

**THE EFFECT OF TEA GROWING ON FOREST DEGRADATION IN
CHINGA AREA OF THE ABERDARE RANGES IN NYERI COUNTY,
KENYA.**

MUTERO PAUL KANIARU

REG. NO.C50/61501/2010

**A research project in Environmental Planning and Management, For the award
of a Master of Arts Degree in Environmental Planning and Management in the
Department of Geography and Environmental Studies, University of Nairobi**

June 2013

DECLARATION

Student's Declaration

I hereby declare that this project is my original work and has not been previously, in its entirety or in part, been presented at any other university for degree award.

Mutero Paul Kaniaru (candidate)

REG. NO.C50/61501/2010

Sign.....

Date.....

Supervisors' Declaration

This research project has been submitted for the course examination with my approval as the University supervisor (s).

Dr B.N.Wambua (supervisor)

Sign

Date

H.W Namai (supervisor)

Sign.....

Date.....

ACKNOWLEDGEMENT

This research project would not have been possible without the support of many people. I wish to express my gratitude to my supervisors, Dr. B.N.Wambua and H.W.Namai who were abundantly helpful and offered invaluable assistance. Their support and guidance in this study led to its successful conclusion. I am very grateful for the guidance and assistance offered by both the teaching and non-teaching staff at the Department of Geography and Environmental Studies. Thank you very much for your generosity.

Deepest gratitude goes to the members of Mucharage forest Association and community members of Chinga area for their assistance in data collection. My friends, especially Mr. Mutahi are acknowledged for sharing the literature in agriculture which was valuable to this project.

The author would also like to convey thanks to the Kenya forest service and Chinga Tea Factory Director for providing the information and data on tea output.

DEDICATION

I dedicate this work to my family and friends for their understanding and support during the study period.

LIST OF ACRONYMS

CBOs: Community based organizations

EIA: Environmental Impact Assessment

FAO: Food agricultural organization

Deforest department.

GDP: Gross domestic product.

GOK: Government of Kenya

ICRAF: International centre for research in Agro forestry.

KEFRI: Kenya forestry research institute

KFMP: Kenya forestry master plan.

KFS: Kenya forest service.

KTDA: Kenya tea development authority.

KWS: Kenya wildlife service.

MCFA: Mucarage community forest association.

MDGs: Millennium development goals

NARC: National rainbow coalition.

OMWASCO: Othaya and Mukurweini water and Services Company.

ODA: Overseas development administration.

SPSS: Statistical package for social sciences.

SSTSK: Small-scale tea sector of Kenya.

TBK: Tea board of Kenya.

TRFK: Tea research foundation of Kenya.

UNCED: UN Conference in environment and development.

UNEP: United Nations environmental program.

WSSD: World summit on sustainable development.

ABSTRACT

Tea growing in Kenya has been expanding into the Aberdare forest where the physical condition for its growth is good and economic returns are profitable. Subsequently, the expansion has contributed to forest loss due to fuel demand in the tea processing factories. Therefore, this study was aimed at addressing the effect of tea growing on forest degradation in Chinga area of the Aberdares Ranges in Nyeri County. The study ignored other sources of forest degradation such as forest fires, pollution and wind. The study covers an area of approximately 36km² where majority of the residents are original inhabitants, only few migrated from settled forest areas when these settlements were banned by the government in the mid 1980s. The main occupation of these residents is cultivation of tea.

The broad objective for this study was: To establish whether there is a link between increased tea acreage and forest degradation and whether the increased demand of wood fuel has a relationship with loss of forest cover. This research was based in Chinga location whose population is estimated at 15000. The research used a case study approach where ten regions were selected; nine of these regions contributed 24 respondents each while the tenth region had 30 respondents. This amounted to 246 respondents that were randomly selected out of an approximate 1500 tea farmers. Determination of relationship between attributes was achieved through cross tabulations and correlations using SPSS package, both the chi square test and simple regression analysis were used to determine the relationship between forest cover change and tea expansion. Regression analysis was also used to determine the effect of the use of wood fuel and forest cover change.

The key findings were as follows: Expansion of tea growing areas in Chinga area has a negative relationship with forest cover (plate 1, and plate 2), the resulting increased tea acreage has led to clearing of more land so as to cultivate tea. More forest trees have continuously been lost as a result. Increased use of wood fuel has led to significant forest degradation. This is contrary to an earlier feeling that the relationship would be negative. This study sought to find out whether there is a link between increased Tea expansion and losses of forest cover and if use of wood fuel has had an impact on the forest cover. The study had the following two conclusions: that tea development has had a significant effect on forest cover; this study inferred an

increase in tea acreage and a reduction of forest cover. At this rate of tea expansion, we may not have any forests remaining in the farmlands in the future. Extraction of wood fuel has impacted negatively on forest cover.

There has been over reliance on wood fuel in Chinga Tea Factory to an extent that for every one ton increase in wood fuel usage, 0.695 acres of forest land is lost at a significant level of 0.05. This study inferred a reduction of 0.695 acres of forest land as being lost for every ton of wood fuel used. On the other hand, for every extra acre planted with tea, 0.889 acres of forest was lost. Both expansion of tea and use of wood fuel have negative effects on forest cover. The tea expansion has led to the cutting of small bushes to pave way for tea cultivation, this increase in tea production has also created demand for more wood to process the increasing tea output by Chinga Tea Factory. The result has been increased illegal logging in order to sustain this demand. There is no realistic afforestation program in Chinga area as large patches of forest clearing are visible (plate 1, page 50) and (plate 2, page 49). This study proposed the following research hypothesis: *there is no significant relationship between expansion of tea and forest degradation in Chinga area.* The study chose the ten year period between 1995 and 2005 because nearly ten years before in 1986, a presidential order that started the Nyayo tea zones was given, It was aimed at stopping forest encroachment. Such unchecked increase in wood fuel use could deplete forest trees in ten years.

The recommendations made were: that a vegetated buffer stripe should be planted along the streams and rivers so as to encourage growing of trees that do not consume a lot of water along the water bodies; Chinga Tea Factory should be encouraged to plant its own trees to improve its own wood fuel base; the Kenya Forest Service should do reforestation to the identified forest patches so as to restore the earlier state of forest.

TABLE OF CONTENTS

JUNE 2013	I
DECLARATION	II
ACKNOWLEDGEMENTS	III
DEDICATION	IV
LIST OF ACRONYMS	V
CHAPTER ONE 1	
1.0 INTRODUCTION	1
1.1 BACKGROUND TO THE STUDY	1
1.2 STATEMENT OF THE PROBLEM.....	6
1.3. RESEARCH QUESTIONS	8
1.4 OBJECTIVES OF THE STUDY	8
1.5 Research Hypothesis 9	
1.7 JUSTIFICATION OF THE STUDY	11
1.8 SCOPE AND LIMITATIONS OF THE STUDY.....	12
CHAPTER TWO 13	
2.0 STUDY AREA	13
2.1 LOCATION AND SIZE OF THE STUDY AREA	13
2.3 VEGETATION COVER AND WILD LIFE.....	16
2. 4 CLIMATE, RAIN FALL TRENDS AND IMPACTS ON THE FOREST	17
2.5 SOCIAL- ECONOMIC FACTORS.....	18
2.6 HUMAN SETTLEMENTS AND SHAMBA SYSTEM	19
2.7 GROWTH OF THE TEA SECTOR	20
2.8 EFFECTS OF DEGRADATION ON THE FOREST.....	21
CHAPTER THREE	24
3.0 LITERATURE REVIEW	25
3.1 INTRODUCTION	25
3.2 EMPIRICAL LITERATURE	26
CHAPTER FOUR	33
4.0 RESEARCH DESIGN AND METHODOLOGY	33
4.1 SAMPLE DESIGN	33
4.2 STUDY POPULATION	33
4.3 SOURCE OF DATA	33

4.3.1 Primary Data.....	33
4.3.2 Secondary Data	34
4.4 SAMPLE TECHNIQUE.....	34
4.5 SAMPLE SIZE	35
4.6. CONFIDENCE LEVEL	35
4.6. CONFIDENCE LEVEL	36
4.7 DATA ANALYSIS.....	37
CHAPTER FIVE	38
5.0 DATA ANALYSIS AND DISCUSSIONS	38
5.1.1 INTRODUCTION	38
5.1.2 DEMOGRAPHIC INFORMATION	38
5.2.1. SOCIAL ECONOMIC DATA.....	40
5.2.1 OCCUPATION OF THE RESPONDENT.....	40
5.2.2 RESPONDENT LEVEL OF EDUCATION	40
5.2.3 RESPONDENTS LEVEL OF INCOME	42
5.2.4 PROPORTION OF TEA FARMERS	42
5.2.5 RESPONDENTS WHO OWNED LAND BY 1996.....	43
5.2.6 USES OF THE FOREST.	43
5.3.4 ECONOMIC LOSS ASSOCIATED WITH COMPLETION OF ELECTRIC FENCE.....	46
5.4 OBJECTIVE 1 AVERAGE NUMBER OF HECTARES UNDER FOREST COVER LOST BETWEEN 1995 AND 2005	46
5.5 OBJECTIVE 2 NUMBER OF ACRES THAT WERE BEING PLANTED WITH TEA BUSHES OVER THE STUDY PERIOD.....	50
5.6 WHO IS RESPONSIBLE FOR FOREST LOSS IN CHINGA AREA?	51
5.8 THE THIRD OBJECTIVE REQUIRED THE STUDY TO DETERMINE THE RELATIONSHIP BETWEEN INCREASED USE OF WOOD FUEL AND LOSS OF FOREST COVER.	54
5.9 EVALUATION OF ENERGY CONSUMPTION.....	56
5.1.0 INTRODUCTION.....	57
5.1.2 THE AMALGAMATED TEN YEAR RESULTS FOR THE NUMBER OF ACRES UNDER TEA AND THE NUMBER OF ACRES UNDER FOREST	63
CHAPTER SIX	67
6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.	67
6.10 INTRODUCTION.....	67
6.20 RESEARCH FINDINGS.....	67
6.4 Recommendations	70
6.5 Recommendations for further research.....	74
REFERENCES.....	72

APPENDIX.....	80
QUESTIONNAIRE.....	80

LIST OF TABLES

Table 1: Kenya tea output in million kilograms.	3
Table 2: Earnings from tea.....	28
Table 3: tea production	28
Table 4: tea area	28
Table 5: Age of Respondents	38
Table 6: Position in the household.....	39
Table 7: Occupation of the respondent	40
Table 8: Level of Education.....	40
Table 9: The average monthly income from all sources (in Ksh).....	42
Table 10 percentage of respondents who are tea farmers	42
Table 11: Respondents who owned land by 1996.....	43
Table 12: Uses of the forest	43
Table 13: Does forest use contribute to forest loss?	45
Table 14: Proportion of respondents who have lost financial gain.....	46
Table 15: Average number of Acres of Land that was under trees between 1996 and 2005...	46
Table 16: Average numbers of acres under Tea in the Study area.....	50
Table 17: shows who is responsible for the forest loss in Chinga area?.....	51
Table 18: Tea produced and fuel wood used.	54
Table 19: wood consumption.....	56
Table 20: Average numbers of acres under Tea and forest in the Study area.....	58
Table 21: Amalgamated results for amount of wood used by the factory and loss of forest in acres.	62
Table 22: Average number of acres under tea and area under forest cover.	63

LIST OF FIGURES

Figure 1: Conceptual Framework	9
Figure 2: Map 1 showing the study area.....	13
Figure 3: Map 2 Central province showing the study area.....	14
Figure 4: Map 3 Chinga location showing the study area.....	15
Figure 5: Position in the household	39
Figure 6: Occupation of the respondent.....	40
Figure 7: Level of Education	41
Figure 8: Forest Uses	44
Figure 9: Average area of land under tree cover.....	47
Figure 10: Tea acreage with years over the study period.....	51
Figure 11: Amount of fuel wood used in tons	55
Figure 12: Average number of piles used per year (1996-2005)	57

LIST OF PLATES

Plate 1: (Chinga river valley).....	48
Plate 2: (Gikira River valley).....	49
Plate 3: A section of land in chinga showing land that was cleared for tea plantation.....	52
Plate 4: A section of eucalyptus plantation cleared in mucarage.....	55
Plate 5: A section of Aberdare forest showing the effects of a land slide.....	60
Plate 6: A section of chinga dam showing muddy water due to soil erosion upstream.....	61
Plate 7: A section of chinga dam showing a plantation of eucalyptus trees along tea bushes.....	62

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

The mountain ecosystems of Kenya include: Mount Kenya, Mount Elgon and Aberdare (Nyandarua) Mountain Ranges. These mountain areas have been recognized as important ecosystems with high social, spiritual, economic and environmental values. They are used as water catchments, forest reserves, national parks and agricultural land. Increasing population pressure on the natural resources of these ecosystems has led to environment and development challenges such as unsustainable utilization, conversion of forest to cropland, human-wildlife conflicts and highland-lowland resource-use conflicts.

It is estimated that 80% of the population use biomass energy while urban development and hydro energy rely heavily on water (minister for Environment and natural resources, 2007). Forests will continue to provide essential goods and services such as timber, poles, fuel-wood, food, medical products, fodder and other non-wood forest products. Forest resources and forestry development activities also contribute significantly to the national economy by supplying raw materials for industrial use and creating substantial employment opportunities and livelihoods. As important as our forests are to the national economy, their sustainable development and management continues to be hampered by a number of factors including: inadequate financial resources and the lack of an enabling policy and legislation. In addition, the increasing population and poverty continue to exert pressure on the country's forest resources. This pressure is witnessed in the current rampant illegal logging, illegal charcoal making and encroachment for agriculture and settlement. Forests cover less than 2% of the country and may be divided largely into natural ones (about 2-million ha) and plantations (about 0.24-million ha). Kenya, which has felled more than 90% of its natural forests, ranks fifth in Africa in terms of the loss of forests (Kamweti et al, 2009). Forests are disappearing at a rate of more than 5 000 ha per year following the settlement of people, cultivation and development projects in the reserves. The decrease in forests has led to the decline of important functions including: prevention of erosion, water yield, and the conservation of wildlife habitats and genetic

resources. It has also caused problems of sedimentation in water systems. Overgrazing and felling of trees have resulted in desertification in arid and semi-arid lands.

Chinga area forms part of the Aberdares that has undergone a lot of negative transformations. Chinga area has steep slopes therefore during heavy rainfall; the clay volcanic soils that exist have a high water absorption capacity making it easier to cut off and slide during heavy rains. It is along Thika-Muranga road at Karungia that a 1km road was swept away during the El-Niño of 1997 to 1998 (Ngechu et al, 1999). Several areas of Chinga have suffered landslides during the recent long rains as is discussed under this study.

The Eastern slopes of Aberdares of which Chinga forms part, suffers illegal logging of indigenous trees and especially the endangered hardwood trees such as Camphor, Cider and Podo. The incursion of forest settlers is evident near Chinga as an aerial survey indicates 16 cultivated fields of Marijuana and 49 fields of cultivated food crops (UNEP, 1990). Animals of international conservation interests including: Black Rhino, Elephant, Leopard and Cape buffalo are also threatened by forest settlers. During the dry season some of these wild animals leave their reserved areas to community homestead where human-wildlife conflict arises.

The main Rivers of Gikira and Chinga have lost much of their water to intensive collection and tapping by Othaya and Mukurweini Water and Services Company (OMWASCO) who supply water to the two Constituencies and therefore forest conservation is very important on this part. It was these and other reasons that in the mid 1980s, the Kenyan government started Nyayo Tea Zones under Nyayo Tea Zone Development Corporation. The Corporation was assigned forest land in order to grow tea to provide a buffer between the agricultural land and forests designated for protection as well as an alternative source of income and employment. This was established by a Presidential order in 1986 and an Act of Parliament in 1988. The approximate boundary planting width that the zones were to occupy were not formally established but a general width of 100m into the forest was nominally accepted. Little consideration was given to the suitability of these areas for tea growth; some of these areas are moderate for tea growing (Forest inventory, 1993) further, the areas have been affected by poor management and poor access leading to further degradation of

the forest. These tea zones have been the largest alternative use of forest land in Mau, For example out of a total of 2152 ha cleared in Mau Forest, only 542 ha were planted with tea(Tea research foundation of Kenya,(TRFK 2009), the remaining land was left un attended, the result was settler occupation. This later culminated in serious forest loss and degradation of the forest. The market promotes growing of Tea for global trading whose output has been increasing within the study period as table 1 below shows. This in turn has impacted negatively on the forest cover at the local level.

Table 1: Kenya tea output in million kilograms.

10-YEAR KENYA TEA EXPORT (Qty in M. Kgs)				
MONTHS	2002	2003	2004	2005
JANUARY	26.3	24.9	28.8	27.3
FEBRUARY	24.0	26.4	26.2	30.6
MARCH	22.3	30.8	35.2	31.6
APRIL	25.3	23.4	30.4	27.6
MAY	23.3	23.4	29.4	26.5
JUNE	22.6	25.8	22.6	28.3
JULY	26.0	26.7	27.2	35.5
AUGUST	20.2	23.6	24.3	35.0
SEPTEMBER	19.2	23.1	28.2	28.6
OCTOBER	19.3	25.9	22.7	21.3
NOVEMBER	21.3	25.3	30.4	25.1
DECEMBER	17.9	26.9	28.4	32.5
TOTAL	268	306	334	350

Source, Kenya tea board, 2012

The figures above show a gradual increase in Tea production from 268 000 000kg in 2002 to 350 000 000kg in 2005. The increase suggests a demand for more land and more importantly more demand for wood. The total Forest area was 3 522 000ha in 1990 and represented 6.2% of land area. The primary forest cover was 704 000ha of land area which represent 1.2% total forest area. The annual change in forest cover is -12 000ha which represents an annual deforestation rate of -0.03%, the change in

deforestation rate since 1990 has been recorded as -1.4% with total loss since 1990 being recorded as 186 000ha. (KFS, 2012)

There have been prolific development programs for expansion of tea growing by the Kenya Tea Development Authority (K.T.D.A) since independence; however, this has not been replicated in plans for sustainable production for Energy to fire the fermented tea. With population increase and over 10% of Kenyans settling 5 kilometres from forested areas where they not only deplete water sources through logging, burning of charcoal, draining of swamps to cultivate crops, but also exploit other forest services. Growing of tea has been attributed to improving the aesthetic landscape. The small-scale tea growers' production surpasses that of estate grower, Tea Board of Kenya (TBK, 2000).

Production of Tea in Kenya for the period 1963 to 2006 suggests a tremendous growth; Small-scale tea farming in Kenya has had a remarkable growth. First Introduced and allowed by law in 1963, it has steadily risen and figures from small-scale tea sector of Kenya (SSTSK) 2007 show 422,000 small-scale tea farmers existed in Kenya. In terms of area under tea and production the small-scale tea farmers have also surpassed that of the large estates however, an analysis of the production figures tells a different story. The increase in Production by small-scale farmers is mainly due to expansion in hectare rather than better agronomic and processing skills/technology. For instance in 1972, Smallholder acreage surpassed Estate acreage but it was not until 1988 when Smallholders surpassed Estates in production .Yet the actual per hectare production figures have remained higher on the Estates as carefully studied Compared to the small-scale farmers. Further analysis by (SSTSK, 2007), shows that in 1972, small scale farmers contributed only 37.3 % of Tea produced that year while in 1988; their contribution had increased to 51.6%. Report by Small-scale Tea Research in Kenya, 2007. According to Food Agricultural Organisation, Lack of regional diversity leads to environmental degradation, most farmers in African countries plant similar crops and rarely practise crop rotation, this in turn lowers the soil quality, and soil degradation is further aggravated by the hilly terrain along the Aberdare Ranges.

According to Ongweny (1977), the Topography and drainage along the study area is such that the cultivated hill slopes of the Mathioya and Sagana basins have mean gradients of 0.24 and 0.27 (with standard deviations of 0.08 and 0.01) respectively, the hilly terrain therefore encourages a lot of soil erosion especially when slopes are left bare as the study seeks to find out. Deforestation is a widespread problem around the world. Kenya is no exception. The need for new settlements, more land to cultivate and more land for grazing, threatens the existing forest. Furthermore, local communities use the forest to extract wood for fuel and for production of charcoal. This might be the greatest contribution to the deforestation in the country. In addition, the commonly used method for fencing cultivated land also demands a lot of timber. These practices have led to an unsustainable management of the forest.

Deforestation has severe consequences. The forest degradation has for example been shown to have a negative impact on the local climate. According to Chebet et al, (2010), it rains less in Marakwet district due to the ongoing deforestation. This has led to a decrease in water level in the rivers, and Water table levels have dropped as well. In addition, soil erosion is a growing problem. The landscape in Central districts is characterized by a hilly terrain, and there is a risk that some areas may be completely destroyed as a result of soil erosion.

After independence in 1963, the government policy on tea encouraged growing of cash crops such as Tea, Tea Research Foundation of Kenya (TRFK). The Kenyan Government then allocated more land from forest reserves in order to expand the tea growing areas and tea factories. The small holder factories that rely on firewood to fire fermented Tea therefore increased with time. According to Kamweti report on energy, 2001, apart from KTDA bringing into the country the much needed foreign currency, they also save the government a lot of foreign cash that may otherwise have been used to import extra fuel. Tea factories and tea collection centres then became agents of rural development in Kenya (Mugambi, 2006). Their location led to sprouting of towns.

These towns needed land to expand, social amenities like schools, road networks hospitals and other communication networks came up. The resulting increase in population led to energy demand; with the easier option being non renewable wood fuel, more trees were cut. Tea development was an economic inducement to the

country and its people, (Murugu, 2004). Its rapid expansion led to forest encroachment. Likewise, farmers were increased due to boy child inheritance of the traditional land. The land fragmentation that resulted, the hilly terrain and increased social amenities led not only to both land and forest degradation but also pollution.

1.2 Statement of the Problem

In the 1992 UN conference on Environment and Development (UNCED), or Agenda 21 noted that other than population density, increased productivity, higher incomes and consumer patterns, have far reaching Pressure on forests. The Agenda also noted that changes on land impacted negatively on forests. Between 1990 and 2005 the annual global forest loss was 0.2 percent, and since Africa was most affected, it forms a basis for this project (GEO Data portal, FAO, 2005).

Chinga is a location in Othaya constituency in Nyeri County. The area borders the South Eastern Aberdare ranges, two rivers (Chinga and Gikira) traverse this area, and the two main cash crops are Coffee and Tea. The latter is grown along the cooler part neighbouring the forest, at an altitude above 1850m. The location is the home of Chinga Dam, the largest water reservoir in Nyeri County. The Chinga River drains into Chinga Dam that is surrounded by tea farms and small bushes that initially had indigenous trees. Most of the forests have since been cut over the years to pave way for tea expansion and therefore justification for this study. The cooler upper section of the study area is ideal for tea growth; it has a combination of fertile –acidic and rich volcanic soil, alongside good rainfall has made nearly 7000 small scale tea farmers earn the third best Bonus payment in Central Kenya (Kenya Tea Development Agency annual report, 2010, 2011).

The hilly terrain that characterises the study area can lead to land degradation if not checked. One Tea factory located at Kagicha called Chinga Tea factory serves 12 regions that grow Tea in the study area. The factory management does not have wood fuel base and therefore sources it from farmers who sell them wood that comes mainly from indigenous trees. Due to increased demand for wood, young cider plantations from forests and Eucalyptus trees are cut leaving the land almost bare. The average sizes of land is 2 to 3 acres with Tea bushes occupying over 80% of the land .In most cases, nearly 19% of the rest the land is used for food crops leaving almost nothing

for trees planting. The reason for this is access to the forest that provides the much needed trees.

The water levels of Chinga dam has gone down over the years, the water depth has reduced from forty feet at independence to an average of ten feet in 2012(Chinga dam community self help group, 2012) .There is evidence from the Chinga Factory management that small scale tea farmers have increased with increase in population. It is for this reason that this study sought to look for any relationship between tea acreage and Aberdare forest cover reduction. Ongweny, G.S (2002) noted that three key areas anticipated for improvement by the Nyayo Tea Corporation has not been actualised. These include: improvement of access roads that had not been done as envisaged; there is no noticeable reforestation as earlier planned and the jobs that would have been realized by the resulting tea plantations did not come about. Therefore, poverty eradication remains a pipe dream. In spite of the strict protectionist strategy adopted by forest managers, the destruction and degradation of Kenya's forest resources still forms a persistent theme in the evaluation of the natural resources sector. These have been captured in broad literatures, from newspapers (Matiru, 1999) through to technical reports by local and international agencies (Wass, 1995; KFMP, IUCN 1996). Authorized and unauthorized excisions are the prime source of forest loss. It is evident that between 1995 and 1999, A total of 44,502.77 ha. Were officially de-gazetted and excised (Matiru, 1999). Between 1972and1980 the forests shrank at an annual average rate of 2% (Ochanda et al, 1981), and later at an average of 3700-5000 ha per year (Wass, 1995). The industrial plantations have faced a similar plight. While the loss of forest cover through excisions for settlement and agriculture as well as uncontrolled exploitation of forest products is thought largely to be the result of a rapid increase in population, it must be noted that the Forest Department (FD) has had little capacity to implement its extensive mandate. FD has been severely understaffed, just as the institutional framework at the time severely limited opportunities for management innovations.

Chinga area is plagued by environmental crimes such as grazing in the forest, illegal logging, poaching and suspected diversion of head waters of Chinga River (Chinga welfare community). These environmental crimes are likely to have reduced the forest

Cover. Just like other parts of the Aberdares Tea growing areas, Chinga area has had a tremendous tea expansion; similarly the farms have been subdivided into small stripes due to inheritance. Although Household energy demand is one of the major uses of fuel wood, there is significant energy requirement for all the processes of refining Tea in the factory. The Chinga Tea Factory does not have its own wood fuel base and relies on forests for the fuel. The extra fuel demand is likely to have significant effect on forest cover and since this is brought about by increased tea production justifies this study.

1.3. Research Questions

This study sought to answer the following research questions:

- i) What is the number of hectares under forest cover that was lost per year from 1995 to 2005?
- ii) What is the number of hectares under tea bushes that was planted per year from 1995 to 2005?
- iii) What is the relationship between increased use of wood fuel and loss of forest cover?
- iv) Has increase in tea acreage led to forest degradation?

1.4 Objectives of the Study

1.41 broad objectives:

The main focus of this study was to examine whether there is a link between increase in tea crop acreage and forest cover reduction. Or the effect of tea growing on forest degradation in Chinga area.

1.4.2 The Specific objectives:

- i) To determine the number of hectares under forest cover that was lost in Chinga area annually between 1995 and 2005,
- ii) To determine the number of hectares that were being planted with tea crop annually between 1995 and 2005,
- iii) To determine the relationship between increased use of wood fuel and loss of forest cover.

- iv) To establish whether there is a link between increased tea acreage and forest degradation.

1.5 Research Hypotheses

This study proposed the following null hypotheses:

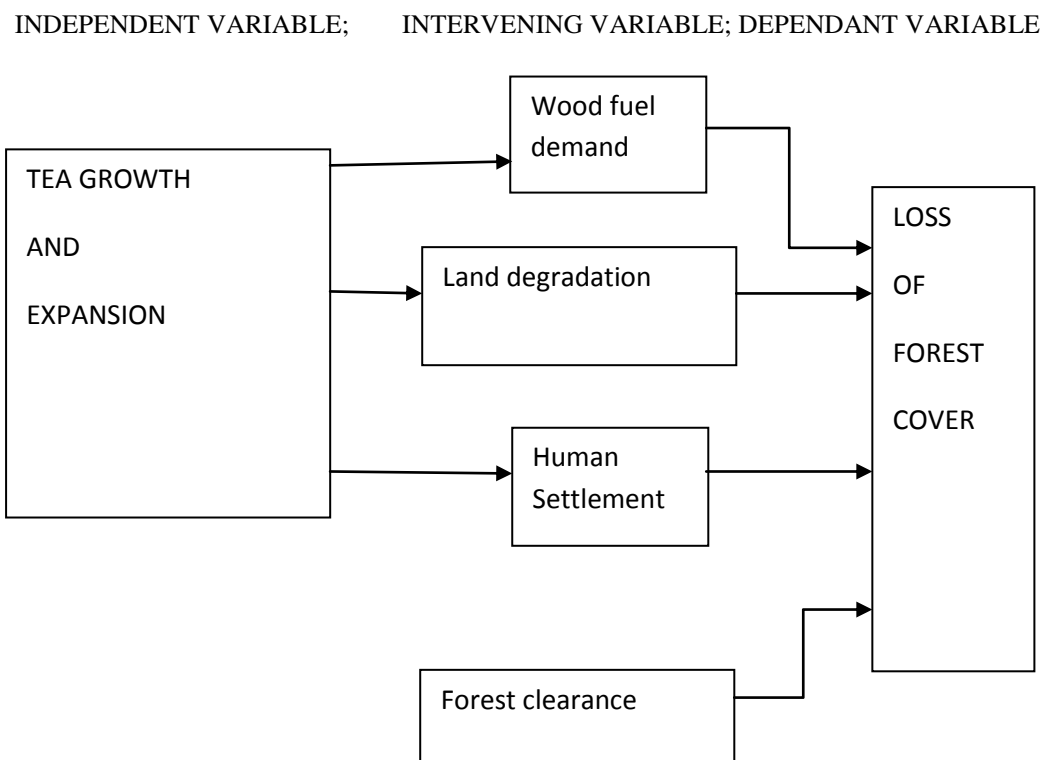
- i. H_0 There is no significant relationship between expansion of tea growing areas and degradation of forests in China area.

H_i Alternative.

- ii. H_0 There is no significant relationship between increased use of wood fuel and forest degradation.

H_i Alternative.

Figure 1: Conceptual Framework



Source, author, 2012.

This conceptual model presents tea as the independent variable, the intervening variables include: human settlement, land degradation and wood fuel demand. The dependent variable is the loss of forest cover.

There exists a delicate balance between the services provided by the forest and agriculture, the numerous ecological services including: regulating hydrological cycles, protection of soils and water sources. All this depends on use of forests (UNEP, 2009). Commercial Agriculture of which Tea forms part is an energy demanding enterprise. This conceptual model presents a link between land degradation, forest degradation and Tea cultivation. Tea cultivation is one part of agricultural practices that continue to demand more land. The whole process of planting to processing of Tea requires a lot of energy most of which comes from fuel wood and more so when the rate of use is more than natural replacement causes forest degradation. This conceptual framework does not take into account any afforestation and re-afforestation programs that may have been undertaken. Factors that relates to climate are ignored in this study. Human settlement and wood fuel demand forms intervening factors, Use of wood fuel by both households and the Tea factory affects the forest cover. Human settlement and demand for forest products has direct implication on the forest. When the forest becomes degraded, it cannot provide the usual services such as necessary moisture to Tea plants as the arrow indicates. Likewise, degraded land will not have sufficient nutrients to support forest growth which in turn influences Tea growth. As the left arrows shows, there is a relationship between increased Tea crop cultivation and forest degradation. There is demand for a lot of wood fuel in the factory which is mostly sourced from the forest. The model considers climate as a condition that influences forest growth and forest clearance as a factor that leads to loss of trees. On the other hand, the need to use poles to fence off tea bushes against domestic animals and the reluctance to plant more trees as compared to tea also minimises tree cover. Increased use of inorganic fertilizer affects the soil PH and as the arrow indicates, growing of tea can lead to land degradation by not only affecting the soil acidity and basicity but also destroying the aesthetic landscape.

The production of Tea depletes soils' nutrients base (Easter Kathure, 2006).Decreased soil fertility leads to less productive land and this in turn leads to clearing of more forest, therefore as land is degraded, forest is also affected as the arrow indicates. Human settlement leads to forest fires when settlers burn charcoal and clear the bushes to get more land. This is in addition to overgrazing that further reduces the forest cover. If more forest is cleared maximum felling potential will be

attained and as such most of the forest service will have been lost. The model looks at tea production as one form of agriculture that may result in forest degradation which in turn would cause loss of fertile soil. Loss of the fertile soil would reduce the land's capacity to sustain biodiversity including the same trees it is dependent on. A form of Forest degradation such as deforestation also leads to land degradation where the soil no longer supports growth of crops. These sources of forest degradation mentioned above including atmospheric pollution and global warming will be considered less significant. This study will consider land degradation, afforestation programmes and climate as less significant and will only look at tea contribution to forest cover loss.

1.7 Justification of the Study

According to world bank population pressure has negative environmental impact, This study is based in Chinga which is a part of Nyeri county where population increased by 100% between 1969 and 1999(strategic environment assessment,2005) The study period forms a duration of ten years since the presidential order of 1986 that formed the Nyayo tea zones. Chinga area is a part of Aberdares where a physical buffer was set up to prevent communities near the forests from exploiting the forest resources. Further more in 1987 the Shamba system was dismantled so as to reverse the trend of forest loss. In addition Kenya forestry master plan (KFMP) initiated in 1991 predicted significant forest loss. In 1993, settlers from Chehe and Hombe forests in Mount Kenya forest were ejected so as to pave way for the tea zones. Some of these settlers came back to their original farms and begun planting more tea. In general, the purpose of managing any resources is to look for a way of utilising it sustainably. The Aberdares, of which Chinga forms part, is a delicate Ecosystem that must be seriously guarded. Therefore, the findings from this study shall help planners and policy makers in the following ways: the policy makers will Monitor and assess the degree of participation of stakeholder groups and application of the principle of Informed Consent and of conflict management mechanisms in forest deforestation decision-making. They will also monitor progress in data collection, assessment, reporting and verification related to forest. Stakeholders on the other hand, will monitor and periodically evaluate the update and impact of information and communication in addition to Knowledge on forest degradation. All relevant stakeholders who monitor and assess the application of social and environmental

safeguards for mitigation against any negative impact will find this study useful. The cumulated knowledge and data forms a basis for research on the best ways of conservation. It also forms background to critique by scholars and basic information on forests to students.

1.8 Scope and Limitations of the Study

The study is centered in Chinga area near the border with the Aberdare forest. The reason is that the amount of interaction between the forest and tea growth is more as the land no longer supports the population and their needs. According to Chinga Tea Factory Manager (2011), there are one thousand and five hundred small tea out-growers served by the factory. These people have very little land left for planting of trees. The study therefore had the following challenges: some tea owners leave tea pickers for more than a month to work for them, it was cumbersome to obtain all the necessary data desired. There are no regular tea pickers in some areas as they migrate from one farm to another where working terms are better. The data obtained was however, found to be consistent. Pre-testing done earlier during survey was found to be consistent with the final results. The location is expansive and therefore required a lot of time and money. The questionnaires were distributed to the tea farmers whose tea farms were next to one another and to tea collection centers to save on time and see most of the target respondents.

CHAPTER TWO

2.0 STUDY AREA

2.1 Location and Size of the Study Area

Chinga location lies between Gikira River to the North-East, Muirungi-Kagicha Road to the South-West and the Othaya/ Mukurweini Border to the South. The location lies between 1800m to the South and 2100m to the North (Philips Atlas, 2000) it has an area of approximately 36 square kilometres with a population of 15000 (National Census 2009).

Figure 2: Map 1 showing the study area.



(Source; Philip Atlas, 2006)

Figure 3: Map 2 Central province showing the study area.

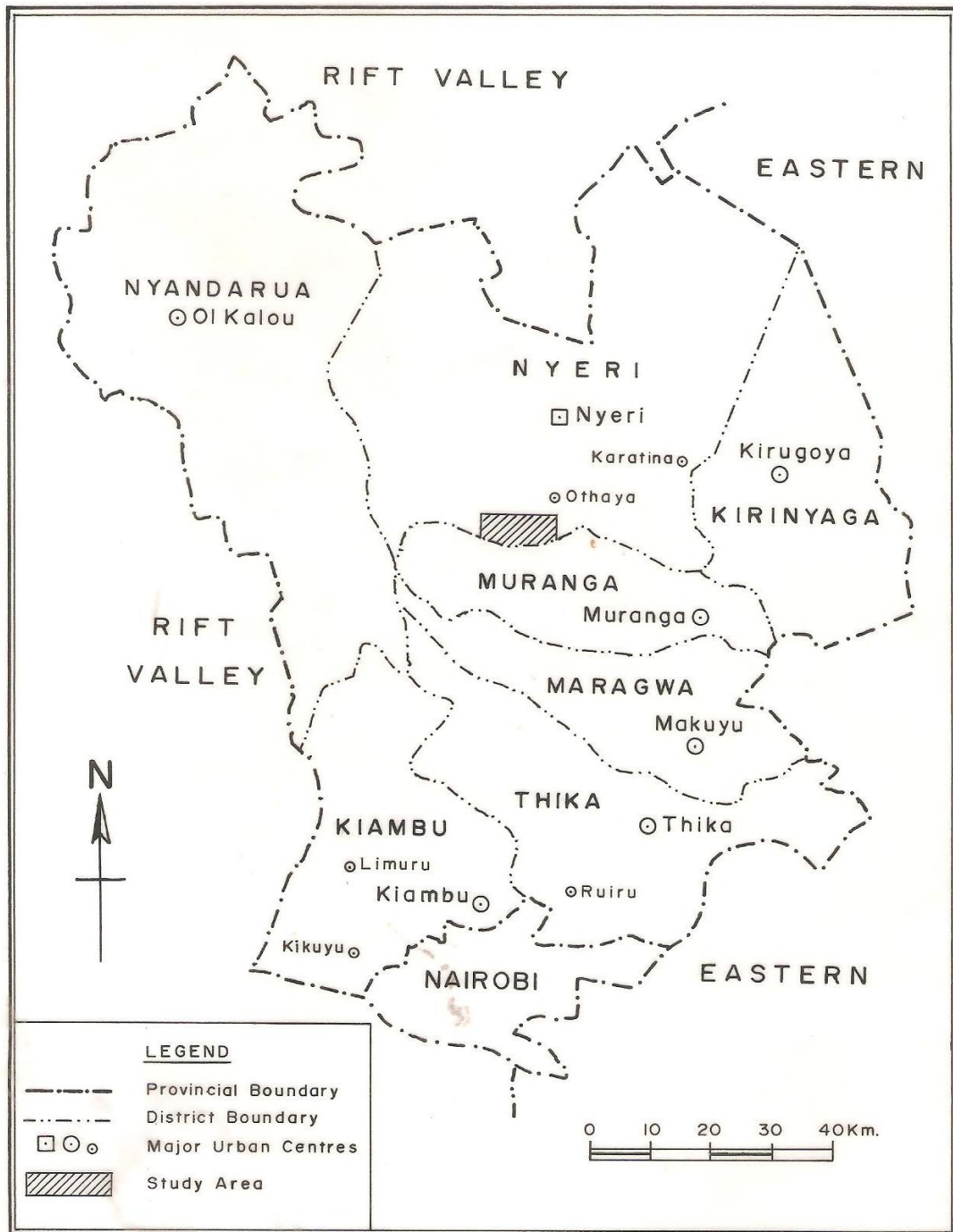
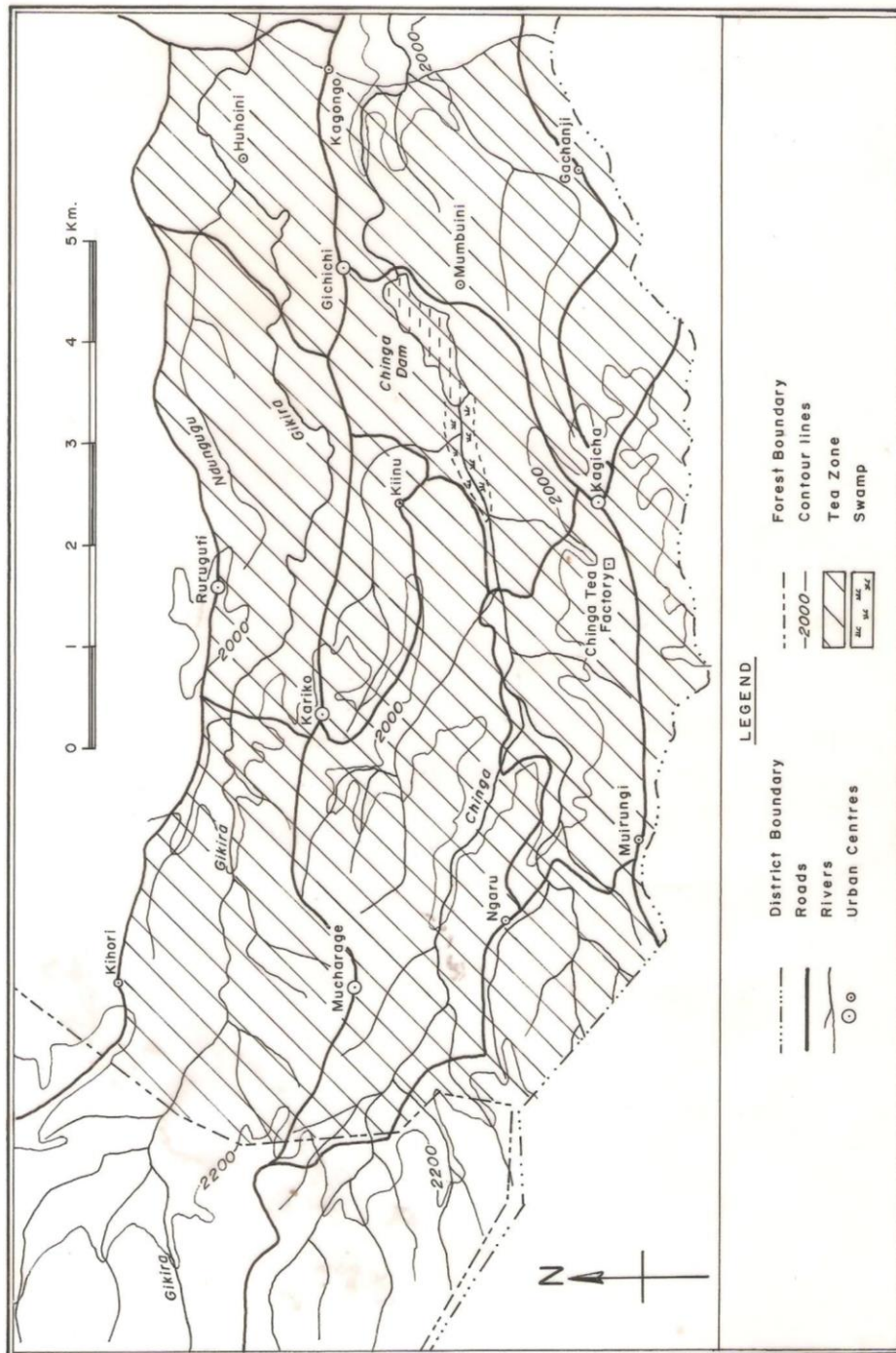


Figure 4: Map 3 Chinga location showing the study area



2.2 Geology of the study area.

The study area has a geology and landscape that contribute to the prevalence of landslides, steep hills with clay soil that allows a lot of percolation. Rapid weathering of pyroclastic rocks in a warm and wet climate creates a regolith which is generally weaker than the underlying better-cemented basalt and basaltic agglomerates. The landslides occur when the weathered pyroclastic regolith become saturated after a heavy rainstorm on high mechanically unstable slopes which slide over the more stable basalts. Over-saturation of clay soils which were also derived from weathering of pyroclastic rocks contributed to the slope failure. Besides fatalities and injuries, the landslide destroys homes, farmlands and topsoil. This phenomenon causes massive economic losses including environmental destruction.

2.3 Vegetation Cover and Wild Life

The main vegetation is that of rain forest that is composed of Kikuyu grass, Ferns, Podo, and Camphor. The steep western edges of the hillside are sparsely inhabited by wildlife compared to the forested gentle slopes to the East, which are home to a wide variety of wildlife. There are multitudes of elephants; buffalos, giant forest hogs as well as the endangered Black rhino and a variety of cats including leopards. The Aberdares contain a rich diversity of vegetation. Some of the threatened hard wood species including: Podo, Hagenia, and cider dot the forest landscape. The forests of the Aberdare Range are being devastated by large-scale unrestricted, illegal human activities of logging, charcoal production and overgrazing of the land by both the wildlife in the area and the livestock of the communities living nearby. The ongoing assault on these forests poses grave threat to Kenya's water security, biodiversity conservation and economic development. Kenya Forestry Research Institute (KEFRI, 2009).

Poor enforcement and abuse of forest regulations by those in charge of their application are clearly also major contributing factors, as well as the use of wood fuel to meet over 70 percent of domestic energy needs in Kenya. High fuel price and low levels of employment are worsening the situation by producing a high demand for charcoal and people willing to take the risk of engaging in an illegal activity. This is the main cause for the prompt and effective policy responses required to prevent

further devastation of the Aberdare Range forests; its integrity is already in great jeopardy. These responses should take fully into account successes experienced in forest conservation, in particular those related to the protection measures put in place on Mt. Kenya since 2000, as well as the partial fencing of the Aberdare Ranges.

2. 4 Climate, Rain Fall trends and Impacts on the Forest

Even with high rainfall in elevations greater than 1,800 m, there is a marked seasonal variation in Both Chinga and Gikira river flow. The rainfall pattern has two distinct wet periods of March-April and October-November each year, separated by dry periods. During the dry months of January to March and June to September, the tea crop does not do well. (Chinga Tea Factory, 2011). Furthermore, Jennifer Jacobs et al, (2009) notes that Tea and grazing of domestic animals are the main land use types that replace the lost Forest cover in altitudes between 1850m and 1900m The region that is covered by this study.

The micro-climate associated with forested areas is often a critical factor in growing of cash crops especially tea in the Aberdare Ranges and around Mount Kenya region. The reason is that the conditions for tea growth are optimal. These conditions include: constant moisture levels, air temperatures of between 10^oc to 20^oc, and coupled with red acidic soils, there is high moisture content. According to Tea Research Institute of Kenya, the high specific heat capacity of water reduces the day and night temperature ranges all this lowering the frost that otherwise attack the crop. Lack of forest cover and increased global warming has also led to more incidences of frost during dry weather. The dry vegetation attracts incidences of fire especially around the Gathiru forest and the Aberdare moorland.

Rainfall follows a similar elevation gradient as that of soils. Mt. Kenya and the Aberdare Ranges receive greater than 1,800 mm/yr of rainfall (Otieno and Maingi, 2000). At the mid elevations (1,200 to 1,800 m) where intensive agriculture is predominant, annual rainfall ranges from 1,000 to 1,800 mm/yr. Below 1,000 m, rainfall is less than 700mm/yr which is too low for intensive agriculture so cropland is sparse and livestock grazing predominates (Otieno and Maingi, 2000).

Ndakaini Dam is suffering from the effects of climate change which has resulted in unpredictable rainfall patterns in its catchment area around the Aberdare Ranges.

Apart from climate change, massive deforestation within the Aberdares has reduced the water retention capacity of the mountains (KFS). The Aberdares used to have abundant marshes of water where, reputedly, elephants were known to sink into the depths. Today, the marshes are all but dry (KFS, 2011).

The last time that a significant water rationing program was implemented in Nairobi was in the year 2000. A year long drought shrank water supply and hydro-electric dams resulting in both electricity and water rationing. Conflicts over water were witnessed in the estates while hotels and offices in the city had to hire trucks from Kajiado District to supply fresh water. The effects of water and power rationing in 2000 caused a negative growth in the Kenyan economy for three straight years.

2.5 Social- Economic factors

The demography in Chinga is identical to other areas in the upper Tana catchment area. Majority of farmers built close together leaving the rest of the land for Tea cultivation. The population density is 250 people per square kilometre on higher slopes and nearly 350 people per square kilometre in small towns (National Census 2009).

The average poverty rate of people in Chinga is 43% or ten times better than Kenya's national rural average. The main occupation for these people is commercial Tea cultivation. Those who do not have farms are employed as seasonal tea pickers. People also engage in food crop farming in small plots to meet their daily needs. Those who used to collect honey from the forest have been encouraged to do Bee keeping on their land. The area is endowed with good climate for dairy farming but only few people who are far from the forest practice it. Those who are near the forest have an arrangement with forest authorities to graze their cattle in the forest. The milk production is therefore very low. Few people who resigned from the public service rather than get back to the ethnic clash areas have embarked on horticultural cultivation and seem to change the people's mindset about this type of farming. The area is endowed with a lot of water, there are numerous streams that have water all year round but no irrigation is being done to provide sufficient food. The area is ideal for foodstuff business as land available is not sufficient to grow enough food.

There are few organizations around the study area. There is a community welfare group known as Mucarage Community Forest Association (MCA), their responsibility is to sustainably use the forest. The membership is farmers who live within five kilometres from the Aberdare forest. Their primary objective is to safeguard their interest in grazing their animals while at the same time protect the forest. Under the guidance of Kenya Forestry Service (KFS), community based projects such as bee keeping is enhanced.

This organization for men (MCFA) caters for their cows in the forests as they graze; it also organizes prompt fee payment to forest authorities every month. Alongside this, the group manages their animal herds. Women have many organizations including those that give micro finance in K-REP and FAULU. Tea farmers are members of Wananchi Tea Sacco which among other things: educate farmers on best financial practice and sustainable loan utilization. Most of these people are members of Churches where they also form self help groups. Young men have no organizations to benefit them positively. Those who don't seek membership in illicit groups find jobs in the construction industry and the current roads construction. Older people are members of Mau Mau Veteran Association Chinga chapter that keeps them up to date on compensation envisaged from United Kingdom.

2.6 Human Settlements and Shamba System

The major cause of deforestation and forest degradation in Kenya, (Lynette et al, 2006) is conversion of natural forests into agricultural land. This was prompted by the acute land shortage faced by communities after colonization, and a need to reduce plantation establishment costs by the Forest Department (FD). It was also meant to provide means of livelihood. Under the Shamba system, the cultivators were incorporated into the FD through employment and were permitted to clear and cultivate indigenous forest cover from a specified land area.

The extent of the Shamba system was restricted to the high potential areas, comprising about 3% of Kenya's land area, and representing 12% of Kenya's total agricultural land. These areas are endowed with fertile soils of volcanic origin and a high annual (>1000 mm) rainfall with a bimodal distribution.

The system was discontinued in 1986 chiefly due to an expanded human population whose demand for forest land allocation exceeded the initial Forest Department (FD) objective of plantation establishment (Lynette et al, 2006). In addition, illegal activities (e.g. forest clearing, tree poaching, and hunting) from the resident cultivators and their families jeopardized forest sustainability. Interestingly, resident cultivators in forest areas with high wildlife populations voluntarily gave up the practice due to crop destruction and livestock predation.

After the Shamba system was stopped, communities living around the forest moved and settled in areas that were cleared. They also set mechanisms by which deforestation began as the settlers could not employ indigenous knowledge of forest management (Linnet et al, 1999). In Chinga, majority of the settlers went back to cultivate more Tea and greatly helped to increase pressure on the same forest they had been asked to move out from. They only reduced the forest farming but because of increased usage of ancestral land the cows had to be taken back to the forest.

The Non-resident cultivation that was introduced in 1986 is a modification of the Shamba system that attempts to reduce the risk of cultivators claiming squatter rights on forest land. The system however, failed to take into account the need to protect crops from wild animals and thieves that invade the plots at night. Even with the electric fence completed in 2004(Jennifer Wanjiru) by The Kenya wildlife, there is still some incursion of some peasants into the forest to graze cattle and collect firewood.

2.7 Growth of the tea sector

The history of tea in Kenya dates back to 1903 when a European settler, Mr. G. W.Cain introduced the first tea plants in Limuru area of Central Kenya. The early settlers and the colonial government restricted tea and coffee growing to large-scale farmers and multinationals, ostensibly to maintain quality. But the main reason by the administration was to discourage the local people from the then very lucrative Tea crop farming. Kenya's attainment of independence in 1963 saw the passing of various Land Reform Bills which have had far reaching impact on agriculture. Tea growing for Instance was made open to the local farmers. The crop has since spread across the

country and is currently an important economic mainstay for many small holder farmers. (Source KTDA, 2006).

Currently, there are about 420,000 small-scale tea farmers in Kenya who have traditionally and by law been under the control of KTDA. The KTDA promotes the plucking of two leaves and a bud, resulting in Kenya producing one of the best Teas in the world. The tea sector therefore has developed and taken root in the Eastern Aberdare Ranges, this according to Murugu, 2004, has led to proliferation of monoculture system of farming that is intensive, since the cost of production of tea leaves has been realised to be low when fuel wood is used. More trees have been cut making the tea factories to destroy their own wood fuel base. Tea industry operates under Tea Act (cap343) and Agricultural Act (cap318).The TRFK asserts that the economic inducements and financial returns to the country led to aggressive planting of tea bushes with little regard to reducing forest cover.

Many tea factories are being encouraged to use firewood to fire the Tea leaves so as to reduce the cost of production and be able to compete favourably in the international markets. The tea sector does not produce its own wood fuel or even renewable Energy the result is deforestation of the forests that serves as a provider of this Energy required.

2.8 Effects of degradation on the forest.

Critical environmental issues in the tea sector include: soil erosion, agro-chemical use and more importantly for this study deforestation. Before, decentralization of forest conservation and management in Kenya was guided by the forest policy of 1957 that was revised in 1968 and much later in 1994. The 1994 draft formed the policy basis for legal reform on gazette and degazetting of forests and natural reserves. This was done on the basis of the 1957 policy and covered licensing of use, prohibitions of some activities, and imposition of penalties, there were also some regulations covering the rights of communities living adjacent to the forests to use specified resources. Some of the shortcomings noted include: the policy only covered gazetted forest reserves and did not provide enough safeguard against forest excisions it also did not recognize the importance of forest for environmental conservation.

In spite of the strict protectionist strategy adopted by forest managers, the destruction and degradation of Kenya's forest resources have formed a persistent theme in the evaluation of the natural resources sector, (Matiru, 1999) through to technical reports by local and international agencies (Wass, 1995). Authorized and unauthorized excisions are the prime source of forest loss. For example between 1995 and 1999, a total of 44,502.77 ha, were officially de-gazetted and excised (Matiru, 1999). Between 1972 and 1980 the forests shrank at an annual average rate of 2% (Ochanda et al, 1981), and later at an average of 3700-5000 ha per year (Wass, 1995). The industrial plantations have faced a similar plight. While the loss of forest cover through excisions for settlement and agriculture as well as uncontrolled exploitation of forest products is thought largely to be the result of a rapid increase in population, it must be noted that the forest department has had little capacity to implement its extensive mandate. FD has been severely understaffed, just as the institutional framework at the time severely limited opportunities for management innovations.

According to International Centre for Research in Agro Forestry (ICRAF, 2002), the destruction of forest has increased due to the ongoing drought in the country. Forest resources have been increasingly exploited as people have turned to alternative means of income by transforming wood into charcoal or selling it as timber. In the Mount Kenya forest reserve, 2,465 charcoal kilns were discovered by the Kenya Wildlife Service in an aerial survey in August 1999. The consequences of the depletion of Kenya's forest resources range from an increased risk of drought to effects on the economy.

Close canopy forests have a crucial role as water catchments. If the forest is damaged, there will be increasing risks of flood during the rainy season and of drought during the dry season. This is particularly true as a consequence of deforestation in the mountainous regions of Mount Kenya, the Aberdare Range, the Mau Escarpment, Mount Elgon and the Cherangani Hills. This amounts to three-quarters of the total of indigenous forests in Kenya, and provides much of the nation's water, highlighting the forest's role as water catchments. "It is very likely that [the current] shortages of water and electricity in the city of Nairobi are related to the degradation of the Aberdare forest," Christian Lambrechts said. Furthermore, Lian hong Gu, 2007, asserts that Global warming could worsen frost damage of the tea crop and other

agricultural crops in future. From his analysis, warming temperatures may be leaving plants less able to withstand freezes caused by frost. Lian noted that plants radiate a lot of heat at night in a period when day and night temperature differences are large. He alluded to the fact that their cell membranes rupture leading to drying.

Deforestation is one of the forms of degradation, the growing global demand for land for the production of agricultural commodities has sometimes led to irreversible loss of forest cover (UNEP,2009).A combination of increase in food demand, loss in soil fertility and escalating food and market prizes further aggravates the problem of deforestation according to UNEP. Increased demand for forestry services needs more planted forests (Urgewald, 2007).The demand for Bio fuels has led to loss of natural forests in many area including Indonesia (FAO, 2006).

Kenya is the least forested country in the Eastern Africa region. Forests and woodlands cover approximately 2% percent of the total land area (UNEP, 2006). Forests are of great importance for the domestic economy of Kenya (National encyclopaedia, 2009) and they are essential in order to conserve soil and water resources (Encyclopaedia Britannica, 2010). The forested areas in Kenya have various legal statuses and are managed by different Bodies (Wass, 1995). The majority of all closed forests in the country are owned and controlled by the government (WRI, 2007) and under direct management of the Forestry Department or the Kenya Wildlife Service.

In most cases, the forests owned by the government have been declared as forest reserves. The fast-growing population requires settlement areas and more fuel for domestic cooking, which threatens the existing forests (Encyclopaedia Britannica, 2009). Wood for fuel and timber are the main forest products. Forests and woodlands supply many families with livelihoods and provide energy, food, and timber (UNEP, 2006). As Much as 80 to 90 percent of the wood is used for energy through firewood and charcoal, while the remaining 10 to 20 percent is used for timber, poles and posts. Biomass is the main fuel in Kenya and stands for over 80 percent of the total energy consumption (WRI, 2007). Deforestation threatens not only the remaining forests but also leads to shortage in the supply of fuel (Encyclopaedia Britannica, 2009). Some

areas in Kenya that suffer from deforestation have been reforested, mainly through forest plantations by the government.

Some farmers have been focussing on planting of Eucalyptus trees. However, the establishment of eucalyptus trees has negative effects on the surrounding environment. Eucalyptus demands a lot of water and hence has a negative impact on the water balance. At the same time, they are hostile to other species and do not allow anything else to grow nearby (Masinde, 2010; Okella, 2009).

Thus, the plantation of eucalyptus leads to water shortage and loss of biodiversity (Okella, 2009). Over the last few decades most of the Aberdare forest has been the focus of irregular settlements and large-scale exploitation. These include: charcoal production and logging of indigenous trees (UNEP). Although logging of indigenous trees has been banned since 1986, logging licenses have been issued on exceptional basis (Butynski 1999), Aberdare National park and Aberdare Forest reserve wildlife placement study and recommendations). Butynski also notes that overgrazing has been on the increase due to uncontrolled access to the forest by opportunistic farmers. The hilly terrain and non productive farmlands make some farmers to abandon farming to pastoralist (Butynski).

According to FAO, Forest Resource Assessment 1990, Kenya is classified among the countries with low forest cover of less than 2% of the total land area. The dwindling forest cover has a severe effect on the climate, wildlife, water resources, and human population. This has caused many of the rivers and streams feeding Lake Naivasha and other lakes to shrink or dry up, leading to a drop in water levels. There is also less rain in the area, in part because there is less forest cover to trap moisture and attract cloud cover. Deforestation is one of several human activities that experts say contribute to climate change. They are especially worried that the emissions of carbon dioxide, methane, and other gases into the air are forming a barrier that prevents the sun's energy from radiating back into space, thus raising the earth's temperature. These scientists blame climate change for causing global warming.

This study was carried out in Chinga location, Othaya district in Nyeri County, on the eastern Aberdare forest where environmental crimes have been committed.

CHAPTER THREE

3.0 LITERATURE REVIEW

3.1 Introduction

This chapter presented the literature review on effects of tea cultivation on forest degradation. The chapter therefore captured empirical studies addressing objectives and problems under study research. Tea production has a negative impact on the environment. Natural habitats, rich in biodiversity, are converted into large areas of tea plant monocultures. This habitat loss leads to a reduction in the general number of species and threatens the survival of entire ecosystems.

Large areas of forest have been cleared to pave way for tea plantations. In India, areas which used to be a combination of forest and grassland and were home to tigers and rhinos have been converted to tea plantations, TRFK, 2009. In East Africa, forests are still being cleared to pave way for new plantations. In 2009, a tract of Ethiopian rainforest was sold to grow tea, despite opposition from Ethiopia's President and environmental authorities. Converting forests into tea plant monocultures decreases the biodiversity of plant species, meaning many other species' habitats are lost. Habitat loss associated with tea plantations has led to the decline of the Lion Tailed Macaque in India and the Horton Plains Slender Loris in Sri Lanka, both of which are on IUCN's Red List of endangered species.

Tea plantations not only result in the direct loss of habitat but can impact negatively on the wider environment. Land clearance alters the natural flow of water and increases soil erosion leading to the loss of wetland habitats and the pollution of rivers and lakes. In the Tanzanian Usambara Mountains, a hotspot of unique species, streams near tea plantations have shown decreased biodiversity. With the alteration of forest to tea plantations, large changes occur in the nature of the habitat. Temperature becomes variable, reducing moisture content and organic layer depth decreases, reducing food availability. Soil microbial activity is slowed and invertebrate richness decreases. Habitat heterogeneity is lost (Johansson and Sandy, 1996). Grown in monoculture, tea plants provide ideal conditions for a number of pests, resulting in the widespread use of toxic pesticides. There has been a report of elephant deaths in Kaziranga National Park, India, after they wandered into a tea plantation and

ate grass which had been sprayed with pesticides. The deaths of cows and vultures in the Assam region has also been blamed on pesticides and has led to renewed calls for its use to be banned.

To meet the increasing demand for tea, more and more land is being deforested and converted into tea plantations. Cases of 'land grabbing' or the acquisition of land by foreign investors has been reported in many countries and several Indian tea companies have purchased land in Uganda and Kenya. These acquisitions can affect local people, who lose rights to the land they depend on, and the local environment. In a recent acquisition of land in Ethiopia, An Indian Company acquired large areas of rainforest, which is home to the indigenous Mazenger people, and converted it to tea plantations.

3.2 Empirical literature

In Malawi, Tanzania and Zimbabwe, 140 000 ha of woodlands are annually cleared only for the fuel wood use for curing tobacco in the whole of the region (Chenje and Johnson 1994). The average forest loss in these countries is 12% annually mainly due to tobacco farming. On the country level, 10 000ha have been cleared in Malawi only by large commercial farms, and 13 000ha have been cleared in Tanzania only for curing Tobacco. The rate of induced deforestation is between 4 % (in Tanzania) and 18 % (in Malawi). According to Utrecht, (October 1997).

Deforestation is one of the most serious environmental issues in Srilanka, the country had 49% forest cover in 1920 but had dropped to 20% in 2005. These forest are mainly cleared for agriculture. Large tea plantations dot the many cascading hills and they continue increasing in Srilanka (Yukek et al, 2004). The tea production of which the country is a leading exporter is largely to blame for forest reduction.

Over the last fifty years, conversion of natural ecosystems for agricultural production is one of the primary causes of forest loss in Eastern Turkey. The total area given over to tea cultivation in the country is approximately 77 000ha, in 2006 up from 925ha in 1951 (Yukek et al, 2004).

Mabira forest in Uganda provides livelihoods to over one million people. Pressure on this forest including agricultural plantation of tea and sugarcane has left the forest officers in a dilemma of balancing the provision of forest habitat for endangered bird

species, endemic forest trees and providing economic livelihood for the communities. The consequence has led to forest encroachment all leading to loss of forest cover (Baranga, 2007).

According to Overseas Development Administration (ODA), Kakamega forest in Kenya is in the neighbourhood of an area of a population density of 500 persons per square kilometre. These people have encroached into the forest leading to massive loss of forest cover. There exist linkages between forests and tea cultivation. Tea is grown around the forests because these forests provides good temperatures and moisture for optimum growth

The initiative by Rhino Ark to join Kenya wildlife Service, Kenya Forest Service and other players to fence the Aberdare forest in 1988 so as to eradicate wanton forest destruction, the presidential order of 1987 that commissioned the Nyayo Tea Zone to stop farmer's encroachment into the forest and therefore increase forest trees may equally help increase tea growth. This is because increased forest cover would lead to more humidity that enhances tea growth and production. These may be used to determine any link between increased tea acreage and forest degradation.

Nairobi accounts for nearly 60% of Kenya's Gross Domestic Product (GDP), (FAO, 1998).The energy, water, and some raw materials used to drive economic activities in the city and its environs are derived from Aberdare forest ecosystem. It is therefore important to find out the relationship between increased growth of tea and its impact on forest cover.

The Aberdare Ranges produces 30 per cent of Kenya's tea and 70 per cent of its coffee, and is home to diverse species of wildlife that include: elephants, giant forest hogs, Rhinos, leopards and the critically endangered Bongo. (Dennis Kibet, 2010). Kenya is the largest exporter of black tea in the world, with over 349,000 tonnes of tea exported annually, accounting for 22 per cent of world exports. However, with impending droughts in the region, Kenya's economy may not grow as is envisaged in vision 2030. Kenya is one of the oldest African producers and has history in tea growing dating back to 1903. Currently, Kenya's tea industry has expanded to 69,000 hectares of land under cultivation by small scale tea farmers; (TRFK).There is enormous contribution of tea to forest conservation and sustainability.

Table 2: Earnings from tea

the sum of the earning exported from Kenya							
Year	1994	1995	1996	1997	1998	1999	2000
Earning(USD)	325888	365707	378509	409884	545416	465442	499027

Table 3: tea production

production and exports from Nyeri county						
Year		1998	1999	2000	2001	2002
production(mts)		294165	248818	236286	294631	287101
exports(mts)		263402	241739	216990	270151	272459

Table 4: tea area

Area planted with tea in Nyeri county						
Year	1995	1996	1997	1998	1999	2001
Area(Ha)	6277	6314	6314	6673	6693	7541

TBK, 2009

Tea earning increased gradually from 1994 as table 2 shows. This is due to aggressive marketing campaigns, increased sourcing of new markets and value addition of the local tea brands. The difference between production values for tea and exports is very small as table 3 shows. The figures would therefore mean more tea is exported than is locally consumed. Although tea production and export output reduced due to unfavourable weather conditions, the area planted with tea increased over the same period as recorded in table 4 above.

The tea sector has contributed Ksh 97billion to the Kenyan economy during 2010/2011 financial year (TBK, 2012). The sector was named the leading contributor to the Kenyan foreign exchange in addition to giving over 5 million Kenyans means of livelihood right from production to consumption at all levels of the tea industry. According to Murugu J, (2004), there has been a rapid expansion of tea growth in forested areas of Aberdare Ranges; this has been due to a Government policy on expansion of Agriculture economy. Furthermore chinga tea factory reported that the tea out growers increased from one thousand in 1990 to one thousand five hundred in

2011. The demand of wood fuel by the processing factories is also noted to have led to loss of forest cover to an extent that it may not sustain the factories in future. FAO notes that the percentage of forest in Kenya dropped to 1.7% in 2002 from nearly 10% at independence. Some of the problems identified include the fact that opening of new Tea zones has led to illegal forest farming, charcoal burning and forest fires. The introduction of this Monoculture has led to importation of fossil fuel and synthetic fertilizers. These factors may have led to a drop in value of tea per hectare between 2001 and 2005 (GOK, 2007). Although growing of tea improves the aesthetic landscape by making it green; it has contributed to land degradation. Murugu (2004), noted that there is a relationship between Tea development and forest cover in Eastern Aberdares; this has also been found to be true in Chinga area. Her study infers a significant impact on forest cover as Tea cultivation is expanded but the conclusion that: increased use of wood fuel has no impact on forest cover needed to be probed more and especially in Chinga area. The study area neighbours the Aberdare forest whose encroachment threatens endangered wildlife including the big five. The country's 3rd foreign exchange earner, tourism would be threatened. The area has some of the threatened trees such as Podo. The world summit on sustainable development (WSSD) in September 2002, reaffirmed land degradation as one of the major global environment and sustainable development challenges of the 21st century. It emphasized sustainable forest management for timber and non-timber products. Addressing the forest degradation therefore, the summit added, will contribute significantly to achieving the millennium development goals (MDGs) of reducing by half the proportion of poor people by 2015.

Chinga area is a part of a hilly terrain with cascading hills, there is evidence of mudslides taking place when it rains leading to further land degradation. There has been a lot of land sub-division leading to thin strips of land that cannot be used to sustain the population sustainably. The Chinga River had over five swamps, (source local Chinga self help group), most of these have since been drained and converted to farmlands. It is hoped that analysis of the two rivers, Gikira and Chinga in the study area can also be a measure of the extent to which Aberdare Ranges are degraded. The study area forms the source of piped water used by OMWASCO to supply water to over 400 000 people in Othaya and Mukurweini constituencies so if the source is affected, safe drinking water for these people would be jeopardized. Increased

interaction between the community and the Aberdare forest as they seek forest services and the demand for fuel wood can lead to reduction in forest cover and in turn reduce the water flow into the rivers. This study sought to investigate the relationship between increased tea crop and reduction in forest cover in Chinga area.

On analysis of performance of tea industry between 1964 and 1996, the area under tea cultivation in the country was noted to have increased. The Tea production in kilograms was also noted to have increased and therefore the number of Tea growers also increased (Global advances in tea science, 1999).

Tea development is highly rated due to its economic benefits to our country and to the growers; it is these profits that lead to an aggressive exploitation of the land at minimum regard to reduction of forest cover. When reporting on impact of tea development on forest cover in parts of Aberdares, Wanjiru, (2004), noted that use of wood fuel by tea factories saves the country a lot of foreign exchange by importing less fossil fuel. Although Tea development has a significant impact on forest cover, she asserts that use of wood fuel did not impact on forest cover reduction in the Eastern Aberdare Ranges negatively. This study sought to find out if opening of Tea zones and increased Tea acreage has led to illegal felling of trees and hence whether this has caused a reduction of forest cover. The justification of this is the fact that allowing more areas of Tea cultivation can only encourage illegal farming, charcoal burning and forests fires. These factors can only do harm than good to the forest cover. After all, the Kenya Forest Service(2000), has identified some key drivers of deforestation and degradation of the forests including: clearing forests for agriculture, unsustainable utilisation of forest resources and poor governance that includes institutional failures of the 1980s through to 1990s. There exists information gaps including: mechanisms of benefit sharing arrangements, and inadequate data on forest resources.

Tea production has been encouraged through motivation of farmers by the Government and through establishing bodies to refine package and market the produce, the result has been prolific production that can only lead to unsustainable production of the same crop. How then can we have sustainable forest conservation with increase of tea acreage? (Murugu, (2004), identified one problem of growing tea as having destroyed its wood fuel base, soil and the local hydrological cycle. How is

this expansion possible without affecting the forest cover? This study is hoped to link the use of wood fuel as also encouraging forest cover reduction. Small-scale farming, tea and eucalyptus plantation, and built up area have increased over time, this has been done with no consideration of wood production. Furthermore, exotic plantations have been found to introduce diseases to indigenous forests and also cause land degradation.

A study done in Kibale National Park (Uganda) by Lwanga J.S 2003.on effects of the change from natural forest cover to tea concludes that Eucalyptus plantations induced changes in top soil properties namely, exchangeable Magnesium and Calcium, available Phosphorous, pH, and bulk density of sub soil. Landscape positions within land use also significantly influenced most of the soil properties due to organic and inorganic agriculture. This further supports the fact that change of forest cover can induce changes in land thereby directly impacting negatively on forest cover.

Forests are important in protecting water catchment areas. When large areas of forest are logged, services such as water supply may be negatively affected. Kenya has one of the most diverse forests in East Africa but these forests are threatened because they are heavily used as a source of fuel or converted to agricultural land. Logging for fuel is one of the main reasons forests are threatened. Out of 22 million tons of wood products used in Kenya, 20 million are used for fuel. Large areas will continue to be deforested if current logging rates and population growth do not decrease. An additional problem when land is deforested for agriculture is that forests often grow on poor soils that are unsuitable for agriculture. Therefore, farmers continue deforesting new areas when soil nutrients become too scarce to support crop farming.

Over the years since August of 1988, conservationists have been alarmed by poaching and reckless felling of trees. The best example is Rhino Ark who teamed up with KWS and KFS to fence the Aberdare forest. The EIA done in 2011 asserts that indigenous forest trees have doubled since year 2000, although this is not evident on the ground. Some indigenous trees such as camphor and Podo takes too long to mature and since these are most sought by saw millers it is not easy to find them. The Tea factories continue to demand wood fuel at an increased rate. With reduced use of

fuel oil hence increased use of wood ones would expect a different outcome. The cultivated land reported to have increased and that farmers are now securing farm produce up to nearly 100% of crop. Although cleaner production is the main agenda due to ISSO compliancy of any manufacturing process and hence many Tea factories including Chinga have two fuel systems of Energy (Oil fuel and wood fuel), they use more of the wood. The result is use of more resources and discharging into the environment more wastes. Due to reduced efficiency of production in the factory there is a possibility of more energy demand all resulting to forest cover reduction, the main source of energy for the community is wood fuel so how can this be done sustainably without reduction of tree cover. This is the main reason why this study sought to look for the link between forest cover and increased tea cultivation.

CHAPTER FOUR

4.0 RESEARCH DESIGN AND METHODOLOGY

4.1 Sample Design

This research used a case study design approach. The reason for this is that a similar study was done in another part of Aberdare Ranges and Chinga forms a very small region of the greater Aberdare eco-system. The researcher visited ten targeted regions of the study area and through Random sampling; identified a diverse unit of 24 respondents in nine regions and 30 respondents in the tenth region. This gave a total of 246 respondents, this approach ensured generalizations and conclusions for the larger population. This research used an interview schedule in form of inquiry. The interview targeted tea out growers around the Chinga Tea Factory, within the ten regions and selected staff from the factory.

4.2 Study Population

Chinga area has two administrative locations, Chinga South and Chinga North and each is administered by a chief. The Chinga Tea Factory is located mid-way between the two locations. Both locations have tea but the North is wetter and forms the study area since it borders the forest. This area has an estimated population of 15 000 and an estimated 1500 tea growers (Census, 2009).

The respondents were tea farmers. Most of these people were willing to be interviewed and therefore the researcher had no accessibility problem. This is in addition to secondary data sourced from both KTDA and KFS. The respondents targeted included people of all age groups. This was to find out which group of people uses the forest resources sustainably.

4.3 Source of Data

This study utilized both qualitative and quantitative data. This was collected from existing literature and primary data from the field. The data required in the study fell into two main categories namely:

4.3.1 Primary Data

The main source was tea farmers' co operative and credit society, the Chinga Tea Factory management and targeted farmers. This ensured profiling the physical aspects

of the area under study. This kind of data incorporated all aspects of human activities that impact on the forest in one way or another. Such data included the various kinds of activities people engage in that degrade the forest at both the household and business levels, the diversity of activities on the study area, interactions between the people and the forest among such other things.

This was collected through observations, recording, and photo taking to identify various ways through which the forest is utilized. Informal interviews with forest users, as well as household questionnaires were used for deeper analysis of the types of forest service's given to the communities at the household and business levels, the mitigation methods adopted to conserve the forest, whether there are measures in place to do re-forestation and afforestation and if they view these methods as beneficial to the community.

4.3.2 Secondary Data

The secondary data was collected from published results from Kenya National Bureau of Statistics and unpublished sources from the co operative societies, the KTDA Chinga branch and estimates from Chief Barazas. The type of data collected gave population distribution and social-economic profile of the study area. The area under both forest cover and that under tea bushes was sourced from both Kenya Forest Service and the Kenya Tea Development Authority.

Both the physical and socio-economic data were combined and used to draw data for analysis and enquiry into any link between proliferation of tea growth and forest cover reduction.

4.4 Sample Technique

The Sampling technique applied in this study was a simple Random sample, this means that a subset of individuals (a sample) chosen from a larger set (a population). Each individual was chosen randomly and entirely by chance, such that each individual had the same probability of being chosen at any stage during the sampling process, and each subset of k individuals had the same probability of being chosen for the sample as any other subset of k individuals. This was done without replacement so as to avoid choosing a member of the population more than once. The rationale for this type of technique is to make sure that the sample represents the entire population

of the study region and that any conclusions drawn may represent the entire population.

The goal of this study was to identify the land use change among Chinga location dwellers and whether they contribute to the changes in the forest cover and land use. The questionnaire and observations were made to find out the extent to which forests have been affected by expansion of Tea. The achievement of this required a study of a large area, where interviewing everyone would be very expensive and time consuming. This is the reason why stratified simple random sampling was adopted. The selection of the sample size was aimed at minimizing the cost, while at the same time maximizing data reliability.

4.5 Sample Size

The population of Chinga North tea farmers is approximately one thousand five hundred (1 500) (Othaya farmers co operative 2009).The sample size envisaged was 246 persons representing ten selected regions of the area under study. The study targeted tea farmers in each region. This is because there is no estimate available of the target population assumed to have the characteristic of interest.50% of the target population was used as recommended by Fisher et al, (1978). It is hoped that this will represent the overall population of North Chinga.

$$9 \times 24 = 216$$

$$1 \times 30 = 30$$

$$\text{Total} = 246$$

A sample size of 246 tea farmers was therefore used in this study.

4.6. Confidence Level

a) Questionnaire.

Questionnaires were administered and filled with the help of the researcher to the sample population of 246 households. The confidence level is defined as the acceptable risk that the sample is within the average of the population, also known as the “bell curve” (Watson, J. 2001). This study uses a 95% confidence level which is standard for most social science applications. This confidence level means that out of

100 respondents sampled from the population, 95 will have the true value of the population (will be representative of the population).

The 95% confidence level, combined with the 5% precision range adopted in the study meant that between 90 and 100 respondents per every 100 sampled was representative of the whole population.

The number of kilograms of green tea was sought from chinga tea factory and used to determine the number of dry tea produced over the study period. This output data was used to calculate the amount of wood fuel used in kilograms; the amount of wood fuel used for the factory was compared to the area of forest lost over the same period.

b) Field observation was done and recorded on photographic plates which were also used for analysis.

c) Oral Interviews

The study sought to utilise qualitative data which was collected through oral interview with people who have lived within the study sites at least for the last four or five decades. This was useful in giving the history of the forest and tea expansion to help determine the turning point on the forest status. Photographs and informal interviews including observations were used at all levels of primary data collection. A sufficient amount of field samples was collected in order to make the analysis statistically valid and representative of the whole population.

In order to allow for accurate data and meaningful information, identification of areas related to study topic and more particularly provide justification for the study topic, both primary and secondary sources were used. The target population of 246 respondents who are easily accessible was identified. To also attain the desired precision and accuracy a male/female ratio of 1:1 was sought. The researcher read and explained the questionnaire to enhance clarity and dispel any fears.

4.6. Confidence Level

The confidence level is defined as the acceptable risk that the sample is within the average of the population, also known as the “bell curve” (Watson, J. 2001). This study uses a 95% confidence level which is standard for most social science

applications. This confidence level means that out of 100 respondents sampled from the population, 95 will have the true value of the population (will be representative of the population).

The 95% confidence level, combined with the 5% precision range adopted in the study means that between 90 and 100 respondents per every 100 sampled will be representative of the whole population.

4.7 Data Analysis

This study measures data in three levels – nominal (as categories), ordinal and interval scales. The analysis techniques adopted for the survey differed according to the scale of measurement of the data, and the required output. The Statistical Package for Social Sciences (SPSS) and Microsoft Excel programs were used both for data entry and basic analysis. Top sheet maps, interpretation and analysis of observed and mapped data. Simple analysis including percentage responses and use of average responses for interval data was also used. The determination of relationship between the attributes being measured was achieved through cross-tabulations, correlations as well as overlay analysis to be achieved through the SPSS package. The chi square test was used to test the relationship between tea expansion and forest degradation and also to test whether there is a link between increased use of wood fuel and loss of forest cover in Chinga area. Simple regression analysis was used to enable this study establish whether expansion of tea has led to reduction of the forest cover and whether demand of fuel wood arising from increased tea output has had an effect of forest loss.

CHAPTER FIVE

5.0 RESULTS AND DISCUSSIONS

5.1.1 INTRODUCTION

This chapter presents the analysis, presentation and interpretations of the data as was obtained from the field on effect of tea cultivation on forest degradation. Out of the 246 questionnaires distributed to the respondents, 183 got responses while the rest 63 never got responses or were poorly filled. This study therefore gave a response rate of 74%. This would be considered credible.

5.1.2 Demographic Information

a) Age of Respondents

Nearly 84% of the area residents are between 21 and 50 years, a very productive age, the same age brackets also uses most of the forest resources leading to deforestation.

Table 5: Age of Respondents

Age	Frequency	Percentage
Below 20 yrs	14	7.7
21-40 yrs	117	63.9
41-50 yrs	37	20.2
Above 51 yrs	15	8.2
Total	183	100.0

Source; field data survey, 2012

The percentage of respondents aged between 21 and 50 years was 84%. This high figure shows that the demographic results obtained were reliable. This is an energy demanding group which as it generates income is likely to consume more resources including wood fuel. This population is likely to cause more loss of forest cover as they expand their economic base.

b) Position in the household

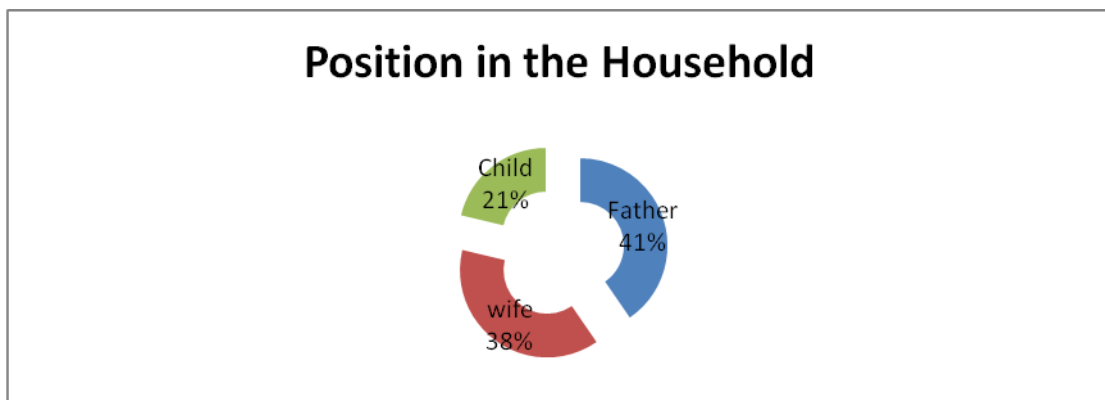
Table 6: Position in the household

Position	Frequency	Percentage
Father	74	40.4
Wife	70	38.3
Child	39	21.3
Total	183	100.0

Source, field survey data, 2012

The results imply that the study approached household heads who are owners of the farms. This gives the study more valid information on the study questions. This information may measure the extent to which child labour is used in this region and also the level to which men participate in tea picking. Majority of the tea pickers are men (40%), children constitute 21% of the tea pickers. This information is also as presented in the figure below.

Figure 5: Position in the household



Source, Author, 2012

The data shows that the ratio of men to women tea pickers is nearly 1:1, this further adds credibility to the data obtained. This however, shows children participation in tea picking, 21% of the respondents were children, a figure that predicts child labour is being used in this region. These children represented their parents in the tea farms because the parents were busy utilising the services of the forest, these include: collection of firewood, building poles or even burning charcoal.

5.2.1. Social Economic Data.

5.2.1 Occupation of the respondent.

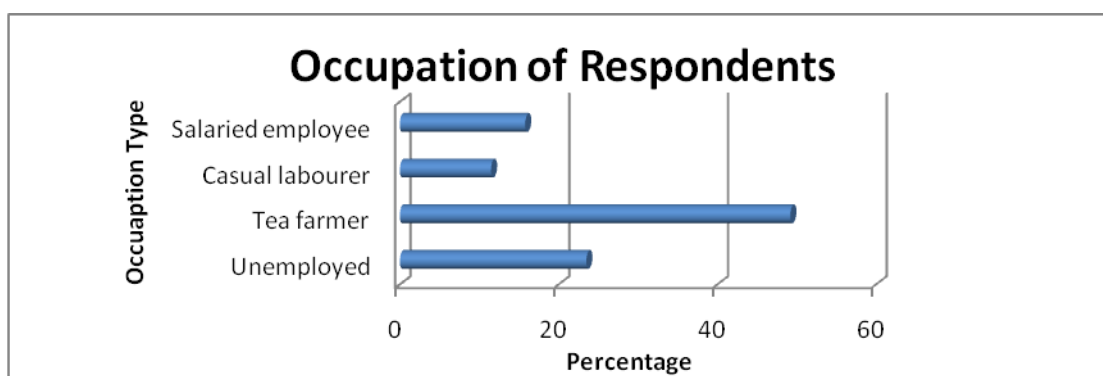
Table 7: Occupation of the respondent

Occupation	Frequency	Percentage
Unemployed	43	23.5
Farmers	90	49.2
Casual laborer	21	11.5
Salaried employee	29	15.8
Total	183	100.0

Source; field survey data, 2012.

A fair representation of the population (49%) earns their living through tea farming and therefore have no other means of income; both the casual laborer's and unemployed workers totaling 35% usually work in tea farms and therefore had useful information to share with the researcher. These people added to the tea farmers, gave a cumulative total of 84.2%, a figure that made the data obtained more credible. 15.8% of the respondents are employed elsewhere alongside growing Tea. This is so because tea is the main cash crop in Chinga area. The results are also presented in the figure below:

Figure 6: Occupation of the respondent



Source, Author, 2012

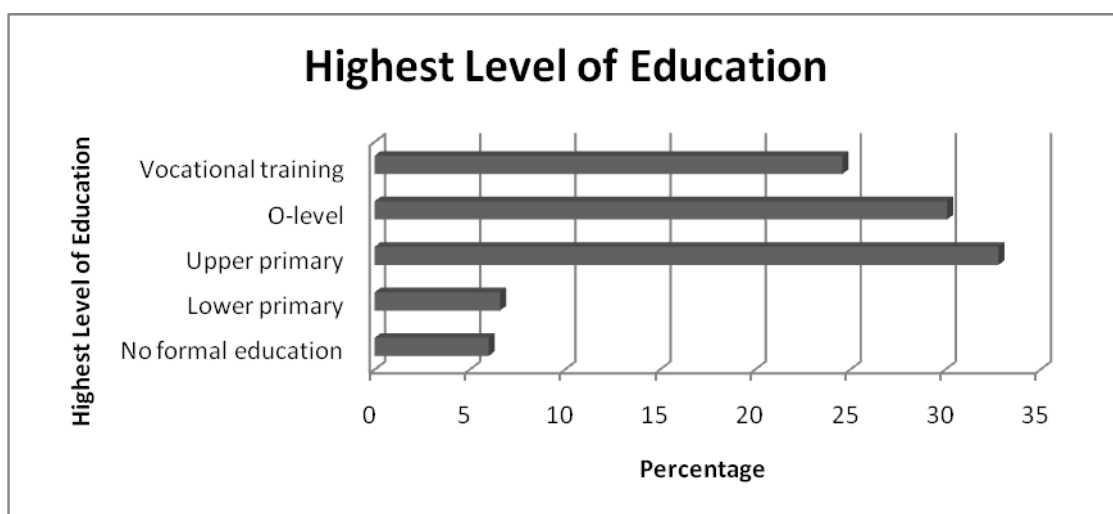
5.2.2 Respondent level of education

Table 8: Level of Education

Level of Education	Frequency	Percentage
No formal education	11	6.0
Lower primary	12	6.6
Upper primary	60	32.8
O-level	55	30.1
Vocational training	45	24.6
Total	183	100.0

Source, field survey data, 2012

Figure 7: Level of Education



Source, Author, 2012

A large proportion of the farmers are of O-level and above qualifications. 55% of the respondents show that the respondents gave valuable responses. The percentage is high enough for this study and therefore the results are credible.

The researcher was able to establish rapport with potential participants and therefore gained their cooperation.

5.2.3 Respondents level of income

Table 9: The average monthly income from all sources (in Ksh)

Monthly Income	Frequency	Percentage
Below 5000	67	36.6
Between 5000 to 10000	50	27.3
Between 10000 to 20000	48	26.2
Above 20000	18	9.8
Total	183	100.0

Source, field survey data, 2012

The table above displays the results on the question of respondent's average monthly income from all sources (in Ksh). Based on the results as displayed, the study established that majority of the respondents as shown by 37% earned a monthly salary of less than 5000ksh; this is less than two US Dollars daily at a rate of Ksh85 to the dollar, this amount of money is not enough to sustain an average family in a region where most of the farming land is under tea cultivation and no space is left for subsistence farming. This group of people is likely to be aggressive in economic ventures that may degrade the forest. Those below 10000 Ksh (27%), between 10000 and 20000 (26%) and above 20000 as shown by 10% respectively. The 9.8% earning higher are also likely to purchase forest services from the poor ones. The total percentage of respondents earning Ksh 10 000 and below is 64%. This suggests a high dependence on forest services in the study area.

5.2.4 Proportion of tea farmers

Table 10 percentage of respondents who are tea farmers

Response	Frequency	Percentage
Yes	121	66.1
No	62	33.9
Total	183	100.0

Source, field survey data, 2012.

According to the results indicated in the table above, the study also established that majority of the respondents were tea farmers (represented by 66%) while the rest

indicated that they were not tea farmers as shown by 34% respectively. The difference between this and (table 10) above is occasioned by some cases where some people hire land from land owners. This is an implication that other residents in the region participate in other activities not related to tea cultivation. A large proportion of the rest of the residents engaged in entrepreneurial activities that relates to selling of charcoal, wood lots, Building poles and foodstuff. These activities are not sustainable as they lead to forest cover reduction. The fact that majority of the respondents were Tea farmers gives the data in the study more credibility.

5.2.5 Respondents who owned land by 1996

Table 11: Respondents who owned land by 1996.

Response	Frequency	Percentage
Yes	80	43.7
No	103	56.3
Total	183	100.0

Source, Author, 2012

According to the results shown in the table above, 56% of the total respondents indicated that they did not have land ownership by 1996 whereas the rest had ownership of their land in the same year as shown by 44%. This implies that majority of the people in the region acquired land through inheritance from their fore fathers and that many obtained ownership after the year 1996. This may have come about through subdivision of ancestral land which can only lead to a conclusion that 44% of the respondents acquired land through subdivision after 1996. Part of both land and forest degradation may have been contributed to by this subdivision. There is also a possibility of people renting land from owners thereby planting more tea or exploiting the existing tea bushes.

5.2.6 Uses of the forest.

The Aberdare forest has many uses to the local communities. These uses have considerable negative effects on the forest. Subsistence farming and source of wood fuel are the main contributors of forest cover reduction.

Table 12: Uses of the forest

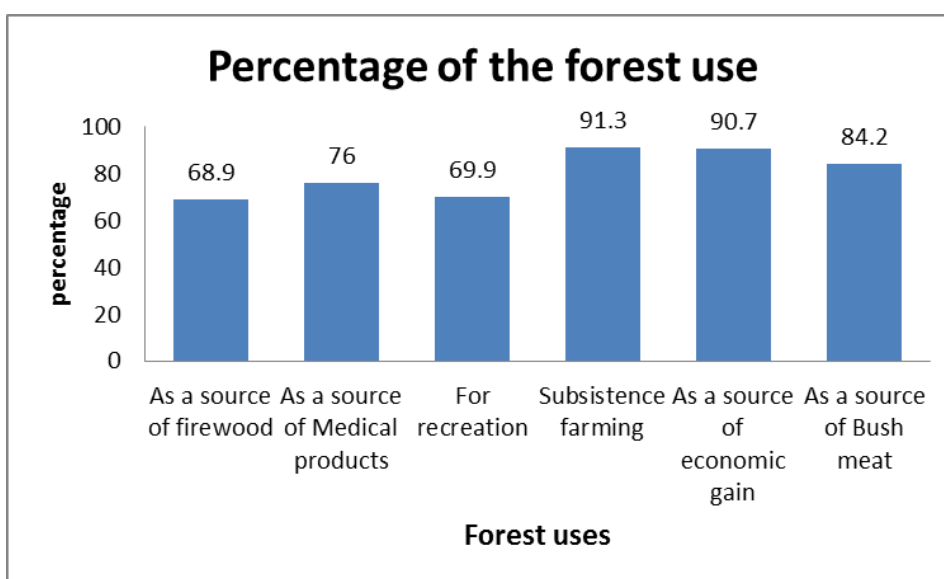
Use	Frequency (Yes)	Percentage (%)	Frequency (No)	Percentage (%)
As a source of firewood	126	68.9	57	31.1
As a source of Medical products	139	76	44	24
For recreation	128	69.9	55	30.1
Subsistence farming	167	91.3	16	8.7
As a source of economic gain	166	90.7	17	9.3
As a source of Bush meat	154	84.2	29	15.8

Source, field study, 2012.

The respondents were required to answer ‘yes’ or ‘no’ for the given uses of the forest. Majority of the respondents gave a ‘yes’ answer for the choices provided.

The results indicates 91.3% of the population in the study area use forests for subsistence farming, the rest of the results is as follows: as a source of economic gain (90.7%), as a source of Bush meat (84.2%), as a source of Medical products (76%), for recreation (70%) and as a source of firewood shown by 69% respectively. Most of the economic gain realized in this study was mainly activities that have to do with cutting of trees or sourcing for trees related products. The main reason for this is short term financial gain in selling of trees and trees products. The land left bare is used for subsistence farming. The result for this is huge environmental crimes.

Figure 8: Forest Uses



Source, Author, 2012

The study therefore concludes that nearly (68.9%) of chinga residents or two in every three people use wood fuel wood from the forest. Forms of recreation such as sight-seeing and nature walks contribute significant utilisation of the forest. Economic gain mentioned in this study includes: gathering of honey and illegal logging of building and fencing materials. These sources are a means of livelihood to the communities in North Chinga. Some members of this community collect eucalyptus barks for the oil used to manage flu, this removal of barks leads to drying of trees. It is imperative to also state that all the six uses indicated above contribute to forest deforestation.

In order to benefit from the forest resources, forest flora and fauna are extracted, a lot of this extraction leads to unsustainable use. Increased demand for these resources results to overuse. Some utilisation of forest resources such as demand for firewood, poles and timber may directly lead to loss of tree cover when not checked.

Table 13: Does forest use contribute to forest loss?

Response	Frequency	Percentage
Yes	148	80.9
No	35	19.1
Total	183	100.0

Source, Author, 2012

Nearly 81% of the respondents indicated that the various forest uses contribute to forest loss. It is therefore true to conclude that the various human –forest interactions contribute to forest cover loss. Area residents are to be blamed for the loss of forest cover in the region. This is as a result of illegal activities which lead to forest degradation. Area residents are subsistence farmers, rearing cows, goats and farming. They also depend on wood for fuel though prohibited by the government. Other residents illegally burn charcoal as well as timber for sale. The blame on the government side was on negligence, poor management and control systems as was highlighted by this study.

5.3.4 Economic loss associated with completion of electric fence.

Table 14: Proportion of respondents who have lost financial gain

Response	Frequency	Percentage
Yes	28	15.3
No	155	84.7
Total	183	100.0

Source, field survey, 2012

Fifteen percent of the population lost their means of livelihood when stringent measures to curb illegal logging and direct use of forest resources were put in place. This is attributable to the completion of The Aberdare electric fence, the result of which human- forest interactions reduced.

In addition, this chapter discusses the research findings from the defined objectives. The main goal of the study was to establish whether there exists a relationship between increased Tea production and Forest reduction in Chinga area.

5.4 Objective 1 Average Number of hectares under forest cover lost between 1995 and 2005

Table 15: Average number of Acres of Land that was under trees between 1996 and 2005.

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Average acres of land under forest cover (Acres)	1.8	1.6	1.5	1.5	1.8	0.6	0.6	0.4	0.25	0.2

Source KTDA, 2012

From the initial acreage, farmers were able to provide evidence of forest land that was lost to tea or other forms of agriculture. The study established a significant decrease in trend of the number of acres that was still under tree cover for the years 1996-2005. The results indicate the decrease in forest cover over the years. The decrease trend can be attributed to deforestation occasioned by the need to create more land for farming,

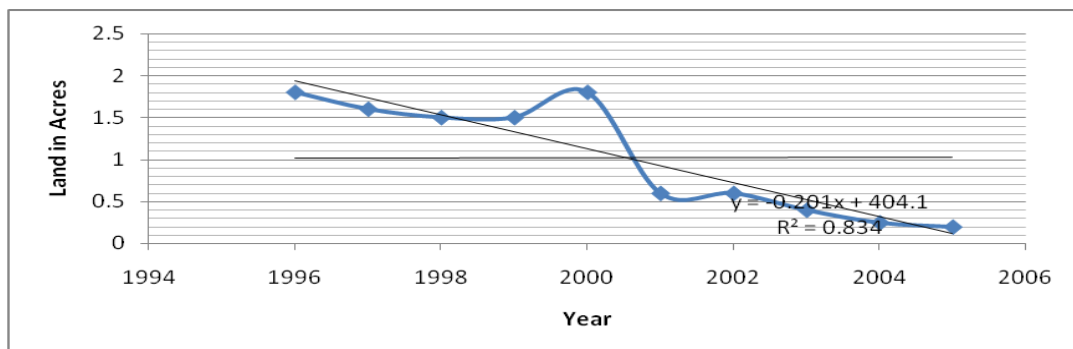
land sales or the subdivisions to create more human settlement and general loss due to overgrazing. These results attributed to the sudden increase of land under forest during the year 2000 to inadequate information from KFS. Linear regression equation obtained from the results for the subsequent years and presented in this study is given by:

$$Y = -0.2015X + 404.16$$

$R^2 = 0.8342$ as shown in the figure below:

The regression equation is in form of: $y = bx + a$, where Y (loss of forest cover) is the dependent variable that the equation tries to predict, X (reduction of land under forest) is the independent variable that is being used to predict Y, 'a' is the Y-intercept of the line, and 'e' is value called the regression. The values of 'a' and 'b' are selected so that the square of the regression residuals is minimized. The rate of reduction of forest land has a negative factor of -0.2015. A coefficient of determination equal to 0.8342 indicates that about 83.42% of the variation in forest loss can be explained by tea expansion.

Figure 9: Average area of land under tree cover

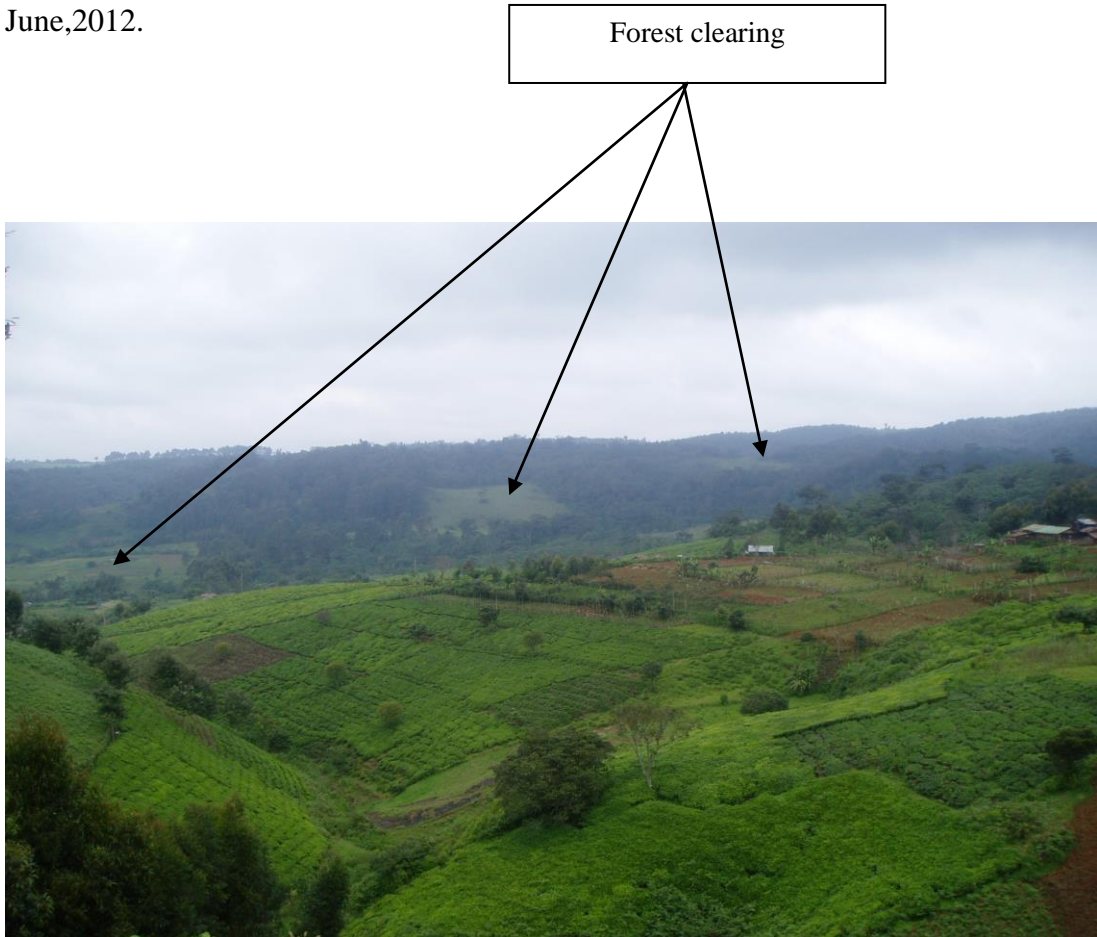


Source, Author, 2012.

As shown in the table 15, with exemption of year 2000, the results indicate a significant reduction of forest cover. There is a strong correlation of 83.4%. The values also fall within regression line thereby making this study make more accurate predictions. This analysis shows that a farmer initially having ten acres of forest can lose approximately eight acres in a few years going by this rate of forest loss.

Plate 1: (Chinga river valley)

A section of Aberdares in the Background showing patches of cleared forests in June,2012.



Source, Author, 2012

The section shows three large forest patches in the background, they originally had cedar and eucalyptus plantations, some loggers in Othaya town and Chinga Tea Factory were licensed to cut the trees in 1990 and to date re- afforestation has not been done. This commercial logging contributed to loss of forest trees and altering the under-canopy.

Tea farms also extend to a radius of five meters off the river; this in addition to eucalyptus trees in the foreground has reduced the water volume in the river. The newly prepared land in the middle ground had indigenous trees which were cleared in February 2012 in readiness for Tea planting during the April long rains. The tea farms shown have very few trees between the lines as would be expected. These trees are required for wood fuel and as wind breakers.

Plate 2: (Gikira River valley)



Source, author, 2012.

The plate shows Chinga area with Mount Sattima in the background. The forest clearing in the middle ground were done by the resident subsistence farmers. Forest authorities allowed it even after the Shamba system had been stopped in 1986. the founder of Greenbelt Movement who was an assistant minister in the NARC government asked the forest authorities to do re-afforestation but this was not done. The fore ground has tea bushes on hilly slopes and more gaps that had trees. The trees were cut in readiness to plant more tea in the farmlands. The Nyayo tea belt in the left middle ground has large patches with no trees and a road construction that led to cutting of more trees. Deforestation has not only reduced biological diversity, increased soil erosion and the siltation of rivers but has also led to loss of renewable

natural resources such as valuable non-timber forest products and ecotourism value of Chinga area.

Poor governance and corruption are making it easy to flout policies and legislation aimed at forest conservation and protection. As NGOs pay more attention to good governance, transparency and accountability, there is growing recognition that corruption facilitates illegal deforestation and that a significant proportion of deforestation occurs illegally despite laws designed to protect forests. These forest patches exist to date and continue to increase in size despite the government ban in 1986 against forest encroachment.

5.5 objective 2 Number of acres that were being planted with tea bushes over the study period.

The study established the number of acres owned by individuals or as a family as varying between 0.2 acres to as many as 9 acres. The area under tea cultivation was found to have increased over the study period. This increase is attributed to a lot of effort put in by tea marketers and the fact that tea is the chief cash crop in this area. Noticeable changes in land under tea cultivation were noted and input result was as the figure 10 shown below.

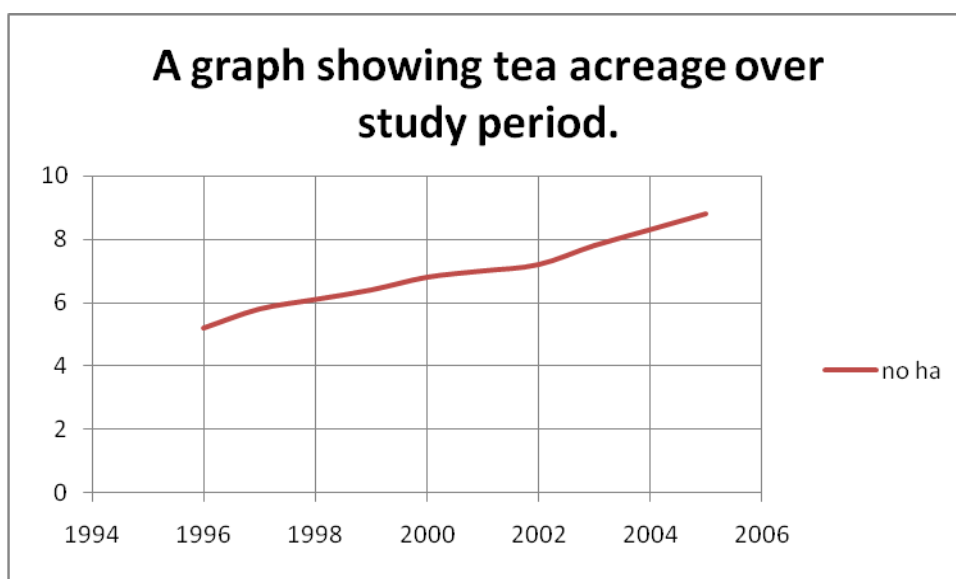
Table 16: Average numbers of acres under Tea in the Study area.

Years	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
No.ac.tea	5.2	5.8	6.1	6.4	6.8	7	7.2	7.8	8.3	8.8

Source, field survey, 2012

Most of the land originally occupied by bushes, trees and grassland was continuously lost to tea farm as the Government exerted pressure on forest settlers to leave the forest. Settlements in Chehe, Kabaru and Hobe forests (Mt.Kenya) were dismantled in early 1990s; the settlers came back to their original farmlands where population pressure resulted to illegal farming in the forest. A section of these people may have contributed to the 44% of the respondents who owned land after 1996.

Figure 10: Tea acreage with years over the study period



Source, Author, 2012.

The graph shows a gradual increase in tea acreage from the respondents' reports. The fact that the gradient is not high shows a low rate of tea expansion. The graph may also imply trees were not entirely lost since as indigenous trees were cut fewer eucalyptus trees were planted.

5.6 Who is responsible for forest loss in Chinga area?

Table 17: Who is responsible for the forest loss in Chinga area?

	Frequency	Percentage
Do not know	53	29.0
Kenya forest services	43	23.5
KTDA	9	4.9
CBOs	4	2.2
Area residents	74	40.4
Total	183	100.0

Source, Author, 2012

According to the study findings presented in the table above, majority of the respondents (40%) indicated that area residents were to blame for the loss of forest cover. Other respondents also indicated that they did not know (29%), Kenya forest services (24%), and KTDA (5%) and CBOs (2%) were also to blame for the loss of forest cover in the region respectively. The study therefore concluded that the main contributors of forest destruction are area residents.

Most of the respondents indicated that area residents are to blame for the loss of forest cover in the region. This is as a result of illegal activities which lead to forest degradation. Area residents are subsistence farmers, rearing cows, goats and farming. They also depend on wood for fuel though prohibited by the government. Other residents illegally burn charcoal as well as timber for sales. The blame on the government side was on negligence, poor management and control systems as was highlighted as the main cause of the noted deforestation. Proper management, planting of more trees and preservation of wildlife for their importance may restore the forest ecosystem.

Plate 3: A section of land in chinga showing land that was cleared for tea plantation.



Source, author 2012.

The land shown above was cleared in November 2011 in anticipation that the April rains in 2012 would be large enough to allow planting of the tea bushes. The cleared trees include Eucalyptus and indigenous Podo trees. The rains were lower than

expected therefore this portion of land remained without vegetation to date (June 2012).

Plate 4.A section of eucalyptus trees plantation cleared in Mucarage.



Source, author.2012.

This farm in Mucarage shows a large patch of farmland forest cleared in 2011 so as to cultivate more tea on the lower section of the existing tea bushes. These trees were cut up to the source of the river thereby threatening the hydrological cycle of this region. Furthermore soil erosion control measures are not put in place so that if the anticipated long rains are heavy then massive soil would be taken downstream. Some of these farming methods are responsible for the muddy outlook of Chinga dam.

5.8 The third objective required the study to determine the relationship between increased use of wood fuel and loss of forest cover.

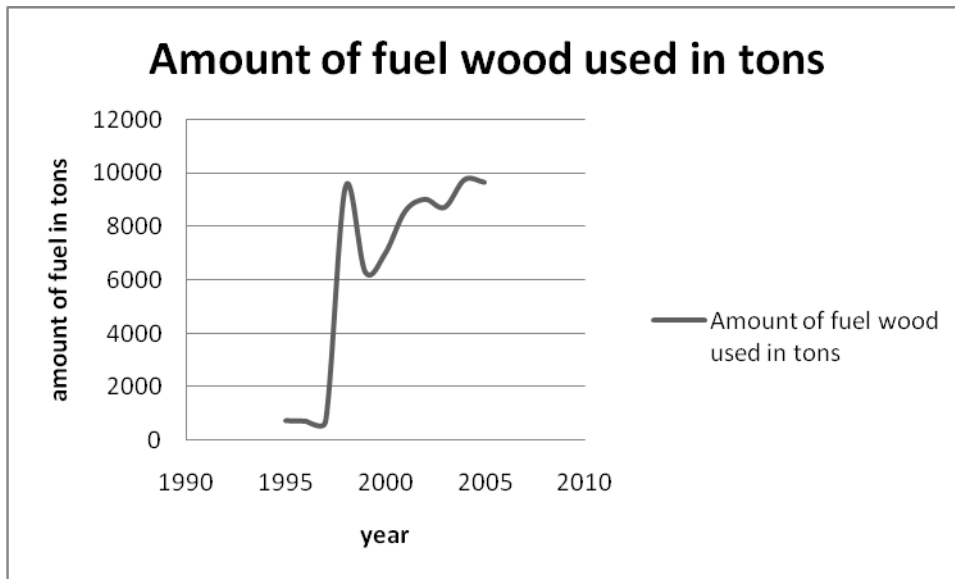
The tea processing industry is responsible for a substantial part of the energy consumption of the industrial sector in the form of electricity, wood fuel, and oil. Wood fuel energy consumption by this sector is one of the largest as the figures below (table 18) shows. The values of the green leaf in kilograms was availed by the factory management, since 3.78kg of green leaf produces 1kg dry leaf and the production machines being used at Chinga Tea Factory are such that 1m³ of dry wood processes 350kg of tea to dryness in addition 1.54m³ of wood is equivalent to one ton of dry wood. These constants were used to calculate the volume of wood fuel used in tons and the production of dry tea in kilograms.

Table 18: Tea produced and fuel wood used.

year	green leaf(kg)	dry leaf(kg)	Volume of wood used(m3)	Amount of fuel wood used in tons
1995	1030218	275554	1103	717
1996	1076828	269207	1076	700
1997	1034556	258614	1034	672
1998	14580070	3645017	14580	9477
1999	10013993	2503498	9703	6307
2000	1750990	2689975	10760	6994
2001	13194455	3298613	13194	8576
2002	13901213	3475303	13901	9036
2003	13434575	3358643	13434	8732
2004	15038856	3759714	15039	9775
2005	14883216	3720804	14883	9674
TOTAL	99938970	27254942		70660

Source, Chinga Tea Factory annual reports (1995 to 2005)

Figure 11: Amount of fuel wood used in tons



Source, author, 2012

Within the study period 1995 to 2005, 99938970 kilograms of green leaf was supplied by the farmers and when processed, 27254942 kilograms of dry tea was produced. Even with efficient wood fuel processors nearly 80 000tons of wood fuel was used. The conversion used was 1m^3 or 0.65tons of dry wood used to cure 350kg of tea to dryness. There is a steep rise of wood fuel between 1997 and 1998 due to the inefficient machines initially used when the factory switched to wood fuel from electricity. Close analysis of the study area (plate 1 and plate 2) shows patches in the forest and less forest cover within the tea farms. The few eucalyptus trees observed are young implying overharvesting of available trees. Farmers are encouraged to sell wood to the Factory to earn their livelihoods due to low monthly Tea pay.

ii) The second null hypothesis for this study stated that “there is no relationship between increased use of wood fuel and forest loss”. The study collected secondary data from Chinga Tea Factory on the amount of green leaf delivered to the factory within the study period. This data was converted to amount of dry tea processed and then used to give the number of kilograms of wood required to refine tea to dryness. The table is shown below:

5.9 Evaluation of Energy Consumption

Approximate amount of wood consumed (wood piles) per year from 1996 to 2005 within homestead was used to show trend of fuel wood demand over the study period.

Table 19: Wood consumption

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Average No. of wood piles	10.5	14	12	14	14.5	16	16.5	17.5	19.5	21.5

Source, Green belt movement, 2009

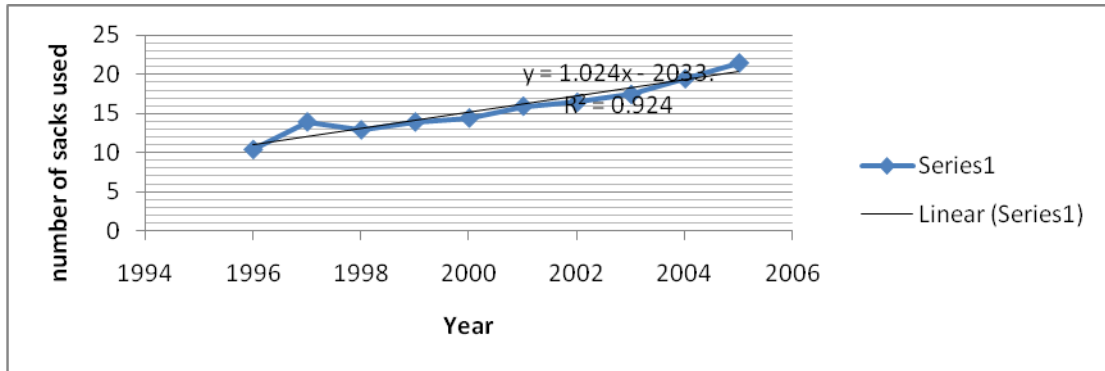
The study established that in a year, a significant level of wood consumed increased between 1996 –2000 as represented by 10- 15 piles per year. The usage of wood decreased from 1997-1998 to at least 12 piles. According to the graph in Figure 5.6, it is also clear that usage of wood has been increasing gradually up to 21.5 piles in the year 2005. The average number of Sacks did not increase steadily over the study period. It was particularly low in 2002 and 2003 due the large campaign against deforestation started by Prof.Wangari who was an M.P in the neighboring Tetu constituency. The results however, imply an increased fuel wood use. The equation for a linear representation is given by:

$$Y = 1.0242x - 2033.3 \text{ and } R^2 = 0.9247.$$

The equation is in the form of $Y=a+bx+c$, where Y is the dependent variable that the equation tries to predict, X is the independent variable that is being used to predict Y, 'a' is the Y-intercept of the line, and 'c' is a value called the regression residual. In this study 'y' represents forest cover that is kept 'a' constant and 'x' represents use of wood fuel that is independent. The coefficient of determination is 0.9247. This implies that the study had 92.47% variation in statistics values which can be explained by the relationship between increased use of wood and forest cover loss. The equation gives a positive value of independent variable (use of wood) of 1.0242X. The implication is a positive effect on dependent variable (loss of forest cover).

This information is also as presented in the figure 12 below.

Figure 12: Average number of piles used per year (1996-2005)



Source, green belt movement, 2009.

81% of the people in Chinga area engage in various forest uses which contribute to loss of forest cover. As plates1 and 2 shows, the communities affected have no trees to use for fuel and would hence result to logging in the forest. It is therefore true to conclude that the various human –forest interactions contributes to loss of forest cover.

5.9 Objective 4: The fifth goal was to establish whether there is a link between increased tea acreage and forest degradation.

5.1.0 Introduction

Tea production has a negative impact on the environment. Natural habitats, rich in biodiversity, are converted into large farms of tea plant monocultures. This habitat loss leads to a reduction in the general number of species and threatens the survival of entire ecosystems.

The objectives of the current Forest Policy that received Cabinet approval in 1994 includes:

1. Increase the forest and tree cover of the country to ensure an increasing supply of forest products and services for meeting the basic needs of present and future generations and for enhancing the role of forestry in socio-economic development.
2. Conserve the remaining natural habitats and the wildlife therein, rehabilitate them and conserve their biodiversity.

3. Contribute to sustainable agriculture by conserving the soil and water resources by tree planting and appropriate forest management.

None of these objectives seems to have been strictly enforced or followed within the study area as plates 1, 2 and 3 above shows.

Table 20: Average numbers of acres under Tea and forest in the Study area.

years	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
No.ac.tea	5.2	5.8	6.1	6.4	6.8	7	7.2	7.8	8.3	8.8
Forest loss(acres)	1.8	1.6	1.5	1.5	1.8	0.6	0.6	0.4	0.25	0.25

Source, field survey, 2012

The number of acres under tea cover increased from 5.2 in 1996 to an average of 8.8 in 2005. There was reduction in forest cover from 1.8 in 1996 to 0.25 in 2005. This was due to stringent measures put in place by the government in the late 1980s after establishment of Nyayo Tea Corporation. Majority of the households could not easily access the forest to cultivate, cut trees or even burn charcoal. The result was systematic clearing of forests in the farmlands and replacing them with tea bushes. There has been financial motivation as implied by table 1; the result has led to tea increased production. Aggressive marketing by The Tea Board of Kenya has also led to increased tea expansion. This made more farmers expand their farmlands. Chinga Tea Factory management were always availing their annual reports to the farmers in the tea collection centers and fertilizer picking points. The fact that any negative aspect was always explained made farmers increase their acreage.

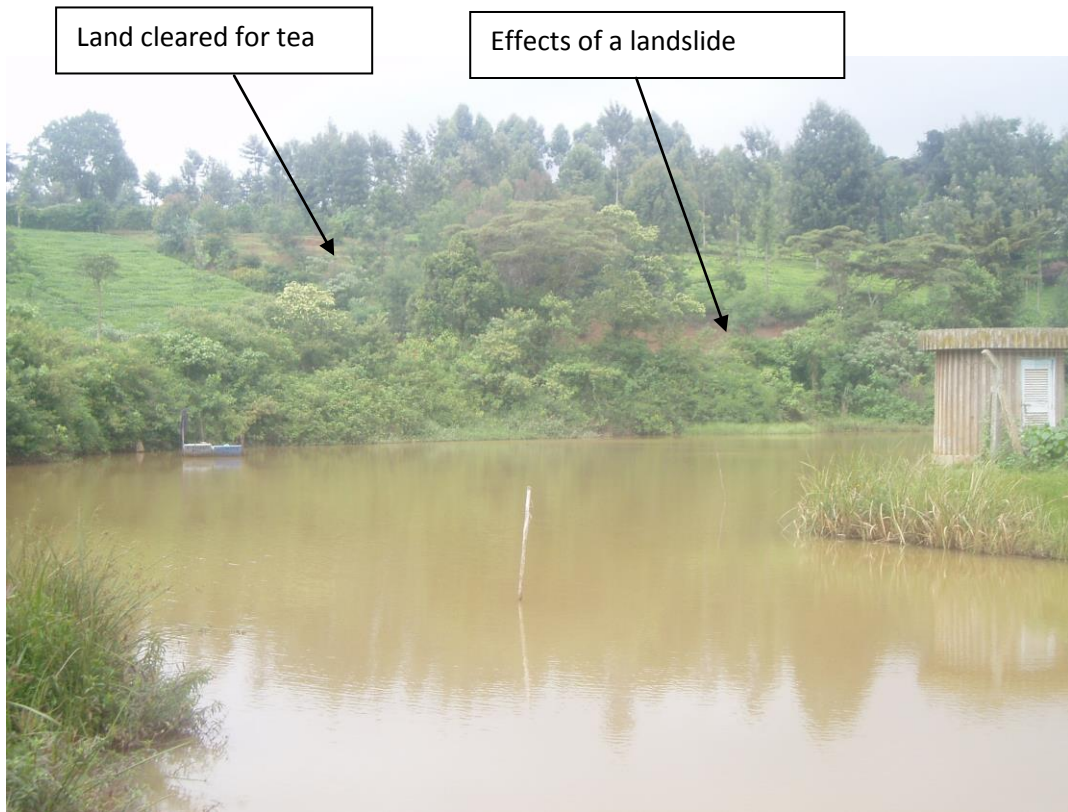
Plate 5: A section of Aberdares Forest showing effects of a Land Slide.



Source: Author, 2012.

This section forms the boundary between the Aberdare forest and the Nyayo Tea Zone in Mucarage, the lower part of the Homestead shown was carried away by a mudslide in 2011. Methods of soil conservation are not practised here, huge effects of landslide are evident in this area as indigenous tree were cut in readiness to teaplanting. when the rains were inadequate this large section was left for simple ferns to grow. The section that was not carried away does not have trees thereby leaving the soil prone to soil erosion. This may eventually make the soil too loose to hold trees in future as the land wound is degraded.

Plate 6: A section of Chinga dam showing muddy water due to soil erosion upstream.



Source, Author, 2012

This section shows Chinga Dam near a water pump, with muddy water, there is a mudslide in the background which together with soil erosion has caused siltation in the Dam. The study established significant changes in physical features between 1996 and 2005. Most of the changes as respondents indicated were signified by the drying up of rivers, forest cover reduced due to cutting down of trees for use in tea factories namely, Chinga and Iriaini, for firewood, timber or charcoal. Since all tea must be dried. Wood is usually the source of energy for this, and as a result drying has lead to localized deforestation.

Water levels in most of the area went down, water catchment areas have been interfered with, and the depth of the Chinga Dam has been reduced by siltation as a small pole put in the foreground shows, the soil eroded from the forest and the hilly Chinga terrain. More human settlements than before as implied in the data above have

led to vegetation cover reduction in the forest. The El Nino rains in the period 1997-1998 had an adverse effect on the lands for farming and lands on forest cover. Most hilly areas experienced mud-slides a phenomenon that caused land degradation in the affected area.

Plate 7: A section of Chinga Dam showing a plantation of eucalyptus trees along side Tea bushes.



(Source: Author, 2012)

The plate shows Chinga Dam and plantations of Eucalyptus alongside Tea farms in the Background, These trees spread their roots to suck up groundwater, Eucalyptus trees have an invading root system which depletes the water supply and exacerbates the fire hazards in areas already prone to wildfires. The threat of diminished water sources caused the Rwandan government to halt plantings and begin uprooting eucalyptus stands in marshlands and near waterways in 2006 and likewise the Ministry of Environment set out a policy to discourage the planting of Eucalyptus in Kenya from 2004. The dryer earth in eucalyptus forests is susceptible to severe erosion and uprooting trees. Even with the forest policy of 1994 there is no land use change in this area and part of this could have contributed to lowering of the water volume in Chinga Dam.

Testing the first hypothesis

Table 21: Amalgamated results for amount of wood used by the factory and loss of forest in acres.

Years	96+97	98+99	00+01	02+03	04+05	Total
Forest(acres)	3.4	3.0	2.4	1.0	0.45	10.25
Wood(t)	1417(1420)	10149(101450)	15570(15569)	17768(17765)	19449(19445)	64353
Total	1420.4	10151	15572.4	17769	19449.45	64362.25

The results were tabulated for the entire study period for every two years and the expected values are calculated as,

Next we have to compute the expected value for each cell, using the formula:

$$(\text{Row total} / \text{Grand total}) * \text{Column total}$$

For the first cell of Row 1 (Class 1, Physical development 2):

$$(\text{Row 1 total} / \text{Grand total}) * \text{Column 1 total}$$

$$=64353/64363.25*1420.4=1420$$

Which is taken as it is due to closeness of the values.

The first expected value is now 1426. Other expected values are calculated similarly and expressed in Brackets.

Now we have to apply the formula for the chi-square statistic:

$$\chi^2 = \sum (O-E)^2/E = (1417-1420)^2/1420 + (10149-10150)^2/10151 + (15570-15569)^2/15569 + (17768-17765)^2/17765 + (19449-19445)^2/19445$$

$$0.0064 + 0.000099 + 0.00064 + 0.0005 + 0.0008 = 0.0084 \text{ or } 0.008$$

$$\text{Degrees of freedom} = (\text{No. of rows} - 1) (\text{No. of columns} - 1)$$

$$= (5-1) (2-1)$$

$$= 4$$

A p-value of 0.05 or less is usually regarded as statistically significant, i.e. the observed deviation from the null hypothesis is significant. For the test to be

significant at the 0.05 level given 4 degrees of freedom the chi square value is 0.008 approximately; the value for χ^2 has to be at least 0.71 This would now give a probability value (PV) of 0.95 which is well above the PV of 0.05 that is considered statistically significant. The calculated value of 0.008 that should give a minimum value of 0.71 falls on the non-significant level on the chi-square table. Therefore, this study cannot accept the null hypothesis. This study concludes that there is a significant link between increased use of wood fuel and loss forest cover. Over use of wood and charcoal are the main sources of fuel and causes degradation of forest in Chinga area.

Testing the second hypothesis

- i. The null Hypothesis stated that there is no significant relationship between expansion of tea growing areas and degradation of forests in Chinga area. chi square test was used.

5.1.2 The amalgamated ten year results for the number of Acres under Tea and The number of Acres under forest lost were tabulated and represented as follows,

Table 22: Average number of acres under tea and area under forest cover.

Years	96+97	98+99	00+01	02+03	04+05	TOTALS
Tea(acres)	11(12.54)	12.5(13.51)	13.8(14.11)	15.0(13.94)	17.1(15.29)	69.4
Forest(acres)	3.4	3.0	2.4	1.0	0.45	10.25
TOTALS	14.4	15.5	16.2	16.0	17.55	79.65

Source, Author, 2012.

The expected values are calculated, Next we have to compute the expected value for each cell, using the formula: (Row total / Grand total) * Column total for the first cell of Row 1.

$$(\text{Row 1 total} / \text{Grand total}) * \text{Column 1 total} = 69.4 / 79.65 * 14.4 = 12.54$$

Which is taken as it is due to closeness of the values.

The first expected value is now 12.54. Other expected values are calculated similarly and expressed in Brackets.

Now we have to apply the formula for the chi-square statistic:

$$\chi^2 = \sum [(O-E)^2 / E]$$

Where O = the observed frequency in each category

E = the expected frequency in each category,

And the summation is made over all categories.

In this case this gives,

$$\begin{aligned} \chi^2 &= (O-E)^2/E = (11-12.54)^2/12.54 + (12.5-13.51)^2/13.51 + (13.8- \\ &14.11)^2/14.11 + (15-13.94)^2/13.94 + (17.1-15.29)^2/15.29 \\ \chi^2 &= 0.189 + 0.0895 + 0.0834 + 0.62 + 0.21 = 1.1127 \end{aligned}$$

Degrees of freedom = (No. of rows - 1) (No. of columns - 1)

$$= (5-1) (2-1)$$

$$= 4$$

A p-value of 0.05 or less is usually regarded as statistically significant, i.e. the observed deviation from the null hypothesis is significant. For the test to be significant at the 0.05 level given 4 degrees of freedom the chi square value is 1.12 approximately; the value for χ^2 has to be at least 1.06. This would now give a probability value (PV) of 0.90 which is well above the PV of 0.05 that is considered statistically significant. The calculated value of 1.12 that should give a minimum value of 1.06 falls on the non-significant level on the chi-square table. Therefore, we cannot accept the null hypothesis. This study therefore rejects the first null hypothesis. There is no significance relationship between expansion of Tea Growing areas and degradation of forest in Chinga area “This study therefore adopts the alternative hypothesis” Expansion of Tea growing areas influences degradation of forest in Chinga area.”

The study used a bivalent analysis where forest cover was the independent variable and acres of land under tea made a dependant variable, table 23 was obtained.

Table 23: Spearman's rho 1

The study used a bivalent analysis where forest cover was the independent variable and acres of land under tea made a dependant variable, table 5.1.8 was obtained.

Table 5.1.8 Correlations

		Acres of land under forest	Acres of land under tea
Acres of land under forest	Pearson correlation Sig(2-tailed) N	1 10	-.889 .001 10
Acres of land under tea	Persons correlation sig(2-tailed)	-.889 .001 10	1 10

Partial correlation between acres under forest and acres of land under tea, Correlation is significant at the 0.05 level (2-tailed)

(Source, author, 2012)

There is a negative relationship between forest cover and tea expansion. For every one acre increase in tea acreage there is 0.889 acres reduction in forest cover at significant level of 0.05 or 5%, if deforestation continues at this rate for the next ten years there will be no forests left in the farmlands.

Table 24: Spearman's rho 2

		Acres of land under forest	Fuel wood used in tones
Acres of land under forest	Pearson correlation Sig(2-tailed) N	1.000 10	-.695 .006 10
Fuel wood used in tones	Persons correlation sig(2-tailed) N	-.695 .026 10	1.000 11

Partial correlation between acres under forest and fuel wood used in tones

Correlation is significant at the 0.05 level (2-tailed)

(Source, author, 2012)

Table 24 above shows that for every ton of wood fuel used 0.695 acres of forested

land is lost at a significant level of 0.05 or 5%.

From the results above Chinga tea factory used 70660 tones of wood fuel between 1995 and 2005,for this fuel the factory would have set aside $70660/0.695=101669$ acres or 40667 hectares of forest land so as to sustain their demand of fuel for the ten years.

There is a negative relationship between forest land and wood fuel used in Chinga Tea Factory; this shows a direct impact of wood fuel on forest growth. Increased use of this type of renewable fuel has led to a significant forest reduction in Chinga area.

CHAPTER SIX

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

6.10 introduction

The purpose for this study was to study the effect of tea expansion on forest degradation and whether the resulting use of wood fuel has contributed to forest loss.

6.20 Research Findings

This research documented the following findings:

The specific objectives for this study were:

To determine the number of hectares under forest cover that was being lost in Chinga area annually between 1995 and 2005, the study established a significant decrease in trend of the number of acres that was still under tree cover for the years 1996-2005. The results indicate the decrease in forest cover over the years. The decrease trend can be attributed to deforestation occasioned by the need to create more land for farming, land sales or the subdivisions to create more human settlement and general loss due to overgrazing. There exist forest patches (plate1 and plate 2) that originally had indigenous trees in 1990 but after clearing, no trees have ever been planted. The study also found out that the area residents were responsible for the forest loss and therefore reduction of water in the catchment area. Furthermore, many residents make business with the factory over sale of wood. As the trees are cut they destroy lower plants that support the local ecology. Water sacking trees such as eucalyptus (plate 6) have been planted near the rivers also causing the same effect. The resulting deforestation has also led to loss of such species of trees as bamboo.

To determine the number of hectares that was planted with tea crop annually between 1995 and 2005, the study concluded an increase in tea acreage over the study period. The study found a significant increase in areas planted with tea over the study period. The said tea expansion was occasioned by both economic motivation and aggressive government campaigns through The Ministry of Agriculture. The study recorded a lot farmland cleared off indigenous trees in readiness for tea planting (plates 3 and 4). The results indicate that every tea acreage increase around Chinga area leads to a

decrease of 0.889 acres of forest land. Therefore, tea expansion has had a negative effect on forest cover. Nearly 44% of the respondents inherited land within the study period. The land subdivisions that resulted may have contributed to both land and forest degradation. The implication of this is that if every tea farm owner is to plant more tea at the expense of trees available then there will be no trees available for poles, wood fuel and other uses. The fuel required to process tea in Chinga Tea Factory will not be available and hence tea economy will be lost.

To determine the relationship between increased use of wood fuel and loss of forest cover. About 37% of the respondents earn less than two dollars a month. This income is not sufficient to meet financial needs of these people. The community resorts to illegal activities such as harvesting trees for poles, burning of charcoal and collecting honey for sale, these activities end up degrading the forest. Table 19 above, shows an over a hundred fold increase in fuel use by Chinga factory over the study period. Use of wood fuel more than doubled in the homestead (table 20). There is a notable increase in wood fuel use as objective three of this study shows and this increased fuel use has contributed significantly to forest degradation. This study shows a reduction of 0.695 acres of forest land for every ton of wood fuel used during the study period. The following factors favored deforestation: the electric fence had not been completed and therefore the forest was more accessible, the high inflation existing in the country occasioned by the effects of Goldenberg raised the agricultural and timber prices. These effects led the Chinga community to move almost near the source of Mathioya River and other mountain peaks to do farming. Timber and building poles business flourished. Most of these poles would end up in Chinga Tea Factory or homesteads.

To establish whether there is a link between increased tea acreage and forest degradation. The linkages between tea expansion and deforestation are most apparent in following respects: First, tea expansion was accompanied by considerable infrastructure development, like the building of small towns, construction of road networks that interconnect these towns, schools and other social amenities that are associated with increased population. Second, tea expanded in areas designed as communal lands such as schools so as to provide an income to these public schools. This meant that no communal land was left for planting of forest.

Nearly 84% of the targeted population is between 21 to 50 years. These are people at the peak of economic demands and therefore engage in economic ventures such as illegal forest tree logging and charcoal burning that leads to forest degradation. For the ten years under this study nearly 40667 hectares of forest trees were lost while supplying chinga tea factory with fuel wood. The rate of forest loss was such that for every acre of land planted with tea 0.889 acres of forest was lost the study established a link between tree reduction in the farmlands and the general forest loss therefore, it was easy to measure the link between increased tea acreage and forest loss. Increased tea acreage has therefore led to forest degradation in Chinga area. Sloping terrain towards the main rivers contributes to landslides when it rains. This loss of fertile soils to the rivers downstream not only degrades the soils but directly causes forest cover loss.

This first null hypothesis was rejected and therefore expansion of tea growing areas influences degradation of the forest in Chinga. Expansion of tea has a negative effect on forest cover in Chinga area. This negative relationship between forest cover and tea expansion now means that for every one acre increase in tea there is 0.899 acres reduction of forest cover. If this rate of forest loss continues unchecked forests in the farmlands would be diminished in ten years.

This null hypothesis was rejected. There is a negative relationship between forest existence and wood fuel used in Chinga area. This is so because of the enormous use of wood fuel in Chinga Tea Factory. The factory reverted to use of wood fuel in mid 1996 and reduced the use of oil. Tea expansion, due to aggressive campaigns by the agriculture economy has led to increased tea output. To process this increased tea output more wood fuel is required with the result being more deforestation. Increased wood fuel demand without proper programs for reforestation would be so dangerous that for every one ton increase in this fuel use 0.695 acres of forest is lost.

6.30 Conclusion

6.31 Consequences of Deforestation

Deforestation has many far-reaching consequences; the environmental functions and services of the forest ecosystem are reduced or even lost, depending on the extent of deforestation (Sponsel *et al.*, 1996). Forests contain numerous species of flora and fauna and protect the soils from heavy rainfall and its effects on erosion.

Deforestation reduces biological diversity and increases soil erosion and the siltation of rivers and streams and can endanger hydro electric dams Moreover; deforestation also means the loss of renewable natural resources such as valuable non-timber forest products and ecotourism value of the area.

This study therefore concludes that: tea expansion in Chinga has led to forest reduction. The negative relationship between use of wood fuel and maintaining forest has led to deforestation. Likewise, increased tea growth has increased wood fuel demand which in turn contributed to forest loss. The purpose of the forest law adopted in 1994 to regulate reforestation, protection and use of forest resources, form the legal bases for prosecution when the rules are not followed. Using sound principles increase of forest productivity, landscape stability and environmental quality in order to perform the ecological, economical and social functions without inflicting damage to other ecosystems. The upper Chinga location is a part of Aberdares ecosystem that has a high human-forest interaction. Much of the land is under Tea cultivation leaving the communities with little or no space to plant trees for domestic use. The result has been overreliance on the forest for wood fuel and other economic gains.

6.4 Recommendations

Since 81% of the respondents indicates that communities contributes forest cover loss then integrated education programs should be initiated through Mucarage Forest Association, Tea Co- operative and Sacco Society so as to educate these people on forest conservation through planting of trees and sustainable use of forest resources. The targeted stakeholders to work with these people should be Chinga Tea Factory through Kenya Tea Development Authority and Kenya Forest Service.

Forestry is aimed at poverty reduction, employment generation and improvement of livelihoods among many other things through sustainable use. Stake holders such as KFS, NGOs and other forest conservation groups should first motivate farmers to grow trees by giving incentives like seedlings and then establish a fund to pay some money for surviving trees periodically. The water and the agriculture Ministries should also encourage farmers to have vegetated buffer stripes along the rivers so as to maintain river flow. This may in the long run improve the forest cover. The results may promote increased timber for sale and wood fuel for by tea factories including

use by communities. Employment may not only increase through elevated demand for seedlings but also through sale of forest and trees products.

A well thought out forestry policy exists but its aggressive implementation has not been done, there needs to be an intergovernmental law that links all Government ministries on strict implementation of forestry policy. This would put in place appropriate institutional arrangements to coordinate and support the forest sector. This study would also recommend that more and better quantitative evaluation be made of direct and indirect losses from tea and other agricultural practice as a basis for determining more effective orientation of research programs. Periodic, preferably annual reports on forest state and conditions should be published for all preferably using a uniform format that will facilitate wide national use and acceptance by all forest stakeholders.

The Kenya Forest Service, Fire Services have the statutory responsibility for dealing with all uncontrolled fires, and therefore an important part of planning should be done in consultation with the local Fire Service. The stake holders should be willing, within the level of staff availability, to help in education and management of forest fires.

In order to allow animals to graze in the forest, The Kenya forestry service charges a fee of Ksh 100 per month for every cow and Ksh 50 monthly for every sheep. The result is increased animal populations which feed more and reduce forest cover rejuvenation. This form of grazing in the forest is not sustainable; the KFS should allow a time of six months before allowing domestic animals to destroy forest trees. The forest patches identified should be planted with trees by the KFS and the communities near the forest. Tea policy should clearly be directed to the promotion of renewable energy. As a signatory to Kyoto Protocol, Kenya should be moving towards the target of ensuring that an increasing proportion of primary power comes from renewable resources, As well as providing internal support to the development of renewable energy, the tea factories should adopt a policy to convert some of their wastes into biomass to minimize overreliance on wood fuel. In addition Chinga Tea Factory management through KTDA should be encouraged to use energy saving production, this may enable them overcome some barriers such as, lack of knowledge about the energy-efficient technologies adopted in the tea processing units. Use Modern equipment that consumes less energy should be used to reduce demand of a

lot of thermal energy that leads to depleting of the forest. There is Lack of awareness about the opportunities available through adoption of energy saving technologies such as carbon credits which would save some money for the factory to enable them plant more trees.

The Chinga Tea Factory does have wood fuel base and should therefore buy land where they should plant trees. This would enable the factory use the wood fuel sustainably, if this would be enforced through KTDA, there would be a reverse of the negative trends that led to deforestation identified by this study. The factory management would also do the following to reverse the trends:

Develop new and cheap energy sources; improve efficiency of the energy production and its transportation. This may also lower tea production so as to save money for wood fuel improvement. By planting trees the factory can earn carbon based finances as stipulated in the Forest Act of 2005 and the Energy Act of 2006. This study would also recommend use of renewable sources of energy such as hydro, wind and solar by the tea factory so as to reduce overreliance on wood fuel.

The KFS should not license loggers in their plantations until an equivalent size of plantations have matured, this would enable trees to grow to maturity. Corrupt forest rangers should not only be sacked but should also be prosecuted; this may be a deterrent to such offences in future. The KFS should also patrol the recently completed electric fence to help curb environmental crimes, such as illegal trade in sandalwood (*Santalum Album*), illegal logging, and illegal trade in other flora.

6.5 Recommendations for further research

This study recommends that study be done on the following areas,

- 1) The effect of expansion of tea on land degradation in chinga area.
- 2) The effect of increased use of inorganic fertilizer due to tea expansion on soil quality in chinga location. and
- 3) The effect of both solid and liquid wastes from chinga tea factory on the Chinga River downstream.
- 4) Relationship between tea expansion and soil water content in chinga.

REFERENCES

Anderson, B. (1963) *Soils of Tanganyika*. Ministry of Agriculture Bulletin, Dar es Salaam 6:1-34
Government of Kenya (2005).

Anonymous, (2002.) *The Tea Growers Hand Book*. 5th Edition. The Tea Research Foundation of Kenya Printing Services. Nairobi.

Butynski, T., 1999, *Aberdares National Park and Aberdares Forest Reserves Wildlife Fence Placement Study and Recommendations*, Nairobi.

Campbell, B. M. Ed. (1996): *The miombo in transition. Woodlands and welfare in Africa*- CIFOR: Bogor.

Chinga tea factory, (2011). *Tea production annual report*, Chinga.

Chomitz, K.M. and Griffiths, C. (1997) *an economic analysis of wood fuel management in the Sahel, the case of Chad*. World Bank, Washington, DC.

CFC (Common Fund for Commodities). 2002. *2001 Annual Report*. Available at <http://www.common-fund.org!publannualreportOl>, Amsterdam, the Netherlands: CFC. FAO (1990), *Forest Resources Assessment*, Rome.

China Tea Information (2002). Centre for Science in the public Interest (CSPI), *Developmental threats to Biodiversity and opportunities for conservation*. China.

Chaudhuri, K. (2002) the Statesman Ltd. *Financial Times Information*. July 28. in the tropics. An historical perspective. - CRC Press: Boca Raton.

Encyclopaedia Britannica, (2003). *The New Encyclopaedia Britannica*, Volume 26. Encyclopaedia Britannica, Inc

FAO (Food and Agriculture Organization of the United Nations). (1987). *Technical and economic aspects of using wood fuels in rural industries*. Rome: UN Food and Agriculture Organization.

FAO (1990) Community Forestry case study series, *social and economic incentives for small holder tree growing*, Rome

Food and Agriculture Organisation (FAO), (2001). *World Production Statistics*. FAO Rome, pp: 51.

Food and Agriculture Organization of the United Nations (1997a): *State of the world's forests*. 1997. - FAO: Rome.

Forests Act, (2005), *Laws of Kenya*. Government printer, Nairobi.

Kenya forest service, (1993). *Kenya forest inventory*, KFS.Nairobi.

George S. (2002).University of Nairobi, Kenya.

GEO Data portal, FAO, 2005, UNEP, Nairobi.

Global advances in tea science, (1999), 153-160, Academic Publisher, London.

Gessesse D, (2011). *Eucalyptus in East Africa, Socio-economic and environmental issues*. Planted Forests and Trees Working Paper 46/E, Forest Management Team, Forest Management Division. FAO, Rome.

GoK, (2010) 2009 *Kenya Population and Housing Census: Volume 1 A, Population Distribution by Administrative Units*. Government Printers, Nairobi.

Government of Kenya (2006). Environmental Management and Coordination (Conservation of Biodiversity, Access to Genetic Resources and Benefit Sharing) Regulations, Government printer, Nairobi.

GoK (1991) *Kenya forest master plan*, government printer, Nairobi. GoK (2007) Ministry of planning and national development, *vision 2030*, Government printer, Nairobi.

Government of Kenya (2006). *Environmental Management and Coordination Act*, government printer, Nairobi.

GoK (2006) *Forest Management Regulations*, Government printer, Nairobi.

Hamilton, A.C. (1989) *the place and the problem*. In: Hamilton, A.C, and Smith, R (Edition) *Forest conservation in East Usambara Mountains Tanzania*, IUCN, Gland.

IARC-WHO.1991). *Caffeine Content in Tea and Other Drinks*. In: Willson, K.C. (Ed.). *Coffee, Cocoa and Tea*. CAB international, Wallingford, UK.

James D (2006) *Foresters and Ecologists*, University of Texas press, Austin

Kamweti et al, (2009), *Causes of deforestation in Africa*. Nairobi.

Katrina B. (1994) *the causes of tropical deforestation and economics*. UBC press, Vancouver.

Kenya, Government of (1994), Ministry of Environment and Natural Resources *Kenya forestry master plan*. Nairobi: Government printer.

Kenya Forest Service (2000). *Drivers of Deforestation and Forest Degradation in Kenya*, Nairobi.

Kenya (2009), *The Environmental management and co-ordination act on Wet lands, river banks, and lake shores management, Regulations of 2009*. Nairobi: Government Printer.

Kenya forestry Research institute (2009). KEFRI, Nairobi.

Kenya Tea Development Agency annual report, 2010, 2011. 1996. Nairobi.

Kibet D, (2010). *Effect of rain on tea production in Marakwet*. Moi University, Eldoret.

Lwanga, J.S (2003) forest succession in Kibale national Uganda, implications for forest restoration and management. New York.

Mugambi J.(200), A Study of waste management Approaches in tea processing factories: A case study of small Holder tea factories in Kenya.

Malimbwi R.(2002) *The analysis of sustainable fuel wood production systems in Tanzania*, Faculty of Forestry and Nature Conservation, Sokoine University of Agriculture, Tanzania.

Michel Ochieng Odhimbo (1998), Policy Dialogue series no 1 and 2, Nairobi.

Monela, G.C. & Kihyo, V. B. M. S., (1999). Wood Energy in Sub-Saharan Africa. In: Palo, M. & Uusivuori, J. (Eds). *World Forests, Society and Environment*. Kluwer.

Mugambi (2006) *Socio-economic effects of tea expansion in rural Kenya*, University of Nairobi. Nairobi.

Murugu R. Wanjiru (2004), *review of the impacts of tea development on the forest covers in parts of Eastern Aberdares region*. M. A research project. Department of Geography and Environmental studies. University of Nairobi.

National Biomass study, (1996) *Land Cover Stratification (Vegetation)*, Uganda Forest Department, Kampala, Uganda.

National forestry authority Audit report. (2006), a critique on proposed sugar plantation in mibira. Kampala.

Natures benefit in Kenya, (2001). *An atlas of ecosystems and human well-being*, Washington, DC and Nairobi, world resources institute, New York.

- Newmark, W.D. (2002) *Conserving Biodiversity in East African Forests: A study of The Eastern Arc Mountains*, Springer, New York.
- Ngechu (1997). *effect of El Nino rains*. University of Nairobi. Nairobi.
- Nigel D (1995). *The timber trade and degradation of Global forests*, Amazon. London
- Nkiruka Chiemelu, International Relations and History (2004), Luce Fellow, summer 2003: At Who's Expense? *Policy formulation in Wildlife Conservation and Human Conflict in Kenya*.UK.
- Nyandika Jane (2008), *Environmental problems Associated with Tea factories in Kenya: A case study of Kebirigo Tea factory*. Department of Geography and Environmental studies, University of Nairobi.
- Ochanda D, (1981) *Effects of logging on forest regeneration in Kibale national park*, Makerere University Kampala.
- Okella, (2009). *desert agriculture and Agroforestry mission*, Lang 2004b.
- Ongweny G S, (2002). *a new estimate of sedimentation rates on the upper Tana River*, East African meteorological department, 1961.
- Peter W, (1995), *Kenya's indigenous forests, status, management and conservation*.
- Rhino Ark (2006), *situation analysis of the Gates of the Aberdare conservation area*, Rhino Ark, Nairobi.
- Solon L. (2001) *Agriculture expansion and tropical forests*, Earths scan, London
- S.Moorthy, (2000) *Energy Efficient Machinery, Seminar on Energy Conservation methods for Tea industry*, United Planters' Association Southern India, Connor.

Tea board of Kenya (2012) *annual reports, 2000 and 2012*, Nairobi.

Tea change. (2002). *Nationwide News Party Limited. Sunday Telegraph, Sydney.*

Tea Research association. (1984) *Tea Technology: Challenge of Tomorrow*, Proceedings of Engineering Symposium, Calcutta.

Tea research foundation of Kenya. (2009). *Tea benefits*. Nairobi.

The Kenya National Environmental action plan-NEAP Report, 1994, Ministry of Environment and Natural Resources, Government printer, Nairobi.

UNEP (2009), Annual net change in forest area, 1995-2005. London

UNEP (2009), forest graphics. UN press and printing services, Nairobi.

Utrecht, (1997). induced deforestation in Tanzania and Malawi by tea expansion. FAO, Rome.

Vijdan K. (2008) *Reading Tea leaves on the Potential Impact of the Privatization of Tea Estates in Rwanda*, Kigali.

Vuchiteh A. (2011) Assessing the correlation between forests degradation and climate change in Manyu region of Cameroon. Amazon publishers.uk.

Wangwe J.B (2008), *Underlying causes of deforestation and forest Degradation in Kenya*. Nairobi

Watson, J. (2001) How to Determine a Sample Size: Tip sheet #60, University Park, PA. Penn State Cooperative Extension Available online at <http://www.extension.psu.edu/evaluation/pdf/TS60.pdf>

Watts, R., (1999). Improving farmer's income. Africa Farming and Food Processing, 9: 26-28. Wallingford, UK

WORLD BANK (2008), *Economics of deforestation and forest Degradation*. Washington DC

Willson, K.C., 1999. Coffee, Cocoa and Tea. CAB International, Wallingford, UK. 3.

Watts, R., 1999. Improving farmer's income. Africa Farming and Food Processing, 9: 26-28.

Yukek. Eucalyptus in East Africa, socio-economic and environmental issues, 2011. Rome Italy

Website sources:

Baechler G (1998) why environmental transformation causes violence. www.library.

Chronology of the dessication of aberdare forest, <http://www.dfd.dlr.del/chronology.htm>.

<http://www.cspinet.org/new/cafchart.htm>.

<http://www.fao.org/documents>.

<http://iipnetwork.org/databases/finance/energy-conservation-small-tea-processing-units-south-india>

<http://www.easternarc.org/pub/disappearingforest.html>

<http://www.cnteainfo.com/english/knowledge/grow/plant.htm>. November 14. Dietz, M. 2002.

www.kenyaforestservice.org

APPENDIX

Questionnaire

Effect of tea cultivation on forest degradation in Chinga area. The research is for academic purposes towards a Masters of Arts degree in environmental planning and management at the University of Nairobi.

All the information provided will be treated with utmost confidentiality. Thank you for your responses.

Questionnaire no-----

Date_____ Interviewer_____

Section A Respondents date-----

SECTION A: RESPONDENTS' INFORMATION

1. Name of the respondent (optional) -----

Sex (tick) male () Female ()

2. Categorize age of respondents in the following age brackets. Please tick.

a) Below 20 years () b) 21-40 years () c) 41-50 years () d) above 51 years
()

3. Position in the Household.

(1) Household head (2) spouse to House hold head (3) Child

4. Primary occupation of the respondent. (Please tick)

(1) Unemployed. (2) Tea farmer (3) Casual labourer (4) salaried employee.

5. Highest level of education.

(1) No formal education (2) Lower primary (1-3) (3) Upper primary (4-7) (4) O-level (1-4) (5) Vocational training. (College/University).

6. What is your average monthly income in Ksh from all your sources?

a) Below 5000 () b) below 10000 () c) between 10000 and 20000 () d) above 20000 ()

Section B. Evaluation of Energy consumption

7. Give an approximate amount of wood you used per year between 1996 to 2005.

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005

8. Are you a tea farmer? Please tick

Yes	No
-----	----

9 (i).Did you own any land in 1996?

Yes	No
-----	----

(ii) If yes how many acres of land did you own individually or as a family?.....

(iii) Please fill in the table below to show any changes in land under tea cultivation by indicating the number of acres of land was under tea cultivation.

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005

(iv)Please fill in the table below to indicate the number of acres of your land under trees.

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005

10. List the physical features that are near where you live, these include Rivers, Wetland, Forest, etc.

11. Has there been any changes in the physical features between 1996 and 2005 in (10) above?

12. In your view what do you think has led to the, (a) negative changes in (10) above?

(b) Positive changes in (10) above.

13. Which impacts in (10) above can be attributed to the growing of tea bushes?

Explain your answers given above.

14. Have you been solving problems in (10) above?

15. Are there organizations in this area that has been/are working on environmental issues in this area? 1. Yes 2. No

16. In what ways do you think the above problems can be solved?

17. Has the energy change from furnace oil to wood fuel had any effect on your income?

Explain?

18. Where do you get your fire wood? Please tick

a) our family farm () b) Forest.()

Section C. Drivers of Degradation.

19. State the levels of significance in the following drivers of change by indicating whether, 1 =Very Significant, 2= Significant, 3= Moderate, 4= little and 5 =very significant.

Drivers of Degradation	Level of significance	Degradation
(I) Fuel wood removal		
(ii) Timber removal		
(iii) Fodder, Leaf, Litter removal	Level of significance	

	Degradation Element
(iv) Overexploitation of medicinal & other species	
(v) Encroachment	
(vi) Overgrazing	
(vii) Wild fires	

Drivers of Degradation	Level of significance	Degradation Element
(viii) Development activities e.g. Roads		
(ix) Settlements to the landless		
(x) Floods		
(xi) Invasive species		
(xii) Rot Diseases		
(xiii) Growing of tea Bushes		
(xiv) Strong winds		

20. In your own opinion, what is the state of Aberdare forest? Please tick.

(a) Very healthy, (b) Healthy, (c) Degraded,

(d) Very Degraded

21. Arrange the above Fourteen elements in the order of prominence, starting with the worst.

22. Explain the first three elements.

a) Fuel wood usage, an attempt will be made to examine the proportion of people that use firewood and charcoal as energy sources.

b) Social economic indicators such as may be leading to illegal subsistence farming, logging grazing of animals in the forest and any other indicator that may impact negatively to the Health of the Forest.

1. Soil erosion indicators, such as bare land- scape and gullies.
2. Vegetation cover.

SECTION C: PEOPLE –FOREST INTERACTIONS

23. Do you use the forest in any of the following ways? Answer yes or no.

(1) As a source of firewood, (2) As a source of Medicinal products..... (3)For recreation..... (4) Subsistence Farming..... (5)As a source of economic gain, Timber for sale etc.... (6) As source of Bush meat. (7)Any other (specify).....

24 Do you think any of these uses contribute to forest loss of cover?

Yes (2) No

24 If yes who do you blame for the Aberdare forest loss of forest cover? Please tick.

(1)Government. (2) Kenya forest services. (3) KTDA. (4) CBOs. (5) Area residents. (6) Others (specify)-----

25. Why are these organizations/people to blame?

26. Do you need a cleaner and a Healthy environment?

(1) Yes. (2) No

27. If yes what do you think is your responsibility?

28. Aberdare forest has recently been fenced using electricity as a means of conserving it, have you lost any economic gain? (1) Yes (2) No

29. If yes how much Ksh per year have you lost.....

30. If Aberdare forest is to further be rehabilitated, what would you like to see improved? -----

31. Would you be willing to participate in soil conservation and tree planting in Aberdare forest without any pay? (1) Yes (2) No