 6'46.98"E, 0°24'41.83"S	+	>3	35° 6'46.98"E, 0°24'41.83"S
211	+	>3	35° 6'41.20"E, 0°24'41.78"S	+	2	35° 6'41.20"E, 0°24'41.78"S	+	>3	35° 6'41.20"E, 0°24'41.78"S
212	+	>3	35° 6'38.80"E, 0°24'46.91"S	+	3	35° 6'38.80"E, 0°24'46.91"S	+	>3	35° 6'38.80"E, 0°24'46.91"S
213	+	2	35° 6'36.73"E, 0°24'43.02"S	-	0	35° 6'36.73"E, 0°24'43.02"S	+	>3	35° 6'36.73"E, 0°24'43.02"S
214	+	>3	35° 6'31.11"E, 0°24'43.48"S	+	>3	35° 6'31.11"E, 0°24'43.48"S	+	>3	35° 6'31.11"E, 0°24'43.48"S
215	+	>3	35° 6'28.80"E, 0°24'48.17"S	+	>3	35° 6'28.80"E, 0°24'48.17"S	+	>3	35° 6'28.80"E, 0°24'48.17"S
216	+	2	35° 6'27.31"E, 0°24'45.89"S	+	>3	35° 6'27.31"E, 0°24'45.89"S	+	>3	35° 6'27.31"E, 0°24'45.89"S
217	+	>3	35° 6'23.29"E, 0°24'47.04"S	+	3	35° 6'23.29"E, 0°24'47.04"S	+	>3	35° 6'23.29"E, 0°24'47.04"S
218	+	1	35° 6'26.32"E, 0°24'40.62"S	+	2	35° 6'26.32"E, 0°24'40.62"S	+	>3	35° 6'26.32"E, 0°24'40.62"S
219	+	>3	35° 6'22.42"E, 0°24'43.93"S	+	3	35° 6'22.42"E, 0°24'43.93"S	+	>3	35° 6'22.42"E, 0°24'43.93"S
220	+	1	35° 6'19.85"E, 0°24'47.72"S	+	2	35° 6'19.85"E, 0°24'47.72"S	+	>3	35° 6'19.85"E, 0°24'47.72"S
221	+	>3	35° 6'20.57"E, 0°24'40.69"S	-	0	35° 6'20.57"E, 0°24'40.69"S	+	>3	35° 6'20.57"E, 0°24'40.69"S
222	+	>3	35° 6'28.29"E, 0°24'39.68"S	+	1	35° 6'28.29"E, 0°24'39.68"S	+	>3	35° 6'28.29"E, 0°24'39.68"S
223	+	>3	35° 6'34.75"E, 0°24'45.45"S	+	1	35° 6'34.75"E, 0°24'45.45"S	+	>3	35° 6'34.75"E, 0°24'45.45"S
224	+	1	35° 7'54.71"E, 0°24'0.66"S	+	2	35° 7'54.71"E, 0°24'0.66"S	+	>3	35° 7'54.71"E, 0°24'0.66"S
225	+	>3	35° 7'49.19"E, 0°24'1.47"S	+	3	35° 7'49.19"E, 0°24'1.47"S	+	>3	35° 7'49.19"E, 0°24'1.47"S
226	+	3	35° 7'46.34"E, 0°24'5.16"S	+	>3	35° 7'46.34"E, 0°24'5.16"S	+	>3	35° 7'46.34"E, 0°24'5.16"S
227	+	>3	35° 7'41.85"E, 0°24'4.65"S	+	>3	35° 7'41.85"E, 0°24'4.65"S	+	>3	35° 7'41.85"E, 0°24'4.65"S
228	+	>3	35° 7'43.35"E, 0°23'58.54"S	+	3	35° 7'43.35"E, 0°23'58.54"S	+	>3	35° 7'43.35"E, 0°23'58.54"S
229	+	>3	35° 7'51.72"E, 0°23'57.21"S	+	3	35° 7'51.72"E, 0°23'57.21"S	+	>3	35° 7'51.72"E, 0°23'57.21"S
230	+	>3	35° 7'42.88"E, 0°24'8.01"S	+	2	35° 7'42.88"E, 0°24'8.01"S	+	>3	35° 7'42.88"E, 0°24'8.01"S
231	+	3	35° 7'51.39"E, 0°24'5.57"S	+	3	35° 7'51.39"E, 0°24'5.57"S	+	>3	35° 7'51.39"E, 0°24'5.57"S
232	+	>3	35° 7'40.22"E, 0°24'1.39"S	+	2	35° 7'40.22"E, 0°24'1.39"S	+	>3	35° 7'40.22"E, 0°24'1.39"S
233	+	>3	35° 7'46.66"E, 0°23'54.28"S	-	0	35° 7'46.66"E, 0°23'54.28"S	+	>3	35° 7'46.66"E, 0°23'54.28"S

HH	Tebeng'wet (<i>Vernonia auriculifera</i>)			Sinendet (<i>Periploca linearifolia</i>)			Tebeswet (<i>Croton macrostachyus</i>)		
	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS
	(+/-)	(no of plants)		(+/-)	(no of plants)		(+/-)	(no of plants)	
234	+	2	35° 8'2.21"E, 0°23'56.59"S	+	1	35° 8'2.21"E, 0°23'56.59"S	+	>3	35° 8'2.21"E, 0°23'56.59"S
235	+	>3	35° 7'57.91"E, 0°24'5.98"S	+	1	35° 7'57.91"E, 0°24'5.98"S	+	>3	35° 7'57.91"E, 0°24'5.98"S
236	+	>3	35° 7'52.63"E, 0°24'9.20"S	+	2	35° 7'52.63"E, 0°24'9.20"S	+	>3	35° 7'52.63"E, 0°24'9.20"S
237	+	2	35° 8'2.64"E, 0°24'3.70"S	+	3	35° 8'2.64"E, 0°24'3.70"S	+	>3	35° 8'2.64"E, 0°24'3.70"S
238	+	>3	35° 8'5.57"E, 0°24'7.29"S	+	>3	35° 8'5.57"E, 0°24'7.29"S	+	>3	35° 8'5.57"E, 0°24'7.29"S
239	+	1	35° 8'7.98"E, 0°23'59.53"S	+	>3	35° 8'7.98"E, 0°23'59.53"S	+	>3	35° 8'7.98"E, 0°23'59.53"S
240	+	>3	35° 8'9.08"E, 0°24'3.52"S	+	3	35° 8'9.08"E, 0°24'3.52"S	+	>3	35° 8'9.08"E, 0°24'3.52"S
241	+	1	35° 8'3.56"E, 0°23'58.82"S	+	>3	35° 8'3.56"E, 0°23'58.82"S	+	>3	35° 8'3.56"E, 0°23'58.82"S
242	+	1	35° 8'2.12"E, 0°23'52.96"S	+	3	35° 8'2.12"E, 0°23'52.96"S	+	>3	35° 8'2.12"E, 0°23'52.96"S
243	+	>3	35° 7'50.98"E, 0°23'53.59"S	+	>3	35° 7'50.98"E, 0°23'53.59"S	+	>3	35° 7'50.98"E, 0°23'53.59"S
244	+	>3	35° 7'37.49"E, 0°24'5.52"S	+	2	35° 7'37.49"E, 0°24'5.52"S	+	>3	35° 7'37.49"E, 0°24'5.52"S
245	+	>3	35° 7'47.54"E, 0°24'7.83"S	-	0	35° 7'47.54"E, 0°24'7.83"S	+	>3	35° 7'47.54"E, 0°24'7.83"S
246	+	>3	35° 7'54.26"E, 0°24'6.54"S	+	3	35° 7'54.26"E, 0°24'6.54"S	+	>3	35° 7'54.26"E, 0°24'6.54"S
247	+	2	35° 8'2.55"E, 0°24'0.21"S	+	3	35° 8'2.55"E, 0°24'0.21"S	+	>3	35° 8'2.55"E, 0°24'0.21"S
248	+	>3	35° 7'37.95"E, 0°24'1.34"S	-	0	35° 7'37.95"E, 0°24'1.34"S	+	>3	35° 7'37.95"E, 0°24'1.34"S
249	+	>3	35° 8'14.08"E, 0°24'0.00"S	-	0	35° 8'14.08"E, 0°24'0.00"S	+	>3	35° 8'14.08"E, 0°24'0.00"S
250	+	>3	35° 8'13.63"E, 0°23'55.83"S	+	1	35° 8'13.63"E, 0°23'55.83"S	+	>3	35° 8'13.63"E, 0°23'55.83"S
251	+	>3	35° 8'17.76"E, 0°23'52.52"S	+	2	35° 8'17.76"E, 0°23'52.52"S	+	>3	35° 8'17.76"E, 0°23'52.52"S
252	+	3	35° 8'11.63"E, 0°23'52.76"S	+	2	35° 8'11.63"E, 0°23'52.76"S	+	>3	35° 8'11.63"E, 0°23'52.76"S
253	+	>3	35° 8'18.77"E, 0°23'58.14"S	+	2	35° 8'18.77"E, 0°23'58.14"S	+	>3	35° 8'18.77"E, 0°23'58.14"S
254	+	>3	35° 8'13.91"E, 0°24'3.84"S	+	3	35° 8'13.91"E, 0°24'3.84"S	+	>3	35° 8'13.91"E, 0°24'3.84"S
255	+	2	35° 8'17.53"E, 0°24'2.42"S	+	>3	35° 8'17.53"E, 0°24'2.42"S	+	>3	35° 8'17.53"E, 0°24'2.42"S
256	+	>3	35° 8'22.45"E, 0°24'1.59"S	+	1	35° 8'22.45"E, 0°24'1.59"S	+	>3	35° 8'22.45"E, 0°24'1.59"S
257	+	>3	35° 8'21.21"E, 0°24'4.80"S	+	>3	35° 8'21.21"E, 0°24'4.80"S	+	>3	35° 8'21.21"E, 0°24'4.80"S
258	+	1	35° 8'10.28"E, 0°24'9.89"S	+	>3	35° 8'10.28"E, 0°24'9.89"S	+	>3	35° 8'10.28"E, 0°24'9.89"S
259	+	>3	35° 8'21.11"E, 0°24'10.05"S	+	2	35° 8'21.11"E, 0°24'10.05"S	+	>3	35° 8'21.11"E, 0°24'10.05"S
260	+	>3	35° 8'15.50"E, 0°24'15.57"S	-	0	35° 8'15.50"E, 0°24'15.57"S	+	>3	35° 8'15.50"E, 0°24'15.57"S
261	+	1	35° 8'3.82"E, 0°24'18.09"S	+	3	35° 8'3.82"E, 0°24'18.09"S	+	>3	35° 8'3.82"E, 0°24'18.09"S
262	+	>3	35° 7'46.82"E, 0°24'15.76"S	+	3	35° 7'46.82"E, 0°24'15.76"S	+	>3	35° 7'46.82"E, 0°24'15.76"S
263	+	2	35° 9'9.79"E, 0°25'48.19"S	-	0	35° 9'9.79"E, 0°25'48.19"S	+	>3	35° 9'9.79"E, 0°25'48.19"S
264	+	>3	35° 8'56.63"E, 0°25'52.55"S	+	3	35° 8'56.63"E, 0°25'52.55"S	+	>3	35° 8'56.63"E, 0°25'52.55"S
265	+	>3	35° 9'5.77"E, 0°25'52.63"S	+	3	35° 9'5.77"E, 0°25'52.63"S	+	>3	35° 9'5.77"E, 0°25'52.63"S
266	+	>3	35° 9'20.89"E, 0°25'50.25"S	+	2	35° 9'20.89"E, 0°25'50.25"S	+	>3	35° 9'20.89"E, 0°25'50.25"S
267	+	3	35° 8'50.42"E, 0°25'54.80"S	+	>3	35° 8'50.42"E, 0°25'54.80"S	+	>3	35° 8'50.42"E, 0°25'54.80"S

HH	Tebeng'wet (<i>Vernonia auriculifera</i>)			Sinendet (<i>Periploca linearifolia</i>)			Tebeswet (<i>Croton macrostachyus</i>)		
	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS	Occurrence	Abundance	GPS
	(+/-)	(no of plants)		(+/-)	(no of plants)		(+/-)	(no of plants)	
268	+	>3	35° 8'57.87"E, 0°25'57.73"S	+	>3	35° 8'57.87"E, 0°25'57.73"S	+	>3	35° 8'57.87"E, 0°25'57.73"S
269	+	2	35° 9'20.88"E, 0°25'57.31"S	-	0	35° 9'20.88"E, 0°25'57.31"S	+	>3	35° 9'20.88"E, 0°25'57.31"S
270	+	2	35° 9'5.01"E, 0°26'0.60"S	+	1	35° 9'5.01"E, 0°26'0.60"S	+	>3	35° 9'5.01"E, 0°26'0.60"S
271	+	>3	35° 9'9.43"E, 0°26'3.01"S	+	1	35° 9'9.43"E, 0°26'3.01"S	+	>3	35° 9'9.43"E, 0°26'3.01"S
272	+	>3	35° 8'51.52"E, 0°26'0.10"S	-	0	35° 8'51.52"E, 0°26'0.10"S	+	>3	35° 8'51.52"E, 0°26'0.10"S
273	+	>3	35° 8'48.52"E, 0°25'59.54"S	+	3	35° 8'48.52"E, 0°25'59.54"S	+	>3	35° 8'48.52"E, 0°25'59.54"S
274	+	>3	35° 8'40.98"E, 0°25'59.74"S	+	3	35° 8'40.98"E, 0°25'59.74"S	+	>3	35° 8'40.98"E, 0°25'59.74"S
275	+	>3	35° 8'46.92"E, 0°26'4.49"S	-	0	35° 8'46.92"E, 0°26'4.49"S	+	>3	35° 8'46.92"E, 0°26'4.49"S
276	+	>3	35° 9'6.15"E, 0°26'13.27"S	+	3	35° 9'6.15"E, 0°26'13.27"S	+	>3	35° 9'6.15"E, 0°26'13.27"S
277	+	>3	35° 8'55.78"E, 0°26'15.51"S	+	3	35° 8'55.78"E, 0°26'15.51"S	+	>3	35° 8'55.78"E, 0°26'15.51"S
278	+	>3	35° 8'34.23"E, 0°26'4.97"S	+	2	35° 8'34.23"E, 0°26'4.97"S	+	>3	35° 8'34.23"E, 0°26'4.97"S
279	+	2	35° 8'35.39"E, 0°26'12.02"S	+	>3	35° 8'35.39"E, 0°26'12.02"S	+	>3	35° 8'35.39"E, 0°26'12.02"S
280	+	>3	35° 8'46.10"E, 0°26'8.93"S	+	>3	35° 8'46.10"E, 0°26'8.93"S	+	>3	35° 8'46.10"E, 0°26'8.93"S
281	+	>3	35° 9'9.25"E, 0°26'6.81"S	-	0	35° 9'9.25"E, 0°26'6.81"S	+	>3	35° 9'9.25"E, 0°26'6.81"S
282	+	>3	35° 8'39.08"E, 0°26'16.14"S	+	1	35° 8'39.08"E, 0°26'16.14"S	+	>3	35° 8'39.08"E, 0°26'16.14"S
283	+	2	35° 8'56.28"E, 0°26'21.43"S	+	2	35° 8'56.28"E, 0°26'21.43"S	+	>3	35° 8'56.28"E, 0°26'21.43"S
284	+	>3	35° 8'40.27"E, 0°26'24.58"S	+	3	35° 8'40.27"E, 0°26'24.58"S	+	>3	35° 8'40.27"E, 0°26'24.58"S
285	+	>3	35° 8'38.79"E, 0°26'30.36"S	-	0	35° 8'38.79"E, 0°26'30.36"S	+	>3	35° 8'38.79"E, 0°26'30.36"S
286	+	>3	35° 9'31.93"E, 0°26'15.42"S	-	0	35° 9'31.93"E, 0°26'15.42"S	+	>3	35° 9'31.93"E, 0°26'15.42"S
287	+	>3	35° 9'20.76"E, 0°26'33.82"S	+	2	35° 9'20.76"E, 0°26'33.82"S	+	>3	35° 9'20.76"E, 0°26'33.82"S
288	+	>3	35° 9'31.59"E, 0°26'33.58"S	+	1	35° 9'31.59"E, 0°26'33.58"S	+	>3	35° 9'31.59"E, 0°26'33.58"S
289	+	1	35° 9'28.96"E, 0°26'27.38"S	+	1	35° 9'28.96"E, 0°26'27.38"S	+	>3	35° 9'28.96"E, 0°26'27.38"S
290	+	>3	35° 9'40.82"E, 0°26'27.70"S	+	1	35° 9'40.82"E, 0°26'27.70"S	+	>3	35° 9'40.82"E, 0°26'27.70"S
291	+	>3	35° 9'31.63"E, 0°26'11.94"S	+	2	35° 9'31.63"E, 0°26'11.94"S	+	>3	35° 9'31.63"E, 0°26'11.94"S
292	+	>3	35° 9'41.61"E, 0°26'10.22"S	+	2	35° 9'41.61"E, 0°26'10.22"S	+	>3	35° 9'41.61"E, 0°26'10.22"S
293	+	1	35° 9'49.70"E, 0°26'17.71"S	+	3	35° 9'49.70"E, 0°26'17.71"S	+	>3	35° 9'49.70"E, 0°26'17.71"S
294	+	>3	35° 9'47.44"E, 0°26'6.06"S	-	0	35° 9'47.44"E, 0°26'6.06"S	+	>3	35° 9'47.44"E, 0°26'6.06"S
295	+	>3	35° 9'39.43"E, 0°26'0.30"S	-	0	35° 9'39.43"E, 0°26'0.30"S	+	>3	35° 9'39.43"E, 0°26'0.30"S
296	+	>3	35° 9'48.74"E, 0°26'1.95"S	-	0	35° 9'48.74"E, 0°26'1.95"S	+	>3	35° 9'48.74"E, 0°26'1.95"S
297	+	2	35° 9'49.83"E, 0°25'56.61"S	-	0	35° 9'49.83"E, 0°25'56.61"S	+	>3	35° 9'49.83"E, 0°25'56.61"S
298	+	>3	35° 9'54.44"E, 0°25'58.80"S	-	0	35° 9'54.44"E, 0°25'58.80"S	+	>3	35° 9'54.44"E, 0°25'58.80"S
299	+	2	35° 9'24.97"E, 0°25'43.77"S	+	3	35° 9'24.97"E, 0°25'43.77"S	+	>3	35° 9'24.97"E, 0°25'43.77"S
300	+	>3	35° 9'20.40"E, 0°25'36.53"S	+	1	35° 9'20.40"E, 0°25'36.53"S	+	>3	35° 9'20.40"E, 0°25'36.53"S

Note: Household (HH) serial no. 1-37 Kabianga, 38-75 Chemamul, 76-110 Koiwalelach, 111-149 Chebirirbei, 150-186 Kapcheluch, 187-227 Kapkitony, 228-262 Kiptome and 263-300 Mobego